Bicycle Reference Manual – Asian Experiences

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Content

Bicycle Traffic in China

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Introduction

China not only houses the largest population, but also the world's largest fleet of bicycles. Bicycles are the principal and most often used means of private transportation in this eastern Asian nation. In fact, the bicycle plays an important transportation role in all developing countries. Bikes have many advantages: low initial cost, low operating expense, small space needs for operating and storing, and the flexibility to go where other vehicles cannot. Bicycles are especially advantageous in China where city mass transit systems are often inadequate for meeting urban travel demands.
Used as a primary means of transportation by large numbers of urban inhabitants, bicycles are a mixed blessing, having advantages as well as serious disadvantages. Like some of the adverse impacts of motor vehicle traffic, bicycles contribute to street congestion and noise (bicycle bells), interfere with pedestrian and other vehicular movements, and are the cause of many street accidents. If urban transportation in China is to be improved, the best place to start is with the use and misuse of bicycles. This article describes bicycle traffic in China and suggests measures to improve bicycle use in the overall transportation mix.

Background Information

The total number of bicycles in China was about 100 million as of 1979. Comparatively, the nation’s total number of motor vehicles (cars, buses, trucks, and motorcycles) was just over 2 million. The proportion of bicycles to motor vehicles is therefore considerable if not overwhelming.
In many large and medium sizes cites there is about one bicycle for every two to three persons. The number of bicycles registered in some of these large cities is compared to population figures in Table I.

TABLE I - REGISTERED BICYCLES IN RELATION TO POPULATION

City	*Beijing*	*Shanghai*	*Tianjin*	*Guanzhou*	*Chengda*	*Wuhan*	*Tangshan*
Number of bicycles* (thousands)	2,800	1,600	1,250	780	530	380	350
Population (millions)	8.71	11.32	7.39	5.35	3.85	3.84	1.0[1]

City	*Kunming*	*Baotou*	*Changchun*	*Nanjing*	*Hanzhou*	*Fuzhou*
Number of bicycles* (thousands)	330	330	300	300	250	190
Population (millions)	1.93	1.0[1]	1.61	3.55	1.11	1.05

* The figures for Beijing, Shanghai and Tianjin are for 1978, the other figures are for 1977.
[1] Rough estimates.

During the last decade, the average rate of growth in the number of bicycles has been about 10 percent in the larger cities, although some areas have increased by 15-20 percent. To keep up with this rise, the annual production of bicycles has also increased rapidly in recent years. The estimate of bicycle manufacturing trends given in Table II implies that production growth rates are rather high and still rising.

TABLE II - BICYCLE MANUFACTURING TRENDS

Year	*1949*	*1952*	*1978*	*1979*	*1980*	*1981*
Number of Bicycles manufactured (thousands)	14	80	8,540	10,095	13,022	17,540
Yearly growth rate (%)	-	-	-	18.2	29.0	34.7

Bicycle Travel Characteristics

In addition to the advantages already cited, bicycles also are non-polluting and energy efficient. Their speed is several times faster than walking and they can easily travel on narrow streets and lanes, maneuvering through traffic congestion nearly as well as pedestrians. Bicycles can easily be parked very close to their destinations and they can carry light loads in addition to the weight of the cyclist. Their energy use efficiency is higher than other modes of transportation including pedestrian. A cyclist moving at 10 miles per hour uses only 97 Btu per passenger-mile, while a pedestrian uses 500 Btu per

passenger-mile walking at 2.5 mph (1). A person's energy consumption over a given distance while riding a bicycle as compared to walking is about one-fifth of the latter and human transport (bicycling and walking) is 10-40 times as energy efficient as motorized transport. (2)
In China bicycles are used primarily for commuting and shopping. Most workers and professionals use bikes because they are often quicker than transit services or other kinds of private vehicles. For example in the city of Tangshan Hebei province), the average percentage of workers and professionals cycling to work is 70 percent; this figure represents about 80 to 95 percent of those working in state-operated offices and businesses. (3)
Streets are generally congested in the large cities not only because they are narrow but also because of the large number of vehicles operating on them. Consequently transit vehicle speeds are very low, making it difficult for them to keep to schedules, often causing excessive waiting passenger time. As a result of perceived time savings, bicycles are being used increasingly for work trips. In one city, for example, over a million work-trip commuters ride bicycles to work while only 600,000 commute by bus. (4) The number of bicycle trips in Chinese cities generally accounts for 30 to 60 percent of the total number of trips. (5)
In addition to transporting the cyclist, bicycles are used for a number of special purposes. For example, children are frequently carried in bicycle "side cars". In rural areas container attachments on bicycles are used to carry agricultural products to market. These are usually heavy bikes especially designated for this purpose. In some parts of China such as Guangdong province, cyclists sometimes use their bikes as a taxi to carry a paying passenger.

Speed

A bicyclist's speed is dependent on a number of factors. These include geographical characteristics, the age and sex of the cyclist, traffic and roadway conditions, and the cyclist's physical ability among other factors. There are often diurnal variations in cyclists' riding speeds. A recent survey showed that bike travel speeds of about 13-18 km per hour (8-11 mph) are greater in the mornings for work trips than the average speed range of 9-13 km per hour (6-8 mph) in the afternoons for return trips home. After the afternoon commuting peak, average speeds once again return to 13-18 km per hour range(6). In moving traffic, effective bike speeds are about 10 percent lower than average motor vehicle speeds.
Design speeds for bicycles in China are different from those in the United States. In general, a minimum design speed of 20 mph (32 km/h) is used in the States 7). This difference may be due to the types of bicycles used and trip purposes. Americans ride primarily for recreation and sport on multi-geared bicycles as compared to commuter usage and heavier, single-geared bicyles of Chinese cyclists.

TABLE III - ROAD SPACE NEEDED PER BICYCLE

Road space needed per	*Relevant States of bicycle traffic*

bicycle (m^2)		
At Midblocks	>10	Very comfortable, can overtake freely, no speed limit pedestrians can cross the road
	8	Comfortable, no speed limit, not very hard for pedestrians TO cross the road
	6	Cannot overtake, have to concentrate attention, very hard TO cross the road
	4.5	Speed under about 10 km/h, more dense bicycle flow, cannot cross the road
Near Intersections	4	Speed under 8 km/h, one bicycle falling over may cause the nearby bicycles to do so
	2.5	Speed under 5 km/h, cyclists have to prepare to get off the bicycles near the intersections
	2.2	Speed of 3-4 km/h, most cyclists walk bicycles

Travel Time and Trip Length

When bicycle travel time is perceived to be about equal to that of a transit trip, most cyclists still prefer using a bicycle because it is cheaper and more convenient. The choice is also influenced by the waiting time for transit vehicle arrivals, the walking time to transit stops, and weather conditions.
For commuting, the average bicycle trip length is generally about 9 km (5.6 mi) for males and 5 km (3.1 mi) for females. (8) Of course, if there is no easily accessible transit route or the walking distance to transit stops is very long, the action radius of the bicycle will be larger. Very long bicycle trip lengths are mainly incurred during recreational rides or when attending cultural events. Long trip lengths are also incurred by farmers carrying agricultural products to markets in relatively flat farming areas where this is feasible.

Road Space Needs

The road space needed for bicycle traffic varies with road conditions and traffic volumes. Space needs for the relevant bicycle traffic conditions are summarized in Table III. When planning for bicycle traffic, road areas of 10-12 square meters (108-129 square meters) are usually allocated for each bicycle at a design speed of 10-20 km per hour (6-12 mph). More space is needed as vehicular volumes increase causing uneven traffic flows and more opportunity for cross traffic interference(9). (See Table III.)

Parking

Although there is a shortage of bicycle parking space in some areas of the larger cities, bicycle parking is not a serious problem in China. Free bicycle parking spaces are available at every office and factory. Inhabitants of residential areas keep their bicycles in their apartments or in adjacent public parking spaces. Many of the bicycle parking areas are roofed and some have walls. Such facilities are provided on the wider sidewalks or in lightly used small streets or lanes. Some parking services employ custodians to look after the parked bicycles. Bicycle parking fees are generally RMB 2 fen or about one U.S cent (RMB is the official term for Chinese currency whose basic unit is the yuan, which equals 100 fen). Traffic regulations mandate that bicycles be parked in designated parking areas. At recreational facilities like cinemas, theaters, gymnasiums, and stadiums, there frequently is a shortage of legal bicycle parking and some bicycles end up parked on sidewalks or in vehicle parking lanes.
Some parking areas are equipped with bike racks. However, most bicycles are parked on their own kickstands. Since most Chinese bicycles have 28" wheels, this is the standard for designing bicycle parking spaces. Urban planners use a parking area of 1.4-1.8 square meters (15-19.4 square feet) per bicycle to estimate the amount of space needed for parking areas, including aisles and maneuvering space (10).

Registration

In China all bicycles must be registered with the authorities and must display license plates. However, cyclists are not required to have drivers licenses. When the ownership of a bicycle changes or the bicycle owner moves from one city to another, the bike must he reregistered. As a result it is very difficult to resell stolen bicycles. Bicycle theft is not a major problem in China.

Bikeways

Bikeways are generally arranged on both sides of the road between motor vehicle lanes and adjacent sidewalks. Bikeways are marked with painted lines or separated from motor vehicle lanes by barriers. In the absence of marked bikeways, bicycles must keep to the right side of the road.
The standard width for a bicycle lane is the total of the bicycle's handle bar width plus a deviation width of 0.4 meters (1.3 feet). The total value is generally 0.9-1.0 meters (3.0-3.3 feet). The width of two bicycle lanes is 2.5 (8.2 feet); for each additional lane 1.0 meter in width is added (11). The maximum bikeway width is limited to 2 or 3 lanes in each direction. Experience has shown that cyclists tend to divide into two bicycle flows (in the same direction) regardless of how many additional lanes are provided.
The minimum radius of curvature for a bikeway in China is 10 meters; in special cases, it may be as short as 3 meters but then the safe speed will decrease to under 10 km/h (6 mph).
According to observation, bicycle speed is not significantly influenced when the gradient is below 1 percent. The speed will begin to decrease as the gradient increases to 2 percent; it will be reduced further to 7-8 km/h (4-5 mph) by a 3 percent gradient (12). So it is preferable that the gradient be below 2 percent. On the other hand, the

speed can become dangerously high when the downgrade is 3 percent. Of course, the resulting speeds also depend on the length of grade.

Use in Various Weather Conditions

Cyclists are sometimes faced with severe weather conditions. When it is raining they usually wear special raincoats, designed to cover the bicycles' handle bars. Since speeds are relatively slow, it is normally not a major problem if the streets are wet and the bicycle does not stop easily when the brakes are applied.
However, in the northern part of China during the wintertime when the streets are covered with ice, cycling is very dangerous. Thus, under icy conditions many bicyclists turn to transit vehicles instead for commuting, shopping, and other trip purposes.

Some Flow Characteristics

Bicycle traffic flows in China are quite large and rapidly increasing. In 1965 the largest rate of flow for bicycles was measured at 8,600 bicycles/hr at Beijing's busiest intersection during morning peak hours. By 1977 28 intersections were experiencing bicycle flow rates of over 10,000 bicycles/hr, the largest of them being more than 20,000 bicycles/hr. An intersection in Tianjing was once measured at more than 50,000 bicycles/hr. In Tangshan after the great earthquake of 1976, 8 intersections had bicycle flow rates of about 10,000 bicycles/ hr(13).
The peak flows, of course, are much higher than the average flows. For example, 1977 traffic flow statistics on 10 arterial streets in Shanghai show that the average bicycle flow rate was 1.6 times as large as the motor vehicle flow rate and ranged up to 6.5 times as large during peak hours. (14)
The rates of flow for bicycles moving in opposite directions vary greatly during the day. Because most businesses are located in the suburbs, the flow of bicycles towards the suburbs is several times higher than towards the urban districts in the mornings and just the opposite in the afternoons.

Bicycle Servicing

There are numerous bicycle repair shops in China, scattered all throughout the cities, towns, and countrysides. It is very easy to replace parts, add air to tires, and perform other such repair/ maintenance services on a bike. There are rental shops that lease bikes to anyone producing appropriate identification. Rental fees are about RMB 0.1-0.15 yuan/hr (5-8 cents/hr); the daily rate is much cheaper.

Traffic Regulations

At the present time, China has no formal national traffic regulations. Although each province and city has its own traffic restrictions, they are quite similar except for slight local differences. Generally, the regulations stipulale:

1. Every bicycle must have a license issued by the proper authorities and display a number plate.
2. Safety equipment must be in good working order (bell, brake, etc.).
3. Every moving bicycle must keep to the right side of the road.
4. Cyclists may not ride two or more abreast.
5. Cyclists may not participate in any race or endurance contest with any other vehicle on public roads.
6. Riders must not hold an umbrella up while cycling.
7. While moving, the cyclist must not remove both hands from the handle bars, cling or attach himself or his bicycle to any other moving vehicle, nor ride on sidewalks.
8. Operators must not turn suddenly, and they must use a hand signal to indicate the direction of the turn.
9. Cyclists must not carry passengers when riding bicycles in urban areas.
10. Public streets or highways are off limits to learners.

Financing

The price of a standard bicycle is about RMB 155 yuan ($83.78). Commuter bicyclists are subsidized RMB 3 yuan ($l.62) per month by the state, or RMB 36 yuan ($19.46) annually. Therefore, a little over four years worth of subsidy is often nearly equal to the price of a bicycle. Because the life expectancy of a new bicycle is at least 10 to 15 years (more than twice the four plus years needed to amortize the cost), a commuter cyclist will realize a good part of the total subsidy as an actual addition to personal net income. In Beijing there are about 3 million bicycles. About 50 percent of them are state subsidized in the amount of RMB 4.5 million yuan per month, for a total of RMB 55 million yuan per year. (15)
Skeptics argue that the annual 55 million yuan subsidy would be enough to improve the urban transit system and the overall urban traffic conditions. Some major cities outside of China like Pyongyang, the capital of North Korea, have forbidden bicycles to run on the streets. Commuter traffic in those cities is handled mainly by public transit.

Problems and concerns

Although bicycles are an important means of urban passenger transportation, too many can cause problems. Despite the separate lanes for motor vehicles and bicycles along all major arterial streets in China, large bicycle flows often spill over into motor vehicle lanes. This disturbs motor vehicle flows, causing average motor vehicle speeds to decrease. Because the number of bicycles has increased greatly in recent years, motor vehicle speeds have correspondingly decreased year by year. For example, on East and West Changan Streets (the widest streets in Beijing) average motor vehicle speeds in 1959 were 35 km/hr (22 mph). They were further reduced to 27-30 km/hr (17-19 mph) in 1979 and to 25 km/hr (15 mph) in 1980. Heavy bicycle traffic has forced motor vehicle speeds to decrease almost to those of bicycles. In Shanghai, average bicycle speeds are 13.32 km/hr (8.27 mph); average trolley-bus speeds are 14.76 km/hr (9.17

mph); and average bus speeds are 16.56 km/hr (10.29 mph). In Tianjin, average transit vehicle speeds are as low as 11 km/hr (7 mph) during peak hours, and at intersections stopped bicycles often form a "bicycle wall" in front of motor vehicles, obstructing almost all motor vehicle traffic, especially turning movements (16).
Mixed traffic flows cannot be regulated easily or efficiently by traffic signal timing systems. It is very difficult for the green "go" wave of vehicles to move forward because of the great difference between the acceleration and speed of motor vehicles as opposed to bicycles. Also, the transverse flows of bicycles dramatically interfere with motor vehicle flows and with the effectiveness of automated signal systems.
In addition, transit vehicle speeds are lowered and schedules are thrown off in urban areas by heavy bicycle traffic. Where vehicle numbers are large, a vicious circle of lowered traffic speeds results.
Traffic accidents involving bicycles have risen in proportion to their total traffic volume. Bicycle accidents constitute about 50 percent of the total traffic accidents in the larger cities of China. For example, in Beijing, traffic accidents involving bicycles make up 49 percent of the total number of accidents: collisions between bicycles and motor vehicles account for 25 percent of the total; bicycles alone, 23.26 percent; and mishaps between bicycles and pedestrians, 1.02 percent (17). In Hangzhou, crashes between bicycles and motor vehicles account for 40 percent of the total traffic accidents. In Tangshan, collisions involving bicycles contribute to 75 percent of total traffic accidents, of which 60 percent are between bicycles and motor vehicles (18). Bicycle accidents are evenly divided between the urban areas and the suburbs.
In 1976, the total direct economic loss from traffic conditions was several hundred million yuan. If indirect losses are included, the total mounts to several thousand million yuan (19).

Recommendations

Though bicycles have certainly caused many urban traffic problems in China, they are and will continue to be an important means of private transportation. Their impact cannot be ignored or neglected. The principal reasons for their comminuted use are:

1. Bicycle traffic can adapt well to road conditions in older cities because bicycle traffic is flexible and can better serve the needs of door-to-door passenger and small goods transportation than larger vehicles.
2. Initial costs and operational expenses for bicycles are very low, making them the most economically feasible private means of transportation now and in the foreseeable future.
3. Cycling does not require any passenger waiting time.
4. Road conditions in the older cities are not amenable to the efficient use of rapid public transit system networks.
5. In mixed vehicle traffic flows, average bicycle speeds are barely below the speeds of buses and trolleys for medium to long distance trips.

6. A bike can make full use of the space on busy streets and still maintain speeds of 12-13 km/hr (7-8 mph) without causing traffic congestion. A bikeway lane width of one meter is sufficient.

Chinese bicycle transportation is currently an important supplement to urban mass transit systems. The control and management of bicycle traffic, however, needs much improvement. The principal measures recommended for improving and administering bicycle traffic are listed below.

Active Development and Improvement of Urban Transit Systems

In China both the population and land area are very large but, because of the topography, the amount of usable land is small, causing urban population densities to be high in order to reserve enough land for agriculture. The road area occupied by each bicycle passenger is much larger than that for a transit vehicle passenger (see Table IV). Consequently, it is urgent that mass transit systems be more extensively developed and used in order to relieve urban traffic congestion. If those who cycle are to be encouraged to change to transit, then the qualify of service delivered by urban transit systems must be improved. Therefore, the effective speed of transit vehicles must increase, passenger waiting times must decrease, passenger walking distances need to be shortened, and vehicles must be kept on schedule. Rapid transit systems should be established in all large cities so bicycle trip lengths and travel times can be decreased along with bicycle traffic flows.

Much more attention should be given to the planning of circulation patterns in residential areas. At present, China's city residential blocks tend to be too large for setting up convenient transit routes. Some blocks are as long as 1-1.5 km (0.62-0.93 mi), requiring local residents to ride bicycles in order to avoid long walks to transit stops.

TABLE IV - COMPARISON OF CHARACTERISTICS OF SOME PASSENGER TRANSPORT MODES IN CHINA

Characteristics	*Bus*	*Passenger Car*	*Bicycle*
Operating speed (km/h)	16-18	30-40	10-15
Capacity of vehicle (person/vehicle)	90-160	3-5	1
Road area per person (m^2/person)	1-2	10-20	6-10
Parking area per person(m^2/person)	1.5-2	4-6	1.5
Relative fuel consumption	1	6	-
Relative transportation costs	1	10-12	-

Spreading Out Bicycle Traffic Flows Over Time

Peak bicycle traffic flows could be decreased if trips were spread over time. In Beijing, passenger flows were 9 percent greater during the peak hours in winter 1979 than in 1978. When about 700 of the larger enterprises staggered their working hours, the flow of passengers decreased by 4 percent-13 percent less then peak flows estimated for 1979 (19). As expected, peak bicycle flows fell off greatly, too.

Spatial Segregation of Bicycle Traffic Flows

Spatial segregation of bicycles would reduce the marginal friction between bicycles, motor vehicles, and pedestrians.

1. Where the number of pedestrians is large, physical barriers could be arranged between the bicycle lanes and sidewalks to prevent disturbances from pedestrians crossing suddenly.
2. Where the volume of traffic flow is not large and the marginal friction between motor vehicle flows and bicycle flows is not really serious, road markings could be used to separate them. In such situations motor vehicles and bicycles would normally run within their own lanes but they still might share when necessary and possible.
3. Where the volume of bicycle flow is rather large and the roads are wide enough, physical barriers could be used to separate bicycle flows from motor vehicle flows. This strategy would be better than the use of road markings because it completely separates the traffic flows. Under these conditions it would not be possible for bikes and motor vehicles to share with each other, so the roads would have to be wide enough to handle both flows.
4. Where the flow of bicycles is very large and it is impossible to avoid serious marginal friction by means of road markings alone and where there is not enough room for physical barriers, exclusive bikeways should be established. They separate bicycle flows from motor vehicle flows satisfactorily and increase the capacity of roads for other vehicles and thus greatly reduce traffic accidents. In new cities or new urban quarters, separate bicycle road networks can be built more easily than in existing developed areas, and if very carefully planned and engineered, can be made to work well. However, such systems are almost prohibitively expensive and difficult to introduce into already buil-up areas
5. In older cities, especially where there are very long blocks, sometimes narrower streets and alleys paralleling main street can be used for arranging separate bicycle rout systems within the appropriate areas. Where the distance between arterial streets is large, there are likely to be many alleys in between and the areas furthest from the arterials may be impossible to serve well with street transit vehicles. With careful planning exclusive bicycle route networks based on such narrower streets and alleys could be set up. Usually pavement improvements and the installation of traffic sighs and signals would be necessary. This kind of bicycle route network would attract much of the overall bicycle traffic, thus lighten the load on principle arterials and improve traffic flows. Urban noise volumes would decrease (in mixed traffic drivers often have

to sound their horns to warm cyclists and pedestrians) and traffic accidents would undoubtedly decrease. For example, when the bicycles were forbidden to use Huaihai Road in Shanghai in 1979, motor vehicle flow volumes increased by 25 percent and their average speed increased by 7.7 percent.

Managing Bicycle Flows Through Intersections

For safety, bicycles must be made to observe the traffic signals just as motor vehicles do. Where intersections are at grade, the stopping areas for both major vehicles and bicycles need to be efficiently arranged. There are two main types of intersection arrangements. The first one has motor vehicles and bikes stopping separately, side by side, for left turn and through travel. Right-turning motor vehicles and bikes jointly use the rightmost lane, the advantage being that there is no disturbance between vehicles going straight ahead and those waiting to turn right. However, under this arrangement, the travel delay for left-turning bicycles is long. The second arrangement has the bicycle stopping area as close to the intersection as possible and ahead of the motor vehicle stopping area. Motor vehicles will generally have to wait for the bicycles to disperse before they can enter the intersection. The advantage here is that the conflict between bicycles and motor vehicles is minimized, but the disadvantage is a relatively longer delay for motor vehicles. Both arrangements involve some weaving section conflicts in the traffic stream before an intersection is reached. Selection of the best arrangement depends on local conditions.
Where traffic flows are extremely high, grade separations for bicycle traffic flows through intersections should be built. Underpasses are better than overpasses for bikes because of the vehicle's smaller vertical clearance and the shorter approach grades required. The latter make for easy grade-climbing given high initial downhill speeds; consequently, cyclists like underpasses better than overpasses.

Road Shoulders

Shoulders are often unpaved or very rough. Thus, pedestrians, bicycles, and other nonmotorized vehicles may be forced to use the motor vehicle lanes. Because the cost of providing motor vehicle lanes is usually much more than for nonmotorized vehicle lanes or paved shoulders, it is only logical that the more expensive pavement should be reserved for motor vehicles as much as possible.

Research Concerning Mixed Traffic Flows and Capacities

Mixed traffic flows contain vehicles having disparate characteristics of size and movement. As a result, mixed flows are uneven and are seriously disturbed by random lateral factors. This makes the development of mixed traffic flow theories very difficult. Although it would be desirable to separate the various classes of traffic flow completely, the high construction costs discourage this approach. It is likely that mixed traffic flows will continue to exist in China and many other countries for a long time.

More research into the characteristics of mixed flows and into cost-effective solutions should be undertaken.

Conclusions

Bicycles play a very important and continuing role as a private means of passenger transportation in China. Along with their distinct benefits have come some serious traffic problems. Today, bicycles are the most important component of nonmotorized vehicles in mixed traffic flows. In order to improve traffic conditions in China's urban areas, the problems of mixed traffic must be studied and solved. The object of such studies should be to make the use of bicycles safe while at the same time improving the quality of all traffic flows both in China and elsewhere.

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Non-Motorised Urban Transport in India

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Abstract

India had 12 cities with more than one million persons in 1981 and will have 24 cities of this size by the year 2000.
Non-motorised transport modes (walk, bicycle, cycle rikshaw and tonga) are important components of the urban transport systems in India. These trips ranged from 26% (Bombay) to 56% (Bangalore) in large cities and 56% (Vadodara) to 69% (Jaipur) in small cities.
Urban poverty persists in India. Data from 9 cities indicate that non-motorised transport is quite significant and particularly so to the urban poor.
While transport modernisation will take place gradually, urban planners must incorporate non-motorised trips as an integral part of analysis and transport planning.
Key words: non-motorised transport, walk trips, bicycles, cycle rikshaws, transport policy, India.

Introduction

Despite various efforts to modernise urban transport systems in India, the non-motorised modes persist. The primary reason for such survival is that these modes are cheap and often as efficient as motorised modes. The poor walk and/or bicycle, not for keeping fit, but primarily to save money.
Modernising urban transport systems and providing additional transport supply is quite costly. However, the allocations for urban transport have been in the order of 10%-15% of the estimated needs during VII five year plan (1982-87) and there is no reason to believe that allocations will expand during the 1987-92 period (1). This means that the non-motorised transport modes are here to stay for the time being.
Four large Asian countries - Bangladesh, India, Indonesia and Pakistan - contain about two-thirds of the world's absolute poor (2). India displays economic vitality and dire

poverty concurrently. Recent estimates of poverty based on definition of 2100 daily calorific intake as suggested by the National Planning Commission of India indicate that 60%-70% of urban residents are poor (3). For example, Bombay is a very wealthy city with GNP which exceeds that of several Asian countries. Yet, in 1981, 71% of Bombay households had a monthly income of less than U.S. $50, which is below the poverty line accepted by the government.
In 1981, India's population was 665 million, of which 24% was urban. The urban population is expected to increase to 28% (280 million) of a total of 1.0 billion by 2001. There were 12 cities with a population of 1/2 to 1 million in 1981. Their number is expected to increase to 24 by 2001.

