allocation of the spatial distribution of dwelling-unit opportunities input to the household-allocation model. These dwelling-unit allocation functions showed that the locations of apartments were more sensitive to employment accessibility than those of the detached dwelling units. The household-allocation submodel also has a tendency to overallocate household growth to the peripheral locations, which is also a zone size effect.

The spatial distribution of the growth in service employment is influenced by the size of the retail shopping area and travel deterrence, the factors incorporated in most allocation functions.

The model described in this paper may be used to support strategic planning studies at the regional scale. It seems to be capable of capturing the major influences on development in growing areas. The allocation functions have plausible structures, and the response of the model to changes in parameter magnitudes suggests that the initial calibration strategy and internal structure of the model were satisfactory. The major deficiency of the model, as in all models of this type, is that it relies heavily on the exogenous input of many of the supply-related variables.

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Urban Transportation in Korea: Lesson for the World or a Passing Phase?

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Research into Korean urban transportation prospects conducted in 1979 and 1980 is summarized. This paper identifies unusually low automobile ownership during a period of rapid growth as the distinctive feature of Korean cities and traces the fiscal, financial, and utilitarian reasons for this phenomenon. It is argued that the low number of automobiles has benefited both existing automobile owners and users of public transportation. The public transportation system is described and evaluated. Future plans for Korean cities are based on the assumption that rapid motorization will occur. It is argued that the plans contain contradictory policies about decentralization and fail to consider viable alternatives. These consist of increasing the efficiency of the existing transportation system while retaining the full set of policies for constraining the growth of automobile ownership and use. It is suggested that this strategy would maintain the efficiency and equitability of the existing city while minimizing investment. If this alternative strategy is adopted, then Korean cities will become the scene for important experiments in urban transportation, comparable to the Singapore area licensing scheme. In this case, Korea might become a lesson to the world. However, if existing constraints on automobile ownership are relaxed, then the present system will prove only a passing phase and Korea will experience the problems of adjustment to the motorcar faced by European and Japanese cities in the past. Irrespective of which strategy is adopted, the achievements in holding down the growth of private cars is a lesson that might be considered in other developing countries.

Automobile ownership in South Korea has remained at an unusually low level during a period of rapid economic growth that spans more than 20 years. This paper presents a summary of research conducted in 1979 and 1980 into the results of restricting such an important variable in the urban transportation system and the prospects for the future (1-4). It is argued that the effect has been beneficial to the majority of urban Koreans, but that a combination of forces is now working to reverse past policies and accelerate the growth of automobile ownership. The short- and medium-term consequences of this growth will be to destroy the existing system. Alternatives exist that would allow sufficient time to experiment to preserve many of the beneficial fea-

Table 1. Major indicators of principal Korean cities.

Item	Seoul	Pusan	Daegu	Inchon	Kwangju	Daejon
Population, 1979 (000 000s)	8.1	3.0	1.57	1.04	0.73	0.61
Area (km^2)	627	436	178	200	213.4	87.5
Urban area[a]	252.6	132.4	64.8	66	34	33.7
Urban density	32 066	22 652	24 228	15 740	21 479	18 085
Private cars	77 008	14 126	8239	3135	2214	2025
Official cars	2131	377	288	110	226	209
Taxis	26 960	20 051	3297	1866	1360	1053
Buses	6411	1915	1712	679	1279	596
Minibuses	600	–	–	–	–	–
Trucks	50 688	18 838	12 849	5048	4323	3593
Total vehicles[b]	167 101	45 114	27 118	12 877	9734	7616
Cars per 1000 people	9.8	4.9	5.5	3.35	3.2	3.48
Bus companies	90	30	30	NA	4	14
Bus lines[c]	193	110	43	NA	NA	NA
Per capita income[d] (1975 $)	1099	900	883	NA	462	705

[a]Excluding mountain, agricultural land, rivers, and lakes; in several cities these act as parks and recreational areas.
[b]Including special vehicles, private buses, etc.
[c]Excluding minibus lines, seatbuses, etc.
[d]Calculated by RORI and Korean Institute for Science and Technology from Bank of Korea data for 1978 at 1975 prices.

Table 2. Sample comparisons of national levels of automobile ownership.

