NAVAL POSTGRADUATE SCHOOL
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THESIS

ECONOMIC ANALYSIS OF VEHICLE SHARING MODE
FOR JOURNEY TO WORK BY
INDONESIAN OFFICE EMPLOYEES

by

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June 1986

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This thesis analyzes the economics of vehicle sharing and the implementation of this mode of transportation for major Indonesian cities. Current vehicle sharing porgrams are reviewed, and a model is validated using historical data. Then the model is used to asses the feasibility of vehicle sharing programs for five areas of Indonesia. The model indicates that such programs are feasible for these areas, and the thesis concludes

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Economic Analysis of Vehicle Sharing Mode for Journey to
Work by Indonesian Office Employees

by

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June 1986

ABSTRACT

This thesis analyzes the economics of vehicle sharing and the implementation of this mode of transportation for major Indonesian cities. Current vehicle sharing programs are reviewed, and a model is constructed which parameterizes the major elements of the vehicle sharing decision. The model is validated using historical data. Then the model is used to assess the feasibility of vehicle sharing programs for five areas of Indonesia. The model indicates that such programs are feasible for these areas, and the thesis concludes by examining some important elements in implementing such programs.

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I. INTRODUCTION

A.   BACKGROUND AND PURPOSE OF THESIS

Currently, transportation to and from work is a major problem for most office employees in Indonesian cities such as Jakarta and Surabaya. Congestion is experienced on highway and city street networks during "rush hours", and these travel peaks are largely attributable to the concentration of single occupancy vehicles which saturate the streets' vehicular capacity during these periods.

The idea of vehicle sharing for transportation to and from work is one possible means to overcome the problem. This mode offers several advantages over typical mass transit modes such as buses. One advantage is convenient door-to-door service, while another is reduced travel time as compared to mass transit. Additionally, vehicle sharing can contribute significantly to the reduction of highway transportation costs, congestion, and pollution. All in all, vehicle sharing can be viewed as having personal as well as social benefits. Studies of vehicle sharing are still rare in Indonesia. This thesis will try to analyze the economics of vehicle sharing modes such as carpools, buspools, or vanpools, and it will attempt to develop some methods of implementation of this mode of transportation for major Indonesian cities.

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B.   ORGANIZATION OF THE THESIS

The thesis is divided into four chapters. Chapter one
is an introduction, which covers the background and purpose
of thesis. Chapter two discusses the economics of vehicle
sharing modes from theoretical perspectives, as well as the
results from some studies which have been done in the past.
Chapter three is a discussion of a proposed system to be
implemented in Indonesia, and chapter four contains conclu-
sions and recommendations.

II. ECONOMICS OF VEHICLE SHARING

A. WHY ECONOMIC ANALYSIS

Economics is the science of resource allocation--the study of both how our economic system actually allocates limited resources and how it might be done more efficiently. Only a limited amount of goods and services are available at any one time, and the wants of economic systems are so great that they exceed the output that can be produced from these available resources.

Taken in this light, our decision to buy a new car means that our family, as a whole, must forego some electrical appliances, new furniture, or a vacation to Hawaii that it otherwise would have. As another example within a fixed military budget, the decision to provide sophisticated submarines means doing without an additional destroyer squadron, or its equivalent. Similarly, our decision to join a vanpool program means getting up earlier and coming home later. Regardless of the level at which the decision is to be made, the allocation is essentially the same-- within a fixed budget (limited resources), the procurement of one item implies that some other items must be foregone.

B.   WHY VEHICLE SHARING

   1.   Initial Program

      In April 1973, the 3M Company of Saint Paul,
Minnesota initiated one of the first commuter van programs
in the United States.   Following 3M's example, over 60
employers have sponsored vanpool programs through 1976
[Ref. 19: p. 1].   The energy shortage period gave increased
importance to the commuter van program.   Other concerns
leading to the program were air pollution (especially carbon
monoxide levels) and traffic congestion surrounding the
general offices.

      During this period, much progress dealing with the
development, operation, programs, and benefits of vanpooling
have been reported.   It is the key characteristic of vanpool
programs that, despite the essential similarity among them,
each is a unique adaption to a particular situation.   A
knowledge of these possible variations should prove helpful
to an employer planning to embark on a vanpooling or vehicle
sharing project in general.

   2.   Program Examples

      Some of the successful vanpool programs can be
mentioned as follows.

         a.   Caltrans Vanpool Project, Sacramento, California
            In order to test the feasibility of vanpooling
as an alternative mode of urban commuter travel, the

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California Departement of Transportation initiated a demonstration vanpool project in July 1975. The major substantive benefits expected as a result of the operation of only three vans (in 1975) were as follows:

- $22,800 per year saved by commuters in operating costs,
- 15,700 lbs of pollutants prevented annually,
- 19,000 gallons per year savings of gasoline, and
- a 15 space reduction in parking needs. [Ref. 19: p. 23]

b. Aerospace Corporation and Air Force Samso Project, El Segundo

.Beginning with a carpool matching service and a charter bus operation in June 1972, the company initiated a vanpool project in April 1975, and by the end of 1975 the program expanded to 17 vans. According to managers of Aerospace/Samso Commute-A-Van Program, three significant features have been primarily responsible for its success: the van style, the method of procuring the vehicle, and the fare structure.

In determining the type of van to be used, rider comfort was the major consideration. Consequently, those vans which were intended for use over a longer routes were furnished with air-plane-type reclining seats. According to the company, the additional ridership induced by this feature more than compensated for the additional cost of seats and the reduced passenger capacity per van.

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The vans were procured by the company through leasing, with the full cost assessed to the passengers. Fuel and maintenance service, partially provided by Aerospace facilities, was charged to each van on a per-mile basis. Finally, the program utilized a commercial liability insurance policy costing $46 per month per van in combination with a van program insurance pool which assessed each van pool $10 per month.

Aerospace employed a unique fare system combining monthly and daily charges. Each regular rider was charged 1/3 of his share of the costs on a monthly basis. The remaining 2/3 of the cost was divided by 17 and was assessed daily. Through this procedure, each van would break even if the rider missed, on the average, no more than one day a week. Both the company and van riders were in agreement that this fare plan provides the greatest equity.

According to Aerospace/Samso, sincere management support for vanpooling is essential for the success of a van program. While vanpooling assures the prompt arrival of the employees in the morning, it also guarantees their speedy departures at the end of the day. Clearly, the Aerospace/Samso van project has been a fruitful one. The attraction of a low cost, comfortable, and convenient ride to work have made vanpooling competitive with more traditional modes of commuting, especially for those employees

travelling longer distances. The result, according to a company study, is an annual reduction of 2 million vehicle miles traveled with energy savings of 130,000 gallons of gasoline. [Ref. 19: p. 20]

c. Continental Oil Company (Conoco), Houston, Texas

The Continental Oil Company began its commuter van pilot program with the purchase of three 12-passenger vans in March 1975. By 1976 the program operated 10 vans transporting 103 commuters daily over distances between 20 and 70 miles. The vanpool program met with the overwhelming approval of management and employees alike. According to a survey of the program, 93 percent of the participants found vanpooling to be equal to or more convenient than their previous mode of travel to work. And 30 percent indicated that they planned to sell a car or not buy an additional one as a result of the program. The company estimated that each van took five automobiles off the road during rush hour and saved approximately 5,200 gallons of gasoline per year. [Ref. 19: p. 27]

d. Ralph M. Parsons Company, Pasadena, California

The Ralph M. Parsons Company found the van program to be an important factor in attracting a number of highly skilled people to the plant, and participating employees fully appreciated saving costs in commuting, while

being spared the daily anguish of driving through heavy Los Angeles freeway traffic. As a result, the company antici-pated the continued expansion of its vanpool program. [Ref. 19: p. 44]

C. PROGRAM BENEFITS AND CRITICAL VARIABLES

An important aspect of vehicle sharing is its potential benefit to the user, the non-user, the general public, and the employer. Major benefits being offered by vehicle sharing modes[1] such as vanpool programs can be summarized as follows:

1. Reduce traffic congestion and parking demand in and around office locations

2. Reduce traffic congestion on streets and highways

3. Create less air pollution

4. Reduce energy consumption

5. Save user's money

6. Provide opportunities to drop ownership of second car

7. Reduce risk and tension of commuting

8. Improve employer-employee relations. [Ref. 10: p. 372]

_____

[1]Types of vehicle sharing are: carpool, buspool, minibus-pool, vanpool, etc.