Urban Travel Patters

Urban travel data for large and smaller cities is presented in Tables 1 and 2. Large cities have mature and diverse transport modes. These systems are generally overcrowded throughout the day. Among the large cities, Bombay alone has a good network of commuter trains. In other cities, public transport means primarily buses. Non-motorised modes varied from a low of 26% in Bombay to 62% in Ahmedabad.
In smaller cities, the trip lengths are smaller. In these cities, non-motorised trips are a higher proportion and varied from 56% in Vadadora to 69% in Jaipur. These trips decrease with the increase in the city size. Mode choice and city size relationships are shown in Figure 1.
Walking is the most dominant mode: 15% in Bombay, 43% in Bangalore and Ahmedabad. The choice of walking trips is influenced by trip lengths, climate, alternative transport and their cost, and the poverty levels. Bicycle trips amounted to 10% in Bombay and 26% in Jaipur. Bicycle is popular among the poor, if they can afford to own one and also, in general, among the students.
Urban travel mode choices by the poor are presented in Tables 3 and 4. The relationship between income and mode choice is presented in Figure 2. Although mode choices are influenced by trip lengths, climate and cost of other alternatives, income is the dominant determinant of mode choice. With increasing incomes, people shift to more comfortable and convenient motorised modes.

Urban Transport Policy

Urban transport systems in India function in an environment characterised by large scale poverty resulting in an inability to pay, and lack of adequate financial resources to create additional transport supply. These conditions are changing slowly but are not expected to change drastically over the next 20 years. On the other hand, urban transport policy goals and planning principles in India are heavily biased in favour of motorised vehicles, ignoring the non-motorised modes used by a large segment of the population (4,5, 6). It is as if these modes (walk, bicycle, cycle rikshaw) did not exist and if they did, they would somehow disappear during the next forecast/plan period. This is not unique to India. In many developing countries, the policy goals are to eliminate/abolish the non-motorised modes and assume" that they will fade of their

own accord (7, 8,9, 10). While transport modernisation must take place, and will take place with increasing incomes, it is important to plan and accommodate appropriately these modes in the interim. The interim period is certainly longer than 20 years especially if the projected levels of poverty are considered (2, 3, 11).
Urban transport policy issues and conclusions are presented in Tables 5 to 8. Urban transport systems in India are characterised by high use of walk and bicycle modes, practically overloaded public transport, and lack of financial resources to make quantum jump improvements. Furthermore, the majority of the urban dwellers are poor and they are the primary users of non-motorised transport. These differences require different approaches to transport analysis and development. For example, it should be mandatory to require assessment of impacts on the poor whenever new transport investments or regulations are proposed. Emphasis should be placed on non-transport solutions to transport problems.
Some key areas needing further research are:

1. Applicability of the concept of equal and universal value of time - Do time savings have equal monetary value or benefit to all persons? What increments of time savings are significant to whom?
2. Road user space and cost allocation - How do we establish priorities for vehicle mix and cost allocation?
3. Modal Efficiency - If bicycles are energy efficient and are universally available even to poor households, do we encourage bicycle ownership and use?
4. Transport Modernisation - What are the most suitable strategies for transport modernisation without increasing the Cost of transport?

While it is necessary to gradually modernize urban transport, it is important to include all modes (non-motorised) within the system. It cannot be assumed that either adequate financial resources are always available or that the poor will/can pay for time savings. It is important to protect the interests of the poor and at the same time provide adequate and efficient transport. Such goals can and should be complimentary.

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Fig 1. Urban Travel Patterns
Population: Non-motorised Mode
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Fig 2. Urban Travel Patterns
Income: Mode Choice
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Table 1. Urban Travel
Large Metro Areas, 1981

Population: (millions)	Bngire	Bmbay	Delhl	Madras	Ahmed
	2.9	8.2	5.7	4.3	2.5
Non - Motorised Trips	55.7%	26.0%	46.5%	41.0%	61.6%
Walk	43.4	15.0	28.7	20.0	43.2
Bicycle	12.0	10.0	14.8	20.0	18.0
Cycl Rkshw	0.1	1.0	3.0	<0.1	0.2
Tonga	0.3	<0.1	<0.1	0.2	0.2

Table 2. Urban Travel
Small Metro Areas, 1981

Population: (millions)	Visakhapatnam	Vadadora	Jaipur	Patna
	1.3	0.8	1.0	0.9
Non-Motorised	59.1%	55.9%	69.0%	66.3%
Trips	42.4	40.1	39.5	35.8
Walk	11.6	15.1	26.5	12.5
Bicycle	4.6	0.5	2.7	17.6
Tonga	0.5	0.2	0.3	0.4

Table 3. Urban Travel
by the Poor

	Dakshin puri	Shakar pur	Poonna mallee
Mnthly Inc/cap	117 Rs	193 Rs	161 Rs
Distance to CBD	14 km	8 km	21 km
Non-Motorised Trips	72%	52%	50%
Walk	58	43	35
Bicycle	14	5	15
Cycle Rikshaw	<1	4	<1

Table 4. Urban Travel
by the Very Poor

	Nand Nagri	Kesava Perumal	1200 Slums (Average)
Mnthly Inc/cap	91 Rs	54 Rs	84 Rs
Distance to CBD	25 km	5 km	N/A
Non-Motorised Trips	47%	71%	84%
Walk	42	41	78

Bicycle	3	21	5
Cycle Rikshaw	2	9	1

Table 5. Non-Motorised Urban Transport
Policy Issues: Walk Trips

A. 15% to 43% of all trips are by WALK.
    - provide adequate and continuous footpaths.
    - provide safe and convenient crossings.
B. 35% to 78% of all trips by the POOR are by walk.
    - The poor walk primarily to save money.
        - encourage short trips:
            - provide adequate housing near employment centers.
            - decentralise work places:
                - reduce need for long trips.

Table 6. Non-Motorised Urban Transport
Policy Issues: Bicycle Trips

A. 10% to 27% all trips are by BICYCLE.
    - provide adequate and continuous cycle paths.
    - provide safe and convenient Interchange systeme when sharing the same road.
B. Encourage easy availability of bicycles.
    - increase production of cycles.
    - Installment purchse; Cycles for-hire.
    - encourage short trips:
        - provide adequate housing near employment centers.
        - decentralise work places:
            - reduce need for long trips.

Table 7. Non-Motorised Urban Transport
Policy Issues: Cycle Rikshaw

A. Cycle Rikshaws are a significant part of the urban transportation systems, particularly in smaller urban areas.
    - 1% to 18% of all trips are by cycle rikshaw.
B. Modernisation and motorisation of rikshaws will take place in the long run. Until that time, they are required by the public.
    - remove regulatory barriere to new supply.
    - provide new supply where there is demand.
    - research as to how the productivity of the rikshaw can be increased economically.

Table 8. Non-Motorised Urban Transport
Policy and Planning Issues

A. Highest priority be given to moving people, using the most common modes, icluding walk, bicycles and pubilc transport.
B. Design guidelines be developed for handling safely and adequately mixed traffic: walk, bicycles and other traffic.
C. Urban planning methods require reduction of trip lengths, particularly to work places.
D. Urban transport studies must include data and analysis of walk and bicycle trips.

A Comparison of Cycle Use in Delhi, Jaipur and Hyderabad

By D.A.C. Maunder

unpublished, 1980

Abstract

There are vast numbers of cycles and cyclists in Indian cities. The cycle is one of the main components of vehicles flow in these cities. The ASRTU/TRRL research team, based in Delhi during 1978-80, implemented surveys of cyclists in the three cities, Delhi, Jaipur and Hyderabad, to collect data regarding: cycle ownership and usage; trip making details; socio-economic characteristics of the cyclist; how cycle ownership is reflected in the patronage of public transport services by cyclists.

INTRODUCTION

In India, as in most countries of the world the cycle is the least expensive personal mechanised travel mode available. However, whereas in most developed countries the cycle tends to have an acillary role to other personal transport modes, in developing countries, the cycle is often the only personal travel mode available. Furthermore it is quite often the only means of travel, other than by foot, because large sections of the population cannot effort public transport fares.

A study instigated by the Central Road Research Institute in 1969 [1] showed that 28 per cent of all inter zonal trips in Delhi were undertaken by the cycle mode. Since 1969 the percentage share of inter zonal trips by the mode has probably diminished to approximately 20 per cent due mainly to the rapid expansion of Delhi; journey distances have increased so encouraging the use of public transport services mainly supplied by the Delhi Transport Corporation. The cycle mode accounts for a significant percentage of interzonal trips in other Indian cities like Hyderabad and Jaipur. It is clearly an important alternative choice to public transport and cycle owners are unlikely to be part of the very large captive market which public transport enjoys in Indian cities.

As part of the joint research project [2]) carried out by the Association of State Road Transport Undertakings (ASRTU) and the Transport and Road Research Laboratory (TRRL) small studies on the role of the cycle in urban transport were carried out in Delhi, Jaipur and Byderabad during 1979. Surveys of cycle users were implemented to

determine data on cycle ownership, costs, trip making, socio-economic characteristics and use of other modes.

Table 1 shows population estimates in the three cities for 1979, together with estimates of cycle ownership.

TABLE 1
Population and cycle ownership in Delhi, Jaipur and Hyderabad, 1979 (estimates)

	Pop millions	Cycle fleet (millions)	No. of cycles per capita
Delhi	5.7	0.85	0.15
Hyderabad	2.2	0.80	0.36
Jaipur	0.9	0.15	0.18

The number of cycles owned and operated have increased substantially in Delhi and other Indian cities during the last two decades. For example in Delhi the number of cycles increased from approximately 650,000 cycles in 1971 to 850,000 in 1979, an increase of 30 per cent in just 9 years. Dehli has probably the largest cycle fleet of any Indian city followed by Hyderabad with a cycle fleet of 800,000. Based on these estimates the ownership level of cycles in Byderabad is very high with every third person having a cycle.

SURVEY METHODOLOGY

Studies were made at six sites on the outer fringes of Delhi, at two sites in the centre of Jaipur and at three sites within the central city area in Hyderabad. In Delhi the sites included some of the major entry points from the outer environs of Delhi, to the city centre. Two locations, ITO bridge and the Jamuna Bridge are major crossing points of the river Jamuna and together with Chirag Delhi are intermediate points between extensive low income resettlement areas and the centre of Delhi. In Jaipur one site, MI Road, is a major thorough-fare into and out of the main market area. The second site, Badi Chowper provides access to the central market area from the direction of Amber. In Hyderabad two bridging points were chosen providing access to the central business district from the south and the third site was located between the twin cities of Hyderabad and Secunderabad.

A team of 4 survey assistants were required to undertake surveys of cyclists. One assistant is needed to stop cyclists so that they can be interviewed, two assistants to undertake interviewing whilst the fourth carried out a classified count of vehicles using the pro-forma shown in Appendix 1.

Cyclists were stopped and interviewed at random throughout the survey period using the questionnaire shown in Appendix 1 each interview being of 1-2 minutes duration. Cyclists who were stopped rarely refused to be interviewed but many refused to stop. A morning was spent at each survey site, the survey hours being 06.30-10.30 in Delhi and Hyderabad and 07.30-11.30 in Jaipur. This period covers both peak and off peak travel periods.

TRAFFIC FLOWS

Peak cycle flow, expressed as a percentage of total vehicle flow, occurs between 08.30-09.00 at two sites and between 07.30-08.00 at one site in Hyderabad. At both sites in Jaipur the peak percentage occurs between 08.30-09.00. The survey sites at these two cities were located within the central area. Generally, the peak percentage occurs later than at most of the sites in Delhi which were located outside of the central area. In Delhi at one site the peak percentage occurred at 06.30-07.00 at another between 07.00-07.30, at three sites between 07.30-08.00 and at the sixth site between 09.30-10.00.

The largest flow of cycles (actual number) passing the survey site during a 30 minute period was found in all cities to occur between 09.30-10.00. At Jaipur the largest number was 1459, in Hyderabad 2010 and at the Jamuna Bridge site in Delhi 7667. At only one site, the Jamuna Bridge, does the 'actual' peak flow coincide with the peak 'percentage' flow, both occurring between 09.30-10.00. At all other sites the peak 'actual' flow seems to occur later than the peak 'percentage' flow. Cycle trips are probably of long duration and consequently may be started earlier than trips by other modes. Table 2 shows the percentage distribution of modes in the total vehicle flow during the entire 4 hour survey period at all sites in the three cities monitored. The sites are not strictly comparable because the sites in Jaipur and Hyderabad were located within the centre of the city whereas those in Delhi were located on the outer fringes of the city. The cycle mode accounts for between approximately 58 and 78 per cent of traffic in Jaipur, Hyderabad and at three sites in Delhi, the latter three being intermediate points between low income resettlement areas and the centre of Delhi. However, at one site in Delhi the percentage is as low as 30 per cent; this site is near to middle and high income residential areas and therefore cycle usage is considerably lower.

Although the cycle is the predominant mode as regards the traffic flow, as regards the total number of person movements other modes such as public transport service buses with their high occupancy and capacity predominate. For example at the Afzal Ganj Bridge in Hyderabad between 09.30 and 10.00, the peak actual flow of cycles was 2200 whereas 42 buses passed the survey site carrying approximately 100 passengers per bus. Therefore 2500 trips are made by cycle (assuming some passengers) and 4200 by bus. Similarly in Delhi at the Jamuna Bridge site between 09.30 and 10.00 7667 cycles passed the survey site compared to 112 buses. Assuming a conservative estimate of 120 passengers per bus in Delhi during this time period, a total of 13400 passenger trips are

made by bus compared to 8000 by cycle. Thus, modal flow dominance does not necessarily entail trip dominance by the mode.

Cycle rickshaw flows are prominent in Hyderabad and Jaipur but at only one site in Delhi (Azadpur) where they are primarily used for the carriage of fruit and vegetables from a nearby market. The operational area of cycle rickshaws in Delhi, is restricted, and hence the minimal percentages recorded. In Jaipur, Hyderabad and parts of the commercial centre in Old Delhi the rickshaw is the major public transport mode for short intra city trip making. Motor cycles and scooters are the second largest percentage mode after cycles at all sites except Afzal Gang Bridge Hyderabad and at Dhaula Kuan in Delhi. In terms of total flow percentage a greater number of motor cycles/scooters were recorded than cycles at the Dhaula Kuan site. In Delhi at the Dhaula Kuan, ITO Bridge and Raja Garden sites motor cycles account for between 24 to 31 per cent of traffic flow compared to 10 to 16 per cent in Jaipur and Hyderabad. But at Chirag Delhi motor cycles account for less than 9 percent of total traffic.

Autorickshaws account for between 3 and 11 percent of traffic at all sites. The proportion at the Chikadpalli Road site in Hyderabad is similar to that at the at the Jamuna Bridge, Azadpur and Raja Garden sites in Delhi at approximately 10 per cent. Cars and taxis account for less than 6 per cent at all sites except Dhaula Kuan in Delhi where they amount to 20 per cent. The comparative affluence of the communities in the south and south west of Delhi is apparent from the observation that 51 per cent of the traffic flow at Dhaula Kuan comprises motor cars, motor cycles and scooters.

The traffic composition at the sites in the three cities are not too dissimilar; Jaipur and Hyderabad have a higher proportion of cycle rickshaw than Delhi whereas personal motorised transport modes are more significant in Delhi. Cars, motor cycles and scooters are probably more evident in the capital because of the comparative affluence compared to Jaipur and Hyderabad. In Delhi there is an-extensive middle income group largely employed in central government or head offices of commercial organisation who possess motor cycles and scooters. There are also extensive motor car fleets owned by central government departments and commercial organisation which tend to inflate the motor car component of traffic flows in comparison to Jaipur and Hyderabad.

CYCLIST INTERVIEW RESULTS

A total of 524 male cyclists were interviewed in Delhi, 246 in Jaipur and 150 in Hyderabad. In all three cities no female was observed cycling a bicycle though many were passengers riding on the rear of the cycle or cross bar. Cycling is obviously a male perogative in India. Most cyclists interviewed tended to be in the 21-60 age group ie the active employment age group though many were aged between 15-20 years, especially in Jaipur.

Table 3 shows the occupation of cyclists interviewed in the three cities.

TABLE 3
Distribution of cyclists by occupation (percentage)

Occupation	Delhi	Jaipur	Hyderabad
Professional	0.2	5	4.7
Skilled	14.2	12.3	15.5
Unskilled	71.5	57.3	59.3
Student	0.9	14.7	2.0
Other	13.2	10.4	18.5
Total	100	100	100

The majority of cyclists have unskilled occupations although a significant proportion in all three cities have skilled jobs. In Delhi over 85 per cent of cyclists interviewed were either skilled or unskilled, the comparative figures for Hyderabad and Jaipur being 74 and 69 per cent respectively. Very few cyclists in the professional employment categary were interviewed in Delhi, though their numbers were more significant in the other two cities. Student cyclists were only significant in Jaipur and this is probably due to the shorter distances between residence and educational institutions in the city compared to Delhi and Hyderabad. The 'other' category in Table 3 includes those who are self employed such as traders and hawkers.

TABLE 4
Income distribution of cyclists (percentages)

Monthly Income Rs.	Delhi	Jaipur	Hyderabad
0-200	13.6	22.9	10.4
201-400	56.5	38.5	56.3
401-600	28.5	21.2	23.6
601-800	1.0	7.8	4.9
801-1000	-	7.6	3.4
1000+	0.4	2.0	1.4
Total	100	100	100

Average	Rs. 337	Rs. 379	Rs. 391

Table 4 shows monthly income levels of cyclists.

In all three cities the largest group of cyclists earn between Rs.201-400 a month. In Delhi 70 per cent earn less than Rs.400, in Jaipur, 61 per cent and in Hyderabad 66 per cent. In Jaipur approximately 23 per cent earn less than Rs.200 a month compared to only 13 per cent in Delhi and 10 per cent in Hyderabad. Ninety eight per cent of cyclists interviewed in Delhi earn less than Rs.600 a month compared to 82 per cent in Jaipur and 90 per cent Hyderabad. Table 3 reflects the 'skilled' and mainly 'unskilled' occupation of cyclists in the three cities. Jaipur and Hyderabad with a small, but significant percentage of professionally qualified cyclists have 9.6 per cent and 4.8 per cent earning more than Rs .800 a month. As a consequence, average monthly income of cyclists is higher in these cities than in Delhi where the average is R.337; in Jaipur it is 12 per cent higher at Rs.379 and in Hyderabad it is 16 per cent higher at Rs.391. Incomes in Delhi may also be lower than found in Jaipur and Hyderabac because three of the survey sites were located between low income resettlement areas and the commercial centre of Delhi. Hence the sample in Delhi may be biased towards these low income cyclists.

Table 5 shows the period of cycle ownership for which a respondent has owned a cycle. By definition more than one cycle could have been owned and utilised during the time periods stated. The time periods given by respondents were approximate, it being difficult for most of them to specify the precise period of ownership.

TABLE 5
Distribution of period of cycle ownership (percentage)

	years						
City	less than 2	3-5	6-8	9-11	12-15	15+	Total
Delhi	16.2	18.9	17.0	18.0	7.8	27.1	100
Hyderabad	9.6	16.3	16.3	17.7	17.0	23.1	100
Jaipur	8.4	21.4		47.1		23.1	100

In all three cities the largest group of cyclists interviewed have possessed a cycle for more than 15 years. Thus, once a cycle is purchased ownership continues far many years even though the cycle may have to be replaced. More cyclists were interviewed in Delhi who have only recently owned a cycle (less than 2 years) than in Jaipur and Hyderabad. Public transport fares were increased by the DTC in February 1979 and this may have encouraged increased cycle ownership in the capital.

Respondents were asked for the age of the presently operated cycle. Table 6 shows the results.

TABLE 6
Distribution of cycle age in Jaipur and Hyderadbad (percentage)

	Age of cycle (years)					
City	0-2	3-5	6-10	11-15	15+	Total
Jaipur	29.5	22.5	26.5	13.5	8.0	100
Hyderabad	16.4	24.6	26.7	13.0	17.1	100

Fifty two per cent of cycles operated in Jaipur are less than 5 years old, compared to 43 per cent in Hyderabad. Forty nine per cent of bicycles in Jaipur are between 3 and 10 years old compared to 51 per cent in Hyderabad. Most cycles in either city are therefore less than 10 years old although 17 per cent in Hyderabad are more than 15 years old. (In Delhi one respondent said his cycle frame was 25 years old though most parts had been replaced.) It would appear that cycles are replaced during the period of cycle ownership, for the average period of cycle ownership in Jaipur is 10 years whereas the age of the cycle presently operated is 6 years. Similarly in Byderabad the average cycle ownership period is reported to be 10 years whilst cycle age operated is 8 years.

In Delhi 63 per cent of cycles were newly purchased and the remaining 37 per cent were purchased as second hand models. In Byderabad similar figures are 49 per cent and 51 per cent. Table 7 shows the distribution of purchase costs whether new or second hand in the three cities of Delhi, Jaipur and Hyderabad.

TABLE 7
Cycle purchase cost distribution

Purchase costs	Delhi	Jaipur	Hyderabad
Rs. 0-50	1.5	1.5	1.4
51-100	18.1	8.0	14.2
101-150	8.6	13.5	19.9
151-200	8.9	12.5	17.0
201-250	5.7	17.5	11.3

251-300	13.4	19.0	7.8
301-350	29.3	28.0	5.7
350+	14.5	-	22.7
Total	100	100	100
Average cost	Rs. 243	Rs. 237	Rs. 221

Few cycles, even second hand, cost less than Rs.50 when purchased though 18 per cent in Delhi and 14 per cent in Hyderabad cost between Rs.51-100. Most second hand models (depending on age) cost less than Rs 200 to purchase at present day costs whereas new cycles cost more than Rs. 350. In Delhi 43 per cent cost more than Rs.301 compared to 28 per cent in Jaipur and Hyderabad. Average costs in all three cities are approximately similar ranging between Rs. 221-243. The average cost of a cycle is equivalent to 72 per cent of cyclists average monthly income in Delhi, 62 per cent in Jaipur and 56 per cent in Hyderabad. Costs are actual costs incurred when the cycle was purchased so that a new cycle purchased 3-4 years ago may have cost Rs.250-300 whereas present new model costs range from Rs.350-600.

A cycle is usually purchased when its cost has been saved over a number of months or years. However a few respondents had obtained loans from banks, employers or relatives. Others had obtained credit from the cycle dealer whilst a small number had received the cycle as either a marriage present or as part of the marriage doury. Ninety nine er cent of cycles were owned either by the respondents interviewed or by relatives or friends. The remaining one per cent of respondents hired the cycle from a dealer on a monthly or weekly basis at a cost of about Rs.2 a day.

Table 8 shows estimates of monthly repair and maintenance costs of cycles in Delhi and Hyderabad.

TABLE 8
Distribution of monthly repair and maintenance costs incurred by cycle owners (percentage)

	Less than 5	6-10	11-15	16-20	20+	Total
Delhi	33.6	44.7	15.0	5.5	1.2	100
Hyderabad	68.1	23.6	6.9	1.4	-	100

Repairs and maintenance generally consists of tyre inflation, puncture repairs and chain link replacements. Seventy eight per cent of cyclists in Delhi and 92 per cent in

Hyderabad estimate monthly repair costs of less than Rs. 16. Maintenance costs of more than Rs.15 a month are probably for older models which by virtue of age are more prone to breakdown and costly repairs. A larger percentage of owners in Delhi estimate repair costs of more than Rs. 10 than in Hyderabad. Reported average monthly repair cost in Delhi is Rs.7.6 and in Hyderabad Rs. 4. 7.

When the respondents were interviewed most were travelling for employment purposes in all three cities. In Delhi 93 per cent were travelling to their employment and in Jaipur and Hyderabad 73 per cent and 90 per cent respectively. There is bias towards 'employment' journeys because the survey hours were either between 06.30-10.30 or 07.30-11.30. The precentage of journeys for employment purposes is probably low in Jaipur for two reasons. Firstly, the survey hours were such that a larger number of cyclists were interviewed during off peak travel hours. Secondly, as shown in Table 3, a higher percentage of respondents interviewed were students. This may, of course, tie in with the off-peak interviews .

Table 9 shows how often the trip being made when interviewed is undertaken. As would be expecte frequency is dependent on journey purpose.

TABLE 9
Journey frequency distribution of cyclists (percentage)

	Frequency of trip making					
City	Daily	5-6 days/week	3-4 days/week	1-2 days/week	Infrequently	Total
Delhi	84.3	9.2	2.3	0.4	3.8	100
Jaipur	81.7	0.8	0.8	3.2	13.5	100
Hyderabad	90.5	1.4	2.0	5.4	0.7	100

In Delhi, 93 per cent of cyclists were making the journey daily or 5-6 days a week, a similar figure to those travelling for employment purposes. Similarly in Hyderabad 90 per cent were travelling for employment purposes and 91 per cent travel daily or 5-6 days a week. In Jaipur however, 82 per cent travel daily or 5-6 days a week but only 73 per cent said they were travelling for employment purposes. The additional 9 per cent travelling daily or 5-6 days a week (for other than work purposes) may comprise students travelling to school or college. A large number of cyclists in Jaipur (13.5 per cent) travel infrequently which is defined as less than once per week, and they may account for approximately 50 per cent of those cyclists travelling for other than employment purposes.

Cyclists estimates of journey distance and time travelling from origin to destination are shown in Tables 10 and 11.

TABLE 10
Distribution of distance travelled bv cycle (percentage)

	Distances (kms)					
City	0-5	6-10	11-15	16-20	20+	Total
Delhi	24.0	25.5	24.6	15.2	10.7	100
Jaipur	65.2	26.7	-	8.1	-	100
Hyderabad	49.0	36.9	8.7	2.0	3.4	100

A much larger percentage of cyclists in the smaller cities of Jaipur and Hyderabad travel less than 5 km than in Delhi. Ninety two per cent of cyclists in Jaipur and 86 per cent in Hyderabad travel less than 10 km compared to only 50 per cent in Delhi. The sprawling size of Delhi and the location of the low income resettlement areas as far as 20 kilometers from the centre account for the distances travelled in Delhi. Average distances travelled are 4.9 km in Jaipur 6.4 km in Byderabad and 10.9 km in Delhi. Distances are for single journeys so that cyclists travel this distance twice daily and generally for either 6-7 days a week.