Country	Year	GDP per Capita (1975 or 1976 U.S. dollars)	Cars per 1000 Inhabitants
Pakistan	1976	200	2.7
Thailand	1975	379	6.2
Philippines	1976	407	8.82
Colombia	1975	574	16.4
Ivory Coast	1976	610	12.8
Ecuador	1976	640	13.7
Paraguay	1976	640	9.9
Korea	1976	707	2.7
	1979	817[a]	6.8
Tunisia	1976	840	21.3
Turkey	1975	900	11.5
Brazil	1975	1158	46.1
Japan	1976	4937	164.0
West Germany	1976	7249	307.6
United States	1976	7912	504.0

Notes: GDP = gross domestic product.
The vagaries of national income calculations in different countries mean that GDP per capita figures cannot be precisely compared without specific country information.
[a]1976 constant prices; all other figures current.

tures of the present system. If conducted, such experiments could be of great interest to Western planners, and the future progress of the Korean urban system should prove deserving of closer attention. Regardless of the future, the Korean experience offers a useful lesson to developing countries with lower per capita incomes.

THE KOREAN CITY

South Korea is the fourth most densely populated country in the world, with a 1978 average density of 364 persons/km^2, compared with 373 in the Netherlands, 361 in England (excluding Scotland), and 304 in Japan. Because 67 percent of the land area is mountainous, only 33 percent is available for agriculture, industry, and cities.

Accordingly, Korean cities are high-density cities, with severe topographical constraints and high land prices augmented by an aggressive green-belt policy adopted in the 1970s. Seoul, the capital, with 8 million inhabitants, is about the size of New York but occupies only one-third of New York's area. Pusan has 3 million inhabitants that are crammed into an awkward site, which is hemmed in by the mountains and the sea. Daegu, the third largest city, has 1.6 million inhabitants. Table 1 (5) lists the major indicators of six principal Korean cities.

As is well known, Korea is one of the world's fastest-growing economies, with an average annual gross national product (GNP) growth rate of 9.9 percent between 1963 and 1978. Population growth has also been rapid, although slowing from around 3 percent/year at the beginning of the 1960s to about 1.6 percent during much of the 1970s. Urban growth has been even faster. Most cities have grown by about 5-6 percent/year, but several cities around Seoul have experienced an annual growth rate of well over 10 percent. The basic ingredients of urban transportation demand--population and income--are therefore extremely dynamic, and the potential rapidity of change compounds the problem of appropriate action.

Koreans do not think their cities function well, but few outside observers can fail to be impressed by the way such high-density cities function. For example, average car journey speeds in 1978 in crosstown journeys at peak times were in the region of 29 km/h, nearly twice that of most large cities in the Western world. When it is remembered that the actual distances involved are short by European standards, and very short in American terms, it appears that the average Korean is spending much less time per day in traveling than his or her American or European counterpart (6; 7, pp. 21-22). Public transportation also has a high average speed.

That traffic and people move as well as they do in this situation is chiefly the result of Korean success at holding down the number of automobiles. As can be seen from Table 2 (8,9), Korea had until very recently a level of car ownership approximately four times lower than countries with comparable per capita incomes, and only 5 percent of households own motorcars at the present time. The consequences have been that the total transportation systems of Seoul, Pusan, and other cities function more smoothly. This is the result of the low number of cars that impede neither one another's progress nor that of public transportation.

CONSTRAINTS ON AUTOMOBILE OWNERSHIP

The motivation for government policies aimed at restricting car ownership does not stem purely from urban transportation considerations. There has been strong government concern to restrict luxuries and conspicuous consumption, to encourage savings, and to reduce social tension. Automobiles have been classified as luxuries, and this has influenced the types of cars available.

The constraints used may be divided into three types: fiscal (subdivided into taxes and bonds), financial, and utilitarian. The Korean tax system

contains little that is unique. The various types of taxes are merely levied at high rates by international standards. These consist of a purchase tax, a defense tax (levied on luxuries and very high incomes), a value added tax, a gasoline tax, and an automobile-ownership tax.