Common sense would suggest that commuters reject mass transit systems and vehicle sharing modes principally because they are dissatisfied with the collection and distribution portions of these modes of commutation [Ref. 14: p. 128]. The latter is largely attributable to the increased travel time and decreased flexibility on a commuting trip. The number of commuters in a vehicle and route deviations[2] are among critical variables that have to be considered before commuters will use these modes of transportation. Therefore, these variables will be closely examined in the next sections.

D. ON TOLERABLE ROUTE DEVIATIONS IN VANPOOLING

1. The D/l ratio

Johnson, et al. [Ref. 12: p. 45] derived the ratio of tolerable route deviation to trip length for vanpools using an analysis of user cost. They suggest that this ratio can be a useful planning tool for estimating the regional potential of vanpooling and for identifying specific areas of highest potential. Why is this ratio important? From this ratio, one can provide information about how close people have to live to one another to be potential vanpool candidates, or what is the total distance a vanpool group may be willing to deviate from the direct

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[2]The deviation from the direct auto trip.

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route to the destination. Intuitively speaking, one will
not join a vanpool if the route deviation is too large.
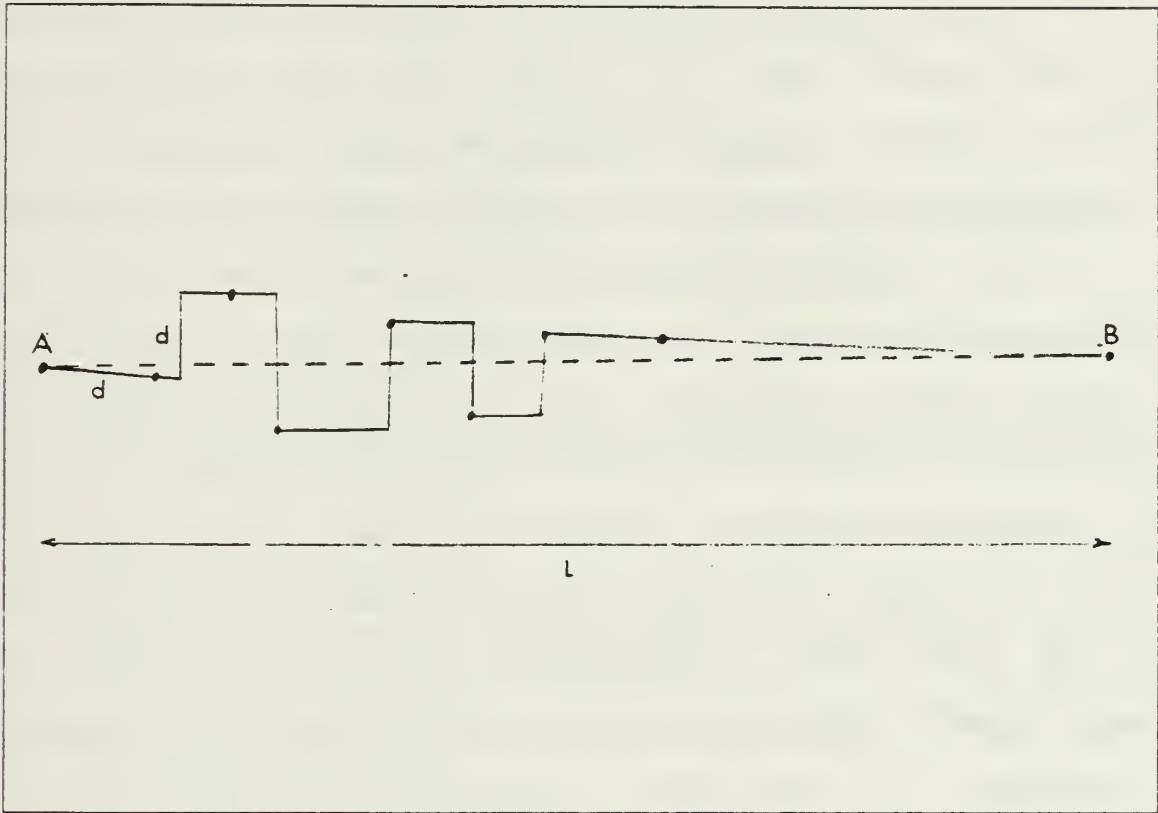
Figure 2.1   A Spatial Model for Route Deviation.

In modeling the decision to vanpool, a typical route
structure can be assumed as similar to that shown in Figure
2.1. As the driver of the van collects passengers, he or
she is making two types of movements: (1) deviations in
order to pick up the passengers, and (2) progress toward the
ultimate destination. It is assumed that the length of the
movement-toward-destination component of the trip for the

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first passenger, which is denoted as 1, is the same as a direct auto trip, while the deviation movement is of the length D = M - 1, where M is the total van distance.

It is also necessary to address the fare structure of the vanpool [Ref. 17: p. 18]. The total costs of the pool are split equally between the regular passengers, and the driver is given any extra fares (retention of passenger fare above breakeven minimum), as well as a free ride. The driver also benefits from the free use of the van in the evenings and on weekends. He or she thus has a significant incentive to deviate from the normal route to work in order to pick up passengers. Therefore we can focus on only the first passenger and assume that he or she will vanpool only if the total cost of the vanpool trip, which includes the cost of extra time spent on the deviations for all remaining passengers, is less than or equal to the total cost of driving an automobile. If this condition cannot be met for some first passenger, no vanpool will be formed. If such a deviation exist, it is called the tolerable route deviation. Algebraically, the condition may be expressed as [Ref. 12: p. 46]:

$$\frac{aC_v^v}{n} + M\left(\frac{T}{S_v} + C_v^v\right) + C_f^v \le 1\left(\frac{T}{S_a} + C_v^a\right) + C_f^a \qquad \text{(eqn 2.1)}$$

where:

- l = length of direct trip from first passenger's home to workplace

- M = total mileage

- D = route deviation = $M - l$

- T = dollar value of one hour of time

- S_v = Overall average speed (including pick up time)

- S_a = Average underway speed of automobile

- C_v^V = Average variable cost of operating a van per passenger per mile

- C_v^a = Average variable cost of operating an automobile per mile

- C_f^V = daily average fixed cost of a vanpool per passenger

- C_f^a = daily average fixed cost of operating an automobile

- a = distance from the driver's origin to the first passenger's origin

- n = number of passengers.

Notice that the term aC_v^V/n, which is the cost per passenger incurred by driving from the driver's origin to the first passenger's origin, is almost always very small compared to the other terms, and for simplicity this term can be ignored. Substituting $l+D$ for M, equation 2.1 can be simplified further to yield the ratio of tolerable route deviation to trip length, D/l:

$$1 + D\left(\frac{T}{S_v} + C_v^v\right) \le 1\left(\frac{T}{S_a} + C_v^a\right) + \left(C_f^a - C_f^v\right)$$

$$1 + D \le \frac{1\left[\dfrac{T}{S_a} + C_v^a\right] + \left[C_f^a - C_f^v\right]}{\left[\dfrac{T}{S_v} + C_v^v\right]}$$

$$\frac{D}{1} \le \frac{\left[\dfrac{T}{S_a} + C_v^a\right] + \left[C_f^a - C_f^v\right]}{\left[\dfrac{T}{Sv} + C_v^v\right]} - 1 \qquad \text{(eqn 2.2)}$$

The fixed costs for an automobile vary depending
upon size and make. The U.S. Department of Transportation
estimates range between $3.88 and $4.94 per day ($1974)

[Ref. 20: p. 8]. Johnson [Ref. 12: p. 46] used 20 percent of the full fixed cost of automobile ownership[3] as the daily fixed cost of operating an automobile. Thus C_f^a was determined roughly at $0.86, which was 20 percent of the fixed cost estimates of $4.30 by Johnson et al.

The daily fixed cost of vanpooling ranged from a high of $1.45 at TVA to around $0.70 for Conoco's program. Johnson et al. placed the cost at $0.94. Based on these estimates, Johnson simplified equation 2.2 further by setting C_f^a and C_f^v equal, which yields:

$$\frac{D}{1} \leq \frac{\left[\dfrac{T}{S_a} + C_v^a \right]}{\left[\dfrac{T}{S_v} + C_v^v \right]} - 1 \qquad (\text{eqn } 2.3)$$

This equation is important because from here we can see how the remaining variables will affect the ratio of tolerable route deviation to trip length.

---

[3]Based on evidence that: (1) 15 to 20 percent of ex-drivers actually give up a work car, (2) 17 percent of TVA vanpool project's participants either sold or put off buying a new car, and (3) the Conoco project reported 25 percent of their participants delaying purchace of, or selling, a car.

Increasing the number of passengers, for instance, will decrease C_V^V, and in turn will increase the tolerable deviation ratio, D/l.