Table 11 shows respondents estimates of time travelling between origin and destination.

TABLE 11
Distribution of cycle travel times (percentage)

City	less than 20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	90+	Total
Delhi	-	28.0	12.7	16.9	15.3	7.5	6.1	6.9	6.6	100
Jaipur	56.0	22.9	9.8	4.0	2.4		4.9			100
Hyderabad	29.6	29.2	14.8	8.7	7.4	2.0	1.3	1.3	6.7	100

In Jaipur the largest group of cyclists estimate their travelling time to be of less than 20 minutes duration. In Hyderabad 29 per cent estimate a similar time period whereas no cyclist in Delhi estimated a travel time of less than 20 minutes. Approximately 80 per

cent of cyclists interviewed in Jaipur and 58 per cent in Hyderabad estimated that they travelled for less than 30 minutes compared to only 28 per cent in Delhi.

Time travelling depends on journey distance and as Table 9 showed a larger percentage of cyclists travel mere than 10 km in Delhi than in Jaipur or Hyderabad. Hence approximately 27 per cent of respondents travel for more than 60 minutes in Delhi compared to approximately 5 per cent and 11 per cent respectively in Jaipur and Hyderabad. Average times were 21.6 minutes in Jaipur, 32.9 minutes in Hyderabad and 49 minutes in Delhi. The times spent cycling a kilometre are therefore very similar in all three cities ranging from 4.4 to 5.1 minutes.

Although the cycle is an obvious inexpensive means of travel to its owner respondents were asked why they did not make use of public transport services, such as provided by conventional bus operators, for the trips they were making when interviewed. Table 12 shows the results.

TABLE 12
Reasons given by cyclists for not using public transport (percentages)

	Delhi	Jaipur	Hyderabad
Costly	50.6	29.3	32.9
Inconvenient	19.5	16.2	37.8
Unreliable	11.5	2.8	-
Own conveyance	11.0	36.5	-
Over crowded	6.1	2.3	-
Time consuming	1.3	12.9	-
Non bus service provision	-	-	9.8
Other	-	-	4.1
Total	100	100	100

'Cost' was the major factor given in Delhi for the non use of bus services whereas in Jaipur cyclists tend to just prefer their 'own conveyance' because of convenience. In Hyderabad 'inconvenient' was the major reason given. 'Inconvenient' describes many factors such as comfort, unsuitable bus services, bus timings, distance walked to bus service stand, waiting times etc.

Although 'cost' is not the prime reason given in Jaipur and Hyderabad it does rank second in importance far the non use of public transport services. It is obviously a major factor when comparing bus fares incurred twice per day for six or seven days a week with the cost of operating and maintaining a cycle that gives service for many years.

In Delhi 'inconvenient', 'unreliable' and 'own conveyance' are important factors whereas in Jaipur 'inconvenience' and 'time consuming' are important. 'Time consuming' is of interest because such cyclists obviously think it is quicker to cycle than incur the penalty of walking and waiting for public transport services as well as the 'in bus' time. These cyclists are probably travelling short distances of less than 5 kilometres. In Hyderabad 9.8 per cent gave as a reason that 'bus services were not provided' between their home and destination and therefore, there was no opporturlity to make use of such services. No respondent in Hyderabad gave as a reason 'unreliable', 'over crowded' or 'time consuming'.

Respondents were asked to visualise how they would make the journey if their cycle was notin working order. Table 13 shows the results for Delhi and Hyderabad.

TABLE 13
Alternative transport mode preferred if cycle is not operational (percentages)

	Cycle passenger	Bus	Tonga	Auto rickshaw	Cycle rickshaw	Walk	Other	Total
Delhi	0.2	51.2	0.4	1.3	-	12.6	34.3	100
Hyderabad	-	17.7	-	-	4.1	12.9	65.3	100

In Delhi more than 50 per cent of cyclists said they would use bus services to undertake the journey if their cycle was not operational. In Hyderabad only 17 per cent said they would use the bus as an alternative. Most (65.3 per cent) cyclists in Hyderabad suggest 'other' as did 34.3 per cent in Delhi. On closer questioning the mjaority stated quite rationally and understandably that they would get the cycle repaired and then undertake their journey. In both cities 12 per cent would walk. These respondents are presumably making relatively short distance journeys or the cost of public transport fares is too much for them to afford. The auto rickshaw, a costly public transport mode would be used by only 1.3 per cent in Delhi and by no respondent in Hyderabad. 0.4 per cent would travel by the inexpensive horse drawn tonga in Delhi, whereas in Hyderabad, where a large number of cycle rickshaws operate, 4.1 per cent said they would use the cycle rickshaw mode. In Delhi this mode, as well as the tonga, is restricted mainly to Old Delhi and therefore it is not an alternative mode for most cyclists.

In Hyderabad cyclists were asked what mode they would use on a journey when not cycling by choice (ie for non-essential trips). Table 14 shows the distribution of responses given by preferred mode. Modal choice depends, of course, on such factors as journey purpose, trip length and how many members of the family are travelling together. But generally cycle owners would use a preferred alternative mode when making non-essential trips other than by cycle.

TABLE 14
Cycle owners preferred alternative travel mode when not cyclinq by choice (Hyderabad)

	Bus	Cycle rickshaw	Auto rickshaw	Other	Total
Percentage	61.4	27.3	8.6	2.4	100

It would appear that the bus service is used by the majority of respondents when choosing to travel by any mode other than a cycle. The cost of bus travel in Indian cities (though expensive in comparison to cycling) is probably the least expensive public travel mode available. A further 27 per cent of the sample of cycle owners interviewed in Hyderabad specified that they would use the cycle rickshaw mode.

Comparing Table 13 and 14 it would appear that the majority of cyclists would not switch to public transport if they were unable to use their cycle for an essential journey. For unessential, and thus less frequent, trips the majority of cyclists use public transport if they choose not to use their cycle.

Table 15 shows the distribution of monthly public transport expenditures incurred by incurred by cyclists in Hyderabad.

TABLE 15
Monthly public transport expenditures of cyclists in Hyderabad(percentage)

Expenditures	Rs.0.5	6-10	11-15	16-20	21-25	26-30	30+	Total
Percentage	21.9	29.2	21.2	10.9	3.6	4.4	8.8	100

The majority of cyclists spend less than Rs. 15 a month on all public transport modes (including cycle rickshaws) in Hyderabad. Approximately 50 per cent spend less than Rs. 10 and a similar percentage between Rs.6-15. Average monthly expenditure on public transport modes is Rs. 12.7 which amounts to approximately 3.2 per cent of the average monthly income of cyclists interviewed in Hyderabad. With average cycle repair/maintenance costs of Rs.4.7 total monthly transport expenditure is equal to Rs. 17 4 or 4.4 per cent of average monthly income.

In comparison, passengers interviewed when travelling by bus in the cityspentan average of Rs.33 per month on public transport. This is equivalent to 7.3 per cent of their average monthly income. It seems clear that regular cyclists do not make a lot of use of public transport and that the cycle is a far cheaper travel mode.

SUMMARY AND CONCLUSIONS

The cycle is the cheapest personal mode of mechanised transport. Large numbers are used in Indian cities and clearly ownership is an important factor in the level of demand for public transport.

The majority of cyclists have unskilled occupations and low incomes. Average incomes of cyclists are Rs. 337 in Delhi, Rs. 391 in Hyderabad and Rs. 379 in Jaipur. The income in Delhi is probably lower than in Jaipur or Hyderabad because three of the six survey sties were located close to low income resettlement areas.

Cycle ownership continues for many years once started. Many cyclists have owned a cycle for more than 15 years and often a cycle lasts for a similar period, though most cycle in Jaipur and Hyderabad were less than 10 years old. The average cost of a cycle is between Rs.221-243. This represents 72 per cent of a cyclist's monthly income in Delhi, 62 per cent in Jaipur and 56 per cent in Hyderabad.

Most cyclists were travelling for employment purposes when interviewed but as the survey hours were between 06.30-11.30 a bias would be expected. Frequency reflects journey purpose with the majority making the same journey twice daily for 5-6 days a week.

A larger number of cyclists in both Jaipur and Hyderabad travel short distances (of less than 5 or 10 km) than in Delhi. So city size is reflected in journey distance cycled. Average distance cycled in Delhi is approximately 11 km compared to 5 km in Jaipur and 6.4 km in Hyderabad. Again the journey distance may be longer in Delhi due to a large number of cyclists interviewed being from low income resettlement colonies which are sited up to 20 km from the centres of Old Delhi and New Delhi. Journey times reflect distance travelled and range from 22 minutes in Jaipur to 49 minutes in Delhi.

The cost of public transport fares is a major reason why cyclists do not use public transport services regularly. Quite naturally cyclists prefer the least cost travel mode so that when by choice they utilise public transport services they travel by bus. When their cycle needs repair trips are deferred until the cycle is repaired so that the cost of a public transport fare is 'saved'. Travel costs are therefore kept to a minimum.

Most cyclists in Hyderabad spend less than Rs. 15 a month on public transport services the average being Rs.12.7 or 42 paise per day. This is equivalent to 3.3 per cent of average monthly income and if cycle repair costs are included then total average transport expenditure by cyclists in Byderabad amounts to Rs.17.4 per month or 4.4 per

cent of average monthly income. Cycle ownership therefore confers on its owner the least or minimum cost travel mode and allows convenience and flexibility with regard to journey timings. It also allows its owner a choice of travel mode; for he is no longer captive to public transport services, he can decide if he wants to cycle or travel by bus, cycle rickshaw or other modes. From the survey of cyclists in the three cities it would appear that cyclists rarely use public transport services in India and so once a cycle is possessed its owners demand for public transport services is minimal.

Acknowledgements

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The 'Majestic' Munjals

By R. N. Bhaskar

Cover Feature
BusinessIndia April 21-May 4, 1986

Beginning as small time bicycle traders in 1943 the Munjals of Ludhiana are today the largest makers of bicycles in India and one of the leading manufacturers of mopeds. Now, with its collaborators Honda of Japan, the group is all set to become a leader in the two-wheeler market within the next couple of years, with a turnover of over Rs 300 crore.

It's almost like a rags to riches story - a small tune family ending up very big indeed. At present the Munjals of Ludhiana control an empire with a colleclive turnover last year of over Rs 143 crores, which is slated to cross Rs 300 crores by mid-1987. Today the Munjals' Hero Cycles is the largest manufacturer of bicycles in India with one-third of the market share, Hero Majestic is the third largest among moped manufacturers with 20 per cent ot the market share, and Hero Honda is poised to become the largest motorcycle manufacturer in India.

Behind these successes lie some very basic factors that make tor corporate excellence - shrewd management techniques, ancillarisation, and the development of a strong, dynamic marketing team with an excellent relationship with the retail network. Theirs is a pursuit of excellence, not the way the Harvard Business School teaches it, but in tune with the way things eventually work in India.

Like most successful groups in India the Munjal group oi companies is also dominated by members oi the Munjal family. At the head of the group is 63-year-old Brijmohan Lall Munjal. In 1943, his father Bahadur Chand Munjal and four sons (two of his sons began doing business only at a much later date) began their career as bicycle traders in Amritsar and Ludhiana. As the market grew in size, Brijmohan Lall managed to persuade the family lo move into the manufacture of handlebars, chain, wheel cranks, frame lugs and pumps for cycles in 1951. In 1956, by which time sales had crossed the Rs 25 lakh mark, the Munjals began to manufacture complete cycles.

As Lall reminisces, "In 1956, the government of India opened the floodgates by allowing as many as 52 new entrants lo manufacture a maximum of 5,000 cycles a year each." This was in addition to those already in the field (see box 1). Hero Cycles itself had a capacity of 7,500 cycles a year.

"When we look back now we can only smile. What we produced then in one year, we now produce in a day," says Lall's son, Sunil Kant Munjal, who is presently in charge of Hero Fibres, another unit of the group which manufactures synthetic fibres and acrylic

yarn. Today Hero Cycles has not only overtaken all other cycle manufacturing companies in India - it produces more cycles than the UK, France, Holland or Belgium - it also boasts of the highest productivity per worker and the cheapest cycle in the country.

FOREIGN COLLABORATION

By 1978, the Munjals moved into the manufacture of mopeds sold under the name Hero Majestic, and by 1984 got Honda Motor Company of Japan to enter into an equity collaboration with them to manufacture 100 cc motor cycles to be sold under the name Hero Honda. It was this collaboration that brought the group into the limelight.

What made them succeed where others did not? The successful evolution from making spare parts to making cycles, and from there to making mopeds and motorcycles - thus becoming a significant presence in the light engineering industry - can be attributed to three vital factors.

The first is the strong financial control the Munjals have exercised all alone. "All trough we have tried to plough back as much as we could into our companies," says Lall. He points to the family's simple life style. "We live in the same large house in Ludhiana that we bought in the fifties," says Lall. "Even the new generation foreign cars we now move around in were acquired only two years ago and that too when we began having guest~ from abroad who were potential collaborators," he says.

The group has maintained an extremely sound debt equity ratio all along. Even as late as 1985 the group's companies had a debt equity ratio of 0.8:1. "It wasn't even that much till 1980," explains Suresh Shetty, deputy general manager (finance), Hero Honda. "Till then the company hardly borrowed any money at all. The real borrowing began only when Hero Fibres was set up in 1980. Even today if you look at the group's capital structure, you will find that Hero Fibres alone accounts for 78 per cent of the total term loans totalling Rs 6.15 crores (excluding Hero Honda of course). The borrowings of the other concern is negligible."

Raman Kant, Lall's elder son, who is the managing director of Hero Honda, points out that the promoters (both Honda and the Munjals) pushed in their share of the capital one year before the public issue. "Our company thus got around Rs 6.2 crores for one year without interest," he says. "That is one more reason why, in spire of our issue opening in the wake of the Delhi riots following Mrs Gandhi's assassination, it was oversubscribed around 11 times."

He also points to the way the project got ready for trial runs within a year without any cost overruns, reflecting the same concern with management of funds and time that had been in evidence while the other Munjal companies were being set up. Their financial conservatism was in some measure responsible for the absence of any real diversification fill 1978, when manufacture of mopeds began.

The second factor in their success is the group's philosophy of striving to supply the best quality product at the cheapest price possible. Today a Hero cycle is sold at around Rs 437, making it the cheapest cycle sold in the country.

Hero Majestic mopeds too enjoy the same distinction. They cost around Rs 3,000 to Rs 3,235 as against the Rs 3,060 to Rs 4.400 Luna manufactured by Kinetic Engineenng, and the Rs 3,795 IO Rs 3.970 TVS 50 manufactured by Sundaram Clayton Lld. Hero Honda motorcycles cost Rs 13,800 (Delhi) to Rs 14,712 (Bombay) inclusive of accessories, compared with the Rs 13,910 to Rs 14,512 of Ind Suzuki (excluding spares). Shetty goes on to point out how Hero Honda has achieved a fuel efficiency of over 70 km a litre against not more than 45 to 50 km a litre he claims is achieved by the competitors.

A crucial factor that has given the grpup its competitive edge is their highly successful move info ancillarisation. In fact, soon after Hero Cycles was set up, the Munjals began looking at the quality and price of vital components that went into the manufacture of cycles. For instance, aware of how supply of chains was irregular and the quality not good enough, the Munjals set up Rockman Cycle Industries Pvt Ltd to manufacture chains and hubs. Today Rockman manufactures 15,000 chains a day. Similarly, when the group found tnat the quality of free wheels that they purchased from local manufacturers was also rather poor, they decided to set up Highway Cycles Industries Ltd in 1971 to manufacture free wheels. Today this unit produces about 19,000 free wheels a day; around 20 per cent are meant for the markets in West Germany, UK and the US.

At the same time, to cut costs further, Highway Cycles also began modifying exisiting machines to make special purpose machines for the manufacture of components for cycles, mopeds, and now motorcycles. "These machines have helped us either in reducing costs, improving quality, or even in increasing productivity," says Umesh Munjal, executive director, Highway Cycles.

SPECIAL PURPOSE MACHINES

He points to the rotary milling machines as one example of how four of the new machines helped phase out 40 of the older ones. This has helped us increase our productivity over ten times what we used to achieve earlier. Moreover, the machines developed by us cost hall of what the conventional machines cost us," he adds. He also talks of how the machines have helped to achieve better quality products, and reduce the rejection rates. Over the years this unit has made over 150 special purpose machines which it has 'sold' exlusively to other units within the group - call does not intend selling them in the market. "At present, for instance, at least 30 per cent of the machines in Majestic Auto Ltd are those that have been developed and made in Highway Cycles," adds Umesh. Today, according to him, at any given time at least 15 special purpose machines are in the process of manufacture at this unit, while another 10 are in the designing stage.

Besides such units within the group, there are others that the Munjals have started, outside the group. These outside units fall into two catagories: the first, where the Munjals or their relatives actually own and run the units, and the second where the Munjals provide technical and financial support to friends and associates outside the circle of the immediate family.

The first category includes units like Munjal Gases set up in 1963 to help Sadanand Munjal set up in business. In this case the Munjal group contributed 50 per cent of the new venture's capital of Rs 40 lakhs. While the Munjal group has a stake in Munjal Gases, Sadanand and his descendants have none in the companies belonging to the Munjal group. Today this unit, with a Rs 70 lakhs turnover in 1984-85, supplies oxygen, nitrogen, and more important, aceteylene gases to the Munjal group of companies.

Similarly, another relative, Balamukand Munjal, was helped to set up a unit to manufacture saddles for cycles and mopeds. Again, the group has no stake in this unit. And like the gases unit, over 60 per cent oi this unit's production of saddles is used by the Munjal group of companies.

Group growth
(RS lakhs)

*Low on account of writing off of Rs 75 lakhs capital expenditure on research and development.

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Then there are other units whose status is not clearly defined, like that of Munjal Castings (turnover for 1984-85 Rs 1.96 crores) Jnrl Munjal Steels (Rs 45 lakhs). This is because as these units technically come under the smallscale sector.

Explaining why the unit was set up, Ashok Munjal of Munjal Castings says, "There are very few units in India which can do quality aluminium die-casting jobs in the small-scale sector. This is because of the government policy which insists that manufacture of aluminium die-cast components below 750 gms is reserved for the small-scale sector." This presents a problem, because to get quality jobs done, a unit needs basic machines which cost over Rs 25 lakhs (not including the cost of tools, furnace premises and installauon costs), while to remain small-scale a unit's outlay should not exceed Rs 35 lakhs. He also points to the need to go in for all kinds of sizes of aluminium die-call components and castings if the unit is to be viable. Obviously, the Munjals need to have such a unit and are yet unable to have it on the scale they want.

While these are units run and managed by the direct descendants ol Bahadur Chand Munjal, there are almost 25 other units which the Munjals have promoted with technical, and even financial aid. The beneficiaries in this category are friends and not-so near relatives like jatender Mehta of Omax Auto which makes sprockets for Majestic

Auto (and very soon for Hero Honda as well, or Jagdish Lal Raheja of Jyoti Industries (crank forgings) or Arvind Kapur of Rico Auto Industries Ltd (hubs and brake panels). The Munjals helped these entrepreneurs in the preparation of feasibility reports, developing special purpose machines to cut costs and ensure quality, and even helped with pricing decisions.

Not a small part of the Munjals' success is attributable to the relationships they have established with these ancillary units. Unlike what is conventionally understood by the term ancillarisation, where the purchaser merely approves the quality and price of the goods supplied by the ancillary unit but is otherwise uninvolved in their management, the Munjals have managed to exercise a much greater degree of control over these units. Their commitment to these units, and the degree of technical and managerial support they provide, is reflected in the fact that each unit is visited by a member of the family at least once a week.

Efficient management of ancillary supplies is in fact one of the group's greatest strengths. The Munjals take a very active role in ensuring that these ancillary units adhere to production schedules, that quality standards are laid and adhered to, and that the products are priced right. Often, the Munjals even help these ancillary units in the procurement of raw materials like steel, by clubbing these units' requirements with their own.

In this they are very much like the Japanese. Indeed, Honda Motor Company's senior executives say they felt very much at home with the Munjals' way of doing things - their close relationship with ancillary units, as also their methods of inventory control and their general work culture - which was certainly part of the reason they chose the Munjals as one of their Indian collaborators.

EASY CONTROL

Ancillary manufacturers like Mehta of Omax and Kapur of Rico also talk of the way the Munjals have taken care not to let ancillary units feel stunted or too controlled. Such a view is articulated by Sunil Kant when he says, "We don't let any supplier of ours suffer. In case we teel he wants to grow, we even help identity growth areas for him. But at the same time we try not to depend on just one source of supply an to ensure that we always have a fall back."

What Sunil Kant says reveals the iron hand within the velvet glove - if an ancillary gets too dillicult to go along with, be it run by relatives or friends, the Munjals have always made it clear that they would not be too unwilling to develop alternate sources of supply.

That the Maunjals have been able to do this successfully for the last three decades speaks volumes for their management skills. In doing so they have departed with conspicuous success from the conventional beliet that busness should be run as business

and that it is bad practice to permit encroachment by friends and relatives. The Munjals have time and again developed such connections and demonstrated that a rigid insistence on quality, price and delivery schedules is not incompatible with doing business with relatives and friends. And contrary to the belief held by some management pundits that a good manager should only select a supplier and then leave him manage his own business, the Munjals have instead shown the advantages of active participation ever in the day to day management of their ancillary units.

In order to ensure that ancillaries' supplies are not disrupted, the Munjals ensure that such units maintain raw material inventories of at least 15 days to 2 months. In turn they ensure that these units do not face stockpiling by litting finished goods almost every day.

Such practices have helped the ancillary units enjoy a regular cash flow (the Munjals settle bills every second week), as well as allowed the group to maintain average raw material inventory levels of not more than 7.5 days. While in some cases like that of steel stops the inventory goes up to one and a half months, in the case of ancillary goods like saddles or pedals, the inventory levels are as amazingly low as just two hours.

Box 1
India cycles along

The bicycle industry in India dates back to 1939 when National Cycle (then known as Hind Cycle) began manufacturing twowheelers on a modest scale. Even though there was a spurt in domestic production following a ban on imports of cycles after independence, and 22 new entrants came into this field in 1956 alone, the total market for cycles did not exceed 6 lakhs. Since then the cycle industry grew to touch 6 million in 1984, dipping to 5.5 million last year. Today the bicycle ownership ratio in India is 1:12.5 persons.

Although bicycle exports from India are estimated to have amounted to US $17.5 million last year, they comprised just 37.9 per cent of the total value of bicycles and parts exported from India (see table). This is because while India's utility bicycles find a ready market in less developed countries, in the developed countries the demand is for sport and leisure bicycles which is met both by local production and by exports from Japan, Taiwan and South Korea.

Enormous potential. But the potential for India competing with these countries too is enormous. This is because Indian cycles and their parts are the cheapest in the world at the same quality level. This can be gauged from the fact that Indian free wheels, as one study pointed out, were priced at just 42 cents each at the Milan Show last fall, far below 60 cents for Chinese products and 55 cents for Taiwan products.

This is because Indian manufacturers have been able to take advantage of low labour costs and excellent use of economies of scale. For instance, this is one industry vvhere only 20 manutacturen make 6 million cycles a year, backed by as many as 3,500 cycle parts makers. Of these over 70 per cent are concentrated in the Ludhiana region developing a healthy infrastructure in this area.

One of the reasons why the Munjals succeeded was because in 1976 they advertised that their cycles were at least Rs 100 cheaper than others avallable in India. Om Prakash Munjal, managing director, marketing, explains how this strategy combined with a dealership of 14,400 people helped boost Hero Cycles sales making the company achieve a quantum leap in salary from around 4.5 lakhs in 1975 to almost 6 lakhs in 1977.

This dual strategy of what Om Prakash calls "taking care of our dealers and giving the best at lowest prices to our customers" is what has kept the Munjals ahead of everyone else both in India and overseas. That is why even though the market shrank last year, the Munjals output grew from 19,24,607 bicycles in 1984 to 20,2 6,100 in 1985.

The Munjals, however, do not plan increasing their present production levels. Though they do not explain why, market observers point to two reasons. One, labour may not be cheaply available in Ludhiana any more (see box 2); and two further penetration of the market may mean lower margins. White the first may be true, the second does not appear convincing

Maybe the answer to creating larges markets is only a problem of marketing. And anyway the potential for exports is still enormous. Or maybe there could be a third possibility - that the margins from moped and motorcycle sales have helped the Munjals decide to turn their attention from cycles to greener pastures!

India's export value of bicycles and parts

Data based on 1980 figure

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ANCILLARY UNITS

As in the case of ancillary units, finished goods do not stay within the plants for more than 12 hours. "This is no magic, but a process of harmonising," says Sunil Kant. Through trial and error we've honed our systems to this level of efficiency," says he. And nowhere is this better visible than at Hero Cycles, where the 7000 cycles produced every day are despatched by over 500 trucks every evening. By nightfall not a single cycle (save may be rejects) is left behind. "We don't have a godown. We don't want one - that would go against our syslems," says Lall.

This has in turn helped the Munjal group of companies maintain a healthy cash flow position. Till two years ago, before the polilical turmoil in Punjab began, letters of credit had to be opened before despatch of cycles and mopeds was made. Now, though despatch is done every day, payments come in within two 'weeks' time. At present only Hero Honda motorcycles enjoy advance bookings for as long as eight years.

Interestingly, when a computer manufaclurer approached the Munjals seven years ago to persuade them to computerise, he reportedly found that in at least 6 of the 14 departments of the Munjal companies, computerisation would have helped only marginally.