In 1979 the annual automobile-ownership tax was set at 225 000 Won (U.S. $346) compared with $25-$30 in many states of the United States or $120 in the United Kingdom. The gasoline tax pushed up the price of petrol to levels 2-3 times those in Europe and therefore six times U.S. levels.

More unusual is the bond. All vehicle purchasers are required to buy an interestless bond (set at $1000 in 1979 in Seoul and at lower rates in other cities), repayable after five years. In Seoul and Pusan, the proceeds are used to finance subway construction, which provides about 15 percent of the funds required for the subway program. In other cities the bond is used to provide public housing.

The financial constraints include the nonavailability of credit, high insurance rates, competing demands on household income, and the pressures to employ a chauffeur. In Korea, there are no financial institutions that give credit facilities to private individuals. This reflects the deliberate government policy of directing all available funds into industrial investment. Even for housing there is only one institution that makes limited advances for mortgages. The private money market (known as the curb market) is disorganized and consists of moneylenders and brokers with interest rates that vary between 36 and 60 percent/year.

Insurance rates are extremely high because of a high accident level and the small market. Equally necessary, many Koreans would argue, is a chauffeur; perhaps 70 percent of car owners in Seoul employ chauffeurs. Accordingly, the urban system has evolved around this fact. Parking facilities tend to be provided on the assumption that the passenger will be driven door to door but the car may be parked at a different point.

As a result, a minimum of $400/month is required to own a car and perhaps $1200 if a chauffeur is employed, at a time when an upper-middle-class salary might amount to $1600 after taxes.

The utilitarian constraints on automobile ownership are those where alternative modes of transportation (chiefly taxis) are available, which provide the same, or similar, levels of service as car ownership. Tax rates are lower for business cars and most large firms own fleets of cars that work on a pool basis. These pools provide transportation to and from work. Family and firm connections usually permit access to a car for special occasions, weddings, family celebrations, trips to the airport, etc.

At the same time, the universal willingness of shops to deliver purchases to the home and the availability of yondal (taxi pick-up trucks) for larger consignments mean that the carriage-of-goods function of a car can be bypassed. Car-rental firms exist, but the low number of drivers and the preference for chauffeurs restricts their usefulness.

The combination of fiscal, financial, and utilitarian constraints has held the ownership of cars at a low level. The high cost of owning and operating a car appears to be more important than the initial high purchase price. This is demonstrated by the small scale of the second-hand car market and the prevailing low prices. With limited exceptions, if a household can afford to operate a car, it can afford to buy a new one. In 1978 only 2 percent of cars were over 10 years old (10). Although this might also be the result of the low number of cars in 1968 (only 13 percent of the 1978 total), the absence of pre-1974 production models on the streets and the common practice of breaking up cars only three years old suggest otherwise. [Many older vehicles are imported cars (such as Mercedes-Benz), which cannot be replaced legally.]

Mopeds and motorcycles, which play a prominent role in Bangkok and other Asian cities, are also absent. This is the product of strict import controls and centrally directed industrial investment. Productive capacity is increasing and the number of motorcycles rose by 80 percent in 1979 alone, although the growth was largely in rural areas and smaller cities. The growth of the number of two-wheeled vehicles, which in Japan preceded the family car, will in future years inject a further variable into Korean urban transportation.

Although in the past the combination of taxes, firm cars, taxis, alternate delivery systems, and the high cost of chauffeurs and insurance has been sufficient to hold the ownership of cars at a very low level, rising incomes and the failure to peg taxes to inflation in recent years have led to a rapid growth of car ownership, as Table 2 shows. Between 1976 and 1979, real per capita income rose only one-seventh but car ownership tripled.

If rapid economic growth resumes in the 1980s and the cost of owning a car falls in real terms, then a rapid growth of car ownership is to be expected, as occurred in Japan in the 1960s and Europe during the 1950s. Under such circumstances, the present favorable urban transportation system will deteriorate as journey times for all road users increase and the cost of public transportation rises.

PUBLIC TRANSPORTATION SYSTEM

In the 1970s, many urban planners dreamed of restricting the use of private cars to the point where the average vehicle speed could double. The opportunity to examine a number of cities in which general car ownership (rather than car use) has been restricted is therefore of great interest. How effectively are the needs of 96 percent of urban Koreans met who do not travel by car?