2. Travel Time and Utility Ratio

Based on a comprehensive survey of nearly 600 participants in the 3M vanpool program, Owens and Sever [Ref. 17: p. 54] reported an average increase in travel time for each passenger of about 10 minutes (for average vanpool trip of 25 miles one-way). Conoco's vanpooling program indicated that their drivers are reporting increases in travel time of between 25 and 30 minutes [Ref. 12: p. 48]. These reported travel times can be used for validation purposes of the D/l ratio derived in previous section (sample calculations are included in Appendix A).

Owens and Server [Ref. 17: p. 22] have developed a utility ratio calculated as:

$$\frac{\text{Pick-up time (in minutes)}}{\text{Line-haul time (in minutes)}} \qquad (\text{eqn 2.4})$$

which has been used as a rule-of-thumb in many vanpools programs. It is assumed that if the ratio remains under one, a stable vanpool is possible. The larger this ratio becomes, the more difficulty there would be in the formation

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and operation of a successful pool due to the exessive time spent picking up and discharging passengers in relation to the total work trip time.

E. CARPOOL SIZE PREFERENCES

1. The Optimal Carpool size

Levin [Ref. 15: p. 71] stated that carpool size (the number of passengers) is one of the most important and critical variables dealing with comfort, economy, convenience, and overall desirability in carpooling. Intuitively speaking either too small or too large a size (relative to number of seats available) results in inconvenience among commuters in a carpool. How this size relates to the gasoline price, wage rates, speed limits, and other factors will be presented in the subsequent discussions.

Assume that n identical individuals, live at equal distances[4] of d miles apart in a residential community and commute to a workplace (see Figure 2.1). A limited access highway connects the workplace and residential community. The line-haul part of the worktrip is H miles. Movement in this model uses two variable inputs, time and gasoline, with prices w and p respectively. Gasoline and time are substitutable. The distance produced with given inputs is independent of the number of passengers in the car. In Figure

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[4]This assumption is taken for simplicity.

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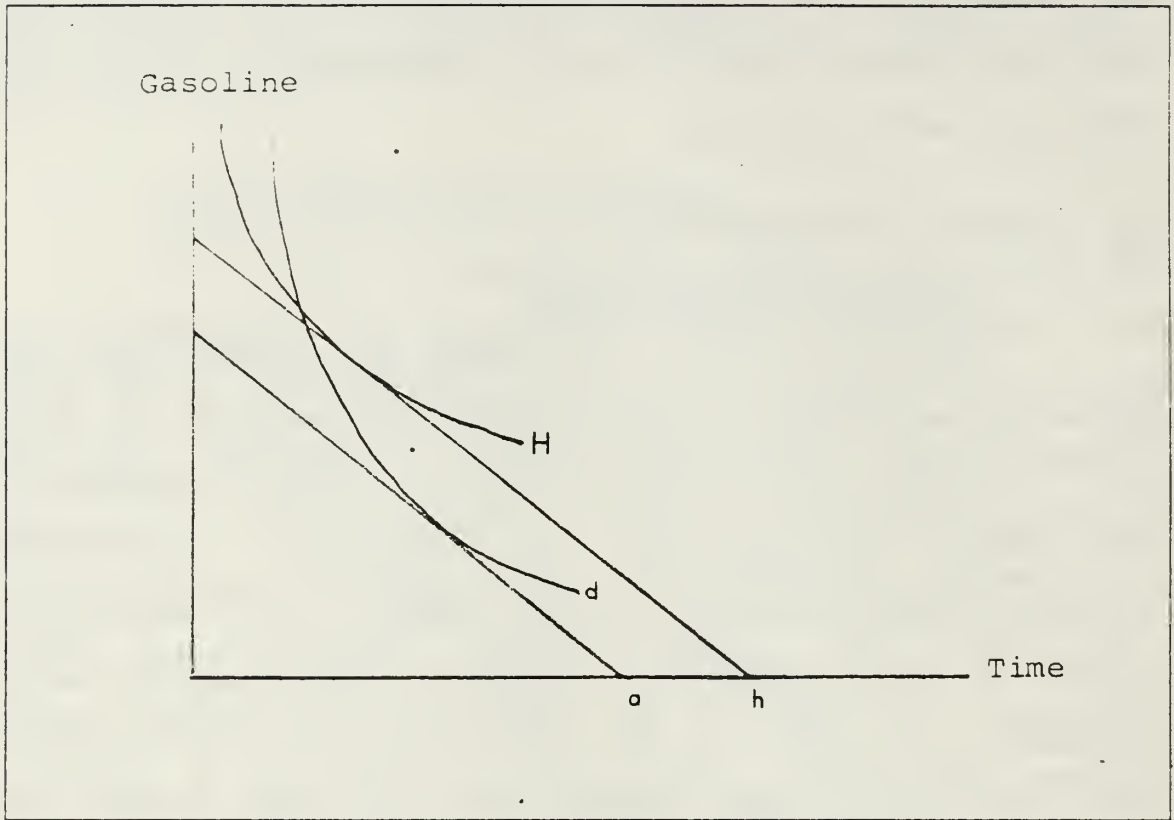
Figure 2.2   Gasoline Intensive.

2.2, the isodistance curve d corresponds to d local miles and the isodistance curve H to H highway miles. Driving one local mile generally is different from driving one highway mile due to differences in design and regulation of local streets and highways. As depicted in Figure 2.2, highway driving is more gasoline consumptive than local driving. Another figure with d and H switched would show the case in which L is more gasoline consumptive than H, for instance due to local streets' condition. [Ref. 14: p. 129]
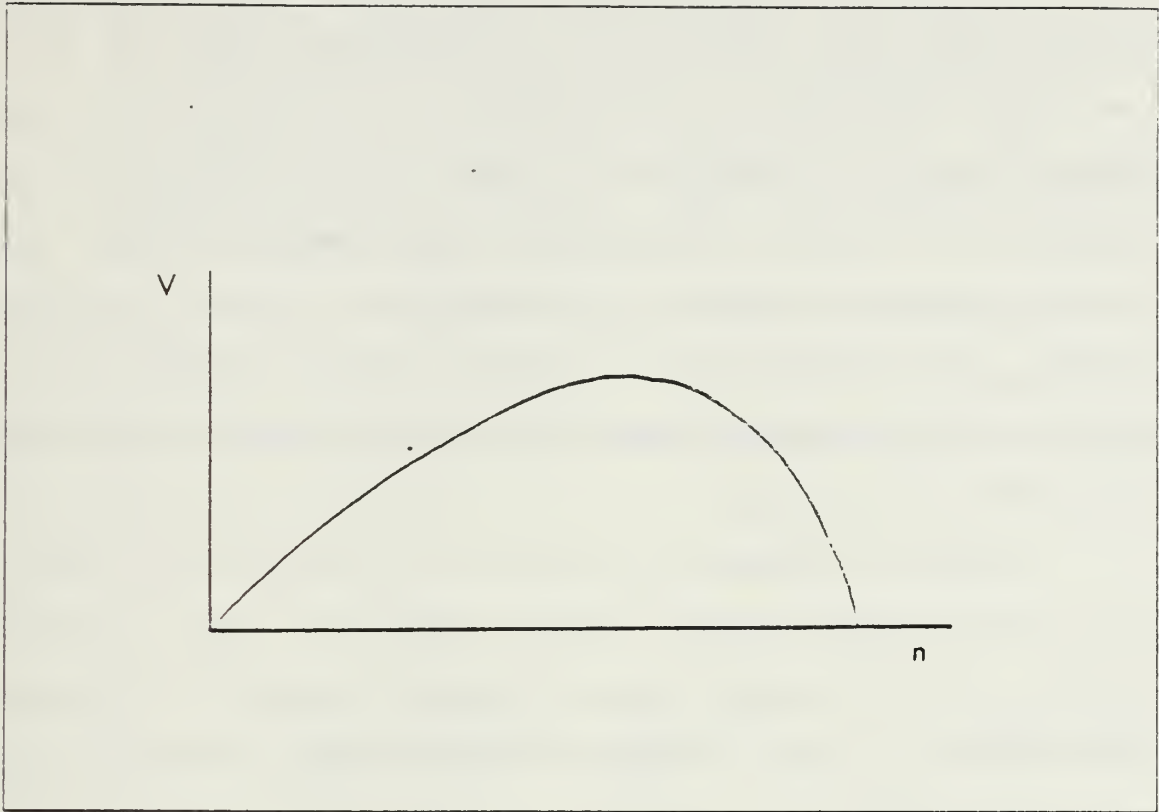
Figure 2.3   Compensating variation, V, vs carpool size, n.