Now however, the Munjals have drawn up an ambitious programme for computerising to cope wilh the volume of work that has grown over the last two years. The first phase of this programme (expected to cost around Rs 60 lakhs) should be over by end 1986 and will be aimed al computerising accounts. A similar amount will be spent on the second and third phases of the computerisation process which will involve costing and production planning and later intelligence operations and planning CAD/CAM operations, all of which, according to Sunil Kant should be possible by end 1987. "We expect this process of computerisation to pay back the investments made in three years time by sheer improvement in efficiency alone."

Box 2
Ludhiana: Too many eggs in one basket!

Ludhiana is a small, closely knit town with a population of barely 1,400,000. Yet it boasts of having units that together account for a turnover of over Rs 350 crores, with the Oswal group of industries taking the lead, and the Munjals a close second.

According to Brijmohan Lall, "If we have grown, a lot of it is due to the special characteristics of Ludhiana - it is a place where everyone is maxing everything anyone can think of." He lays emphasis particularly on "the simplified methods of production which make these units very flexible in taking up jobs".

While these are some of the reasons that Lall puts forward to explain why Ludhiana is unique in itself, there are some other peculiarities about this town which have contributed to the prosperity of these units. For one, of having a 7,000 strong workforce, the Manjal units have not faced a single day's closure on account of labour drscord. They've been shut twice: once for 14 days after operation Blue Star, because transport facilities came to a halt, and then again for a few days after the recent Ludhiana killings. Other manufacturers have not faced any problems from workers either. This could be either because there is no strong union in Punjab, or it could be a result of the work culture prevatiling in and around Punjab.

The absence of a union could be the result oi the mixed composition of the workforce

in Punjab, especially in and around Ludhiana. The growing agricultural fortunes of the rural populace of Punjab and neighbouring states like UP and Bihar has led to large-scale mobilisalion of the labour force not only between the states but also between the agricultural and industrial sectors.

Consequently, turnover in Ludhiana's workforce has reached about five per cent lately. This is likely to increase and, while it impedes the formation of a union, it could cause the quite Punjab based managements quite a few sleepless nights.

The low turnover in Ludhiana's workforce has also been a result of the close co-operation between rival managements. For instance though Hero Cycles and its next door neighbour Avon Cycles are rivals in the market place, neither entertains workers leaving one unit lo join the other. This has resulted in a stable workforce. The significance of this is evident from the happenings at Hero Fibres. "Here the culture is totally different," complains Lall. "One jobber brings in 15 or 20 people and goes out with them." Located in UP. Hero Fibres has not yet been able to achieve the management culture that other Munjal units have cuiltivated.

But with changing demographic patterns, prodded on by the parochial winds of politics, the future of Ludhiana as a commercial centre and its work culture is anyone's guess. And this could be why the Munjals are watching such developments, more closely than most.

Group financial profile - 1985

(Rs lakhs)

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Family Tree

Late Bahadur Chand Munjal

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"To ensure that the introduction of compu ters will not wrinkle the work culture in the group companies we, have already begun holding exposure classes to explain the concept and to remove fears" says Sunil Kant who has emerged as the corporate planner and the most articulate spokesman for the group. To retain the culture that has enabled the group companies to function without a single days' loss of work (save 14 days afler operalion Blue Star when traspont facilities came to a grinding halt and a couple of days recently after the Ludhiana killing), the Munjals plan to induct no more than two EDP experts for proramming. "The best of the work will be done by the existing workforce which will be given the required training," says Lall.

Besides the obvious benefits to ongoing operations thal computerisation should ensure, it is the new and the most prestigious project of the Munjals, Hero Honda Ltd, that is expected to make a dramatic difference to the group's bottom line. By June 1986, Hero Honda should achieve a turnover of Rs 42 crores from sales of over 40,000 motorcycles (its bookings exceed 7 lakhs, which should take eight years to meet). By mid-1987, sales should cross Rs 82 crores from the 75,000 vehicles that are expected to be produced. And if informed sources are to be believed, the company is shortly expected to apply for doubling its licenced capacity from the present one lakh motorcycles per annum to two lakhs.

At the same time, the Munjals are going ahead full sleam for selling up Munjal Showa Ltd at a cost of Rs 12.5 crores for manufacturing 2 million shock absorbers every year, all of which are expected to cater to Hero Honda's needs and add another Rs 16.5 crores to the groups turnover by end 1987.

Expansion plans for Hero Cycles costing Rs 3.5 to 4 crores are also on the anvil according to which wheel rims will be manufactured each year (60 per cent to cater to the entire requirement of Hero Honda). A similar expansion at Highway Cycles at a cost of Rs 5 crores will produce pressure die-call parts (60 per cent of which will cater to Hero Honda's total requirement). All these developments are expecled to add Rs 40 to Rs 44 crores to the group's turnover in two year's time.

Another major expansion planned is that of increasing Majeslic Auto's capacity from 1.1 million mopeds to 2 I million mopeds. Most of the expanded capacity will be used to manufacture 'Poke' mopeds in collaboration with Styler Daimler Puch of Austria which Lall regards among the world's best as far as mopeds are concerned. These mopeds are expected to cost around Rs 1,500 more than the present range of mopeds. This venture should more than double this unit's turnover to around Rs 70 crores and make the Munjals also the largest moped manufacturer in India. Though the expansion plans have been okayed by the government, the project cost has yet to be worked out with Styler Daimler Puch.

Major bicycle manufacturers of India

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QUANTUM GROWTH EXPECTED

All these together should push the group's turnover to more than Rs 300 crores by end 1987. Market observers believe that once the expansion plans materialise, they should make the Munjals market leaders not only in cycles, vihich they are now, but also in mopeds and motorcycles.

That is, if everything goes right. Source close to the family point out that the Munjals have stayed together essentially hecause of Lall. Once his active involvement is no

longer there, will the group remain a cohesive one or will it, like almost all Indian families splinter? While this is a question only time can answer, the fact remams that if the past is anything to go by, the Munjals clearly have a 'majestic' future ahead of them.

Pressure of Domestic Demand and Export Performance in India

By R.S. Tiwari

A Case Study of Bicycle Industry; 1960-61 to 1974-75
Foreign Trade Review (New Delhi), Vol. xiii, No. 4, p. 341-364, Jan-March 1979

Excerpt from: Bicycle Reference Manual for Developing Countries. Edited by Barbara Gruehl Kipke, April 1991.

Preface

The Author expresses his deep sense of gratitude to Dr. K.K. Subrahmanian of Sardar Patel Institute of Economic and Social Research, Ahmedabad for his constant encouragement and valuable suggestions. Moreover, thanks are also due to Shri M.S. Trivedi of the same Institute for clarifying some theoretical problems with his valuable discussion. Unforgetable thanks are also due to Shri V.P. Bharadwaj of Gujarat University for thoroughly going through the earlier draft of the present paper and giving certain valuable suggestions for improvements. Responsibility for errors, in the present paper, however, is entirely mine.

Export Performance

EXPORT PERFORMANCE in India has widely been recognised as an essential requirement since the commencement of the Second Five-Year Plan. It is basically important partly because it finances import repayments and debt disbursements and partly because it (export) is conducive in many ways to Indian economic development process. But the fact that India's relative export shares compared to the other countries of the world have been decreasing over time raises certain crucial questions. One question which traditionally seems to have been generally posed in this regard is why India and other developing region, despite their best possible efforts, could not have been able to increase substantially their relative export shares? Other pertinent question which is equally important is how this melody could be overcome, i.e., what are the major correctives to be adopted through which relative export shares could be considerably improved? A large amount of theoretical analysis has been undertaken and a number of sophisticated econometric models has been worked out over a period of time to answer these questions. Most of the studies in this context concentrate their analysis on demand constraints, supply bottlenecks and association of both over a different period of time. Broadly, the analysis of problem has been undertaken at an aggregative level. In fact, the real problem of export deterioration could be meaningfully examined at the

level of individual export product item and import country level. Domestic demand for a product in an economy plays an important role in the determination of export performance. Moreover, it is supply side of the problem of export explanation. In this paper an attempt is made to examine the relationship between domestic demand and export performance of India at a disaggregative product and selective import country level over the period 1960-61 to 1974-75. Section I reveals existing India's major export trends, Section II reviews the relevant literature and sets the problem in its proper perspective, Section III explains some important methcodological issues, Section IV reveals findings of the study and Section V derives certain conclusions relevant for policy recommendations.

EXISTING EXPORT TRENDS

It is significantly noticeable from the structure of India's existing exports that export-shares of machinery and transport equipments, groupwise, have shown a remarkable increase in 1975 (6.38%) over 1961 (0.58%)[1], whereas, export shares of most of traditional product exports, groupwise, have been revealed either stagnant, fluctuating or steadily deteriorating over time.

India has successfully pushed up its exports of machinery and transport equipment at a very fast rate i.e., as much as 5602.10 and 400.15 percentage points respectively in terms of percentage change and average growth rates.

The export of bicycles is observed to have boosted relatively at a rapid rate in terms of percentage change and average growth rates as compared to exports of coffee, cocoa, tea and mate, silk, cotton, motor cycles, radio receivers and sewing machines. Further,when annual compound growth rates of Indian exports grew by 11.61 per cent, bicycle exports witnessed a significant increase by 53.40 percentage points. However, despite the fact that India's exports, in terms of absolute value level registered a markable increase its relative export shares, fell down to more than a half in 1975 (0.5%) over 1961 (1.1%) level. This overall India's export-per- formance has partly been accompanied by trade diversion from western world markets to Eastern and Developing World markets and partly because of growing world-wide inflationary trend and emergence of Bangladesh as a new export market. The decline in relative export shares of India has also resulted from comparatively successive export performance embarked by the rest of the world. Annual compound growth rates of Indian exports, over the reference period increased by 11.62 per cent, whereas world exports (annual compound growth rates) went up by 20.05 percentage points. This trend is strong after the period 1971 when compound growth rates of Indian exports were only 22.08 per cent whereas world exports (compound growth rates) recorded a modest increase, i.e., 35.22 percentage points.

Although the general observation that India has been diversifying its export shares from western markets to East European and developing markets is valid[3], in the case of bicycles it is not true. Bicycles, over the reference period, are being exported largely

and invariably in the same old markets, viz; Iran, Afghanistan, Indonesia, Nigeria, the Netherlands, Singapore, Sri Lanka and the USA[4]. At the same time, bicycles are being increasingly recognised as one of the essential export-product in the group of engineering goods from the point of foreign exchange earnings in India. Hence in the light of these structural characteristics of Indian export trends it is necessary to proceed to literature review and problem setting.

LITERATURE REVIEW AND PROBLEM SETTING

An analysis of domestic demand hypothesis has received the-due importance in the explanation of export performance in India. It is essentially important from two points. First, to determine the testable relationship between growing domestic demand and export-performance; and secondly, to infer about the existence of the potentialities of changes in domestic demand to achieve policy instruments via export expansion.

It is generally hypothesised that at a peak level of domestic demand amounts of goods and resources which would have otherwise been released for export markets and industries tend to be diverted to non-export markets and industries. And structures of costs and prices of exported goods as compared to their rivals would be too uncompetitive to stand in export markets. Hypothetically, therefore, variations in domestic demand, ceteris paribus, would result in retardations in exports (5, 6, 7, 8, 9). The above mentioned pressure hypothesis has also been ex- plained in entirely a different fashion. In this approach an increase in domestic demand leads to an increase in export performance through the inducement of productive technology. It follows that at a higher level of economic development process, an increase in domestic demand generates a higher level of local value-added. And the improvement in technology-induced within the sets of production systems tends to enhance export competitiveness of products in terms of price and quality. Thus, after certain time level, products manufactured locally tend to "spill over" from domestic market to world export markets. This hypothesis thus tentatively predicts that if ceteris paribus assumption is made then higher the level of domestic demand greater would also be the export performance (10, 11, 12, 13, 14).

In the former approach, causes of export deteriorations have been mainly associated with growing pressure of domestic demand (5, 6, 9), whereas other sets of explanatory variables viz.; time lags, waiting times and credit facilities seem to have little impact on the problem (7, 8). However, world demand and relative prices are observed to be relatively neutral in their effect (5, 6, 7, 8, 9). In the latter approach, growing domestic demand, on the other hand, enables manufactures to increase their exports through discriminatory policies, i.e., by charging higher prices in home market and competitively lower prices in the export markets (10). Domestic demand specifically related to exports positively only during the second stage of economic development process (11).

Therefore, one sort of hypothesis detects that domestic demand is inversely related to export performance, whereas, other refutes it. Taking both approaches to the problem, the relationship seems to be "indeterministic" and each approacn provides only a partial picture of the problem.

In above approach domestic demand has arbitrarily been assumed to be given over a period of time. But in fact, for understanding the nature of problem it is more important to know the specification of important factors underlying domesticdemand determination. Moreover, "deterministic models" as such do not have substantial grip into the real problem of export determination. In this context more dynamic "export deterministic models" are needed which would be able to explain meaningfully the structural requirements of import-markets, viz., per capita GDP, internal prices of identical products, population increase and internal demand patterns etc.

The problem of export performance needs a careful exarnination in India which is faced with the pressure of foreign exchange constraints. Therefore, we initially propose to examine the pressure of domestic demand hypothesis and exportperformance of bicycles product (SITC 733.1101) over the period 1960-61 to 1974-75 at 1960-61 prices.

METHODOLOGICAL ISSUES

Estimated stock of a commodity, in this case bicycles, with domestic consumers is assumed as a proxy variable for domestic demand. In fact, real proxy for domestic demand of individual consumers is the proportionate fraction of their total income to be effectively spent on bicycles' purchasing. However, due to scarcity of adequate data the present method, also used by NCAER in estimating the demand for scooters, has been followed.[15] For the purpose of our estimation, we assume that life time of bicycles prevailing in Indian market must be fifteen years.

The estimate of domestic stocks with consumers has been accumulatively worked out as total output+imports-exports over the period 1960-61 to 1970-71. Total output of bicycles which is readily available at current producers prices has been converted at 1961 base.[16] Import and export values of bicycles originally available at CIF and FOB prices, are found to be objectively uncomparable. And due to lack of appropriate conversion factors these data have been converted at 1961 wholesale prices for all the years under study.[17] Moreover, personal disposable income originally available at current prices has been purposefully converted at a comparable base by using comparable implicit price deflator over the period 1960-61 to 1970-71.

Similarly, relative price-indices of bicycles have been worked out by percentage ratios of bicycles' wholesale price indices to that of general wholesale price indices at a comparable base. Estimated stocks of consumers are treated as a dependent variable whereas, personal disposable income and relative prices are explicitly used as independent explanatory variables. The regression equation in the compact form would be:

(1. Equation in values)
y = alpha + bX + CZ
y = -2518.96 - 6.62 X + 0.03 AZ
(3.604) (0.004)*
R^2 = 0.97* .....

(2. Equation in quantities)
^y = alpha + bx + CZ
^y = -23281.47 - 65.21 X + 0.25 Z
(34.40)*** (0.037)*
R^2 = 0.97* .....

where,
y = domestic demand for bicycles (consumers' stocks) in million rupees at 1961 = 100
^y = domestic demand for bicycles (consumers' stocks) in quantity 1000' nos.
X = relative price indices of bicycles in rupees at 1961 = 100
Z = personal disposable income in million rupees at 1961 = 100
* indicates significant at 1 per cent level
*** indicates significant at 10 per cent level
Figures in parenthesis denote the standard errors of estimate.

To reinforce our regression results regarding the sign of explanatory variables compound growth rates over period 1960-61 to 1970-71 at 1961 prices have been calculated and are given below.

	Annual compound growth rates (1960-61 - 1970-71)
Domestic demand in million rupees	31.10%
Domestic demand in quantity in '000-nos.	30.46%
Personal disposable income in million rupees	3.60%
Relative prices in rupees	-6.70%

Regression results and annual compound growth rates explain that only increase in the level of personal disposable income would have stimulated domestic demand of bicycles. However, the ß coefficient of relative prices for explaining domestic demand of bicycles are found to be statistically insignificant in terms of values and inversely associated in terms of quantities respectively.

The domestic demand for bicycles estimated from equations (1) and (2) are used as an independent explanatory variable for explaining the behaviour of export performance over the period 1960-61 to 1974-75 in the subsequent analysis. Export of bicycles is explained by domestic demand (consumers' stocks) estimated from equations (1) and (2) indices of per capita GDP and imports at 1961 prices. Indices of per capita GDP at 1961 market prices have also been considered as other independent explanatory variable to reflect the purchasing power ability for selective import-countries of bicycles from India, viz., Iran, Afghanistan, Nigeria, the USA, Netherlands, Singapore, Sri Lanka and Indonesia.[18] Similarly, indices of imports for major import-markets have also been introduced at a comparable base as another independent variable to represent their internal demand patterns. Moreover, in order to observe the impact of Government policy on export performance dummy variable would be incorporated in some regression models. Standard multiple regression model is used to test the hypothesis in this analysis.

Information regarding exports and imports (volumes and values) have been collected from "Monthly Statistics of Foreign Trade", Department of Commercial Intelligence, Calcutta, Government of India.[20] Total output data for bicycles over the period 1961 to 1969, excepting 1967, have been taken from "ASI Census Sector", furnished from CSO, New Delhi.[21] Total output data for remaining years, viz., 1967. 1970 and 1971, have been projected on the basis of annual average compound growth rates. Additionally, information regarding personal disposable income and prices have been selected from "RBI Bulletin"[22] and "Wholesale Price Indices"[28] respectively. However, data regarding personal disposable income for ending two years i.e., 1974 and 1975, have been projected by the same method of annual compound growth rates. Information relating to imports and import prices and mid-year population for selective import countries are carefully collected from IFS (International Financial Statistics)[24] and "Monthly Bulletin of Stattstics"[25] furnished by IMF and United Nations respectively. Moreover, the data for GDP at current prices and its implicit deflators for selective import markets have been collected from "World Table".[26]

Assumptions

a. Bicycle in home as well as in export markets is assumed to be homogenous in character.
b. Main objective of domestic manufacturers is assumed to be profit maximisation.

The Analysis

Export of bicycles in India has widely been observed to be determined by sets of controllable and non-controllable variables. Factors substantially affecting export of Indian bicycles from demand side are thought to be explained largely by sets of international forces, viz., relative prices, per capita GDP anti internal demand patterns of selective import-markets. Whereas, the factors on the supply side are widely determined by sets of internal variables, viz., subsidy-cash, open, disguised, nominal

and explicit-premiums, direct tax concessions and import entitlement and replenishment schemes. In fact, the combined effects of both-supply bottlenecks and demand constraints-would reasonably explain the determination of export performance.

Since data for bicycle prices in importing countries are not found to be adequately available, the influence of relative prices on export of Indian bicycles has been objectively ruled out. Moreover, the quantification of policy impact on the quantum of exports product is practically impossible, mainly because of its fluctuating nature.[27] Nevertheless, dummy variable would be incorporated in some regression models in order to capture the policy influences. Multiple regression models are being given here as follows to test the proposed hypothesis.

ß Coefficients of estimated domestic demand of bicycles (i.e., the stock of domestic consumers) are found to be statistically significant in equations 3, 5, 7 and 9. In addition, ß coefficients of indices of pattern of internal demand for selective import markets in this case bicycles are marked to be statistically significant in cases 3,4,5 and 6. Whereas, ß coefficients of indices of their per capita GDP are statistically reliable only in two cases, i.e., equations 5 and 6. However, coefficients of policy variable are seemed to be statistically insignificant and therefore, unreliable throughout the period under study. R^2, in all the cases are significant, shows the percentage of variations explained in this subsequent analysis. Durbin Weston Statistics (DW), straight forwardly, reflects the absence of auto correlation for most of the data used in various regression models.

Thus, pressure of internal demand operating both in export and import markets determines the export performance in terms of values, whereas, the behaviour of internal demand prevailing only in selective import markets explains substantially the export performance in terms of quantities. In fact, during the reference period, export demand for Indian bicycles in these import markets might have been stimulated partly due to the availability of export of bicycles from India at a comparatively cheaper price compared to the rest of the world export markets and partly due to the lack of production of bicycles in their local import markets. Further, the effect of increased percapita GDP in their selective import markets has, however, outweighed the favourable effects of domestic demand prevailing in both the markets of export and import regions in explaining the rate of export performance of Indian bicycles.

The prospect of rate of export performance of bicycles in its developed and developing import markets might have been adversely affected due to increased level of industrialisation in the former and due to observed inflationary trend as a result of continuous spurt in oil prices in the latter.

MODELS
Coefficients of determination of export, performance of bicycles in India with respect to domestic demand, policy variable, indices of per capita GDP of selective markets

and indices of their internal demand patterns during the period of 1960-61 to 1974-75 at 1961 prices

Model I: Simple Linear Regressions

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Model II: Logerthemic Regressions

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Model V: Share Model with Policy Variable

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The upshot of our analysis, i.e., performance of relative share of export of bicycles is being explained dominantly by the pressure of internal demand operating in Indian economy. Other explanatory variables are found to be statistically insignificant in this particular context. Annual average compound growth rates are also presented to supplement our regression results.

	Annual average compound Growth rates (1960-61 to 1974-75)
1. Export of bicycles in '000 US$ at 1961 = 100	46.09%
2. Export of bicycles in nos.	41.48%
3. Share of export of bicycles in million US$ at 1961 = 100	27.31%
4. Estimated domestic demand of bicycles in million US$ at 1961 = 100	14.86%
5. Estimated domestic demand in '000 nos.	19.94%
6. Indices of per capita GDP in US$ at 1961 = 100	0.27%
7. Indices of internal demand in US$ at 1961 = 100	20.28%

Compound growth rates of indices of GDP and home demand as compared to estimated domestic demand seem to be relatively ineffective in determination of compound growth rates of exports.

Hence, domestic demand in association with internal demand pattern seems to be a dominant explanatory variable in explaining the export of bicycles as compared to the other structural determinants from import markets and Government Policy. Variations of domestic demand might have led to the expansion of domestic production through the improvement in productivity. Production coefficients, given below, explain that input requirements of coal and anodes to produce one physical unit of bicycles, excepting 1965, have declined in 1969 as compared to 1961. Which explains in other words, that an increase in productivity would have led to an increase in bicycles' production.

	Coal in tonnes	Amodes in tonnes
1961	0.0028	0.00006
1965	0.0030	0.00002
1969	0.0011	0.00004

Forgoing analysis, with the help of multiple regression model, compound growth rates and productivity trends explains that variation of domestic demand has been positively associated with export performance. And, therefore, Linder's hypothesis has once again been reaffirmed in the case of export performance of bicycles in India at 1960-61 prices.

CONCLUDING REMARKS

Various studies undertaken on theoretical as well as on operational grounds do not tend to explain the testable relationship between domestic demand and export performance in an economy. Our analysis with the help of multiple regression models and compound growth rates tend to explain that "growing domestic demand" is an important explanatory variable and, is positively, associated with the export performance of bicycles in India over the period 1960-61 to 1974-75 at 1960-61 prices. And thus, hypothesis developed by Linder and others is found to be firmly acceptable in our analysis at the level of individual export product item, bicycle and import country level.

Explanation of export performance in India has received a growing importance since 1960's, mainly because Indian relative export shares in the world export market started deteriorating at a much rapid pace than earlier. And hence, it was realised that some improvements in the foreign exchange earnings could be brought about through export performance of bicycles. It also helps to a certain extent in achieving the objective of

economic self reliance which is well realised thrust of planned Indian economy.[28] Resource allocation strategy in favour of bicycle industry seems to be economically viable from our findings from the point of long run trade prospects as well as internal economic welfare implications.[29] This finding disapproves the view occasionally held that resource allocation strategy does not have economic rationale in Indian economic context. However, in order to examine the feasibility of resource allocation strategy at a macro level from the point of view of export performance in India, an analysis of exports of engineering goods, under the pressure or resource constraint would have to be meaningfully examined at a more disaggregated manner at product and market level.

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18. Indices of per capita GDP at 1961 prices of Indian bicycles import markets have been derived by using the implicit GDP deflators at comparable base. Moreover, after having converted at US dollas the total GDP of each import market has been divided by corresponding population. And the averages of total GDP of all the import markets have been expressed in indices form at a comparable base.
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Appropriate Technology: An Empirical Study of Bicycle Manufacturing in Malaysia

By Fong Chan Onn

This study is based on the results of a project on appropriate technology financed by the International Labour Office, Geneva. The paper was completed while the writer was a Japan Foundation Fellow at the Institute of Developing Economies, Tokyo. Support from these organizations are gratefully acknowledged. the writer, however, remains responsible for the opinions expressed.

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INTRODUCTION

The dramatic recovery of Western Europe after the end of the Second World War brought with it the widely held notion that, in order to alleviate the problems of poverty and mass unemployment encountered in developing countries, rapid industrialization utilizing the latest technologies developed in industrialized countries should play a key role in the economic development of these nations (4) (15). However, by the dawn of the 1970s, it became apparent that this strategy was not bringing the miracles anticipated. Two decades of rapid industrial growth has led merely to the creation of a small, albeit prosperous, modern sector juxtaposed upon a far broader traditional sector subsisting at poverty level. The promise of massive job opportunities, as a consequence uf industrialization, never materialized. There is overwhelming evidence that this is mainly because of the fact that the technologies, which formed the basis of industrialization in developing countries, were the capital-intensive ones developed by the high-wage industrialized nations (2) (3) (18). Such technologies, after transfer to developing countries, were never able to generate the massive income generating opportunities anticipated.