Tables 3 and 4 (3) show that between 20 and 30 percent of all trips in Korean cities are made on foot. Both income and urban density would lead one to expect this. Indeed, many walk trips go unrecorded because the corner shop is less than 1 km away. The average walk trip in Pusan in 1979 was 17 min. Without obstructions one might expect a distance of around 2 km. In fact, walking in all Korean cities is full of obstacles. Major streets have a sidewalk flow of 4000 pedestrians/h along sidewalks often only 3 m wide and with street furniture located without regard for pedestrians.

At most major intersections in Seoul, the pedestrian is forced to go over or under the road, and may have to do both to cross diagonally. This is an additional reason why the average vehicle speed in Seoul is high. Not in Tokyo; Washington, D.C.; New York; or in any comparable capital city in Europe is the pedestrian forced to take such long detours to avoid delaying traffic. The subjective feel of any walk trip is that it is much farther than a comparable distance in a European or American city. This has repercussions on the rest of the system, i.e., discouraging walk trips and encouraging the use of taxis for short trips. These short trips reduce the availability of taxis, although they increase the profitability of taxi operations.

More than 60 percent of all trips are made by bus. All buses are privately operated but routes and fares are strictly controlled by city governments. Seoul alone has 90 city bus companies that operate about 200 lines. Although the Korean public

Table 3. Modal split including walking.

Mode	Modal Split (%)			
	Seoul, 1977	Pusan, 1979	Kwangju, 1979	Daejon, 1978
Bus	56	50.8	45	54
Walking	17	30.1	27	34.5
Taxi	16	12.0	10	3.5
Passenger car	3	3.6	9	3.5
Subway	4	–	–	–
Other	4	3.5	9	4.5

Table 4. Modal split excluding walking.

Mode	Modal Split (%)				
	Seoul		Pusan, 1979	Daejon, 1978	Kwangju, 1979
	1977	1979			
Bus	67.0	66	72.6	83.2	61.6
Taxi	19.0	19	17.1	5.3	13.6
Subway	4.8	7	–	–	–
Passenger car	3.6	8	5.1	5.2	12.3
Other	4.8	–	5.0	6.8	12.3

despises their buses, the bus system is a highly efficient people mover that offers a service without public subsidy. Buses are frequent, running at an average of 3- or 4-min intervals and covering the city with a comprehensive network that serves all areas and offers through routes, so that all parts of the city can be reached with a single interchange. In short, they offer everything but comfort.

There is considerable tension between the necessity of operators to make a profit or to cease operations and the control that city halls and planners wish to exert. From an operator's point of view, the ideal route passes through the city center and out the other side. However, buses that carry nearly 70 percent of mechanized trips are widely regarded as holding up traffic. There are indeed problems in certain main arteries where streets have only two lanes in each direction and one lane may have a solid train of buses. The fact that bus trains form is a reflection of the high volume of passengers who move along a particular corridor rather than a defect in the bus network. However, the announced aim of Seoul planners is to prevent through bus routes and force passengers to change to special city-center buses.

Currently, buses have high speeds as well as high volumes compared with their Western counterparts. This is partly a by-product of general traffic conditions conducive to higher speeds but is equally the work of very efficient crews.

A third factor is the relatively long distances between bus stops. In the city center, bus stops are about twice as far apart as in European cities. This obviously encourages vehicle speed at the expense of passengers who may have to walk farther before boarding or alighting, which would be more acceptable if walking were easier.

Moreover, a Korean bus stop within the central business district (CBD) is probably the length of a subway station. At each stop a bus train forms with 30 vehicles that serve 10-20 routes, and each vehicle crawls along most of the length. This negates most of the benefits of long distances between stops and speedy unloading at outer-city stops. Experimentally, bus stops at certain points have now been segregated, thus reducing layover time.

In one city, Daejon, the bus operators have solved the problem of being forced to operate marginal routes by city officials. The 14 operators have formed a cooperative in which all companies form a pool that will cross-subsidize unprofitable routes. Clearly, this is only possible if the companies that hold the most profitable routes agree to participate.

