THE IMPACT OF ENERGY AND ENVIRONMENTAL FACTORS ON TRANSPORTATION SYSTEM PLANNING AND DEVELOPMENT

WITH PARTICULAR REFERENCE TO THE CITY OF NAIROBI KENYA

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1. **INTRODUCTION**

Transport facilities are costly, placing a heavy burden on the public budget and on private resources. Both the capital and recurrent costs of transport use up sizeable amounts of available foreign exchange. In so far as transport pre-empts a large share of available resources less are available for other purposes, such as the improvement of other aspects of urban infrastructure. On economic as well as environmental grounds, reduction in costs of providing transport particularly in terms of foreign exchange is of high priority.

Transport services are one of the most potent sources of pollution. Particularly as urban centres grow and as the economy becomes more complex requiring more transport, the demand for transport services increases, the density of traffic grows and the resulting pollution reaches levels which make the environment unpleasant and increasingly dangerous to health.

The availability and quality of transport services is an important factor in the quality of life. The unpleasantness and tension involved in travel is one of the most negative aspects of modern living. Even for the better off, congestion, noise and pollution can make travel an unpleasant part of the daily
routine, while for the poor the need to walk long distances, the time spent waiting for transport and the over crowded conditions all add up to draw a significant part of day's energy for unavoidable travel from home to work.

In this paper an attempt is made to evaluate the impact of environmental factors on the planning and development of public transportation. The paper also gives an account of the various measures that the government of Kenya intends to take to conserve energy in urban areas and their effects on the transportation system.

2.0. ENVIRONMENTAL CONSIDERATIONS IN URBAN TRANSPORTATION

Urban transportation planning is an agent of change, an intervening factor thus the subject of 'Environmental Considerations' must examine the Interaction of the transportation system with the cultural and ecological systems of which it becomes an Integral part.

The fundamental assumption in this discussion is that a systems view of the environment is essential to planning for the man/environment interface. In this view the environment is defined as a complex set of systems, in dynamic interaction with each other, that surround and include man. This entails describing
changes in the dynamic interactions of environmental elements.

Since such a consideration centers on the environment of man, it is necessary to subdivide the environment into two systems, the ecological and the cultural. Planning can operate at a scale which is both beneficial to the ecological base and the cultural complement by working to maintain the equilibrium between the two.

This equilibrium is not a static one. Changes that occur in the cultural environment act on the ecological bases causing changes in that system. These initial changes are translated into further alterations within the ecological system. The cumulative ecological changes feedback into the cultural base giving rise to initial conditions which also have a resounding effect in the cultural system. Both environmental systems are constantly changing to maintain complementarity of elements within themselves and between themselves.

The ecological component of the environmental system has perhaps received the least consideration in the realm of Urban transportation planning. Possibly the fact that very few natural ecosystems survive in the advent of Urban growth and consequent improvement of the transportation system in time, can explain this negligence. Again the importance of the ecosystems to
man's environment as a necessity to his very survival has become to his awareness in very recent times and it is only now that the very complex relationships in the environment are being unravelled. Yet the importance of the understanding of man's activities on the ecosystem and the corresponding effects on those systems and the cultural system, cannot be over emphasized. Perhaps this importance cannot be very well realized in already built-up cities as much as in the creation of new towns where the ecosystem is undisturbed. However, even in existing cities, there are still wild spaces left in the form of parks or reserves; there are river and lake systems associated with these urban settings (Nairobi, Mombasa and Kisumu environs are good examples).

How does transportation planning and development interfere with the ecosystem? Highways do not only destroy natural environment, but can also do an excessive damage on the ecosystem. The traffic noise, fumes, vibration, and vehicle presence disrupt surrounding eco-communities, to the point of chasing them away. The presence of a highway creates a physical barrier which can easily exterminate communication to either side. Highway Pavements interfere with the drainage system of a region, which does not only affect the ecosystem in the neighborhood, but can also affect a Lake ecosystem through possible modification of the River system. Thus the aggregated effects
can be enormous. Since transportation development accompanies and in fact encourages urban sprawl (a characteristic of most urban set-ups—encroaching directly into the rural areas) due consideration should be given to balance the ecological and cultural components while planning for society needs. The cultural component of the environmental system needs clarification for the purposes of this discussion. In this connection it would be useful to distinguish between a program's outputs and impacts, the latter being the subject under consideration. Outputs are those results of a project that are directly related to the functional nature of program. Thus, transportation improvement project outputs are those changes in traffic flow—in all its various metrics: Speed, volume, travel time, trip distance, etc. - that result from the improvements.