In an urgent effort to try to rectify this developmental mishap, the concept of "appropriate" technology ("Appropriate" is the epithet now used most commonly, perhaps because of ist intrinsic ambiguity, in prereference to others such as "indigenous," "progressive," "labor-intensive," "self-reliant," and "intermediate.") pioneered by the ILO (5), and a number of other researchers (2) (11) (16) in the early 1970s. The main thrust of research in this direction has been the recognition that "modern" technologies transferred from the industrialized countrics may not be suitable to the receiving developing countries, not only from the viewpoint of inadequate employment generation, but also from the viewpoint of inducing misallocation of scarce resources leading oftentimes to political instability (1). Given this premise, it is then essential for developing countries to conduct extensive research - empirical or theoretical - to determine the types ot technologies most

appropriate to their environment. One way of persuing such research is to examine the set of currently available technique for a perticular product (or process), and out of this evaluation identify a technique which is most appropriate with respect to an accepted set of criteria. (The criteria adopted for this study will be specified and justified later. Actually this research approach ignores the possibility of developing new appropriate technologies. Such as possible is held by some economists which believe in "investment in knowledge" (see, for example, (6) (19). However, we believe that for stable technologies, it is possible to identify an appropriate technology by evaluating the set of currently available techniques. For the product chosen for this study, namely the bicycle, the manufacturing technology is relatively stable. Hence the methodology is justified.) In this study we perform such an investigation for bicycle manufacturing in Malaysia. Bicycle is the most common form of transport equipment in Malaysian households. It is owned by about 50 per cent of families with income below M$99 (The momentary unit used in this paper is the Malaysian dollar. As at the end of 1978, the conversion rate is US$1.00 = M$2.20.) per month and about 75 per cent of families with income between M$100 - M$299 per month (19). Hopefully, conclusions from this study would ofer policy implications for the promotion of appropriate technologies in not only this important sector, but also in the other sectors where the manufacturing techniques are similar, e.g., metal fabrication and general engineering industries.

CRITERIA FOR EVALUATION OF APPROPRIATE TECHNOLOGY

Morawetz defines appropriate technology "as the set of techniques which makes optimum use of available resources in a given environment. For each process or project, it is the technology which maximizes social welfare if factor prices are shadow priced" (12, p.517). The definition implies that a technically efficient technology is not necessarily an appropriate technology because the price and availability of limited resources, and the social welfare function should eventually determine the set of appropriate technologies. The definition, however, leaves social welfare function undefined. Though it would be relatively simple to offer a rigorous definition of the social welfare function; it is however difficult operationalize from Morawetz's concept of appropriate technology to arrive at a set of criteria for the evaluation of appropriate technology. (See Sen (17, p. 7) for discussions on the difficulties involved in operationalizing any rigorous definition of the social welfare function. Thus instead of operationalizing Morawetz's definition, we utilize Eckaus's approach which states that the only criteria for evaluating the "appropriateness" of technological discussions is with reference to the general goals of development (3, p. 37). This assumes that the group social welfare function is as enunciated in the develop- ment goals, and appropriate technologies are technologies which can enhance (and not retard) the achievement of these goals. The principal development goal of Malaysia is eradication of poverty with a reduction in inequality of income disiribution (10, Chap.9). Within the extent of this goal, this means that the whole range of technologies which pruduce different qualities of bicycles should be examined. Relevant characteristics are investment and labor intensities, scale of operation, simplicity of operation and repair, appropriateness of product, and use of locally produced inputs (raw materials and machinery) (18, p.98). From this examination, it may be possible to identify a current technology (or an improved version of a current technology) which comes closest to being an appropriate

technology-in the sense of enhancing the achievement of the goal of poverty preventation. However, before we priceed to evaluate the bicycle manufacturing technologies currently available in Malaysia, we shall briefly describe the present state of the Malaysian bicycle industry. This would provide a good basis upon which the technologies can be evaluated.

THE MALAYSIAN BICYCLE INDUSTRY

There are a number of bicycle types, of which the general roadster is the most common. The component requirement of a typical roadster is presented in Table 1. From the table it can be seen that the frame, fork, mudguard, handle-bar, chain guard, luggage carrier, and stand require raw material inputs consisting mainly of steel tubes and sheets, and require relatively simple manufacturing processes of cutting, grinding, thread forming, pressing and bending, and welding. These parts can be produced by most well-equipped workshops. The other parts require a higher level of technology, since they involve more sophisticated machineries working on semi-finished inputs like high carbon steel. They are generally produced by specialized firms.

Al present there are only two large bicycle manufacturers in Malaysia; namely the internationally well-known Raleigh Bicycle and Far East Metal Works, an indigenous firm. There are, however, a number of ancillary firms manufacturing some parts of components of a bicycle. Though no complete listing of these establishments exist, attempts made to identify them through the directory of manufacturing establishments, the yellow pages, and the bicycle dealer associations have revealed a total of eleven of these firms. (It should be noted that the number of bicycle establishments as recorded in (8) includes manufacturers of tricycles and trishaws as well.) These firms are spread out rather evenly over the whole country.

In terms of components manufactured it can be seen from Table I that all components with the exception of crank and chain wheel, hubs, pedal, and bell are manufactured by the ancillary firms. The ancillary firms do not market their own brands of bicycles. They merely manufacture bicycle components and sell them either to the two large manufacturers (hence the name "ancillary") or to the bicycle dealers for the replacement market. The tariff levied on imported bicycle (completed set) as at 1978 is M$60 per set. On imported component parts the tariff varies according to the parts-ranging from M$20.00 on one body frame to M$I.00 on parts of brake system. The total tax on all the parts (levied separately) for a bicycle amounts to M$74. The tariff schedule offers uniformly high protection on all components, e.g., M$20 for a body frame and M$15 for luggage carrier. Though in the short-run this may benefit the local bicycle manufacturers, in the long run it is unlikely to stimulate them to be export-oriented even in components in which the local firms have strong international comparative advantages in terms of factor endowment.

TABLE I
Main Components of a typical roadster bicycle

* for details of the machineries and processes, see (20)
+ Most firms manufacture more than one item

Up to 1969 the domestic bicycle industry remained a relatively small sector - generating a value added at market prices of only about M$0.4 million, and an employment of less than 200 people (8, various years). However, the commencement of Raleigh (Malaysia) increased the value added to about M$1.6 million in 1969 and M$2.4 million in 1972, or about M$2.0 million per annum for the three years immediately after its establishment. The employment also increased to about 390 in 1969 and 500 in 1972. The labor productivity in the bicycle sector hovered around M$2,600 to M$2,900 per worker up to 1967; after 1967 it increased to between M$4,000 to M$5,400 per worker. This is, however, still significantly below the 1968 average labor productivity of M$5,179 per worker in the transport and communication sector (7, p.285). This is not surprising since the Malaysian transport sector is dominated by the more investment intensive automobile assemblers.

TABLE II
Domestic Market for new bicycles

Source: Private interviews with Raleigh (Malaysia) and Malaysian Bicycle Dealers Association

Unlike motor vehicles, ownership of bicycles requires an official registration. Estimation of the domestic market for bicycles, hence, has to be on the basis of its relationship to the economic environment and past sales. The Malaysian Bicycle Dealers Association's estimate of the domestic market for bicycles is as given in Table II. The minimum economic size for a bicycle plant that manufactures the simple pressed and bent spurts, and purchase the other components from ancillary firms, is about 25,000 units per annum (20, Chap. 6). From Table II, it can be seen that the domestic market is more than sufficient to cater to the two large bicycle manufacturers currently operating. In fact there appears to be room for the viable existance of about two more bicycle plants. The minimum economic size for a specialized plant producing high-techology components like crank and chain wheel, hubs and pedal is about 100,000 units per annum (20, Chap. 7). Hence it would seem from Table II that, even with a market share of about half the domestic market, ancillary firms producing these specialized components can be viably established in the country.

In terms of marketing network both Raleigh and Far East market their bicycles in "completely knocked down" packs to bicycle dealers spread throughout the country. These dealers, in turn sell the bicycles to the retailers (bicycle shops), either in assembled form or in knocked down packs, to be assembled by the retailers. In general, the Raleigh brands are retailed in the range of M$200 - M$240 per unit, the Far East brands in the range M$15 - M$180 per unit, while the local brands (assembled by bicycle retailers from purchased components) are anywhere in the range of M$100 - M$150. The bicycle ancillary firms also market their components and parts produced through the formal marketing system. They sell their components to the bicycle dealers, who in

turn sell them to the retailers for both the new and replacement market. With respect to market share, the bicycle dealers association estimated that as at the end of 1978, Raleigh und Far East each has captured about 35 per cent to 40 per cent of the market. The remaining 20 per cent to 30 per cent is shared by the other brands.

BICYCLE MANUFACTURING TECHNOLOGIES - Introduction

In this section we will focus our discussion on comparing the manufacturing techniques of Raleigh (a foreign-based firm) and Far East, as well as those used by the local bicycle component manufacturers. The essence of the comparison is "modern" manufacturing technique (i.e., those used by Raleigh) and less "modern" techniques (i e., those used by Far East and other local establishments). The bicycles manufactured by both Raleigh and Far East bicycles some selfmanufactured components and some components which are purchased from external suppliers-locally as well as abroad. Table III presents the details of the origin of the components that are used in the Raleigh and Far East bicycles. The table also lists the components manufactured by six local bicycle-component firms. These six local bicycle-component firms are fairly representative of the bicycle ancillary industry and hence should be sufficient for the purpose of generalization regarding the ancillary sector.

The manufacturing techniques used by Raleigh, Far East, and the relevant ancillary firms are summarized in Table IV. We can compare these techniques on technical, economic, and organizational grounds. Since all the relevant firms produce essentially similar items, such comparisons do reflect the relative state of the manufacturing processes.

BICYCLE MANUFACTURING TECHNOLOGIES - Technical Comparison

From Table IV it can be seen that technically Raleigh and non-Raleigh manufacturing techniques can be compared in terms of input materials, the basic machining operations (cutting, filing, bending, pressing, and threading), the joining operation, the finishing operation, and quality control.

All input materials utilized by Raleigh are imported from its parent company in United Kingdom. For the non-Raleigh firms, the majority of the input materials are purchased locally (e.g., steel tubes, bolts and nuts, etc.). These materials may be of acceptable quality, but are unlikely to be as high quality as the Raleigh materials. Specialized items like high-carbon steel sheets are imported from Japan or Taiwan.

TABLE III
Bicycle components manufactured by primary firms and ancillary component firms

Note: SM - self-manufactures. P-UK - purchased from United Kingdom. P-Lo - purchased locally. P-J&T - purchased from Japan and Taiwan.
Only manufacture those items marked x.

In the case of Raleigh the basic machining operations of cutting, filing, bending, pressing, and threating utilize very little manual efforts. All operations are performed automatically by equipment. These operations are performed semi-automatically in the non-Raleigh firms. More manual efforts are involved, although the finished components tend to be less consistent in quality than that of Raleigh's.

In Raleigh, all *joints* are welded using a spot-welding machine. The joints are also brazed in a dip-braze furnace, resulting in joints which are not susceptible to corrosion. In the case of the non-Raleigh firms the joints are welded using manual oxy-acetylene gas welding sets. The quality of the welding, in this case, depends on the ability and experience of the welder and, on the average, may be of lower quality than that done using a spot-welding machine. Further the joints are not brazed, and hence are more susceptible to corrosion.

TABLE IV
Manufacturing operations used by Raleigh (Malaysia), Far East and Ancillary Firms

Raleigh's finishing operations are, in general better than that of non-Raleigh. For paint finish, Raleigh uses electrostatized paint applied by dipping. The primer coat is stove-baked for greater corrosion resistance and more even finish. Far East uses non-electrostatized paint applied via a spray system, while in the case of the ancillary firms the paint is applied to the components manually.

Raleigh maintains a very rigorous policy of quality control. All components- self-manufactured as well as locally purchased - are subjected to continuous testing by the parent company. Each completed bicycle must be able to sustain 258 hours of continuous use under Raleigh specified conditions. On the other hand both Far East and the ancillary firms do not have a very rigorous quality control policy. Parts are generally subjected to visual inspection, but not mechanical testing.

In summary it can be said that Raleigh's technical quality is geared towards meeting its own very high international standards, while that of the non-Raleigh firms are more directed towards meeting the demand and standard of the domestic market.

BICYCLE MANUFACTURING TECHNOLOGIES - Economic Comparison

A detailed micro-level comparison of the mechanism of the techniques is difficult. However, in Table V we provide a number of economic indicators to compare the performance of the manufacturing techniques.

In terms of investment, (In this paper investment will be used in place of capital. This is to overcome all the objections of capital as a concept of factor input (see (18)). Further, since the equipment utilized by all the firs are of the same vintage, and have almost the same expected life-span, the current replacement cost is used instead of the annual equivalent replace-???) Raleigh has the largest current value followed by Far East. The current value of investment of a bicycle ancillary firm is typically small, being less than M$1 million. In terms of employment

both Far East and Raleigh have about 200 workers each. The workforce in the other firms is generally small, being less than 100 workers each.

In terms of the intensity indicators Table V shows that there is a clear distinction between Raleigh and the non-Raleigh firms. Raleigh uses an investment per labor of M$46,000 while that for non-Raleigh firms varies between M$27,000 to M$8,000. Table V also shows that Raleigh's value added per labor of M$13.000 is double or triple that of the other firms which varies between M$5,500 to M$1.300. This clearly indicates that Raleigh's technique is more investment intensive. This enables it to generate a value added per labor far higher than the other bicycle firms. In terms of value added per dollar investment, there is also a significant difference between Raleigh and non-Raleigh firms, the value being 0.29 for Raleigh and between 0.15 to 0.20 for the non-Raleigh firms.

Given that the firms in this study work only on a one-shift basis and each have an approximately equal number of holidays, the degree of capacity utilization for Raleigh and non-Raleigh firms is about the same (see Table V). The higher investment productivity, for Raleigh cannot, therefore, be explained by a higher capacity utilization rate. Since the age of Raleigh equipment is not very different from that of non-Raleigh equipment, it is also unlikely that non-Raleigh equipment would have deteriorated so much (vis-à-vis Raleigh equipment) as to cause a drastic decline in its equipment productivity. Further, since bicycle manufacturing technology is a relatively stable and open technology, it is highly unlikely that Raleigh could have used more productive methods of working on the equipment without the non-Raleigh firms coming to know about them and using these methods themselves. Hence the only likely explanation for Raleigh's higher investment productivity seems to be its ability to capitalize on its international image, and collect monopolistic rent on its products in the form of higher prices (i.e., higher than that justified by its better quality). (As was mentioned in Section II, Raleigh bicycles are more expensive than other brands of bicycles. See also (2, Chap. 1) for a further elaboration of this tendency of large multinationals.)

TABLE V
Economic indicators of Raleigh and non-Raleigh manufacturing firms

Source: Based upon private interviews with the relevant firms and their annual reports.
[a] The relevant base is December 31, 1978
[b] Computed from an appreciation rate of 10 per cent per annum based on cost at time of purchase. Time of purchase of machinery and cost were extracted from the relevant company annual reports. This item also includes working capital which is estimated to be the difference between current asset and current liability.
[c]Labor productivity is computed in M$ per worker rather than bicycles per worker. This is because the firms manufacture only parts of a bicycle, and it is not possible to compare their output on the basis of units of bicycles.
[d]Based upon a 100 per cent capacity of 16 working hours per day for 290 working days per year.

Fig. 1.
Relative Efficiency of Bicycle Manufacturing Techniques of Different Firms

Note: R - Raleigh; FE - Far East; TL - Tan Lian; SH - Sin Heng; JC - Joo & Co.; GL - Gree Lee; and BP - Batu Pahat

It is also evident from Table V that the techniques of some firms are more efficient (with respect to labor and investment productivity) than the others. Figure 1 presents the plot of labor productivity against investment productivity. From the figure it can be seen that techniques used by Raleigh and Far East can be considered as efficient. Techniques used by the other firms all lie to the north-west corner of the line joined by Raleigh and Far East and are therefore inferior. However the positions of Sin Heng and Joo & Co. are just off the efficient line. Their techniques are therefore, "almost" efficient.

In terms of purchase of input materials and components, Table V shows that, while there is no significant difference between Raleigh and non-Raleigh firms in terms of value of local components purchased per dollar of value added, there is a significant difference between the two groups of firms with respect to value of imported component per dollar of value added. Raleigh uses about M$2.1 of imported component per dollar of internal value added, while the average for the non-Raleigh firms is only about M$0.60. With respect to total cost of purchased parts and components, Raleigh uses about M$3.0 worth of externally manufactured components to every M$1.0 worth of internal value added, while that of non-Raleigh firms is about M$1.0 externally manufactured components to M$1.0 internal value added. The high value of imported components (and hence total externally purchased components) may be accounted for by the fact that Raleigh imported components are more expensive than imported components utilized by non-Raleigh firms.

BICYCLE MANUFACTURING TECHNOLOGIES - Organizational and Marketing Differences

Besides being more investment-intensive, Raleigh also differs from the non- Raleigh firms in organizational structure and administration. These differences are listed in Table VI.

Raleigh is essentially a foreign controlled firm. Decision making are vested in the hands of a number of expatriates seconded from the parent company. All the non-Raleigh firms are operated as Malaysian privately-owned limited companies. Except for Far East, non-Raleigh firms do not employ university graduates on its management team. In fact, except for Far East, there is no separation between the owner and the chief executive in the other non-Raleigh firms. In these cases the owner is also the chief executive.

In general the employees of Raleigh is better paid (This may be a reflection of the higher labor productivity of Raleigh firms. It is difficult to compare the skill levels of Raleigh workforce vvith that of the other firms. No formal vocational qualification is required of process workers before they are hired and generally every process vrorker is expected to learn "on the job." However, only Raleigh has a formal

in-plant training scheme for its hired workers. In so far as wage can be a measure of a worker's experience, then one can conclude that Raleigh workers are generally more experienced than thoxe in the non-Raleigh establishments.) than employees of the non-Raleigh firms. The average wage of a direct Raleigh employee is M$400 per month, compared to M$300 per month for that of Far East and about M$200 per month for that of the other firms. Non-Raleigh firms (other than Far East) experience a high labor turnover rate. On the other hand, there is a very low rate of labor turnover in Raleigh. This may be attributed to its relatively high wage rate, as well as the existence of a formal training program for its employees. The labor turnover rate for Far East is intermediate between that of Raleigh and the other non-Raleigh firms.

TABLE VI
Organizational characteristics of Raleigh and non-Raleigh firms

Source: Based upon private interviews with the relevant firms and their annual reports.
Note: I.A. - industrial area; R.A. - residential area

Another major difference between Raleigh and non-Raleigh firms is the major emphasis in which Raleigh places on the quality and image of its brand of bicycles. This message of superior quality is constantly conveyed to the public through constant advertisement campaigns in the newspapers and sports magazines. Table V shows that Raleigh uses M$0.40 of advertising expense for every dollar of value added which is far higher than that of the other firms. The marketing strategy of Raleigh is impressing upon the potential buyer that the higher quality more than justifies the higher retailer price. Tbe marketing strategy of non-Raleigh firms (especially Far East) is one of selling a product at a cheap price.

BICYCLE MANUFACTURING TECHNOLOGIES - Appropriate Technology

From the perspective of Morawetz (12) and Eckaus's (3) definition of appropriate technology and Stewan's (18) list of desired characteristics in appropriate technology, the above discussions indicate clearly that with respect to the Malaysian development goals, Raleigh technology may not be the most appropriate bicycle technology. An improved version of Far East technology (with improvements in quality control, and finishing operations) may be the more "appropriate" technology for bicycle manufacturing in Malaysia. The reasons for this observation are as follows.

1. It is a relatively efficient technique in the sense that no other techniques currently available in the country can achieve the same level of labor productivity with the same or less level of investment productivity.
2. Amongst the bicycle manufacturing techniques, its value of investment intensity is intermediate-it being between the highly investment intensive Raleigh technique and the highly labor intensive (but inefficient) techniques of the bicycle ancillary firms. In relation to the industrial sector as a whole, this technique's requirement for investment seems to be reasonable in the sense that it is far below the investment intensity of sectors which are obviously

investment-intensive (e.g., petrochemicals) and above sectors which are obviously labor intensive (e.g., footwear manufacture). (see Lim (7, p.285). Actually Lim used value added per employee as the surrogate measure for capital intensity. Based on his computations, in 1968 the value added for the transport equipment sector is M$5,179, M$102,717 for the petroleum sector, and M$2.212 for footwear manufacture.) Thus its demand on the country's investment (a limited resource) seems to be consistent in relation to its ability to generate jobs.

3. In terms of scale of operation requirement, that required by Far East (This assumes that a smaller scale of operation of the Far East-type technique is not feasible. Actually this may be too conservative an assumption, but for the purpose of argument it is safer.) is not beyond the reach of the currently smaller firms or that of the larger ancillary firms. In terms of organizational requirement it is certainly not beyond the ability of the entrepreneurs who run the ancillary firms, since the basic style of organization is the same. Further, with respect to skill requirement of the workforce, the types of skill workers required are not far above the skill level of the workers in the present ancillary firms. All in all, this technique seems to be readily adoptable by local entrepreneurs.
4. The Far East-type of technology manufactures a product which can meet the basic need of reliable transportation at a price acceptable to the low income families. (At M$150 per bicycle, it is between one to two month's household salery of an average low income household.) For these families bicycle is the only feasible form of family-owned transportation mode. This technology is, therefore, consistent with the nation's developmental priority which is eradication of poverty.
5. There is a great potential for bicycles manufactured by Far East-type techniques. Far East brands now constitute about 35 per cent of the domestic bicycle market, in spite of Raleigh's well coordinated advertising strategy. With a more coordinated marketing and advertising campaign, bicycles manufactured by Far East-type technique can make an even bigger inroad into the domestic market.

It should be noted that the suggested appropriate technology, which is a slightly improved version of Far East technique, is one based on new equipment. (Not second-hand equipment as was the case of some technologies in early Japan (6) (13). It is generally felt that a technology based on old equipment is not likely to be appropriate, since it can create many problems with respect to spare parts, maintenance, and product quality.) The characteristic that makes it appropriate is essentially the substitution of labor in the machine-peripheral activities (14). For example, in the cutting/filing/threading operation for body frame manufacture, the tube length is manually adjusted instead of being done by machine. The basic "core" machine activities upon which the basic reliability of the product depends, is basically similar to that of Raleigh (the most investment-intensive technique).

Further, it should be pointed out that Far East-type technique has been identified as appropriate only on the basis of evaluation of techniques currently available. It may very well be a more appropriate technology for bicycle manufacturing can be developed through new and intensive research and development efforts. This, however, may not be forthcoming in the foreseeable future since bicycle manufacturing

techniques are relatively stable and are not likely to be easily affected by new innovations.

POVERTY PATTERN AND APPROPRIATE TECHNOLOGY - Introduction

In this section, we briefly discuss the poverty pattern in the Malaysian income, and then examine how the utilization of an appropriate technology for bicycle manufacturing will be consistent with the governments developmental goal of eradication of poverty by uplifting the standard of living of the lowest income group of the population.

POVERTY PATTERN AND APPROPRIATE TECHNOLOGY - Malaysian Poverty Pattern

In terms of absolute number of poverty households, (The poverty line income is that income necessary to cover minimum nutritional requirements and essential non-food expenses to sustain a decent standard of living (10, p. 160).) Table VII shows that the total number of poverty households increased from 791,800 in 1970 to 835,100 in 1975. In 1975, it was estimated that the incidence of poverty occurred in 54.1 per cent of the rural households but only 19.0 per cent of the urban households. The incidence of poverty among rural households is particularly high, and current government developmental strategies aimed at reducing the number of poor households to 43.1 per cent of the rural households, and 15.8 per cent of the urban households in 1980, and to 23.0 per cent and 9.1 per cent of the rural and urban households respectively in 1990. In terms of absolute numbers, the plan call for the reduction of poor households to 768,300 in 1980 and 513,900 in 1990. (It is not the intention of this paper to evaluate the feasibility (or otherwise) of the achievement of these targets. Hence these targets are accepted at their face values.)

TABLE VII
Peninsular Malaysia: Poor households by rural and urban strata, 1970-90

Source: (10, p.73)

Given the great emphasis of the government to uplift the level of income of the poorest income group to that above the poverty line there will be a higher and higher proportion of the population which will be above the poverty line but still below the medium and high income line by the end of the various developmental plans.

In 1967-68 (see Table VIII) 55.3 per cent of the households earned incomes of less than M$100 per month, which is the generally accepted poverty line for 1968. (The 1967-68 Socio-Economic Sample Survey (9) defined income to be cash income. This generally understates income of the low income groups, since these groups generally supplement their cash income with home produced food crops, transfer payment from relatives, etc.) About 35.7 per cent of the households earned between M$100 to M$299 per month, which corresponds to the households above poverty line but below the medium or high income levels. From Table VIII it can be seen that bicycle is the major item of consumer durables owned by these two groups of households. For families in poverty and just above poverty categories bicycle is an extremely important piece of family consumer durable. It is owned by

about half of the families in the poverty category and about three-quarters of the families in the just above poverty category. Hence if the governmental targets, as set out in Table VII, for the eradication of poverty are achieved there will be a tremendous increase in demand for bicycles. Given this expected large increase in natural demand for such bicycles, it is not only socially desirable but also consistent with the overall objective of the upliftment of the living conditions of the poor, that government policies on the bicycle sector should be directed towards the growth of manufacturing establishments utilizing the appropriate technology, i.e., Far East-type technology which is efficient yet not too highly investment-intensive.

TABLE VIII
Ownership of consumer durables by household income

Source: (9)
* Income here is defined to be cash income

POVERTY PATTERN AND APPROPRIATE TECHNOLOGY - Appropriate Technology and Employment Generation

The encouragement of the utilization of appropriate technology for bicycle manufacturing will, further, have the desirable effect of generating more employment opportunities than if the more investment-intensive Raleigh-type technology were encouraged. The current average annual production of both Raleigh and Far East is about 50,000 bicycles each. From the table of domestic demand (Table II) it can be seen that there will be scope for two more plants of the present Far East capacity by about 1981. (The projected demand by 1981 is about 196,000 bicycles per year. Hence there will be enough scope for four bicycle plants of capacity of 50,000 units per year. Again we are making the conservative assumption that Far East-type technology requires at least a workforce of 200.) The required investment for these two plants, if the Far East-type technique is used, would be about M$11.2 million with an employment potential of over 420 workers. However, if the Raleigh-type technique is adopted for these two plants, the required investment is about M$16.8 million with an employment capacity of about 390 workers. Hence, with the Far East-type technique there would be an extra thirty jobs created. Further the surplus investment of M$5.6 million (i.e., M$16.8 million - M$11.2 million) can be invested in other sectors to create more employment.