The value of commuting (measured via compensating variation),[5] V, is assumed to depend on the amount of companionship, reflected by the size of carpool, n. Since companionship, in sufficient doses, may become a nuisance, its marginal value may become negative (see Figure 2.3).

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[5]Compensating variation compares two alternative price, income, and utility situations. Compensating variation is defined to be the amount of income that could be taken away from a person in the new situation in order to leave the person as well off as in the old. Equivalently, it is the amount of money someone would be willing to give up in order to have the change occur. [Ref. 2]

A carpool incurs three kind of cost. First, the cost of line haul, $h(H,w,p)$.[6] It should be noted in this case that carpooling is assumed to save line-haul time because non-driving time in a carpool may be employed for productive or leisure activities. The second cost is the cost of assembling riders, $(n-1)a(d,w,p)$, for an n person carpool. The third cost is the cost of coordination, $c(w,n)$, with positive first-order and second-order derivatives [Ref. 14: p. 130].

Cost of line-haul, h, and cost of assembling riders, $(n-1)a$, are divided equally among n passengers (for n person carpool). Now, a carpool will maximize a member's surplus from commuting (given the value of commuting is greater than sum of the costs):

$$V - \left[\frac{h}{n} + \frac{(n-1)\ a}{n} + c \right] \qquad (eqn\ 2.5)$$

where:

- V = value of compensating variation of commuting, as a fuction of n

- n = number of passengers

---

[6]The symbols are explicitly defined in the next paragraph of this section.

- h = cost of line haul, is a funtion of H, the line haul distance, w, the time price (it is assumed equal for all commuters in a pool), and p, the gasoline price

- a = assembling cost, is a function of d, the local distance between two consecutive passengers (it was assumed equal), w, and. p. (For an n person carpool, total assembly cost = $(n-1)a$.)

- c = cost of coordination, is a function of w and n.

The optimal carpool size can be determined by differentiating equation 2.5 with respect to n and setting the derivative to zero:

$$\frac{dV}{dn} - \frac{(a-h)}{n^2} - \frac{dc}{dn} = 0 \qquad (\text{eqn } 2.6)$$

or

$$\frac{dV}{dn} = \frac{(a-h)}{n^2} + \frac{dc}{dn} \qquad (\text{eqn } 2.7)$$

This equation states that for the optimal size of carpool the marginal value of companionship equals the marginal cost of ridership for each of the identical individuals. The marginal cost of ridership consists of the marginal transportation cost of ridership, $(a-h)/n^2$, and the marginal

coordination cost of ridership, dc/dn. For a sample calculation of optimal carpool size, see Appendix B.

The marginal transportation cost of ridership, $(a-h)/n^2$, can be positive or negative, because an increase in the carpool size reduces each member's share of the line-haul cost at the rate of h/n^2, but due to the necessity of picking up additional members, it also increase each member's share of assembly cost at the rate of a/n^2. Since in this case h is assumed to be greater than a, the size of the carpool is limited by the increasing marginal coordination cost of ridership, dc/dn.

2. The Determinants of the Carpool Size

How exogenous variables affect carpool size will be discussed here, since the effect is not always obvious.

a. Distance--Carpool size

From equation 2.7 it can clearly be seen that a greater line-haul distance, H, implies a lower marginal cost of ridership, because the cost saving at any carpool size is greater. The size of carpool, n, therefore is positively related to the line-haul distance, H. A greater residential dispersion, d, on the other hand, implies a higher marginal cost of ridership, because the potential of cost saving by carpooling is diminished by the greater cost of assembling. The size of carpool therefore is negatively related to the residential dispersion.

b. Gasoline Price--Carpool Size

The relationship of the gasoline price to the carpool size is not always in a unique direction, since a higher gasoline price raises both the line-haul cost, h, and the assembly cost, a. Since a higher line-haul cost implies a larger carpool, while a higher assembly cost implies a smaller carpool, how the gasoline price affects the carpool size depends on the factor intensities of highway and local journeys. In the case for which the line-haul part is more gasoline consumptive than the assembly part (as it was assumed), then following a rise in gasoline price, the line-haul cost increases more than assembling cost. This implies decreasing marginal cost of ridership. As a result, carpool size will increase. Therefore, in the case where line-haul part is more gasoline consumptive than assembling part, the carpool size is positively related to the gasoline price.

c. Wage Rate--Carpool Size

The wage rate affects not only the marginal transportation cost of ridership, $(a-h)/n^2$, but also the marginal coordination cost of ridership, dc/dn. Its effect is not necessarily in the same direction for each component, thus their sum becomes uncertain. For instance, a higher wage rate may increase the line-haul cost more than it increases the assembly cost, so the marginal transportation cost will go down. But a higher wage rate necessarily

forces the marginal coordination cost to go up. It is therefore unclear in what direction a higher wage rate shifts the marginal cost of ridership.

The effect of the wage rate on carpool size can be established definitely only if the wage rate shifts the marginal transportation cost, $(a-h)/n^2$, and the marginal coordination cost, dc/dn, in the same direction. This is the case where assembling two adjacent riders take more time than line-haul, and as long as maximum speed limits are fixed and remain binding [Ref. 14: p. 132]. If these requirements are met, then the carpool size is negatively related to the wage rate.

d. The Binding Speed Limits--Carpool Size

Lowering the maximum highway speed limit (say, from 55 to 50 mph) pushes commuters farther away from their unconstrained optimal driving behavior, therefore imposing higher line-haul costs on them. A higher line-haul cost always makes sharing by carpooling more attractive, hence, carpool size will expand. On the other hand, raising the maximum local speed limits (say, from 30 to 35 mph) relaxes somewhat the constraint on local driving. The assembly cost, therefore, goes down, and this again, in turn, encourages expansion of the carpool size.

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F.   RESULTS FROM PAST STUDIES

1.   Johnson's Result

Using equation 2.3, Johnson et al.   [Ref. 12: p. 47]
computed that the maximum ratio of total deviation distance
to line haul travel distance was about 0.24 (using actual
data in 1977).   This calculation was based on an average
automobile speed of 30 mph and a van speed of 25 mph.   The
value of time was $4.00 per hour ($ 1977), that is 40
percent[7] of the hourly wage rate, a standard rule-of-thumb
which has been used by a number of researchers [Ref. 12: p.
46].   Since the ratio of D/l is sensitive to choice of speed
and value of travel time, sensitivity analysis was also done
in computing this ratio.   The range which resulted was
between 0.20 to 0.35.

2.   Recalculation of D/l Ratio

The author tried to recompute the ratio of D/l by
using equation 2.2 in order to get more accurate results by
not ignoring the difference between daily fixed costs for an
automobile and daily fixed costs of a vanpool.   Sensitivity
analysis also was done for various number of passengers,
speeds, and time prices.   The results are presented in Table
I.   Conclusions from this recalculation are that greater
deviations will be tolerated at:

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[7]Winston [Ref. 22] gives much larger value of time, that
is 74 percent of wage rate, for transit on vehicle time, but
this is an average across auto, bus, and rail modes.

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(1)   higher speeds

(2)   lower fixed costs of vanpooling compare to fixed costs of automobile

(3)   lower time prices

(4)   greater number of passengers or smaller variable cost of vanpooling per passenger

(5)   greater variable cost of automobile.

TABLE I

SENSITIVITY ANALYSIS RESULTS FOR D/L RATIO

n	S_a	S_v	T	C_f^a	C_f^v	C_v^v	C_v^a	D/l
	(mph)		($/hr)	($/day)		($/pass.mile)		
9	30	25	3	0.86	0.94	0.011	0.078	0.310
9	30	25	4	0.86	0.94	0.011	0.078	0.200
9	30	25	5	0.86	0.94	0.011	0.078	0.120
9	30	25	5	0.96	0.70	0.011	0.078	0.460
9	35	30	4	0.96	0.94	0.011	0.078	0.280
10	30	25	4	0.86	0.94	0.010	0.078	0.204
11	30	25	4	0.86	0.94	0.009	0.078	0.210
12	30	25	4	0.86	0.94	0.008	0.078	0.216

3.   Study from The Ralph M. Parson Company's Vanpool Program

The maximum deviation tolerable for a given route length indeed is very critical in the decision to vanpool. There are a number of researchers who try to estimate this maximum deviation from empirical data.   One of the studies has been made from the Ralph M. Parson Company's vanpool

routes. A direct route from the first pick-up point of each route to the destination was measured and subtracted from the total route length for the total collection distance. The results are presented in Table II. The average ratio distance (collection distance/line haul distance) from these actual vanpool routes can be used to verify the predicted range of D/l ratio by Johnson. In this case, the average ratio of 0.26 is within Johnson's estimate of D/l range of between 0.20 and 0.35.