In 1979, the seat bus--a direct bus from the city center to selected suburbs (mainly aimed at commuters)--was introduced. More important minibus lines were also created. Both have been an unqualified success. They are faster, and the minibuses are much more maneuverable in traffic. Stops are spaced even farther apart and fares are three times as high as those on ordinary city buses. By 1980 it was estimated that minibuses carried 3.5 percent of mechanized trips. On a number of routes, demand far outstripped supply. However, the city showed considerable reluctance to authorize more vehicles and one must hypothesize that powerful interests are opposed to more minibuses.

Because minibuses are operated by existing city bus companies, the one mode to clearly suffer from their competition was the taxi. Ordinary taxis carry about 19 percent of trips. In terms of passenger kilometers, Seoul taxis may perform as much as 25 percent of the total, and for the Korean middle classes the taxi is the normal mode of transportation.

In any rational calculation of modal choice, the high probability of catching a taxi within a short time is obviously important. In 1978, under the stimulus of 12 percent GNP growth, the demand for taxis far exceeded supply, so that a wait of 20 min at a Seoul taxi rank was quite possible. But with 10 000 more ordinary taxis and 1000 new call-taxis and minibuses, supply and demand balanced by mid-1979 and tipped heavily in the consumers' favor as the recession deepened.

In 1974 the first subway was opened in Seoul. This was a 7.8-km link between newly electrified suburban railways that link satellite cities to the south. A total of four further lines for Seoul and four for Pusan are planned. The first section of Seoul subway 2 opened in October 1980. As in Tokyo, private enterprise is involved in the promotion of subways; i.e., building and preparing to operate subways 3 and 4.

Visiting consultants usually express severe doubts about the wisdom of building subways. This has been partly the result of the failure of Bay Area Rapid Transit (BART) in San Francisco and the Washington, D.C., Metro to fulfill all their promises. Likewise, cost/benefit studies in the Netherlands and United Kingdom in the 1970s have suggested that projected subways are not justified, but they have been built nevertheless for political reasons. Is this also true of Korea?

In compact high-density cities with low automobile ownership, subways offer a significant alternative that does not compete with existing modes for space. Currently, subway 1 carries about 6 percent of mechanized trips in Seoul. The central corridor in Pusan under which subway 1 is to be built currently has an hourly flow of 36 000 passengers traveling in buses where there is no room between the mountains and docks for further road widening. Similar flows are recorded in the major corridors in Seoul. In terms of speed, subway 2 has reduced the journey time to the east of the city by half compared with buses.

Although cost/benefit studies of subways have been conducted in Korea, it cannot be claimed that a full range of alternatives such as bus-only roads was evaluated. In high-density cities, expensive

engineering is the only way to increase capacity in the system, and subways may be justified. Nevertheless, the actual decision to construct them was based on political considerations without adequate data for a rational choice to be made.

ROAD NETWORKS AND TRANSPORTATION SYSTEM MANAGEMENT MEASURES

Despite the fact that major roads in downtown Seoul are often four or five lanes in each direction, the overall proportion of the city devoted to roads is low. Only about 14 percent of the urban area is devoted to roads, compared with 20-26 percent for most European cities and more than 30 percent for most U.S. cities. Even the 14 percent is misleading, since the CBD has a road ratio of more than 20 percent, which leaves proportionately less for the other areas.

Obviously, a high-density city can ill afford to progressively surrender land to the motorcar. Seoul city estimates that to add 0.5 percent to the road ratio would now consume its annual total budget. In response, Koreans have evolved what they term super blocks, which are eight-lane highways or on a wide-spaced grid, with each block enclosing a considerable area compared with the U.S. model. This speeds through traffic but leaves minimal street widths inside each block; indeed, at their smallest they are merely a meter wide. The problem then becomes, What happens when traffic wants to penetrate each block for access and in order to park? The answer is potential and often absolute chaos, with cars, handcarts, bicycles, and pedestrians fighting their way through confined spaces among parked vehicles.

Clearly, each incremental augmentation of motorcar traffic makes this particular problem worse. One might have expected transportation system management (TSM) measures such as one-way streets, pedestrian-only streets, parking restrictions, and so on to be systematically applied. However, by mid-1980 there were a few token one-way streets, more honored in the breach than the observance, one short stretch of a counter-flow bus lane, and one small area where the pedestrian was supposedly in a traffic-free zone.