The adoption of appropriate technique to produce bicycles demanded by the new low income (but above poverty level) households created as a result of government development efforts, in turn produce a larger number of employees (Larger than would be the case of the more investment-intensive Raleigh-technique is utilized. Further the wages of employees of firms using the appropriate technique would be lower than that of employees of firms which use the more investment-intensive type technique.) who would be potential consumers of bicycles (and other products) produced by appropriate techniques. This cycle is represented by bold lines in Figure 2. The cycle in bold lines emphasizes the income diffusion aspect of appropriate technology utilization. Products manufactured by appropriate technologies efficiently meet the requirements of the low income group and thus raise their

standards of living. Further the utilization of appropriate technology in itself generates a larger number (compared to utilization of inappropriate technology) of industrial job opportunities, enabling more of those below the poverty line to be raised above it. Although the bicycle sector is a relatively small sector, together with the utilization of appropriate technology for the manufacture of other products, employment opportunities created would be substantial. This, in turn, would generate substantial consumption effect for appropriate products. This would result in the upliftment of the standard of living of a far larger number of poverty group than if inappropriate technology were used.

Fig. 2.
The appropriate Technology , Employment, and income diffusion cycle

POVERTY PATTERN AND APPROPRIATE TECHNOLOGY - Government Policies and Appropriate Technology

Thus far we have been discussing the adoption of appropriate techniques by private entrepreneurs. From the viewpoint of social welfare there is also ample justification adoption of government policies to promote the utilization of appropriate techniques by private entrepreneurs.

The current Malaysian scheme for promotion of industrialization, as incorporated in the Investment Incentive Act of 1968 and the Investment Incentives (Amendment) Act of 1971, are aimed at promoting the growth of firms using technology which are either very investment-intensive or very labor-intensive (7, Chap. 12). Appropriate technology generally have an intermediate degree of factor intensity (18,). Some fine-tuning of the incentives would seem necessary if appropriate technology is to be promoted. There need to be an incentive based on both the level of fixed investment and employment. (It should be pointed out that under the present incentive scheme a firm cannot enjoy both the incentives based on fixed investment and those based on labor relief.) This would provide an opportunity for firms with medium levels of fixed investment and employment, as most appropriate technologies tend to be, to compete on the same footing as the more investment-intensive und the more labor intensive firms. Further, much more research need to be done (or encouraged to be done) to determine the types of technology appropriate to the various industrial sectors. Since an appropriate technology is generally product specific, this requires a series of studies on different products, particularly the major products of the Malaysian economy. (These include processing of agricultural products, food and beverages, textiles and footwear, wood products, metal products and machinery manufacture and repair, and transport equipment.) Generalizations and conclusions can then be drawn on the pattern of appropriate technology; and this would be extremely helpful for the design of policies to promote appropriate technology. (A ringing example of the usefulness of this sort of studies is contained in (2). As was shown in Section III, bicycle manufacturing in Malaysia consists mainly of the basic machining operations of cutting grinding, filing, threading, etc. Thus the findings of this study may also be applicable to other sectors with such activities, e.g., the metal working sector, general repairs and services, etc.) The government can also help in providing consultancy services on appropriate marketing and advertising

strategies to raise the image of the appropriate products close to the "ideal" desired by the consumers, besides the conventional areas of finance, technical operation, and management. In the case of bicycle manufacturing, this is particularly important. Image building of a transport mode through advertising is a very complex area, and large establishments in this sector (Examples are the large automobile manufacturers (General Motors, Ford, Nissan, etc.) in the motorcar sector, the large two-wheeler manufacturers (Honda, Vespa, Raleigh, etc.) in the two-wheeler industry.) have done a great deal of research on this the government could tap on this vast source of information, and advise potential future bicycle manufactures on their optimal advertising and marketing strategies.

The likely effects of these suggested deliberate efforts of government to pro- mote appropriate technologies are shown as hatched lines in Figure 2. Policies aimed at the promotion of appropriate technologies would result in more appropriate products being produced. This can lead to more efficient satisfaction of the needs of the lower income groups, and their resultant improvement in standard of living. The consultancy services directed at product improvements and more effective marketing and advertising strategies would create more demand for the appropriate products, especially among the medium and high income families. This in turn would lead to a more optimal utilization of resources among the firms manufacturing appropriate products, and would enable them hopefully to produce the appropriate products even more efficiently. The end result is a reinforcement of the income diffusion aspect of appropriate technology adoption. This would contribute towards fulfilling the government's stated goal of eradication of poverty by 1990.

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Effects of Protection on the Development of Bicycle Industry in West Pakistan

The Board of Economic Inquiry,
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PREFACE

This project was undertaken at the suggestion of the Director of Industries, Government of West Pakistan, to study the impact of protection on the growth of bicycle industry and the allied industries manufacturing tyres and tubes, spare parts and accessories.

The sample, on which the study is based, covers all the five factories manufacturing bicycles, (4 in Lahore and 1 in Karachi), five factories producing tyres and tubes (2 in Karachi and one each at Lahore, Gujrat and Sialkot) and 14 out of 24 factories manufacturing spare parts and accessories (8 in Lahore, 3 in Karachi, and 1 each at Sialkot, Lyallpur and Rawalpindi). All these factories are registered under the Factories Act, 1934. In addition, 10 out of 19 unregistered small scale concerns were also included. The sample is, therefore, fairly representative.

The data was collected with the help of two Questionnaires which were sent by post. But the response being poor personal contacts and help from the Directorate of Industries improved the response and elicited better co-operation of the respondents.

At the time of Independence, there was not a single factory in Pakistan producing bicycles, tyres and tubes and only a very limited capacity for manufacturing some spare parts and accessories existed. The annual average of bicycle imports during the period 1948-52 came to 1,27,080. But with the suspension of O.G.L. it came down by 85.5 per cent to only 18,462. This gave the first impetus to the establishment of the industry in West Pakistan. But severe competition from abroad forced the industry to seek protection which, after an enquiry by the Tariff Commission, was granted in 1962. Previously to this, protection had already been granted to cycle pump and bicycle tyre and tube industries.

Protection stimulated the establishment of further unit, and benefited the industry in many ways. Total capital investment increased from Rs. 51.1 lakhs in 1959-60 to Rs. 142.8 lakhs in 1963-64, i.e., by 179.5 per cent; and investment per factory during the

latter period increased by 110 per cent. Production of bicycles increased from 2,928 in 1953-54 to 19,496 in 1958-59 and 1,24,056 in 1963-64.

Bicycle tubes were first manufactured in 1949 in Pakistan at Karachi and the industry spread to other places later. The bicycle tyre and tube industry received protection in 1953. Capital investment in this industry increased from Rs. 86.0 lakhs in 1959-60 to Rs. 184.0 lakhs in 1963-64 or by 140 per cent. Investment per factory increased by over 28 per cent during this period. Production of tyres and tubes in Pakistan increased by 343 per cent between 1953 and 1964.

Statistics relating to the factories (registered and unregistered) producing spare parts cover only the sample under study. Here also progress is quite obvious. As regards registered factories (sample 14 out of 24), in 1963-64, their total capital investment was Rs 43.18 lakhs which ment Rs. 3.08 lakhs per factory as against Rs. 1.79 lakhs in 1959-60, i.e., an increase of 72.1 per cent. The total value of output of these factories increased from Rs. 15.41 lakhs in 1959-60 to Rs. 28.82 lakhs in 1963-64, and average value of production per factory from Rs. 1.28 lakhs to Rs. 2.06 lakhs during the same period or by 60.9 per cent.

The unregistered factories are small scale concerns and as already noted, 10 out of 19 were included in the sample. The average investment per factory increased from Rl. 13,795 in 1959-60 to Rl. 15,794 in 1961-62 and Rl. 19,028 in 1963-64. The impact of protection is obvious for the last period. The value of output increased by 49 per cent between 1959-60 and 1961-62. the index of production (1959-60=100), rose to 197,7 in 1962-63 and 252,7 in 1963-64. It was revealed that between 1959-60 to 1963-64, while capital invested per concern increased by 37,9 per cent, the value of output per concern increased by 152,7 per cent. This was due mainly to greater rate of utilization of productive capacity with the increase in demand. The greatest difficulties had been the non-availability of raw materials and the shortage of capital.

The study further reveals that although domestically produced bicycles are still inferior to the imported product, their quality has been improving.

The burden on the consumers due to higher prices, an inevitable result of protection, is obvious, but let us hope that this sacrifice on the part of the consumer will put the industry in its feet and will, in due course, enable it to face foreign competition without artificial props.

On the whole, the study indicates that the industry has derived considerable benefit from the policy of protection and Pakistan is approaching self-sufficiency with respect to this poor man's conveyance.

This report has been prepared by Mr. Aziz Anwar who deserve appreciation for the hard work that he has put into it. Mr. H.A. Syed, the Deputy Director of the Board, supervised the work and scrutinised the first draft of the report.

The board is grateful for the help received from the Directorate of Industries and co-operation given by the manufacturers concerned.

S. M. AKHTAR.

INTRODUCTION

The bicycle is the cheapest known means of conveyance. It is not only very convenient but also particularly suited to the socio-economic conditions of the masses in the developing countries. In Pakistan, as in other under-developed countries, road transport being still in its infancy, bus or train services are confined to big cities only. This makes bicycle a real boon to the working population, students and the business community. No less benefitted are the people in the villages were, owing to semi-primitive pattern of living, the bicycle has naturally come to be recognised as the quickest means of transport.

Import of Bicycles and Components

At the time of emergence of Pakistan, (The division of Indian Sub-continent into Bharat and Pakistan took place on August 14, 1947 under the Indian Independence Act of 1947. The former provinces of the Punjab and Bengal were also partitioned by the Radcliffe Award in August, 1947, under the same Act. Pakistan comprises of two Wings - East Pakistan and West Pakistan - separated from each other by a distance of over one thousand miles of Indian territory.) a very meagre share of industries fell to its lot and the new-born State was deficient in the poduction of even necessaries of life. There was not a single plant in Pakistan for the manufacture of bicycles, tyres and tubes and only a very limited capacity to manufacture some bicycle spare parts and accessories existed at that time. On the other hand, the demand for bicycles continued to grow. The increasing demand had to be met by resort to their import, facilitated further by placing this item on Open General Licence (O. G. L.). As a result of this policy, a large number of bicycles were imported into Pakistan upto 1952. The table on the next page gives the number of bicycles imported into East and West Pakistan as well as their value for the years 1948 to 1960.

Table 1
Number of Bicycles Imported into East and West Pakistan

+ (Jan.-June)
Source: Report on Bicycle Manufacturing Industry - Pakistan Tariff Commission, Karachi, 1963, p.3

It will be seen from the above table that the bulk of bicycles imported was earmarked for West Pakistan. The value of total imports increased from Rs. 9.6 million in 1948 to Rs. 11.6 million in 1952, when the O.G.L. was suspended consequent upon the abrupt end of the Korean boom. This led to tapering off of world demand for our agricultural raw materials, of which there had been over-production, thus giving rise to conditions of economic depression. All imports of bicycles and spares were brought under licencing

with the result that only a limited number of them were allowed to enter the country. The annual average number of bicycles imported during the O.G.L. period, i.e., 1948-52, was 1,27,080. With the suspension of O.G.L., however, the average number of bicycles imported during the period 1953 - 58 came down to only 18,462 per annum or a decrease of 85.5 per cent. Import figures for subsequent years were available on financial year basis (July - June) which are given on the next page. The number of bicycles imported into West Pakistan, decreased from 22,832 in 1961-62 to only 67 in 1962-63. This fall was due to the imposition of ban on the import of complete bicycles into Western Wing on commercial licences by the Government from the shipping period January - June, 1962. A limited number of bicycles were, however, imported into West Pakistan on bonus vouchers.

Table 2
Number of Bicycles Imported and their Value

Source: Central Statistical Office, Gouvernment of Pakistan, Karachi

Spare Parts. The value of bicycle spare parts imported from other countries into East and West Pakistan for the years 1948 to 1960 is given below.

Table 3
Value of Import of Bicycle Spare Parts

(Amounts in thousand Rupees)
+ (Jan.-June)
Source: Report on Bicycle Manufacturing Industry, 1963, p.3.

It may be mentioned that upto June 1953, almost all the parts imported were used as spare parts. Since July 1953, however, a major portion of the imported parts was utilized as components for assembling complete bicycles in the country.

The value of components and spare parts imported from other countries for the subsequent period on financial year basis increased from Rs. 56,10,0130 in 1961-62 to Rs. 77,28,000 in 1963-64, as is clear from the table given below. The rise was due to the ban imposed on the import of complete bicycles. This resulted in the import of increasing number of components and spare parts which were required by the indigenous bicycle manufacturers.

Table 4
Value of Components and Spare Parts Imported

(In thousand Rupees)
Source: Central Statistical Office, Karachi

Tyres and Tubes. The import of bicycle tyres and tubes into Pakistan for the years 1948 to 1952 is given below.

Table 5
Import of Bicycle Tyres and Tubes into Pakistan

Source: Report on Tyre and Tube Industry, Tariff Commission, 1953, page 7.

Bicycle tyres and tubes worth Rs. 29,900 were imported in 1960-61. The value, however, decreased to Rs. 10,200 in 1961-62 and further to Rs. 1,700 in 1962-63. During the next year, the imports increased to Rs. 9,800.

INTRODUCTION - Production

Bicycle Industry. Side by side with the import of complete bicycles and spare parts, efforts were made to assemble various parts of bicycles, imported as well as indigenous within the country. It was with the assistence of the Department of Industries of the former province of the Punjab, (The former province of Punjab was amalgamated with other provinces into One Unit of West Pakistan on October 14, 1953.) that a factory at Sialkot succeeded in assembling the first ever bicycle in Pakistan which was introduced in the market in 1950 as the "Suddle" cycle. This concern, however, could not hold its own and the cut throat competition with the imported bicycles drove it out of the field.

As already mentioned, all imports into the country were brought under licensing in 1952. Five items of bicycle parts, which were manufactured locally, were dropped from the import list. These steps gave an impetus to the establishment of the industry in West Pakistan. As a result, two bicycle manufacturing plants were installed at Lahore in 1953 under the name "The Pakistan Cycle Industrial Co-operative Society, Ltd.", commonly known as "Rustam Cycle Factory" and the "Capital Industries, Ltd." Another concern, namely, "Sartaj Industries, Ltd.", also located in Lahore, went into production in 1954. These three factories began to assemble bicycles with about 90 per cent of the imported parts. In due course of time, however, they were in a position to assemble bicycles, of which all parts were locally made with the exception of some, like free-wheels, chains, hubs, rims, chainwheels and chain-wheel cranks, B.B. fittings, head fittings, bolts, nuts and steel ball which were mostly supplied by U.K., Japan and West Germany.

The conditions prevalent at that time were far from satisfactory for the development of the industry. It had to withstand the impact of severe competition from the imported bicycles which were generally preferred by the public. The industry was, therefore, in need of protection before it could stand upon its feet and it approached the Government of Pakistan for the same. On the recommendation of the Pakistan Tariff Commission, the Central Government granted protection to the bicycle manufacturing industry in 1962.

The cancellation of the O.G.L. in 1952 and various other steps taken by the Government, including the protection granted, helped the development of the indigenous industry. As a result, the number of bicycles manufactured in West Pakistan increased year after year as is clear from the table given below.

Table 6
Annual Production of Bicycles in West Pakistan

Tyre and tube industry. In June 1955, there were 12 units engaged in the manufacture of bicycle tyres and tubes in Pakistan with a capacity to produce 1 million tyres and 2 million tubes per year. Productive capital of Rs. 4.7 million was estimated to have been invested in these units. (The First Five-Year Plan (1955-60), Planning Commission, Government of Pakistan, page 453.)

This industry was granted protection in 1953-54, much earlier than the protection granted to bicycle industry. Its production increased manifold in the country. The indices of the number of tyres and tubes produced rose from 100.0 in 1953 to 443.5 in 1964, as is clear from the table on the next page.

Table 7
Production of Tyres and Tubes in Pakistan

Source: Monthly Statistical Bulletin, September 1965, pp.2421-23.

INTRODUCTION - Objectives and Scope of the Survey

It was at the suggestion of the Directorate of Industries, Government of West Pakistan, that the Board of Economic Inquiry decided to undertake this survey. The object of the project was to study the impact of protection on the growth of bicycle industry as well as industries manufacturing tyres and tubes, spare parts and accessories. It was also intended to review the quality of production and price trends over a number of years.

The scope of the survey covered pedal bicycles of all sizes and specifications. Factories registered under Section 2(j) (Under Section 2(j) a factory means "any premesis including the precincts thereof whereon twenty or more workers are working, or were working on any day of the preceding twelve months, and in any part of which a manufacturing process is being carried on with the aid of power or its ordinarily so carried on.") of the Factories Act 1934, as well as smaller unregistered concerns, were covered by the survey.

THE BICYCLE MANUFACTURING INDUSTRY - Introduction

This chapter is devoted to a detailed study of the progress made by the bicycle manufacturing industry in West Pakistan. The analysis presented below will help in bringing out the effects of restrictions imposed on the import of bicycles, as well as of the protection granted to this industry in 1962.

At the time of the survey, there were five bicycle manufacturing factories in West Pakistan. The present survey, as stated earlier, covered all the five units. Four of these were situated at Lahore while the fifth was at Karachi. Two of them, namely, Saifee Development Corporation, Karachi and the Batala Engineering Co. (Bicycle Division), Lahore went into production only recently and were, thus, in the initial stages of their operations. The names and years of production of these are given below.

Name of the factory	Year
1. Pakistan Cycle Industrial Co-operative Society, Lahore	1953
2. Capital Industries, Lahore	1953
3. Sartaj Industries, Lahore	1954
4. Saifee Development Corporation, Karachi	1963
5. Batala Engineering Co., Lahore	1964

Sartaj, Saifee and BECO are public limited companies. P.C.I.C.S. was established under the Co-operative Societies Act, 1912, while the Capital Industries is a private limited company.

1. Pakistan Cycle Industrial Co-operative Society, Lahore

   In July 1953, 22 traders in bicycles and spare parts, with their experience and resources, established "Pakistan Cycle Industrial Co-operative Society," commonly known as "Rustam Cycle Factory." This was the first unit installed in the country, with a meagre capital of Rs. 22,000.

   This enterprise was started as a small bicycle assembling plant, having its own workshop in a congested locality of Lahore. In the beginning, the factory manufactured only simple components and spare parts. Its main activities were confined to the assembling of complete bicycles from imported components. At the time of the survey, the workshop was housed in its own building at Mile 4 on the Shahdara-Sheikhupura Link Road.

   The first bicycle assembled by this Society was displayed on the Pakistan Day, i.e., 14th August, 1953, in which 90 per cent imported parts (in value) were used. At the time of this survey, however, its bicycles contained hardly 10 per cent imported parts. The organisers were of the view that by the end of 1965 their bicycles would contain only about 5 per cent foreign components.

   Initially, the Society started manufacturing bicycles of three brands, viz.. *Rustam, Sohrab* and *National Labour,* but now the factory produces only the first

two brands. Besides, the factory also produces tricycle-carriers, push-chairs, 4-wheeled carriers and vans for invalids.

2. Capital Industries, Ltd., Lahore

   Eleven importers and dealers of bicycles with their knowledge and experience joined together in 1953 to organise the Capital Industries, Ltd. This concern has been manufacturing *Eagle Popular and Eagle Delux* brands. Originally, the workshop was situated on Mcleod Road, but was later shifted to Lytton Road. In the meantime the foundation stone of a modern factory was being laid in Gulberg. The new building was completed in November, 1958 when the entire plant and machinery was shifted to the new premises.

3. Sartej Indutries, Ltd., Lahore

   The Sartaj Industries was established with the main object of manufacturing sewing machines. But it was in 1954, that the factory was expanded to include bicycles also. The factory is situated in Gulberg Lahore. It has been making *Sartaj* and *Crown* brands of bicycles. In this factory, there are machines which manufacture bicycle components and accessories, some of which are also utilized for producing parts of sewing machines.

   The Sartaj Industries entered into a joint venture with G.M. Pfaff A.G. of West Germany and formed a new concern under the name M/s. Kaiser Sartaj Company, Ltd. The foreign participants were responsible for providing capital in the form of machinery and technical know-how. At the time of the survey, German experts and technicians were busy in installing machinery for the manufacture of *Kaiser, Rhine* and *Gritzner* bicycles.

4. Saifee Development Corporation, Karachi

   The Saifee Development Corporation went into production in October, 1962 but its bicycle department was opened in September, 1963. It is a public limited company having 1,596 shareholders. It has a modern engineering workshop in Karachi. A team of qualified and experienced designers was at work preparing designs of tools, equipment and products to be manufactured by the Corporation. During the first year of its production the unit manufactured only 661 *Saifee* bicycles on an experimental basis. The production was, however, stopped as some defects were found in their brand.

5. The Batala Engineering Company (BECO) Lahore

   The Batala Engineering Company (Pakistan), Ltd., is a joint stock company and one of the biggest engineering concerns in the country. Apart from their works at Badami Bagh, Lahore, it has recently set up a new factory near Kot Lakhpat,

about 12 miles from its Badami Bagh workshop, for the production of bicycles and electric motors. The new plant was considered to be one of the most modern and fully automatic. Its bicycle division started production in February 1964.

The BECO's investment in this venture, when complete, was expected to amount about Rs. 100 lakhs on capital outlay. The foreign exchange requirements were arranged through the Pakistan Industrial Credit Investment Corporation. The production capacity of the unit was one lakh bicycles per annum oil single shift basis. During the trial period, the manufacturers would be using certain imported parts but they aim at producing all the parts and accessories in their own workshop.

The model of the bicycle has been adopted from a famous Dutch manufacturer 'Gazelle' who, besides selling the patent rights, have provided the necessary technical data required for its manufacture. During the year 1963-64 only spare parts worth Rs. 27,752 were sold. The marketing of BECO bicycles, however, started in September, 1964.

6. Hyderabad Relief and Rehabilitation Trust, Karachi

   The Central Government accorded permission in favour of Hyderabad Relief and Rehabilitation Trust, Karachi, with a sanctioned capacity of 75,000 bicycles per year. The Trust started implementation of their scheme by undertaking construction of a building at Karachi. Some machinery was imported. Four engineers were sent to West Germany for training. But, despite all these efforts, the project had to be abandoned due to financial and certain other difficulties and the imported machinery was sold away to Sartaj Industries, Lahore.

THE BICYCLE MANUFACTURING INDUSTRY - Capital Investment

The following table gives the total capital investment (fixed as well as working) in various bicycle concerns of West Pakistan as also the investment per factory for the years 1959-60 to 1963-64:

Table 10
Total Capital Investment in Bicycle Manufacturing Industry

The above table shows that the total capital investment increased from Rs. 51.1 lakhs in 1959-60 to Rs. 142.8 lakhs in 1963-64 - an increase of 179.5 per cent. The average investment per factory more than doubled while the index number rose from 100 to 210. It may be noted that the total investment had been increasing at a higher rate since the year 1961-62 when the protection was granted to this industry.

As already mentioned, the first BECO bicycle appeared in the market in September, 1964. It was estimated that about Rt. 100 lakhs were invested in the bicycle division of BECO.

THE BICYCLE MANUFACTURING INDUSTRY - Installed Capacity

The installed capacities of manufacturing complete bicycles by P.C.I.C.S. and Capital Industries, per single shift, since the year 1953 - 54, are given on the next page.

Table 11
Annual Capacity per Single Shift

The annual installed capacities of the two units have risen 10 times during the period under review.

As already stated, the first bicycle assembled by the P.C.I.C.S. was displayed in the market on 14th August, 1953. At that time, the factory was equipped with a few hand presses only and some other old machinery. Orders were, however, placed for the import of new plant when the Central Government granted permission to manufacture 10,000 bicycles a year. In 1957-58, another consignment of automatic machinery was installed with the result that the annual single-shift capacity shot up to 60,000 bicycles.

The installed capacities of the five units of West Pakistan per single shift at the time of the Tariff Commission enquiry (1958-59) and the present survey (1964-65) are given below.

Table 12
Installed Capacities of the Manufacturing Units

The preceding table shows that the installed capacities of the three old units have risen from 1,20,000 in 1958-59 to 2.12,000 in 1964-65 besides new capacity of manufacturing 1,20,000 bicycles installed by Saifee and BECO. The effective installed capacity of the BECO was 1,00,000 per annum and it was expected that it would reach the target production during the year 1966-67.

Extension Plans. Bicycle industry has developed considerably since the restrictions were imposed on imports. There is, however, scope for further balancing and modernising it to produce quality bicycles and to make the country self-sufficient. Some of the mills have drawn up plans for improvements which are given below.

Name of factory	Nature of improvement
1. P.C.I.C.S.	The Society has obtained loan of Rs. 12,20,000 in Japanese Yens from

	P.l.C.I.C., Karachi for modernising the plant.
2. Capital Industries	They have applied for licence to import machinery for balancing and modernising their unit.

A rim plant has already been installed by the Capital Industries, while an electroplating plant is under installation. It is hoped that with the modernisation the products of the Capital Industries would reach international standards.

THE BICYCLE MANUFACTURING INDUSTRY - Demand for Bicycles

i. According to the Director-General, Supply and Development, Goverment of Pakistan, the country's annual demand, at the time of Tariff Commission enquiry, was 1,00,000 bicycles (30,000 for East Pakistan and 70,000 for West Pakistan).

ii. The Pakistan Tariff Commission assessed the demand for bicycles on the basis of imports made fn the Open General Licence period (1950, 1951 and most of 1952), when there was no local production. The average annual number of bicycles imported during - this period was 1,48,000. The average value of accessories imported during this period was Rs. 28,38,098. Assuming that half of the value of imported accessories went towards assembling complete bicycles and the other half was used for replacements, the number of complete bicycles thus assembled with the accessories comes to about 8,869, calculated on the basis of the average value of a bicycle in knocked-down condition at Rs. 160. Availability of bicycles in the years 1950 to 1952 was, therefore, 1,56,900 a year. A number of these bicycles are known to have been smuggled out of the country and the figure did not take into account stocks at the beginning and the end of the period. On the other hand, the Commission had to allow for the increase of demand on account of increase in population and in individual purchasing power. The Commission, therefore, placed the demand for bicycles at a figure around 1,75,000 per year. It may be added that this estimate was true only at the retail prices of bicycle of Rs. 180 to Rs. 200. If prices were to fall substantially there would be a large extension of the demand. (Tariff Commission Report, 1963, page 2.)

iii. According to the First Five Year Plan (1955-60) the total annual capacity of 1,15,000 cycles per annum was considered to be sufficient to meet the demands of the country during the Plan period. (Para 140, p.464.) No such figures were, however, mentioned in the Second Five Year Plan (1960-65). But even if 20 per cent increase be estimated and added to the previous estimate the total requirements would at the most be 1,38,000 bicycles per annum. According to the Second Plan. "The demand for bicycles will be covered entirely from domestic production. To achieve this target, existing bicycle factories will be enabled to import additional equipment as needed. If the demand is still not properly met, it may be necessary to establish one or more additional units." (Page 251, para 128.)

iv. According to the views of the three old bicycle manufacturing units the demand at present was at the most about 1,25,000 cycles per year for West Pakistan and 35,000 for East Pakistan, making a total of 1,60,000 bicycles.