TABLE II

ROUTE DISTANCES FOR RALPH M. PARSONS CO. VANPOOLS

Observation	Line Haul Distance	Collection Distance	Ratio
1	44	5	0.11
2	42	12	0.29
3	34	2	0.06
4	26	8	0.31
5	28	3	0.11
6	24	8	0.33
7	24	8	0.33
8	24	8	0.33
9	20	8	0.40
10	40	12	0.30
11	36	12	0.33
		Average	0.26

Source: Johnson et al.

4. Montgomery Wards' Vanpool Program

Montgomery Wards' vanpool program gave another result concerning the ratio of collection distance to line haul distance, as presented in Table III. From these results, Johnson [Ref. 12: p. 47] concluded that the highest ratios tended to come from distant suburbs where reasonably high speeds can be maintained during the pick-up driving and the lowest ratios tended to come come from parts of the city where there was substantial congestion for much of the trip.

TABLE III

ROUTE DISTANCES FOR MONTGOMERY WARDS VANPOOL

Van Pool	Line Haul Distance(mile)	Collection Distance(mile)	Ratio
1	28.25	12.50	0.44
2	28.00	14.00	0.50
3	22.50	9.00	0.40
4	19.00	4.00	0.21
5	11.50	1.50	0.13
6	12.00	4.00	0.33
7	28.25	5.00	0.18
8	36.25	5.50	0.15
9	25.00	4.00	0.16
10	37.25	3.00	0.08
11	27.50	5.00	0.18
		Average	0.25

Source: Johnson et al.

5. Utility Ratio's Calculation

William L. Berry [Ref. 17: p. 66] applied the utility ratio factor (pick-up time/line-haul time, see equation 2.4) used in 3M Pilot Program. By applying the utility ratio to each vanpool, Berry was able to calculate the average rider's maximum value of time in order to drive singly to work in an automobile as an alternative to the 3M Commute-A-Van. He assumed that the cost of operating an automobile was 10 cents per mile and that the line haul distances for auto and Commute-A-Van were equal. The average maximum value of time was then calculated for each vanpool. The maximum value of time was defined as the maximum which a commuter picked up exactly one half way through the pickup route could value his personal time and still ride in a 3M Commute-A-Van. Berry's calculations are given in Table IV. It is interesting to note that many 3M Commute-A-Vans exceed the utility ratio "rule-of-thumb" of 1.0 mentioned earlier. It is also interesting that there is some economic incentive to participate in a vanpool even though the amount of extra time picking up and dropping off passengers may be substantial.

6. Driving Arrangement Preferences

This section will be present results from a research program conducted at the University of Iowa. The aim of this study was to investigate the role of interpersonal

TABLE IV

VANPOOL UTILITY RATIO
AND AVERAGE MAXIMUM VALUE OF TIME

Utility Ratio	Value of Time ($/hour)	One-Way Pick Up Time (minutes)	One-Way Line-Haul Distance (mile)	Number of Vans
0.35 to 0.75	12.11	15.9	21.5	10
0.76 to 0.99	· 6.80	26.8	22.2	7
1.00 to 1.20	5.04	25.8	16.4	14
1.21 to 1.60	3.41	29.0	14.8	11
1.61 to 2.40	2.69	33.4	13.2	10
Max. 2.40	$ 20.51	45.0	48.0	
Min. 0.35	3.37	7.0	5.0	
Mean 1.18	5.83	26.2	17.2	

source : Owens,B.

factors in carpooling. The basic approach was to form a multi-attribute carpooling situation through factorial design techniques and to use simple rating scales to measure attitudes toward the alternative carpooling situations. Analysis of variance tests were used to assess the relative importance of selected carpool attributes and to describe how these attributes combine to determine attitudes toward carpooling [Ref. 15: p. 71].

Research in carpooling and ride-sharing has emphasized the role of interpersonal factors such as acquaintanceship in desirability of passengers. Such

research has in fact led to carpool promotional programs that emphasized the role of the "personal touch". This study also emphasized the role of another personal factor, preferred driving arrangement, in determining attitudes toward carpooling. Preferred driving arrangement was defined as a choice between serving as a driver, serving as a rider, or sharing driving responsibility with others. This study tried to investigate how alternative driving arrangements were evaluated on a variety of attitudinal dimensions and how driving arrangements combine with other economic and convenience factors to affect desirability of carpooling.

There were two experiments conducted. The first experiment used undergraduate students (20 males and 20 females) at the University of Iowa. Each was shown 36 unique carpooling situations described by all combinations of the following factors:

(1) Size of carpools: 2, 3, or 4 persons

(2) Roundtrip distance: 10 or 30 miles

(3) Driving arrangement: always drive, always ride, or driving duties shared equally

(4) Extra time to pick up and deliver passengers: 5 or 10 minutes per rider.

In addition, each participant received two trials on which the driving situation was described as drive alone, that is no carpool, and distance was either 10 or 30 miles.

The second experiment was run on 48 staff members from the University of Iowa. They were selected from the University's carpool matching list, that is the list of those members who signed up to be matched with others for the purpose of carpooling or vanpooling. Respondents were contacted initially by telephone. The short telephone survey consisted of questions about their current carpooling situation: are they now in carpool, what is its size and composition, what are their reason for carpooling, what are the driving and cost-sharing arrangements and how satisfied are they with their carpool, etc. They were then asked permission to be sent a written survey consisting of an abbreviated version of the experimental design used in Experiment I (for students) and the same set of question-naire items. In each experiment they were asked merely to write a number between 0 and 20 to represent how desirable or undesirable each carpooling situation appeared to them personally.

The results can be summarized as follows:

(1) Differences in desirability rating as a function of driving arrangement varied as a function of the sex of respondent. Shared driving was rated highest by both sexes, but males rated driving over riding while females rated riding over driving. The same pattern was observed in both experiments. In addition, driving arrangement had greater effect on females than on males in each experiment.

(2) Desirability ratings decreased appreciably for both sexes in each experiment as carpool sizes increased.

(3) Carpool desirability ratings increased in each experiment as distance increased. In both experiments, however, the effect of distance was smaller than the effects of other variables.

(4) Desirability ratings in each experiment showed a large decrease as extra time per rider increased.

(5) In each experiment, desirability ratings for drive alone conditions decreased appreciably with distance, with females giving particularly low ratings to drive alone for 30 miles.

Respondents in Experiment II differed greatly in age, occupation, and carpooling experience from those in Experiment I. Respondents in Experiment II would be expected to provide realistic evaluations of the carpooling attributes under investigation because many of them were being affected by these attributes in their own carpooling situations. Nevertheless, carpooling desirability ratings were remarkably similar in the two experiments.

Carpool size and amount of time to pick up and deliver passengers emerged as the most important factors in both experiments. This is consistent with what was mentioned before about carpool size and tolerable route deviation to trip length. Driving arrangement also emerged as an important determinant of carpooling desirability in both experiments, especially among female respondents who prefer shared driving and riding all the time. Results from the questionnaire items reveal some interesting differencies between attitude of the different respondents in the two experiments. The student-participants in Experiment I

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who were largely non-carpoolers were able to express prefer-
ences for sex of driver, rider, and acquaintanceship. On
the other hand, many of the respondents in Experiment II,
all of whom were either in carpool or were seeking to join
one, did not express such preferences. These respondents
were apparently more concerned with finding appropriate
"matches" on the basis of work schedules and home location.
[Ref. 15: p. 84]

The interpersonal factors such as acquaintanceship
in desirability of passengers and preferred driving arrange-
ment which led to the carpool promotional programs are
important factors in promoting vanpools as well. The role
of the "personal touch" in the pooling program should be
emphasized.

G. SUMMARY

This chapter has presented the background theories
needed for subsequent discussion of the proposed system.
After presenting the benefits offered by the program, the
critical variables of pooling modes, that is, the D/l ratio,
the number of passengers, the travel time and utility ratio,
all have been thoroughly discussed. The results of the past
studies which were used to validate the model being used
also were provided.

Johnson's calculation of D/l ratio based on equation 2.3
resulted in a range of between 0.20 and 0.35. The author's

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recalculation based on equation 2.2 placed the range of between 0.12 and 0.46. The actual vanpool routes both from Ralph M. Parson Co. and Montgomery Wards' vanpool programs gave average ratios which fell in the above ranges. The average travel time delays of 3M vanpool program again validated the above range for the D/l ratio. From these results, therefore, it can be concluded the above model successfully reflects actual vanpool situations. The next chapter will discuss the potential locations around Jakarta and Surabaya and validate these potential locations by using the model from this chapter.