The most strikingly successful measure is the total ban on heavy lorries in central areas except during the 12:00-4:00 a.m. curfew hours. At other times, goods are unloaded at peripheral depots and then brought in by small trucks.

FUTURE PLANS

Korea is a rapidly changing country, with cities and income growing fast and life-style changing rapidly. One might expect a cautious and experimental attitude to urban planning to prevail. This is not the case. It has been decreed by the Ministry of Home Affairs that by the end of 1981 every city in Korea shall have an unchangeable master plan that covers all urban details to the year 2000. This included a national set of guidelines that directed each city to have highways 50 m wide (14 lanes), running from north to south and east to west and meeting in the geographical center of the city. In draft plans this instruction had been obeyed literally so that all through traffic from every direction would pass through the very center of the CBD. There were no directions for ring roads or for even basic facilities such as bus stations (11).

The implicit assumptions were that automobile ownership and automobile use would continue to grow and that sufficient road space to keep the traffic flowing could be provided. Each plan envisages both an increase in the road ratio and an expansion of the city over a much larger area. Nowhere within the guidelines for planning procedures are there provisions for costing the plan or providing revenues to bring such a city into being. Correspondingly, there was no evaluation through cost/benefit analysis of various alternative schemes.

The present situation in Korean cities is an evolved rather than a planned situation. No planner ever sat down and drew up a set of guidelines to produce the largely favorable situation that exists, although attempts have been made to create master plans in the past. Today's Korean cities are largely the product of market forces with the additional ingredient of the restrictions on automobile ownership and use.

The main aim of Korean planning since the late 1960s has been decentralization. In general, it has been held that any decentralization is good, and there has been a marked tendency to fail to distinguish among the four main categories:

1. Removal of economic activity to another part of the country (e.g., industry or administration),
2. The creation of subcenters within cities,
3. The removal of economic or social activity from the center to the periphery of the existing city (e.g., relocation of industry, administration, social, and transportation facilities), and
4. The gradual evolution of suburban sprawl through a lowering of residential density and the growth of conglomerations as smaller settlements are absorbed.

Of the four types, only 1 and 2 are compatible with the existing types of cities. Types 3 and 4 are incompatible with profitable privately owned public transportation systems and, in particular, with the creation of a subway network that relies on the existence of high volumes of traffic between limited destinations. They encourage the use of automobiles and low-occupancy vehicles such as taxis, thereby placing penalties in the way of those who do not own cars and cannot afford taxi fares. They tend to increase passenger kilometers and normally increase the amount of time spent in traveling. Even in Tokyo, where the subcenter has evolved with relatively high levels of skill (i.e., building on an already existing rail network), the effect has been to double journey-to-work time.

Numerous examples of the problems caused by indiscriminate decentralization could be given (1-4, 12). In general, land use planning is being executed crudely without regard to the transportation implications. In particular, no consideration is being given to whether the type of city being created preserves the existing beneficial features of the city or whether it demands the use of private vehicles.

Quite apart from planned measures, the growth of private automobiles independently creates decentralization. Car owners can live farther from their work and beyond public transportation routes where land prices are lower. Services whose patrons are predominantly car owners can likewise be sited away from public transportation. In this manner, the city begins to segregate itself.

In American and European cities, the tendency has been for public transportation to deteriorate rapidly as the public system loses the marginal riders on whom the greatest profit is made while congestion from the increase in private vehicles raises operating costs (13). The deterioration and the rise in fares, if a realistic pricing policy is in operation, lead to an increased incentive to own a car. At this point the lower-income groups suffer from not only decreased accessibility but also higher travel costs per passenger kilometer.

POTENTIAL FOR IMPROVING EXISTING SYSTEM

The description of the existing urban transportation system indicated that there were considerable inefficiencies in the present system. Analyses of these inefficiencies suggest that with a minimum of investment the capacity and efficiency of the present system could be expanded while the attractiveness of nonmechanized and public transportation trips can be enhanced. This requires the application of the best practice in advanced countries to Korean cities.