It should be noted that the demand for bicycles has been increasing in rural areas at a higher rate than in the urban areas where more automatic vehicles like scooters, auto-cycles, etc., are preferred. It is reported that while the sale figures of dealers in towns over the last three years have remained almost static they have jumped up in distant villages and outlying places. All this happened without any publicity campaign in rural areas. The sale could, therefore, be pushed still further, in small towns and villages with the help of a publicity campaign. With an increase in road mileage and improvement in the standard of living in the backward areas, during the Third Five Year Plan (1965-70), the demand for bicycles is likely to rise further. Our industry is in a position to meet the challenge of the time.

THE BICYCLE MANUFACTURING INDUSTRY - Total Supply of Bicycles

There were two sources of supply of bicycles in the country, i.e., import and indigenous production. Upto 1952, the only source was the import from other countries. It was the year 1953 which recorded, for the first time, 686 bicycles produced by the Pakistan Cycle Industrial Co-operative Society and the Capital Industries, Ltd. The total supply of bicycles, imported as well as Pakistani, for the years 1948 to 1959, is given below.

Table 13
Total Supply of Bicycles in West Pakistan

The above table shows that indigenous production has been increasing from year to year, especially since 1958. On the other hand, import of bicycles has varied from year to year. The table on the next page gives total supply of bicycles in West Pakistan for the years 1960-61 to 1963-64.

Table 14
Total Supply of Bicycles in West Pakistan

Although the import of foreign bicycles is totally banned on commercial scale, yet a limited number can be imported on bonus vouchers. Import restrictions, in due course of time, led both to an expansion in production and to improvement in quality. But the practice of import even on bonus vouchers was fraught with risk to the indigenous industry, In principle, it was agreed that bicycles should be imported in this way but inferior ones should only be allowed with restrictions, as they tend to shift the demand from local to foreign bicycles because of their brands. Moreover, their sale prices were almost at par with the local ones. Some foreign brands of bicycles were being dumped in the country. It was claimed that these were inferior in quality in comparison with local products, but having foreign labels they were selling like hot cakes. The Government, however, took steps to check this enace and their import (of the value of

less than £ 9) was banned under the bonus voucher scheme in January-June, 1965 policy.

The bicycle industry of Pakistan is undoubtedly a foreign exchange saving device. As there is no steel plant in Pakistan, the manufacturers are forced to import basic raw material. The foreign exchange, with which only one complete bicycle is imported, is utilised in making about three bicycles locally.

THE BICYCLE MANUFACTURING INDUSTRY - Brands of Indigenous Bicycles

The names of the brands manufactured in the province and those of the corresponding foreign patterns are given in the following statement.

Name of factory	Brands of cycles	Pattern
1. P.C.I.C.S.	(i) Rustam	Hercules
	(ii) Sohrab	Raleigh
	(iii) National Labour	Philips
2. Capital	(i) Eagle Popular	Hercules
	(ii) Eagle Delux	Raleigh
3. Sartaj	(i) Sartaj	Philips
	(ii) Crown	Philips
4. Saifee	(i) Saifee	..
5. BECO	(i) BECO Delux	Gazelle
	(ii) BECO Standard	Gazelle
	(iii) BECO Popular	Gazelle

Note: A new bicycle King, designed for rugged service, was also introduced by P.C.I.C.S. on 1st July, 1965.

THE BICYCLE MANUFACTURING INDUSTRY - Production

During the first five years of the establishment of Pakistan, our show rooms had a wide variety of imported bicycles on display. There was not a single indigenous brand in the market. The few small scale manufacturers of spare parts and accessories were struggling hard to keep themselves afloat by producing such items as stands, carriers,

mudguards, saddles, chain-covers, bells, etc. Such were the conditions under which the indigenous industry was trying to find its feet. It was after the cancellation of the Open General Licence in 1952, whereby imports were ratrieted, that planning for the establishment of indigenous industry was begun. The first local bicycle appeared in the market in August, 1953 and since then the production had been increasing year after year. The following table gives the number of bicycles manufactured by various factories of West Pakistan:

Table 15
Number of Bicycles Manufactured in Factories of West Pakistan

SUMMARY AND CONCLUSIONS

The object of this project was to study the impact of protection on the growth of bicycle industry as well as industries manufacturing tyres and tubes, spare parts and accessories. It was also intended to review the quality of production and price trends over a number of years. The scope of the survey covered pedal bicycles of all sizes and specifications. Factories registered under Section 2(j) of the Factories Act 1934 as well as smaller unregistered concerns were covered by the survey.

At the time of this survey, there were five factories manufacturing bicycles and another five producing bicycle tyres and tubes in West Pakistan, all registered under the Factories Act. All these units were covered by the survey. In the case of concerns manufacturing spare parts and accessories, a sample consisting of 14 registered and 10 unregistered units was selected. These factories were situated at Lahore, Karachi, Sialkot, Lyallpur, Gujrat and Rawalpindi in West Pakistan.

Bicycle Manufacturing Industry

When Pakistan came into being, there was not a single plant in the country for the manufacture of bicycles, tyres and tubes and only a very limited capacity to produce some parts and accessories existed. The increasing demand had, therefore, to be met by imports. The annual average number of bicycles imported during the O.G.L. period, i.e., 1948-52, was 1,27,080. With the suspension of O.G.L., however, the average number imported during the period 1953-58 came down to only 18,462 per annum showing a decrease of 85.5 per cent.

The restrictions imposed on the import of bicycles as well as spare parts gave an impetus to the establishment of the industry in West Pakistan. Two bicycle manufacturing plants were installed in 1953 under the name The Pakistan Cycle Industrial Co-operative Society, and the Capital Industries. In 1954, Sartaj Industries also started assembling bicycles.

The conditions prevailing at that time were far from satisfactory for the development of the industry. It had to withstand the impact of severe competition from imported

bicycles which were generally, preferred by the public. The industry was, therefore, in need of protection before it could stand upon its feet and it approached Government for this purpose. On the recommendation of the Pakistan Tariff Commission, the Central Government granted protection to the bicycle industry in 1962. Before this, the Government had already granted protection to bicycle pump industry and bicycle tyres and tubes industry. As a result, two more factories, namely, Saifee Development Corporation (1963) and BECO (1964) started manufacturing bicycles.

Capital Investment. The total capital investment in this industry increased from Rs. 51.1 lakhs in 1959-60 to Rs. 142.8 lakhs in 1963-64 - an increase of 179.5 per cent. The average investment per factory more than doubled while the index number rose from 100 in 1959-60 to 210 in 1963-64. Besides, about Rs. 100 lakhs were invested in the bicycle division of BECO. The total investment increased at a higher rate after the protection was granted to the industry.

Installed Capacity. An enquiry into the industry was conducted by the Tariff Commission in 1958-59. The installed capacities of the three old units rose from 1,20,000 in 1958-59 to 2,12,000 in 1964-65. During this period new capacity of manufacturing 1,20,000 cycles was installed by Saifee and BECO.

Production. The production of bicycles has been increasing year after year. Starting from 2,928 in 1953-54, it increased to 19,496 in 1958-59 and to 1,24,056 in 1963-64. The year 1959-60 recorded a big jump to 51,304. This was due to the liberal grant of import licences for raw materials. Production has been increasing at a higher rate since the grant of protection. The use of imported parts has been progressively decreasing as against the home-made parts in the assembly of a complete bicycle.

The demand for bicycles has been increasing in rural areas at a higher rate than in the urban areas where more automatic vehicles like scooters, auto-cycles, etc., are preferred. With the increase in road mileage and improvement in the standard of living in the backward areas during the Third Five-Year Plan (1965-70) the demand for bicycles is likely to increase further.

Recently, the Pakistan Cycle Industrial Co-operative Society has obtained foreign currency loan of Rs. 12,20,000 in Japanese Yens from P.I.C.I.C., for modernising its plant. The Capital Indutries

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Intermediate Transport in South East Asian Cities

Three Case Studies by Alan K. Meier

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This series of Information Papers is circulated as a means of disseminating information and soliciting comments about the work of the I.T.D.G. Transport Panel. The Panel welcomes any ideas and suggestions arising from the content of the papers, and these should be forwarded to:
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Foreword

This Information Paper combines three case studies of intermediate transport in Asian cities, and highlights both the differences and the similarities in the systems. The Paper is the work of Alan Meier, an overseas member of the ITDG Transport Panel, and is based on surveys carried out in late 1974 and early 1975. Some of the observations are impressionistic, and others are based on depositions by local inhabitants. However, this in no way detracts from the main value of the work which is that it records the very rapid changes in intermediate forms of transport that have taken place in these cities, and gives an account of the factors which have influenced this. In one sense the studies are already outdated, yet they are unique in that they were undertaken during a critical period of change. Furthermore, the publication of this Paper is timely in view of the current debate about the future role of intermediate forms of transport in the urban areas of developing countries.

In reading the section on Saigon it should be remembered that it describes the situation prior to the transfer of power in South Vietnam which resulted in Saigon being re-named Ho Chi Minh city.

For convenience, all costs and prices have been expressed in U.S. dollars, converted from the local currencies at the exchange rates prevailing at the time of the surveys.

There is frequently confusion over the many terms used to describe particular forms of intermediate transport. The following definitions may assist the reader:

Pedicab:	a general term used in this paper to describe pedal-driven, *passenger-carrying* three-wheelers.
Tricycle:	a general term used in this paper to describe pedal-driven, *load-carrying* three-wheelers.
Becak:	(pronounced "bechak") the name given to pedicabs in Jakarta.
Cyclo:	the name given to pedicabs in Saigon.
Trisha:	the name given to pedicabs in Penang.
Jitney:	a general term used to describe small (in comparison with buses) public passenger transport vehicles which typically are owned by private operators, have flexible routes, and pick up and drop passengers on demand.
Opelet:	a particular type of jitney used in Jakarta.

Helicak, Bemo, Minicar and Mebea are the names given to particular types of motorised three-wheelers used in Jakarta.

I. J. Barwell
Editor

Abstract

This report describes intermediate forms of urban transport in Jakarta Saigon and Penang, with the emphasis on those modes which appear to be of particular technological or sociological significance. Descriptions of the vehicles and the organisational structures are included, together with data on operating costs and charges. The report highlights both the variety of forms of intermediate transport which exist in Asia, and the rapidity with which these systems can be transformed as conditions change.

Introduction

In late 1974 and early 1975 I toured various cities in Southeast Asia with the intent of examining intermediate transport. The focus was general: I sought to discover what kinds of vehicles were used, the social context of their use, and any unique aspect of intermediate transport in the cities I visited. My definition of intermediate vehicles was broad: anything that moved people faster than walking, i.e., faster than sandals, cheaper than an automobile on a passenger- kilometre basis, and smaller than a bus. The number of vehicles fitting these requirements was truly remarkable and it was not possible to record them all. Therefore I tried to be selective, choosing only the vehicles that seemed important either technologically or sociologically.

In the rest of this paper, I discuss my observations of intermediate transport in three Southeast Asian cities. They are by no means complete but do convey the sense of the intermediate transport network in those cities.

Transport in Jakarta - Background

Jakarta, which now has over five million inhabitants, was founded in the early seventeenth century by the Dutch East India Company. Batavia, the Dutch name for the city, quickly became the commercial and political capital of the archipelago. In the beginning, the town lay inside a fortress, but after a series of malaria epidemics, the Dutch moved the capital outside the original city walls. Most of the European-style development followed the principal arteries (Ref. 1), and between the major roads the Indonesians settled in the traditional kampong style (kampong is poorly translated as 'village'). The kampong consists of a compact and often densely populated community. Those around Senen, an important market area, have densities of up to 50,000 people /sq. km., and their size varies from a few hundred metres on each side to perhaps a kilometre. The kampong is the structural unit of Indonesian society, and each has a political and a religious leader. The kampong is rarely penetrable by motor vehicles on more than a few routes, most of the activity being on small paths about one metre wide. Recently, new city plans have called for the eradication of the inner-city kampongs, but the impact, or even the extent of the clearance, is not known. The last few years have seen changes in the central kampongs, for many of the wider streets penetrating them have been paved and, at the same time, the bordering gutters have been covered. These two actions have allowed larger vehicles to enter.

Automobiles are still a possession of the upper class. Several models are assembled locally, including Toyota, Volkswagen and Mercedes. Duties are set very high to make locally assembled vehicles competitive with imports. Buses are also assembled locally, and account for 8,000 of the 400,000 motor vehicles registered in Jakarta (Ref. 2). In 1974 the number of buses was increasing by 1% a month. Many people walk in Jakarta, either because they live too far from the bus routes or they simply cannot afford the fare.

Jakarta is the political and commercial capital of Indonesia, and because it is the showplace of Indonesia many observations pertaining to it do not apply to the other large Indonesian cities. But often what is presently occuring in Jakarta will soon be seen in the other Indonesian cities. Change is taking place so rapidly that the transport mix described here might only be found in the other cities by a later visitor.

Due to the structure of Jakarta, with large arterial highways bounding barely penetrable kampongs, the transport systems show a similar division. Unique forms of transport have evolved for the very short, intra-kampong movements, while an entirely different set of vehicles are used on the major routes.

Transport in Jakarta - Within the Kampong

Movement within the kampongs faces several constraints. First, there are few major roads cutting through them which means that most motor vehicles cannot enter or at least reach most homes. As a result, smaller, two and three-wheeled vehicles are the principal modes of transport, but even these cannot always operate on the narrow paths and twisting alleys. There, all goods must be carried on foot. The favourite method seems to be by using a balanced wooden pole where the cargo hangs on both ends. Some of these poles are curved upward at the ends, seemingly to avoid poking anyone. Many food vendors carry their wares on poles, complete with a brazier on one end. I have also seen wicker baskets, carried like backpacks, used very efficently. All the kampong paths are wide enough to accommodate two of these modes passing each other.

On the wider paths and alleys water carts and becaks appear. The water cart, a two-wheeled cart carrying eight ten-litre cans, is a familiar sight in the kampongs, most of which do not have running water. The becak, a three wheeled pedicab which usually carries two passengers, is used extensively for both intra and interkampong transport. The driver sits behind the passengers and provides power to the single, driven rear wheel. For steering purposes the entire front compartment turns on a heavy-duty pivot beneath the passengers. There is a single brake on the rear wheel operated by a lever underneath the driver's seat. Becaks are built in every large Indonesian city to a unique design, though in Jakarta production has now ceased in anticipation of the 1979 ban.

The design of the becak makes steering difficult since it is very awkward to turn the whole passenger compartment, and the heavy-duty pivot adds weight and weakens the frame. Furthermore, no brakes can be used on the front wheels because: a) since the wheels spin independently, even braking is impossible and b) if even braking were possible, the driver might flip the becak end-over-end. Thus, a becak driver must be extremely careful when carrying heavy loads; he simply cannot stop quickly. Even in the hilly city of Bandung, there is only a rear brake, though a foot lever had been added for greater leverage on the brake. However, the Bandung becaks did have a lower gear ratio for easier hill climbing and a free wheel for coasting.

The inter-kampong transport aspect of becaks is slowly being stifled by government prohibitions. By 1979 it is planned to eliminate all becaks from Jakarta. The prohibition is intended to occur gradually; first the becaks were banned from certain district and principal highways. Later the becak-free districts will be enlarged and new ones included. Finally, all becaks will be banned. The first phase has already been completed, most of downtown and the main arteries are becak-free. During the night, however, between ten in the evening and six in the morning, these areas are once again open to becaks. Becaks will lose this night-time freedom at the end of 1954. During the daytime the becaks are confined to intrakampong movement because they cannot use the principal roads bordering the kampong.

A great number of the becak rides are from the principal roads into the kampong. As a result, the becaks tend to cluster around the intersection of the major kampong access roads and the arterial roads. The becak is also used heavily in shopping areas so great clusters are found around the market areas, too. They are so easy to hail and use that even the lower middle class ride becaks for short distances. It is ironic that the middle class in Jakarta will have to walk more than in other Indonesian cities because the becak substitutes are over-priced for such casual use. This convenience of instant, short-distance transport is rapidly disappearing in Jakarta.

Nobody knows exactly how many becaks operate in the city of Jakarta. Estimates range from 30,000 to over 100,000. The city government issues only 20,000 licenses, but the becak owners make copies and the best estimates are that an average of three becaks are operating on each license. With 20,000 licenses this means there are approximately 60,000 becaks ir Jakarta. Almost all are owned by the Chinese, often as many as two hundred by a single man. The owner leases them to drivers a flat fee of approximately $0.75 for a twelve hour day. The driver, who is responsible for maintenance, probably clears around $1 day. (Unskilled labour in Jakarta earns about the same.) Rental fees and income are about 25% lower for the night shift.

While it is common knowledge that the Chinese own all the becaks, comparatively little is known about the approximately 90,000 becak drivers. (This figure is my estimate based upon 60,000 becaks used for one and a half shifts.) It is generally believed that the becak drivers are the new arrivals to the city and driving a becak is their first job. After a couple of years driving a becak, the driver is familiar enough with the city to find a better job. Evidently, this stereotype is not entirely true. Surveys in Bandung found that many becak drivers were moonlighting civil servants or from other lower-middle income jobs. (Ref. 3) It has become very important to know the socio-economic background of the becak drivers because the government is initiating a large scale retraining programme. Clearly , an entirely different approach is needed if they are dealing with under-employed former becak drivers as opposed to un-employed becak drivers. Most of the government programmes assume the problem is un-employed becak drivers, so retraining will focus on training for factory jobs, work on neglected plantations, or transmigration. There is also a large programme to upgrade the becak drivers to helicak drivers. Upgrading involves training to receive a driver's license and

government assisted purchase of the motorized vehicle. Only a limited number of new drivers could possibly be absorbed in this manner since the motorized replacements are at least three times as efficient, in terms of passenger-km/day, as the becaks, thus, only a third as many vehicles and drivers are required. However, because of corruption it is likely that few becak drivers will ever benefit from this programme.

The implications of a ban on becaks are serious and serve as an example of the imposition of technology on a society which is neither economically nor socially prepared. A large number of persons will become un-employed (or underemployed) while a much smaller number of new jobs will be created. Unless there is a substantial lowering of fares on the becak replacements, the ban will deprive the lower class of their only means of individual transportation.

Furthermore, the introduction of becak substitutes will adversely affect the quality of life within the kampongs for, despite the high noise level on the roads around them, they have remained remarkably quiet. The introduction of motor vehicles inside the kampong will not only increase the noise levels but also the air pollution, since the exhaust fumes will tend to stay trapped in the narrow streets and alleys.

The government claims that becaks are degrading and cause accidents and, for those two reasons, should be banned. In addition, becak driving serves as employment for illegal immigrants to the city. There is a ban on migration to Jakarta by the unskilled, and elimination of the becaks would remove one of the important sources of employment for new arrivals. There has been a running battle between the city government and the becak drivers. Whenever enforcement of the becak-free zones becomes lax, the becaks return to these more profitable areas. Eventually the police notice and crack down. The riders are fined and the police also check for illegal residency.

Bicycles, motorcycles, and motorscooters are also seen within the kampong, though most of the destinations are outside the kampong. It should be understood that these two-wheelers navigate even the smallest alley with ease so that every home can potentially own some sort of vehicle.

Transport in Jakarta - Outside the Kampong

Jakarta, like many of its sister cities in Southeast Asia, is in the midst of an awesome upheaval in transportation, and the last five years have witnessed the introduction of an entirely new set of transport modes. Before the 1970's, there were five ways for people, excluding the elite, to move around the city. These were: the becak, the bicycle, the bemo, the opelet and an expanding bus system.

The opelet is the oldest vehicle, appearing in the early 1940's. It is the jitney of Indonesia, a nine-passenger station-wagon-like vehicle, usually built up with wood from an Austin chasiss. Exactly how the Austin was chosen is unknown, and strangely, the

name "opelet" comes from the few vehicles built-up from Opels. There is room for one passenger in the front seat and for another eight on the two parallel benches behind the driver. The passengers board and disembark through the back door, and pay their fare to the young conductor, who is hanging on to the back. The fare is $0.06 regardless of distance. A Westerner might find the benches uncomfortable due to the lack of headroom, but many Indonesians actually prefer the opelet to the newer competitors based on Hondatrucks, because they have wider seats ant more leg room. They do object, though, to the exhaust which so often leaks into the passenger compartment. With so many old opelets operating it is no surprise that they have a bad reputation for accidents.

The opelets travel on pre-established routes. The boy conductor continually yells the opelet's destination while trying to persuade pedestrians to ride in his vehicle. The routes are often ten to fifteen kilometres long originating in the suburbs and terminating near a major city centre. One major route, for example, operates on a north-south artery connecting Kota, the old city and major financial centre with the residential areas to the south. She opelet does not easily convert to a cargo vehicle but many people use it to go to more distant markets carrying large baskets of goods. In general, the opelets appear to be decrepit and grimlooking vehicle:

For reasons not entirely clear, the government does not like the opelets and there are rumours they will soon be banned. At present only two moves have been officially made in that direction. One of these is to ban opelets on certain routes, the other is the establishment of a microbus system on one of the major opelet routes. A new, Indonesian made, eleven passenger vehicle is expected to be in production soon, and this may conceivably become the government-approved replacement for the opelet.

Most of the opelet routes compete directly with bus routes. Passengers often prefer the opelets because they are almost always assured a seat and are usually slightly faster than the buses. In addition, the frequency of service is better; many routes have over 2,000 opelets. The opelet and bus fares are identical, so purely service characteristics determine the choice of mode. Clearly, if the opelets are banned, and no substitute is provided, there will be a lot of dis-satisfied bus riders. Exactly how many people ride opelets is not known.

Bemos were introduced to Jakarta in 1961. (The name originated from becak-motor) A bemo is a three-wheeled, seven passenger vehicle. Six passengers sit behind the driver on two opposing benches. An extra passenger sits up with the driver. The bemo is basically the same as the vehicle known as the "samlor" in Bangkok, although the seating configuration is different.

The bemos are concentrated in the central city area. They follow a route that often includes penetration of the kampongs through the wider alleys. Officially, the fares are fixed by the government and depend on the number of zones the passenger crosses. In reality, inflation and the difficulty of enforcement have made a mockery of the fixed

fare system. Still, on every bemo is stencilled a crude map of central Jakarta showing the zones and fares. The drivers consider holiday service overtime and charge accordingly, i.e. double time. Earlier this year the minimum bemo fare was $0.12. During a national holiday it went up to $0.24 and, after the holiday, it went down to $0.18. It never did return to the original rate. The fare for a particular journey is usually settled by negotiation between the driver and the intending passenger.

The late sixties also saw the introduction and proliferation of motorcycles and scooters in Jakarta, and many different models are now being used. In 1974 there were 213,000 motorcycles and scooters. The number is increasing by about 2% a year (Ref.2). The number of motorcycle accidents has grown more than proportionately. The figures for 1974 are not yet released but I have reliable information that as many as six persons are killed in motorcycle accidents each day. Helmets are only rarely worn. Very few women are seen driving motorcycles although they are frequent passengers. To accommodate their dresses and skirts, they are forced to ride side-saddle.

Bicycles are not licensed in Jakarta so no accurate estimate of their use exists. Bicycling is not confined to the young; older people use them both for movement and transport of goods. Wicker baskets are often secured to the back to carry grass, garbage, or wood. I have also seen wooden and metal frames attached to the bicycle to carry special goods. Bicycles are manufactured in Indonesia, but most are imported from Japan and China. The Chinese bicycles ($90) were more expensive than the Japanese ($78) and appeared to be heavier-duty models. For example, the Japanese brakes were cable operated while the Chinese bikes used rods. The trade-off here is weight for durability, and if the bike is to be used for cargo transport then the most durable type will be chosen. For personal transport, however, speed is more important so the lighter bike will be chosen.

Bicycle repair is done in the streets on a wooden stand by itinerant repairmen. The repairman has a few tools and spare parts, and is capable of performing all light repairs including wheel truing and tyre patching. Becaks can slso be repaired at these facilities and it is not uncommon to see several up-ended becaks clustered around a repair stall.

In the early seventies an entirely new group of vehicles appeared in Jakarta. These were the motorized replacements for the becaks. The origins of these vehicles can be traced back as far as 1960, when the government attempted to reduce the number of becaks in Jakarta from, according to one source, 60,000 to 15,000. These numbers are certainly wrong. They are probably the number of issued licenses which understates the true number by a factor of three, i.e. 180,000 to 45,000. The plan also included becak-free zones and roads, operating area restrictions, and fixed fares. The exact fate of this plan is unknown but, evidently, implementation ceased very shortly after it had begun (Ref. 4). The fiasco made it clear, though, that before becaks were banned an adequate replacement must be provided. At least one vehicle, the helicak, had its roots in this realization. The introduction of the bemo in 1961 may have also been a step in this direction.

The first of the new vehicles, the helicak, appeared in 1971. The name helicak is meant to symbolize the connection of the two great civilizations; "heli" originates from the Greek word for fire, "helios", and "cak" comes from the Sanskrit word for wheel, "tjakra". If you ask the man on the street, he will tell you the name helicak comes from helicopter and becak. The helicak is a three wheeled vehicle with a helicopter-like passenger compartment straddling the two front wheels. The driver sits behind this compartment astride what is basically a Lambretta motor scooter minus the front wheels. The front wheels are steered but, unlike the becaks, the passenger compartment does not move. The passenger compartment is completely enclosed in a metal frame with tinted windows.