Impacts on the other hand are defined as the by-products of the improvement process and the improvement itself. Transportation project impacts include economic, social, political, psychological aesthetics—these being the subsets of the cultural component and ecological, which has already been introduced. Impacts are definitely a form of project results, but they have only come to be included in program evaluation in recent times. This is for several reasons. First, some impacts must be called unintended, since they have not been expected and are sometimes distinctly negative. There has been a
reluctance to admit to their existence. Second, even the beneficial impacts have been difficult to predict with any degree of certainty. Therefore, program evaluation has focused almost entirely on project outputs for a long time.

Obviously, both outputs and impacts must be considered together in any transportation planning exercise. The direct outputs (commonly referred to as the 'primary' impacts) of transportation system improvement are well defined and relatively easy to predict in contrast to transportation impacts. For the purposes of this paper, the focus will be solely on transportation impacts. This means that the paper deals primarily with what are commonly called non-user costs and benefits as opposed to use costs and benefits, since the latter stem directly from the project outputs. In some instances, the user and non-user is, in fact, the same person in two different roles. This person may face a conflict in his desires with respect to each role that is difficult to resolve. Despite this conflict, he does have trade-offs or a balancing of positive and negative impacts. In other instances, notably the construction and operation of expressways within the central cores of metropolitan regions, the roles of user and non-user are embodied in different persons in such a way that those who benefit from the transportation improvement are often not the individuals who suffer from it.

This paper treats the issue of the incidence of benefits and
costs but cannot address itself to the questions of whether or not this incidence is equitable, how to compensate those who bear the costs of construction and operational impacts who should be compensated for what and by whom and whether or not the net result to society is positive. Such issues are ultimately left to the decision-makers and in any case they are tied to a particular community in space and time.

2.1 COMMUNITY IMPACTS OF TRANSPORTATION SYSTEM IMPROVEMENT

As mentioned previously, the cultural component of the environment is more obvious and direct in urban situations than the ecological component. As a result, there is abundant literature dealing with the social impacts. The following text discusses the probable activity changes resulting from physical changes.

2.1.1. DEMOLITION OF HOUSING AND BUSINESS SPACE

1. New location effects.

This includes capital cost of new space, changes in cost of production, costs of building up business demand and supplier relationships, inability to obtain zoning, licensing and permit approval as well as psychological reaction to new location and loss of old.

2. Loss of property by present owners.
3. Changes in level of quality and average costs in total stock remaining, hence changes in price/quality ration. This has a variety of effects on those displaced, those remaining in the neighborhood and community at large.

4. Overcrowding due to lack of supply, which might result in physical and health effects.

5. Reduction in tax base, with a result of reduced expenditures for Municipally-funded programs.

6. Contact between specific households and businesses will be reduced.

7. Possibly greater separation between employer and employee.

8. Location transfer costs such as personal costs involved in searching for a new location and expenses for moving equipment and supplies to new locations.


10. Changes in external costs and benefits of physical environment (health, crime, fire hazard, neighborhood contribution to property value). This might have changes in characteristics
of resident population as more (less) amenable environment
attracts more mobile families and consequent spread of
external effects and resulting property value changes.
A long run impact might be change in metropolitan demo-
graphic patterns.

2.1.2. DEMOLITION OF PUBLIC FACILITIES INCLUDING SCHOOLS,
PARKS, CHURCHES, HISTORIC AREAS OR MOVEMENTS

1) Increased accessibility costs to obtain certain
   services (e.g.) education, recreation, fire protection)
2) Loss of irreplacable facilities

2.1.3. CHANGES IN TRAFFIC FLOW SYSTEM

1) Ambient enviornment effects.
   (i) Noise
   (ii) Air pollution
   (iii) Aesthetics of physical design
   (iv) Vibration, etc.

2) Intra-neighborhood accessibility (increase probable)
3) Intra-metropolitan accessibility (increase probable)
4) Traffic hazards (increased or decreased)
5) Location transfer costs
6) New location effects
2.1.4 DISPLACEMENT OF BUSINESS

Disruption of established interaction patterns might result in reduction in income through loss of markets dependent upon accessibility.