Walking should be the starting point. As Thompson has observed, the short walk trip is the highest achievement of the transportation planners' art (7, p. 47). Each Korean city is a consumate example of the fact that there is no consideration of how walk trips can be encouraged and facilitated. The standardized macroplanning practiced in Korea discourages on-the-ground observation of what is actually happening in Korean cities. The lack of a pedestrian network is particularly unsatisfactory, although Koreans have begun to develop what could become a viable underground system. During 1979 and 1980 this was just beginning to offer one or two arterial routes. It has a special attraction to city governments in that each section paid for itself, since it was built as a shopping arcade in which the advance rentals paid for the construction. The chief problem is that there is no network design based on demand, and only selected stretches can be built when there is demand for shops; outside the CBD it is not economically viable.

Existing underground thoroughfares are already getting crowded and the notion of putting all pedestrians underground is impractical. It is essential that a systematic surface system of pedestrian-only streets be developed by using existing back streets, with appropriately controlled pedestrian crossings in main streets.

The possibility of bus and pedestrian-only malls is well worth considering. When Uljiro, one of the major east-west routes, was closed to all other traffic because of subway construction in 1980, bus times improved immediately, in some cases halving journey time. By segregating buses and other traffic, some of the tensions could be removed. At the same time the improvement of modal interchange--especially pedestrian, bus, and subway--needs to be made.

One of the greatest dangers about the new subways is that the interchange for pedestrian and bus will be ill-conceived. Existing interchanges are poor, even where space exists for improved systems to be effected very simply. Moreover, there is an assumption among city officials that the creation of a subway will automatically drain off all demand for buses.

This is far from the case along the existing subway 1. It will certainly take longer-distance traffic from the buses where the journey time is substantially shortened, as for instance in the case of the existing portion of subway 2 where the journey time is halved. However, subway fares are on a stage system. This means that the bus becomes cheaper with distance, since a flat-fare intracity rate applies.

The problem arises when a route rationalizer eliminates a through bus, which creates a journey that starts and ends on a bus but includes a subway stage. This triples the cost of the journey--no small consideration for at least 40 percent of the population. Indeed, it may be claimed that the present city system is highly equitable. There are no parts of the city not easily reached by one change of a bus. This will no longer be true of the city of the future.

At the other end of the scale, the design of new construction south of the Han River creates a disincentive to walk to a bus stop from new middle-class apartment areas. Indeed, the failure to plan these areas to minimize the desire to travel by taxi and ultimately by car is serious. The new areas remain very dense, although high-rise apartments are segregated from shops and public transportation by highways planned on the super-block concept.

Unless existing prejudices against buses are revised, there is a real danger of disaster when the subway system is regarded as complete. Unless buses and subway are allowed to compete and find their equilibrium, both public transportation operators and the public are likely to suffer. Ideally, the completion of the subway system should inaugurate a reduction in bureaucratic control on bus routes and permit negotiation for a variety of fare schemes between bus companies and subway operators. The alternative is likely to be large-scale bankruptcy, with the city governments being forced to operate loss-making routes.

Within the bus system there is plenty of room for improving the quality of the bus service, both through introducing a greater variety of types like express buses and minibuses and through improving existing designs of Korean city buses. The present design reflects its evolution from converted army lorries. The potential for making both smaller and larger vehicles is considerable.

When the economy picks up, the call-taxi must be encouraged. The old call-taxi could not be relied on to arrive when booked and thus failed in its basic advantage. But unless consumers are offered a door-to-door service that can be ordered by telephone, they will increasingly opt for their own cars. Likewise, one would hope to see something like the public light bus of Hong Kong authorized, which has proved highly popular in similar urban environments. This hybrid between a bus and a taxi could provide a further alternative mode in the dense-traffic conditions of Korean cities.

Assuming that cars do increase, if the number grows slowly enough, there is a potential for systematic application of TSM measures that can ease the flow of traffic. With a very selective construction program designed to fill in missing links and ease pinch points, particularly where through traffic can be diverted from downtown areas, TSM strategies ought to keep Korean traffic moving at close to its present speed for the next decade.