III. <u>DISCUSSION OF PROPOSED SYSTEM</u>

This chapter will present and discuss potential locations around Jakarta and Surabaya for a vanpooling program, and by using the upper bound of the ratio of deviation distance to trip length, an analysis of feasibility will be provided.

A. POTENTIAL CANDIDATE LOCATIONS

The selection of the area in which to organize a vanpool is based on number of potential riders who live in a specific area. These potential passengers can be found in two ways: (1) selecting from residential areas where some employees of the same office/company live together, and (2) selecting from the existing companies where groups of employees possibly live in close proximity to each other or in company housing. The second method will not be further examined due to the lack of data, but it can be mentioned that such situations do indeed exist; that is, groups of employees in a company which live close to each other, such as employees of the state oil company (Pertamina), banks, cement industry, aircraft industry, ship industry, and so on.

From the first method there are five general areas around Jakarta and Surabaya chosen as the potential

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candidates for a vanpool program. These general areas are listed in Table V. Each area exhibits slightly different trip characteristics. Also included in Table V are the distance ranges to work sites (Jakarta or Surabaya). The estimated value of D/l was calculated by dividing the estimate of deviation distance resulting from 10 passengers by the distance to work site. The estimated deviation distance for each location, was provided in consultation with Indonesian-N.P.S. students who live in Jakarta and Surabaya.[8]

B. ESTIMATE OF THE D/L RATIO'S UPPER BOUNDS

The upper bound of the deviation to the trip length can easily be computed provided we know the value of time, T; the average speed of a van and an automobile, S_v and S_a; and variable cost of a van and an automobile per mile, C_v^v and C_v^a. Using 1985 conditions the value of time can be estimated to be within the range from Rp1350.00 (rupiah, Indonesian currency)[9] to Rp2250.00 (based on 60 percent[10] of

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[8]There are twelve students who currently live in Jakarta, and four students who currently live in Surabaya. The estimation was based on how the housing locations are spread out, type of community (employees from one company or from several companies), approximate number of population, and so on.

[9]Conversion for May 1986 is: $U.S.1 = Rp1126.

[10]Use weighted average on Winston's [Ref. 22] estimates (20 percent of auto value time + 40 percent of bus value time + 40 percent of rail value time).

TABLE V

POTENTIAL CANDIDATE LOCATIONS

No.	General Area	Distance to work site (km)	Deviation distance (km) *	Transportation provided besides indiv. vehicle	Estimate of D/l range
1	Bogor/Depok	40-60	4 **	electric train	0.067-0.100
2	Bekasi	25-40	5	buses/minibuses	0.125-0.200
3	Jatiwaringin	10-30	2	minibuses #	0.067-0.200
4	Gresik/Tandes	20-30	5	minibuses	0.167-0.250
5	Gedangan/Tara-tap	20-40	5	buses/minibuses	0.125-0.250

*   Based on 10-passenger van.
** We estimated average distance of two consecutive passengers
    here equal 0.4 km, then multiply by number of passengers, etc
same as vans, serve as public transportation.

wage rates).

Based upon the Indonesian Naval Academy's pooling program (telephone conversations between the author and pool coordinator on March 1986) the reported value of C_V^v ranged from Rp3.50 to Rp4.50 per passenger kilometer, while C_V^a ranged from Rp26 to Rp31.5 per km. The last variable, van and automobile speeds, ranged from 30 to 60 km per hour. The upper bound of the D/l ratio can be computed for conditions existent in each potential vanpool location. These are presented in Table VI (The computations for Table VI are contained in Appendix C).

TABLE VI

ESTIMATE OF UPPER BOUND OF THE D/L RATIO

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No	General area	S_a (km/hr)	S_v (km/hr)	Upper bound of D/l

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1	Bogor/Depok	60	50	0.637
2	Bekasi	50	40	0.464
3	Jatiwaringin	55	45	0.553
4	Gresik/Tandes	50	40	0.529
5	Gedangan/Tara-tap	50	40	0.529

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From the upper bound calculation of the D/l ratio the following conclusions can be drawn:

(1) comparing Table V and Table VI it can be seen that all of the five locations offer high potential for vanpool programs.

(2) Bogor/Depok and Jatiwaringin general areas are among the highest potential vanpool areas with their D/l ranges approximately one sixth of the upper bounds.

(3) Jakarta locations (general areas 1 to 3) have greater upper bounds compared to those of Surabaya locations (general areas 4 and 5). This makes intuitive sense since Jakarta's highways are generally better than Surabaya's so that reasonably high speed can be maintained, and also its values of time are slightly greater due to the greater of wage rates.

(4) All in all, the upper bounds of the ratio of deviation distance to trip length for conditions in Indonesia are generally larger than for similar situation in the U.S.A. This again makes intuitive sense, because there are better economical conditions, highways, streets, etc., in the U.S.A.

C.   VANPOOL VS CARPOOL AND BUSPOOL

As an answer to the growing problems of transportation to and from work, traffic congestion, and air pollution for Jakarta and Surabaya, a vanpooling program could immediately be instituted. Vanpooling has several distinct advantages over both carpooling and buspooling, including the following:

(1)   Vans can carry up to three times the passenger load of an automobile for less than twice the operating cost. Therefore cost per passenger-miles are lower than with automobile.

(2)   Since there is no need for participants to take turns driving as in the typical carpool, some employees can dispense with a second car.

(3)   Vans can operate more economically than can buses from areas of low employee concentration and shorter distances (good for general areas 3 to 5), because of their size and flexibility.

(4)   Vanpools can provide customized pick up service, in contrast to buspools, which usually require an assembling of riders at a common embarkation point.

(5)   Vans present no off-hour garaging problem and, in fact, may be used by the pool operator as a personal vehicle.

The most important step is implementing the vanpool. The task can be divided into two stages. First, the familiarization stage consists of explaining to potential users how the program works, what motivates a person to be a driver, the purposes served by the program, and so on. Second, the implementation stage consists of determining if vanpooling is applicable to a given firm, the minimum number

of employees required forming the pools, obtaining vehicles, and so on.   For details of the implementation step and some considerations in vanpool programs, see Appendix D.

Surely, on one hand, not of all considerations listed in the appendix will fit within conditions in Indonesia.   On the other hand, certain approaches and considerations are to be found almost universally in both conditions (Indonesia and the U.S.A.).   Such considerations can be mentioned, for instance: (1) program initiation and program promotion can be applied except for legal considerations which have some differences among other things.   (2) Pool coordinator, financing of program, advantages and disadvantages of program, except the method of fare collection which has differences, all in all, will fit very well for conditions in Indonesia.   Indeed, a brief overview of the existing guidelines and considerations of the programs leads to this conclusion: there is no one key to a successful van program--any number of variations are possible.

IV. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

This thesis has considered pooling as an appropriate proposed mode of transportation for Indonesian office employees to and from their work. Conclusions from this study are as follows:

(1) As is apparent from conditions in Indonesia, vanpooling usually has greater flexibility and efficiency over bus and carpool. This is due to its size, which is not too big and not too small, fit with condition of streets and home locations of employees. From its fixed costs perspective, vanpool program also offers smaller capital as compared to buspool program.

(2) Vanpooling is potentially available for employees who live in Bogor/Depok and Bekasi general areas around Jakarta and Gresik/Tandes and Gedangan/Taratap general areas near Surabaya.

(3) The upper bounds of the ratio of deviation to trip length, D/l, among five general areas are fairly high, as compared to the range of D/l estimates for each area, which indicates the high potential locations for vanpooling program.

B. RECOMMENDATIONS

The following are some recommendations concerning the proposed pooling program in Indonesia:

(1) The companies, firms, or services should consider implementing vanpooling programs by taking examples from many successful vanpool programs in the U.S.A. and by purchasing one to three 10 to 14-passenger vans.

(2)   Due to the demonstration nature of the project and possible labor issues, the company should finance the fixed cost of van program entirely through its own funds, and employees using the service should be covered by workmen's compensation when riding in the van.

(3)   If the employees live in public housing (very close to each other), pick up points should specifically be limited to 3 or 4 locations per route. This will minimize travel time.

(4)   The initial vanpool program should be carefully monitored by the vanpool coordinator's office,[11] which also acts as a promoter of vanpooling by keeping a list of prospective riders, and by serving as an information clearing house.