Many people feel the helicak is a dangerous vehicle to ride in. After all, the passengers will be the first to impact upon collision while the driver can jump off. The statistics give an entirely different story. In the three years helicaks have been operating there have been no fatalities and few serious injuries.

Jakarta is pioneering come fascinating work in traffic aggregation. Most of the major arteries (and all of the new ones) have a system of traffic segregation. On each side of the road, separated by a small curb or median, is a stopping and slower vehicle lane. This stopping lane is just wide enough for a helicak to pass a bus. A11 vehicles which will be stopping in that block enter the stopping lane at the previous intersection. Many of the smaller vehicles such as the helicak, becak, bemo, and bicycle are required to use the stoppinf lanes. The inside lanes are preserved for through traffic which, as a result, moves fairly rapidly. During the peak hours the situation reverses as the through traffic lanes clog up while the stopping lane remains relatively clear, allowing the buses to pass fairly quickly.

The critical point in any traffic segregation scheme is the inter- section; the different types of traffic must somehow merge make the suitable change in cource, then separate themselves again. The problem is exacerbated in Jakarta because of the diversity in speed and acceleration of the vehicles. Jakarta has minimised the problem in two ways. First the major intersections are spaced far apart, this being due, to come extent, to the kampong form of settlement. Second, the traffic islands at the intersections slow the traffic to such a speed that the vehicles in the stopping lane can merge safely. The slower vehicles can enter the traffic island, execute their turn and re-enter the stopping lane without an excessively long wait.

Transport in Saigon - Background

Saigon is one of the few cities whose transport system can visibly be observed to have been affected by the energy crisis. The oil price rises are still less than a year old, yet the city's transport system has undergone a massive retrenchment in the face of these new economic realities. The Saigon of the very recent pact was unique in that its transport system was based on the motorcycle. No other city has had such a network and, for that reason, the system should be described before it disappears entirely. At

the same time, it is fascinating to observe Saigon make the adjustments to a new transport mix.

The present transport situation in Saigon - a city of two and a half million - is difficult to describe because there are no statictics indicating the relative use of the different transport modes. It is clear, however, that very many people walk to work. Saigon is a city of refugees and many of them cannot afford any transportation other than that provided by their feet. Two hour walks into the city from the outlying slums are not uncommon. The wealthier residents have a variety of modes available. Bicycles are now widely used generally by school children, though adults in ever increasing numbers are riding too. Pedicabs, called cyclos in Vietnam, are also numerous (about 5,300) and many of them appear to be quite new. The smallest public transport vehicle is the lambro; about 2,300 of these three-wheeled, eight-passenger vehicles now operate in Saigon. There are also about 800 buses, working approximately thirty routes, but most visible are the 250,000 motorcycles and mopeds (with the whole mass generally referred to as hondas). On the streets, the hondas dominate the traffic mix, with very fev cars providing competition.

By 1965 the Vietnam conflict and the American involvement had begun in earnest. The huge injections of dollars caused by the American presence created an unusual problem for the Saigon government. Somehow, these excess dollars, which were quickly finding their way into the wallets of thousands of Vietnamese workers, had to be mopped up before they sparked an inflationary spiral. Acting on American advice, the Vietnamese government chose luxury imports to be the sponge. The principal import was to be motorcycles, all under 100 cc. 800,000 Japanese motorcycles and Italian motorscooters were imported over the next four years. By rigging the exchange rate, the 'hondas' as all this group of vehicles were called, were within reach of all but the very poor. For a while, the sponge effect worked and inflation was held to tolerable levels. But by 1969, American operations needed far less labour and had closed many of the dollar outflows and quickly the dollar surplus turned into a deficit. Inflation struck hard. ln response, the Saigon government banned importation of all foreign vehicles. The ban worked well; there are few cars or hondas of post 1969 vintage in Saigon, excepting the locally assembled La Dalat car (by Citroen).

1965 marked the beginning of the Vietnamese "love affair" with the honda. I do not believe it vas a love affair so much with the machine as with the independence the honda gave. Suddenly, hundreds of thousands of people in Saigon were freed from all the constraints of public transport. When reporters spoke of the loving care with which the Vietnamese maintained their hondas, they were really speaking of the peoples' love of the freedom the honda gave them.

For the next seven years, the honda served as the principal means of personal transportation. There were alternatives (some people, for various reasons, simply could not ride a honda) such as the lambro and the cyclo, but the city really moved on hondas.

One explanation has already been given for the immediate acceptance of the honda, but I think there are others that were crucial. For example, women have not been excluded from riding hondas. This is partly due to the traditional independence of Vietnamese women, but also to their style of dress, namely the Ao dai which allows the women to straddle the motorcycle or bicycle with no loss of modesty. While there is a "men's honda" and a "women's honda", the distinction is slowly disappearing in the face of demand for any honda. (The difference follows that of men's and women's bicycles.) Another requirement for successful use of a motorcycle is decent roads. The honda's efficiency is seriously impaired when the streets are filled with potholes. Saigon had, and still has, well paved streets, so the hondas can move at maximum speed. Weather also plays an important role. There have been no unique adaptations to the weather except, the acceptance that if it rains really hard one is either going to get wet or be late. Throughout Southeast Asia, motorcyclists wear their raincoats backwards, an effective measure against a light rain. Fortunately, the showers are brief even in the rainy season, so all the hondas scramble for shelter and wait out the shower. Another consideration is the baggage problem, Knapsacks, the American solution, are not used, nor are the farm wicker baskets. Usually, people will use a cyclo or a lambro if anything more than a shopping bag is required. Finally, a culture must be able to accept the constraints imposed by the limited passenger capacity of the hondas. I do not believe the Vietnamese were forced to make any concessions simply because they were not constrsained; that is, the Vietnamese are so amall that four people often squeeze onto a honda. Not all cultures or cities can meet the constraints imposed by the hondas, but it is clear that Saigon did.

Transport in Saigon - The energy Crisis

The new bus system came just in time. By late 1973, when the energy crisis struck, the bus system was already established. The fuel shortage in Vietnam was exacerbated when the Viet Cong destroyed the principal fuel depot. Within weeks the hondas nearly vanished; not only did the price of petrol reach intolerable levels but a plain shortage made it unavailable even if they had the money. The buses were packed and bicycles enjoyed a rennaisance that has not yet ended. Eventually the prices fell somewhat and availability returned to normal, but a mortal blow had been dealt to the honda era.

In late 1974, the honda era is not yet over. The number of hondas registered in Saigon has not changed, although residents have noted the traffic consists of much fewer hondas and many more bicycles. Saigon is quieter than it has been in years. The honda owners have become a lot more cost conscious and limit their use to essential travel.

The number of buses has been increasing very rapidly. New routes are added every month. Many people are leaving their hondas at home and riding the bus. At the end of 1974 there were approximately 800 buses operating in Saigon. Few cities can boast of such a rapid introduction of mass transit. On a per capita basis this is still small, but since most of its riders are former honda drivers, the impact on traffic can be enormous.

The lambros have also felt the impact of the buses. They cut their fares in order to remain competitive in spite of sharp increases in fuel costs. In the space of one year 1700 of the 4000 lambros ceased operations. (Many drivers were switching to buses.) Before the buses, lambros netted $5 to $6 per day. After the introduction of the buses, and the fuel crisis, their income has fallen to less than a dollar a day. The price of a lambro has shown a similar drop; whereas in early 1973 a used lambro cost $1,500 it now costs about S600. I suspect only rural demand keeps the price from dropping further. The survival of the lambros in Saigon hinges on two adaptions: first, if the lambros can change their routes so as to complement rather than compete with the buses, i.e. feeder lines, and second, whether they can convert their vehicles to cheaper diesel engines. (Some lambros already have converted. They are easily recognised with their upright exhaust pipe giving out a stream of black smoke.)

In the meantime, the cyclos have enjoyed a surge in use. Many new cyclos can be seen in Saigon. In addition, a little new technology has been introduced. The new models have a drum brake on the back wheel instead of a caliper brake. Cyclo drivers earn about $0.50/day, but this is usually for a short shift. Like many Asian cities, many cyclo drivers are moonlighters so they do not work a full shift. The drivers rent a cyclo for about $0.50/day.

Bicycles, too, have suddenly increased in popularity. Virtually all young people ride bikes and many older people are now pedalling to work. Saigon's bicycles are locally manufactured and are unique in that a second seat is built over the rear wheel possibly a carryover from the hondas. The second seat is well used by students going to school. New bicycles cost at least $60, but even at these high prices people are buying the bikes at the dozens of new bike stores in Saigon.

A new form of public transport has arisen in response to the energy crisis. This is the honda ôm ("ôm" means "to hang on"). basically, the honda ôm is just a honda serving as a taxi. Its origins can be traced to the American presence in Saigon around 1966. The honda ôm's would take the Americans back to the base from the nightclubs downtown. Now, with the operating cost of a honda so high, many owners have resorted to moonlighting as a honda ôm to defray some of the higher costs. A honda ôm costs about half as much as a taxi - minimum $0.08/km - and is usually much faster owing to the honda's agility in traffic and the decrepit state of Saigon's taxis, which are small, twenty five year old Renaults. The fare is negotiated before use. Curiously, the honda ôm seem to be all of a certain style. I have never seen, for example, a Vespa or Lambretta motor scooter used as a honda ôm.

Transport in Penang - Background

Transportation in Penang is not typical of Asian cities since, with the exception of trishas, the people move in a very conventional way. The transport mix reflects the influence of three factors that, at some time in the future, every Asian city must face. By far the most important is the impact of newly gained wealth by the middle class.

The cities of Malaysia have a large middle class that is far richer than is normally the case in Southeast Asia. The Penang transport mix reveals how people have combined this new wealth with their very strong feelings about status, the second factor, to choose a transport mode. Their free choice is constrained by the third factor, a government unwilling to allow innovation in transport.

Penang is a small island (350 sq. km.) lying off the north-west coast of Malaysia. About 450,000 people live on the island, almost: all of them in Georgetown, the principal city, and its suburbs. Georgetown is in the north-east corner of the island, while most of the industries are towards the south. Across the narrow straits, connected by a ferry, is the city of Butterworth (pop. 40,000) and a few satellite communities. Butterworth is Penang's railhead as well as the site of several industrial estates.

Transport in Penang - Transport of People

As indicated, the transport modes in Penang are conventional. The street are filled with cars, motorcycles and bicycles. In 1973 statistics for the Province Wellesley, which includes Penang, Butterworth and its hinterland, give the following figures for motor vehicles, with annual growth rates in parentheses: 49,000 cars (10%), 75,000 motorcycles (22%), and 1061 buses (100%) (Data obtained from the State Motor Vehicle Department). The city of Georgetown registers non- motorised vehicles. The most recent figures were: 200,000 bicycles (2%), 2,500 trisha (1% decrease) (Ref. 5).

Car ownership is growing rapidly and in the Penang area there is now about one automobile for every ten persons. Both the increased incomes and pressures of status have stimulated the shift to cars. There are many Volvos and Mercedes in Malaysia, while at the lower end of the market Fiat and Japanese models predominate. The government and private businesses have assisted new buyers of cars by providing very low interest loans (4% is common) to their employees. Such interest rates amount to a 20-40% subsidy of the purchase price.

The Malaysian policy that every family should have a house is also forcing the purchase of cars. For the predominantly rural population this policy is really an affirmation of the status quo, but it spells disaster for the urban areas. Large housing tracts have been built which can only be served by cars. Kuala Lumpur, the wealthiest and fastest growing city, has born the brunt of this development, and now has traffic jams comparable to cities five times its size.

Penang has not suffered from this tract development to the same extent as Kuala Lumpur, principally due to-its stagnation - only 2% annual growth over the past decade. Recently however, new development has started in the southern area which will similarly be locked into a car-based transport system, even though the old city's narrow and winding streets simply will not be able to absorb many more automobiles.

Motorcycle sales reflect the higher incomes received by the younger generation. The figures are from 1973 and there are now probably more than 90,000 machines in use in the area. Motorcycles are ideally suited to Penang. The narrow and winding streets are easily negotiated and, while weather is a constraint, people still seem to ride in the rain. Nearly all of the motorcycles in Penang are in the 50cc-125cc range, and prices start at about $450. Both sexes ride motorcycles but driving is a predominantly male role, while women often ride side-saddle on the back. The native dresses make motorcycle driving nearly impossible for women, so the activity is restricted to those who have westernised their dress. All of the women drive the smaller, clutchless models. These have a small basket located between the driver's knees, in which a briefcase or a purse can be placed with reasonable security.

Bicycles are very popular in Penang. The city is ideal for bikes as it is perfectly flat and distances are never great. The bicycles are mostly of an English design, manufactured in Malaysia, though a few are imported from Japan and China. Bicycles cost from $60-$85 which is within the financial means of most of the urban population. They are principally ridden by boys and men, and the few women that ride bicycles must wear western dress. The number of bikes has grown at about 2% annually which parallels population growth. The petrol price rises had no noticeable impact on sales, indicating the demand for bike transportation is independent of the other transport modes.

There have been a few attempts towards the construction of bicycle lanes. Some sidewalks have been widened and signs erected. Sometimes just a yellow line divides the highway, but this arrangement is particularly dangerous since buses and motorcycles cut into it without warning. Considering that over half of the wheeled vehicles in Penang are bicycles, it is surprising how little has been done to accommodate them.

Besides taxis, trishas are the only public means of personal transport. There are about 2,500 trishas in Penang. They have a unique design that even differs markedly from Kuala Lumpur. The greatest difference is the positioning of the pivot point. The pivot is behind rather than beneath the passenger compartment, which substantially reduces weight and complexity as well as lowering the centre of gravity. The actual joint on the Penang trisha is so small that it almost escapes notice, while in Jakarta it creates a massive undercarriage. To compensate for the loss of leverage in steering, since the driver is now much closer to the fulcrum, a steering handle extends away from the passenger compartment towards the driver. This appears to work just as well, though sometimes the rider must move the seat back to prevent his knees from hitting the bar. There are several other interesting features of Penang trishas. The caliper brake is applied via a foot pedal rather than a hand lever. All Penang trishas have a slot for an umbrella for the driver as well as the usual canopy for the passenger, This is positioned on the steering bar and protects the driver from the overhead sun or monsoon showers. Municipal law requires some form of light for night operation. Perhaps a quarter of all the trishas have electric lights, most of them generator powered, with a six volt battery wired in parallel to maintain light when stopped. Some, however, just operate on a

battery. Usually there are two side lights and one at the rear, but the fanciest trishas have six or seven lamps, including turn signals. The other trishas use wick lamps. Both trishas and freight tricycles have two kickstands. One stand lifts the rear wheel off the ground and serves as a bumper while moving. In the front, under the passenger compartment, or under the cargo box on the freight tricycle, a hinged grille folds down to raise the front wheels off the ground. By lifting all three wheels off the ground, the trisha or freight

Transport in Penang - Transport of Goods

In the transport of the vast majority of people, Penang is very conventional. It comes as a surprise then to see the great diversity of intermediate freight and goods transport modes. I believe this is explained in part by the irrelevance of status in freight transport; cost alone is the determining factor. Without the encumbrance of status, all sorts of practical freight transport vehicles have evolved.

There are still over a hundred handcarts operating in Penang. Most of them carry freight related to port activities, but they are often seen throughout the city. Since Penang is a relatively small city, the handcarts are still very convenient for carrying several hundred kilos of bulky goods between business premises. Typical cargoes are: lumber, empty containers, grains and furniture. The carts run on large, wooden, steel-rimmed wheels. The handcart business is both owned and operated by Indians. Little is known about the system except that the pullers hire the carts from the owners. It appears that this business too, is just marginally profitable. There are usually fifteen to twenty carts parked in vacant lots in the Indian district of Penang that never seem to be moved. There are also a number of damaged carts lying in the streets which might account for the 10% decrease in registrations last year. Bullock carts were used inside the city as recently as the 1960's and are still frequently seen outside in the suburbs.

Bicycles are often used to carry freight. Virtually every bicycle has a rack built over the back wheel. Sometimes just a wicker basket is lashed on, but in the case of more specific uses a specially adapted rack is built. Bread delivery, for example, is usually done with a large box over the rear wheel. Milk vendors also carry their brass milk containers on the back of their bicycles. Bicycle vending and hawking appears to be another exclusively Indian occupation.

Similar trades are performed on motorcycles. Racks are built over the back seat to carry the goods. Usually the racks are equipped with retractable legs for support when parked. Many similar items are peddled from motorcycles and bicycles but the chief difference is the regions they serve, the motorcycles working the more distant suburbs. Some food vendors, who operate out of kitchens in Georgetown but sell in the suburbs, use motorcycles. One motorcycle had a special rack designed to carry several containers of bottled gas. The postal service uses bicycles for its inner city delivery and motorcycles for the suburbs.

Trishas are also an important freight vehicle. Trisha riders will often supplement passenger fares by carrying goods. They might, for example, arrange to make a regular delivery of some goods to a number of stores each morning. A common practice is to carry meat carcasses from the butchers in the market to their institutional customers like the hospitals and schools. If someone wants to move some goods, he merely hails a trisha, negotiates a fare, and loads up.

During World War II, a second form of trisha appeared. It was basically a bicycle with a sidecar attached to its left side. This form was used exclusively in Singapore - a few remain for tourist consumption - and partly in Kuala Lumpur. In Penang, however, the few that ever existed were converted to freight use. This is a very simple operation; the sidecar was designed so that the seat could quickly unscrew, leaving a flat, one and a half metre long, freight bed. The arrangement is ideal for odd shaped objects like glass or metal stock. Every glazier's shop, for example, has one of these tricycles.

The bicycle with a sidecar (for people) is interesting because it demonstrates another evolutionary route of the pedicab. Clearly, the sidecar pedicab evolved from the bicycle while the trisha evolved from the freight tricycle. Curiously, both Singapore and Penang had bicycles and freight tricycles, but one city, Singapore, fashioned its human transport out of the bicycle while the other, Penang, fashioned its after the freight tricycle. There are no known cultural or historical differences important enough to justify such differentiation. (The fate of the Singapore pedicab is interesting. Singapore had no hinterland to which to export its phased-out pedicabs, so they were shipped across the Straits of Malacca to the Indonesian city of Medan - the only Indonesian city to have this form of pedicab.)

The most fascinating vehicle in Penang's transport mix is the freight tricycle. Although it has parallels in other Asian cities, no other place has exploited it so well as Penang. It closely resembles the trisha except that a large metal box is placed between the two front wheels instead of a seat. The rear half of the frame is identical to the trisha, though a lower gear ratio is sometimes used. Unlike the trisha, the tricycle's front kickstand is retractable, via a lever, from the rider's seat. The steering bar is adjustable on the new models so that it will not knock the rider's knees. There are two models, medium duty and heavy duty. They differ only in the sturdiness of the front wheels. Recently, however, a new model has been introduced which uses a much smaller pair of front wheels, about the size of the smallest Honda motorcycle. They command a premium over the traditional tricycles because they can carry heavier loads and the tyres last several times as long. Since a tricycle lasts over twenty years, the accumulated savings on new tyres make the premium worthwhile. In addition, the smaller wheels allow the installation of a deeper box for greater capacity and a lower centre of gravity. Penang's roads are so well sealed that it is no more difficult pedalling with the small wheels. New tricycles with the small wheels cost about $175.

Virtually every shop doing any sort of delivery or freight movement has a tricycle. Officially, there are just over 2,000 tricycles in Penang. In practice, there are probably

closer to 3,000. The tricycles are ideally suited for Penang's narrow streets. They can efficiently carry loads of 5 to 200 kg. of distances up to four kilometerr. A number of tricycles travel much greater distances, leaving the city entirely to gather a crop of coconuts, sugar cane, or bananas, for use in the food stalls.

Other tricycles are used strictly for hawking purposes. This includes selling meat, bread, and ice cream. Naturally, special adaptations are made for each function. The meat tricycles, for example, are mobile butcher shops, capable of supplying most of a housewife's needs.

The tricycle construction industry is very closely tied to the consumption of food. Malaysia and Singapore are unique in that thousands of people obtain their meals from food stalls. Dozens of different foods are prepared in these stalls, from soup to satay, fried noodles to prepared fruits. Some of the stalls are fixed, but most of them are on wheels. Originally, they all had four small solid rubber wheels. The vendor would push his stall to his assigned position and then wheel it home late in the evening. If he lived far away from his vending area, he might arrange a parking place nearer the area.

Over the years the four wheel stalls were slowly replaced by specially adapted tricycles. The adaptations include stoves, ovens, refrigerating facilities, sugar cane presses, shelves, drawers, and roofs. Many are wired for electricity, either from the mains or from rented batteries (which cost about $45 a night). As a tricycle, the stalls have vastly increased mobility which allows them to visit several neighbourhoods each night. It also allows the stall to follow the crowds to special events as well as simplifying loading and supplying.

Each tricycle stall is custom made to the buyer's specifications. Most of the stalls are fairly well standardized; that is, fried noodle stands are virtually identical, so the builder can keep patterns of the parts. While the food at the stalls is often sold on a commission basis, the stall itself is individually owned. They cost around $340.

Many tricycles are used to service the food stalls. Every evening, for example, a tricycle will deliver a battery to each stall to power its lights. There are several large kitchens that use a fleet of tricycles to deliver prepared food to the stalls. Other tricycles deliver charcoal, ice, meat, sugar cane, bean sprouts, and noodles. At the end of the day another tricycle takes away the stalls' garbage. Altogether, about 500 tricycles are used to service the food stalls.

So far, only a few of the shops are building tricycles or stalls with the new, smaller wheels. The design will no doubt spread because all the shopkeepers I spoke to had already recognized the superiority of the smaller-wheeled vehicles. Since the life expectancy of the tricycles is so long, conversion will be a slow process in any case.

The construction of stalls on tricycle chassis' confuses estimates of new tricycle manufacture. Government statistics indicate a ten percent decline in the number of

tricycles. Perhaps ten shops are working full time building and repairing tricycles and stalls, and many are built each year, perhaps as many as two thousand. Most of them are converted into stalls but maybe an eighth end up as freight tricycles. Of the 200 chassis manufactured annually in one shop I visited, 25 were destined to be freight tricycles. One thing is clear, however, the tricycle business is alive and prospering. Despite official statistics to the contrary, the number of freight tricycles must be rising, perhaps by as much as five percent annually.

Surprisingly, there have been no attempts at motorisation of the tricycle, though Penang has more than adequate machine shop facilities for such a conversion. The only indication that motorisation has been considered came from a trisha owner. He said he had heard rumours that the government was considering a motorisation programme to replace trishas. Since tricycle and trisha construction are more of a tradition than a technology, it must be understood that the introduction of an engine is more like the introduction of a cultural change, rather than merely a technological innovation.

It is not clear why the freight tricycle is so popular in Penang. The city is not unique with respect to geography or industry. Perhaps the only differentiable feature from other Malaysian cities is its Chinese majority. It is my impression that the Chinese seem to have a preference for these small vehicles. In most Southeast Asian cities the preference is diluted or obscured due to their minority status. Only in Penang and Singapore do the Chinese constitute a majority. In the past, Singapore also had thousands of tricycles but now they are fast disappearing, probably as a result of the nation's affluence. Conceivably, their popularity may be due to their technological superiority. I believe the Penang freight tricycle is the best design in Asia.

Conclusion

These three case studies are in no way complete descriptions of the cities. Moreover, they are now rapidly becoming outdated. But several conclusions can be drawn from them. First, each city has several unique aspects due to its size, organization, social composition, climate and geography. The direct consequence of this is significantly different intermediate transport networks. Before we attempt to transplant a vehicle from one city to another, we must determine what aspects of the first city were critical to its success and whether those aspects exist in the second city.

Second, the speed with which the cities are changing their transport systems is much faster than in the developed countries. New vehicles appear, enjoy wide use, and are displaced by a more efficient competitor, often in less than a decade. This sort of transformation is occurring continually (and peacefully for the most part) as a result of changes in the economic and political climate. It is also important to note the fate of the obsolete vehicles. They are exported to the smaller cities and rural areas where sales capitalize the purchase of newer vehicles for the largest cities. Thus, the transformation of the large cities' transport systems can have substantial influence on the rest of the country.

Third, unless there are extraordinary situations there is a general tendency to shift into motorized vehicles. (From a microeconomic standpoint, motorized vehicles are almost always more efficient, especially in cities where a premium is associated with time.) This is perhaps one of the greatest crises facing the less developed countries. Transportation is the fastest growing use of (generally imported) petroleum in the less developed countries. The foreign exchange burden resulting from the oil has unquestionably crimped development. However, the individual or business does not see this cost; it only sees the cost of the petrol. Even with some of the highest petrol prices in the world. the businessmen and the upper middle class are so confident that motorized vehicles are cost-effective (i.e., profitable) that they continue buying them in record numbers. There exists, then, a conflict of private and national needs, that of microeconomic efficiency and national development. The government cannot fully suppress this shift to motorised transport because it is, in part, an essential element of economic development. Nor can it tolerate the exploding growth of petroleum demands of the transport sector. There is no simple solution to this dilemma.

What are the extraordinary conditions where the shift to motorized transport has not occurred? The first is the condition of extreme economic collapse such as occurred in Saigon (now Ho Chi Minh City in 1974-75.) There the shift to motorized vehicles took place in the mid-1960's and then reverted back to bicycles in the mid-1970's. This is clearly not the route to economic development, even though the end result may be enviable. A second condition is less well defined, and not fully understood. For what appears to be a complex set of circumstances, Penang found that the freight tricycle served its purposes admirably and that there was no real need to shift to motorized vehicles, This situstion is all the more remarkable given the comparable wealth of Penang's residents.

In search for appropriate transport, the less developed countries need not rely solely on the developed nations for assistance. There is a wealth of expertise and a great diversity of vehicles available from other less developed countries indeed, they are often neighbours. At the same time, the vehicle cannot be considered alone. Its function, service characteristics, and social context must all be considered in a complicated equation that determines an appropriate technology.

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