EQUITY, EFFICIENCY, AND LOW AUTOMOBILE OWNERSHIP

The evaluation of transportation plans is frequently couched in terms of pareto optimality, in which the optimum system is the one in which no change could produce a more satisfactory system for one individual without making it less satisfactory for another. Those who lose under the present system belong to the marginal group of households who would buy cars under a different fiscal regime, but only up to the point where an increase of cars would lead to general congestion. Once congestion grows, those who would gain would be heavily outnumbered by losses to all other transportation users.

Such an ideal evaluation is rarely approached in reality where financial considerations are paramount. It can be argued that the preservation of existing policies is more likely to produce a beneficial system, however evaluated, in the Korean context. There are two reasons for this point of view. The first is that the present system provides a good level of service for most citizens and the second is that there is only an illusion of choice for Korean cities. So-called full motorization is

not practicable in the Korean context because of the high population density and unsuitable topography. Even if the residential density were to fall to one-third of current levels, the continued circulation of traffic would depend, as it does in most major European and Japanese cities today, on a majority of car owners commuting by public transportation. But it would be by public transportation that required a subsidy.

Korea has very little land to spare. It must import every barrel of oil, and pollution is already a serious problem from industrial and domestic sources without a rise in automobile emissions. The diversion of public expenditure into road construction merely to maintain the existing level of service would be at the expense of urgently needed sewers, water supply, housing, and public amenities, as was the case in Japan in the early 1960s.

At the same time it is equally unrealistic to suppose that car ownership will not grow in a country where incomes are rising. All that can be controlled is the rate of growth of car ownership and use and the improvement of the existing system to ensure that potential car buyers and car users have alternative modes available. Currently, it is a theoretical assertion that the rate of growth can be permanently slowed, since it has never been attempted in practice, and experts still disagree on the ingredients of the model for predicting the rate of growth of car ownership. [Note that the Singapore government managed to stabilize the car fleet at 62/1000 in 1973 and 1974 at approximately the same per capita income as Seoul now enjoys, and the fleet actually declined in 1976 (14).]

Only if this course of action is adopted will Korea produce any lessons for the developed world. Up to the present, the unique system that exists in Seoul and other major cities can justifiably be regarded as a passing phase produced by the temporary phenomenon of low automobile ownership. Currently, the only lesson is a mental exercise in imaginative transportation planning and implementation to produce a more satisfactory system in the future.

It has been argued in the previous section that the cities contain sufficient inefficiencies to permit improvements in the urban system that will be greatly enhanced if the policy of restraining automobile growth is continued. If certain courses are taken to their logical conclusion, then it is at this point that Korea will begin to produce lessons of great interest. The provision of an integrated pedestrian system on a citywide scale has rarely been attempted in an existing city, although occasionally it is provided in new towns.

A further case would be if Korea applies the area-licensing scheme as practiced in Singapore. The Singapore scheme covers only 5 km^2. Initial assessments for Seoul suggest that a minimum of 22 km^2 would have to be included. The implementation of such a scheme would therefore be of much more direct applicability to a number of major cities throughout the world.

It must be emphasized that only if measures to enhance alternative modes of transportation are taken can a policy of restricting use of automobiles be effective. This in turn requires that current urban planning practices are revised. Unless Korean urban planning techniques pay close attention to the existing land use and transportation patterns and to the consequences for urban transportation of major relocation decisions, transportation strategy and urban planning will pull in opposite directions. The beginnings of an integrated approach have been inaugurated but are grossly underfinanced and out of accord with planners who work on other aspects of city planning.

On the whole, Western planners have abandoned the integrated citywide transportation planning approach. If Korean cities are to evolve along the lines suggested, they will require techniques that may well offer considerable lessons to developing and developed countries.

CONCLUSION

No solution to urban transportation is ever definitive, for people do not travel to please transportation planners but instead travel as a by-product of their daily lives. As has been argued throughout this paper, the future of Korean cities is at a critical point. Internal forces within Korea may well produce pressures for expansion of the domestic automobile industry. If this is so, then the potential of Korea as a lesson will be lost, and the situation described above will be accounted for as merely a passing phase.

This does not alter the fact that for many developing countries the Korean experience remains of great interest. Much would depend on the willingness of governments to restrain the growth of automobile ownership, but the other features of the Korean system are also of considerable interest. Perhaps the country that might profit most would be mainland China.

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