(5)   In implementing the vanpooling program, the number of passengers and the amount of time to pick up and deliver passengers should be carefully evaluated, and the possible effect of the convenience factor among the passengers should be assessed. Increasing the number of passengers will increase the amount of time to pick up and deliver them, and this is especially true for conditions where assembling two adjacent riders takes more time than line-haul, due to traffic effects. This, in turn, will result in inconveniences among the members of the pool.

(6)   The role of interpersonal factors such as acquaintanceship in desirability of passengers and preferred driving arrangements should be carefully monitored.

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[11]The utility ratio (pick-up time/line-haul time) should then be computed, to verify the "rule-of-thumb" ratio of 1.0.

APPENDIX A

VALIDATION OF D/L RATIO USING TRAVEL TIME DELAYS

If we consider the average travel route of about 25 miles (as in 3M company), and assume:

(1) S_a = 30 mph

(2) S_v = 25 mph .

(3) n   = 8 - 10 persons

(4) travel time difference for first passenger = 20 min (for average increase for all passengers for about 10 min) then, the van trips takes 25/25 * 60 min = 60 min, the automobile trip takes (60 - 20) min = 40 min, the direct auto distance is 40 * 30/60 miles = 20 miles, the deviation trip distance is (25 - 20) miles = 5 miles, so, the ratio, D/l = 5/20 = 0.25 (which agrees with the range suggested by Johnson, that is between 0.20 and 0.35).

SAMPLE CALCULATION OF N

This is an example of calculation of the optimal vanpool size. In this case we will maximize:

$$V - \left[\frac{h}{n} + \frac{(n-1)\,a}{n} + c \right]$$

where:

(1) h = f(H,w,p) = cost of achieving H miles of highway distance. Where w = time price per hour = \$3.00 to \$10.00 per hour, say, w = \$5.00 per hour; p = gasoline price per gallon = \$0.75 to \$1.20 per gallon, say, p = \$1.00 per gallon. For H = 10 miles, highway's speed = 50 miles per hour, and 15 miles per gallon of gasoline, it takes = (10/50) hrs = 0.2 hrs, and consumes = (10/15) = 0.67 gallons of gasoline. Then h = \$(0.2*5)+(0.67*1) = \$1.67 per 10 miles.

(2) a = f(d,w,p) = cost of achieving d local miles. Assume the same value of w = \$5.00 per hour, and p = \$1.00 per gallon, local speed = 30 miles per hour, and 20 miles per gallon of gasoline. For d = 10 miles, it takes = (10/30) hrs = 0.33 hrs, and consumes = (10/20) = 0.50 gallons of gasoline. Then a = \$(0.33*5)+(0.50*1) = \$2.17 per 10 miles.

(3) c = f(w,n) = cost of coordination, say c = $k*w*n^2$. V = f(n) = compensating variation, say, we have step function:
       V = n   for 0 < n < 4
       V = 6-0.5n   for 5 < n < 8
       V = 10-n   for 9 < n

(4) For H = 30 miles and d = 10 miles. Objective function becomes:

$$\text{Max} = V - (3*1.67)/n - (n-1)*2.17/n - k*5*n^2$$
$$\text{subject to: } V < n$$
$$V < 6-0.5*n$$
$$V < 10-n$$

for k = 0.01, using GINO program, n = 4.

For various values of V and c the values of n are as follows:

V	c	n
$V < 0.8\,n$		
$V < 13 - 0.5\,n$	$0.05\,n^2$	8
$V < 19 - n$		
same as above	$0.05\,n^3$	3

APPENDIX C

CALCULATION OF UPPER BOUNDS OF THE D/L RATIO

Using equation 2.3, the upper bound of the D/l ratio for validation can be calculated for the five general areas around Jakarta and Surabaya. The value of time for Jakarta estimated between Rp1500 and Rp2250, and for Surabaya between Rp1350 and Rp2250, that is 60 percent[12] of wage rates of each location. The estimated speed varied between 40 to 60 km per hour for Jakarta, and between 40 to 50 km per hour for Surabaya. The results are presented in Table VII.

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[12]This is based on weighted average of the value of time given by Winston [Ref. 22] (.2*6 percent + .4*83 percent + .4*65 percent = 60.4 percent).

TABLE VII

THE D/L RATIO UPPER BOUND OF THE FIVE GENERAL AREAS

General areas	n	S_a	S_v	T	C_v^v	C_v^a	D/l upper bound
-	(persons)		(km/hr)		(Rp/hr)	(Rp/pass. km)	-
Bogor/	9	50	40	1500	4.50	31.50	.464
Depok	9	50	40	2250	4.50	31.50	.259
	9	60	50	1500	4.50	31.50	.637
	10	50	40	1500	4.05	31.50	.480
	11	50	40	1500	3.68	31.50	.493
Bekasi	9	40	30	1500	4.50	31.50	.266
	9	40	30	2250	4.50	31.50	.103
	9	50	40	1500	4.50	31.50	.464
	10	40	30	1500	4.05	31.50	.277
	11	40	30	1500	3.68	31.50	.285
Jatiwa-	9	45	35	1500	4.50	31.50	.442
ringin	9	45	35	2250	4.50	31.50	.185
	9	50	40	1500	4.50	31.50	.464
	10	45	35	1500	4.05	31.50	.382
	11	45	35	1500	3.68	31.50	.393
Gresik/	9	40	30	1350	4.50	31.50	.328
Tandes	9	40	30	2250	4.50	31.50	.103
	9	50	40	1350	4.50	31.50	.529
	10	40	30	1350	4.05	31.50	.330
	11	40	30	1350	3.68	31.50	.340
Gedangan	9	45	35	1350	4.50	31.50	.428
/Taratap	9	45	35	2250	4.50	31.50	.185
	9	50	40	1350	4.50	31.50	.529
	10	45	35	1350	4.05	31.50	.443
	11	45	35	1350	3.68	31.50	.456

APPENDIX D

INITIATING THE PROGRAM

Given that the locations considered to be potential for vanpooling is known, what is the next step? The following questions may be come up, and here are some guidelines for initiating the program as suggested by Conoco [Ref. 4: p. 1-1]:

1.   The Familiarization Stage

    a.   What is vanpooling?

Vanpooling is a commuting alternative in which employees who live near each other ride to and from the work site in a van.   The employee riders pay fares which cover the cost of the vehicle and its operating expenses with the company absorbing administrative accounting overhead.

    b.   How does the program work?

For a pilot program, the company purchases some vans, based on a survey taken from the employees. From the survey, the locations of those who are interested are plotted on maps.   A volunteer driver from among existing employees is then selected and the van is filled with employees who live in close proximity to each other.

    c.   What motivates a person to be a driver?

First, it must be emphasized that the drivers are employees who already have a fulltime position with the company; so this is a kind of add-on position. Employees seek the driving job for a variety of reasons. Incentives are provided the driver including a free ride to work and personal use of the van. In turn the driver drives the van to and from the work site, is responsible for seeing that routine and preventive maintenance is performed, collects the fares, and performs the simple record-keeping function.

    d.   What purposes are served by the program?

The primary purpose is energy conservation. In addition it reduces pollution to the atmosphere, relieves traffic congestion, and lessens the demand for auto-related facilities. To management it is self-supporting, minimizes tardiness, reduces absenteeism, and improves employee morale. For employees it provides an alternative to commuting to and from work which is more economical, safer, dependable, and enjoyable.

    2.   The Implementation Stage

        a.   How can we determine if vanpooling is applicable to our firm?

First, run a simple economic analysis taking into consideration the cost and salvage value of the van over a specific period of time, together with other fixed and variable expenses and extrapolate from this the monthly operating cost for a given daily round trip mileage.

Secondly, distribute a letter to all employees explaining briefly what vanpooling is and the estimated fares will be. (For cost and fare calculations example, see Appendix E.) Ask them to return a questionnaire indicating interest or non interest; whether they would prefer being driver, back-up driver or passenger; and their home address and work schedule if applicable. Thirdly, the results of the second step should be analyzed to determine the number of interested participants and their geographical proximity to each other.

        b.   Is there some "rule of thumb" minimum number of employees?

There is no doubt some minimum number below which this concept would not be practical. Perhaps the best way to make this determination would be from the survey outlined above (we can also use equation 2.3 to verify the determination). Even though a vanpool may not be practical, this is a good tool to assist employees in finding carpool associates.

        c.   It is practical. What's the next step?

Complete the study, but before sending it to the final approval authority, it is not only practical but politically sound to consult with such pertinent groups as Legal, Insurance, Personnel, Transportation and Service Departments. Their suggestions and critiques will be helpful and normally essential. With final approval, order

the vans, then select the drivers. From the survey, furnish
them the names of prospective riders and let them form the
pool.

　　3.　Considerations in Vanpool Programs

　　　　What follows is an outline of factors which enter
into the decision making process of vanpooling. Different
companies have different considerations and the list below
is an illustration of different considerations, concerns,
solutions, and so forth, that result from a decision to
investigate and ultimately implement a vanpooling program
[Ref. 19: p. 4].

　　　　a.　Program Initiation

　　　　　　(1)　Employer concerns.

(a) Lack of employee interest

(b) Company liability in case of accident

(c) Possible large capital outlay

(d) Company subzidization of only one group of employees

(e) Need for ongoing commitment

　　　　　　(2)　Reasons for program.

(a) Energy conservation

(b) Desire to reduce air pollution and traffic congestion

(c) Better public relations

(d) Attract employees

(e) Allows employees to adjust to plant relocation

(f) Severe parking problem

(g) Allow long distance commuters to continue employment despite rising cost of commuting

(3) Essential ingredients for successful program.

(a) Sufficient number of employees at a plant who reside near one another, work on same shift, and are interested in vanpooling.

(b) Strong support from company leadership

(4) Matching techniques.

(a) Roster system

(b) Pin/number system

(c) Locator board/pigeon hole system

(d) Zip code system

(e) Grid system

(f) Regional system

b. Program Promotion

(1) Promotion techniques.

(a) Bulletin board

(b) Company newsletter

(c) Letter to employees

(d) Vanpool display areas

(e) Word of mouth

(f) Group presentations

(g) Distribution of travel surveys

(2) __Employee incentives__.

(a) Low fares

(b) Preferential parking

(c) Flexible work hours

(d) Comfortable van

(e) Convenient personal service

(3) __Legal considerations__.

(a) Drivers licences

(b) Vehicle registration

(c) Regulation as common carrier

(d) Competition with established transit system

(e) Liability and insurance

(f) Compensation of driver

c. Program Operation

(1) __Van provision__.

(a) Purchase

(b) Lease

(c) Lease with option to buy

(d) Employee pools purchase vans

(e) Employee group purchases vans

(f) Contract operator hired

(2) __Fuel and maintenance__.

(a) Obtained at private service stations

(b) Provide by company at retail price

(c) Provide by company at discount price

(d) Obtained at one private service station

(e) Included under van lease

        (3) Insurance.

(a) Special van policy

(b) Included under fleet policy

(c) Self insurance

(d) Self insurance, with additional liability or collision policy

(e) Included under van lease

        (4) Route length.

(a) No minimum

(b) Minimum of 10 miles (16 km) one-way (to ensure break-even at competitive fares)

(c) Minimum of 20 miles (32 km) one-way (primary focus on long distance commuters)

        (5) Van service.

(a) Door to door

(b) Park and ride

(c) Walk to pick up points

(d) Combination door to door and common collection points

        (6) Van utilization.

(a) Single-shift commuting

(b) Multi-shift commuting

(c) Intra-plant shuttle

(d) Inter-plant shuttle

(e) Sublease to community groups

(f) Daily company business

(g) Personal use by drivers during non-business hours

(h) Personal use by any pool member during non-business hours

(i) Multi-employer commuting

(j) Daily use by employees to travel to medical or business appointments

        (7) <u>Van riders</u>.

(a) Employees from one company

(b) Employees from several companies

(c) General public

(d) Permanent riders

(e) Casual riders

(f) Mixture permanent/casual riders

      d.   Pool Coordinator

        (1) <u>Qualifications</u>.

(a) Valid driver's licence

(b) Chauffeur's licence

(c) Safe driving record

(d) Low incidence of absenteeism or tardiness

(e) Employee

(f) Enthusiastic about the program

(g) Recomendation of supervisor

(h) Able to provide off-street parking

        (2) <u>Responsibilities</u>.

(a) Drive van according to establish schedule

(b) Keep van fueled, serviced, and cleaned

(c) Keep log of van operation and expenses

(d) Organize pool group

(e) Maintain number of passengers above minimum level

(f) Collect fares

(g) Establish fares

(h) Train back-up drivers

(i) Establish routes

        (3)   Incentives.

(a) Free commuter transportation

(b) Personal use of van during non-business hours at minimal
charge

(c) Retention of passenger fares above break-even minimum

(d) Compensation under workmen's compensation

     e.   Financing of Program

        (1)   Method of financing.

(a) Fares pay all costs

(b) Fares pay all but administrative costs

(c) Each van operates on break-even basis

(d) Entire program operates on break-even basis

(e) Partially financed through leasing of van to employees
for personal use

(f) Partially financed through business use of van

(g) Partially financed through leasing of van to community
groups

(h) Company pay all costs

(i) Partially funded by casual riders

(2)   Method of fare collection.

(a) Company cashier collects

(b) Driver collects

(c) Payroll deduction

(d) Monthly fare

(e) Daily fare

(f) Weekly fare

(g) Bi-weekly fare

(h) Combination monthly and daily

 f. Advantages and Disadvantages

  (1) Advantages to employer, non-riding employee, and general public.

(a) Reduction in traffic congestion at company site

(b) Reduction in parking space needs and outlays for parking facilities

(c) More efficient land use for auto related facility

(d) Decrease absenteeism and tardiness

(e) Improved employee morale may result in increased worker efficiency

(f) Enhanced attractiveness of company to potential employees

(g) Broader labor market

(h) Availability of extra vehicles for daily company use

(i) Good public relation

(j) Minimize effect of plant relocation on company operations

(k) Reduce air and noise pollution

(l) Reduce energy consumption

    (2) Disadvantages to employer and non-riding employee.

(a) Potential increased liability

(b) Absorption of some administrative costs

(c) Gives rise to corporate commitment

(d) (to non-riding employee) company subsidization of commuting costs of only those vanpooling

    (3) Advantages to rider.

(a) Reduction in costs of commuting

(b) Reduction in risks and tension of commuting

(c) Less insurance costs for personal automobile when not driven to work

(d) Reduction in mileage of personal automobile and/or increase in mobility for other family members

(e) Sale of a personal automobile or postponement of additional purchase

(f) Reliable service

(g) New acquaintance make trip pleasant

    (4) Disadvantages to rider.

(a) Increased travel time

(b) Decreased flexibility on commuting trip

(c) Unavailability of personal automobile for errands and appointments during day

(d) Must pay for days when van not ridden

   (5) <u>Advantages to coordinator--driver</u>.

(a) Free commuter transportation

(b) Personal use of van at minimal cost

(c) Retention of fares from passengers in excess of minimum number required by company

   (6) <u>Disadvantages to coordinator--driver</u>.

(a) Additional responsibility and time for maintaining van pool

APPENDIX E

COMMUTE-A-VAN COST CALCULATIONS EXAMPLE

[Ref. 5: p. E-1]

I.   Fixed costs of Commute-A-Van Vehicle (all in $1974)

        Cost of Vehicle $4891.00

        Immediate Depreciation   121.00

        Cost for Depreciation

        purposes $4770.00

1.   Depreciation over 48 months $ 99.00/month

2.   Insurance $480/year   40.00/month

3.   One-time fixed costs - 1st year

        Sales Tax $196.00

        Tires   121.00

        License   83.00

        2nd - 4th years

        License(average) 201.00

        Total $601.00 $ 12.52/month

4.   Cost/month for 48 Months $ 151.52/month

5.   Estimated Value of Vehicle

        after 48 months is $1800. or $ 37.50/month

6.   Monthly fixed cost to be received

        by User Income (4 minus 5) $ 114.02/month or

        $1368.24/year

7.   Yearly Fixed Cost used for Fare

        Calculation purposes $1400.00/Year or

        $ 117.00/Month Fixed Cost/Vehicle

II.   Operating Costs for Commute-A-Van Vehicle

1.   Gasoline: $.36/gal. @ 9 miles/gal. $ .04/mile

69

2. Oil change, filter and lubrication
   at 3000 mile interval
   @ $7.25/each time $ .0024/mile

3. Other Maintenance $ .0100/mile

4. Tires - cost for life of vehicle $ .0100/mile

5. Total Operating Cost $ .0624/mile
   For Fare Calculation purposes and
   personal mileage charges $.07/mile was used

III. Fare Calculation

- Step 1 Daily round trip distance

- Step 2 Miles per year (250 days times above mileage)

- Step 3 Fixed Oper. Cost per mile ($1400. divided by miles/yr)

- Step 4 Operating Cost per mile ($.07/mile)

- Step 5 Total Cost per mile (3 plus 4)

- Step 6 Cost per day (cost/mile times daily mileage)

- Step 7 Cost per person perday (cost/day devided by 8)

- Step 8 Cost per person per month (21 times cost/day/person)

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