2.1.5 DISPLACEMENT OF INDIVIDUALS AND FAMILIES

Disruption of established interaction patterns

1) Additional transportation costs to maintain previous contacts which would result in reduced frequency of contact.
2) Contacts between specific households will be reduced which results in reduction of social interaction.
3) Contact between specific households and business reduced.
4) Employees may pay more to commute to their jobs.
5) Contacts between households and public institutions may change.

2.2 A REVIEW OF ENVIRONMENTAL IMPACT METHODOLOGIES

In discussion of methods for environmental impact assessment it will be useful to distinguish between three types of methods that have been proposed. It is helpful to classify impact assessment methods into three analytic functions: identification, prediction and evaluation. The details of these three methods are given in the appendix at the end of this paper.
3.0 ENERGY CONSIDERATIONS

This section explores different transportation planning and management techniques currently under use in Nairobi in the light of scarce energy resources and particularly the rising cost of petroleum products.

3.1 BACKGROUND

The rising cost of petroleum products is having a very damaging effect on the Kenyan economy. In 1978, the foreign exchange bill for crude oil imports into Kenya was £K 70 million. By 1979, due to a series of price hikes by OPEC in (January 1st, July 1st, and November 1st) the bill rose to about 90 million pounds - an increase of nearly 30% in one year. Taking the most recent price rises of crude oil into consideration, it is likely that during the year 1980 we shall have to pay as much as £155 million. In other words, we will have to find an extra £65 million out of the Kenyan economy over and above our 1979 bill which in itself was £20 million higher than the cost in 1978.

The very size of this largely unavoidable price we have to pay for oil imports each year adds urgency to our efforts to take effective measures in energy conservation, in order to contain our fuel bill to manageable proportions.

Oil is the major source of conventional energy in Kenya. It
accounts for more than 80% of the total conventional energy consumption.

The table on this page gives the consumption pattern of the primary sources of commercial energy in percentages from 1973-1978. Most of the energy consumed is in the urban areas.

Primary sources of commercial energy consumption in Kenya from 1973-1978:

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<tbody>
<tr>
<td>Coal and Coke</td>
<td>3.2</td>
<td>2.9</td>
<td>2.0</td>
<td>2.5</td>
<td>2.3</td>
<td>1.7</td>
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<tr>
<td>Petroleum fuels</td>
<td>86.1</td>
<td>84.5</td>
<td>84.8</td>
<td>86.5</td>
<td>85.3</td>
<td>82.8</td>
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<tr>
<td>Hydro electricity</td>
<td>10.6</td>
<td>12.6</td>
<td>13.2</td>
<td>11.0</td>
<td>12.4</td>
<td>15.5</td>
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<tr>
<td>Total</td>
<td>100</td>
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From the above figures, it is quite clear that the major source of energy consumption is Kenya has been petroleum fuel. The critical question is to what extent can the heavy dependance on oil be retained.

The broad composition of consumption based on different marketing
companies of petroleum products in 1978 was as follows:

1. **Essential Services**
   - Hospitals, schools, hotels, Armed Forces,
   - Kenya Posts and Telecommunications,
   - Food Processing
   - %
   - 4

2. **Infrastructure**
   - Railways, sea and airports
   - Governments
   - East African Power & Lighting,
   - road construction,
   - road transport
   - %
   - 4
   - 48

3. **Agriculture**
   - %
   - 8

4. **Manufacturing Industry (Local)**
   - %
   - 11

5. **Manufacturing Industry (Export)**
   - %
   - 8

6. **Private automobiles (including Matatus*)**
   - %
   - 21

   **TOTAL**
   - %
   - 100

From the above, it is quite clear that transport facilities consume most of the available energy in the country, i.e. 69%. Any effort to conserve energy must therefore address itself to this sector. Out of the total energy consumed in the transport sector, 30% is consumed by private automobiles and matatus.
This paper attempts to focus its attention on the possible conservation measures the Government can take in urban areas as far as private automobiles and matatus are concerned. It is believed that by altering the working hours for different sectors, a further reduction in consumption of fuel is possible and at the same time, reduce traffic congestion in the streets. Conservation measures in commerce, industry and agriculture are considered at length in the recently established Inter-Ministerial Committee on Energy Conservation under the chairmanship of the Ministry of Energy. The membership consists of 10 government ministries that are directly connected in the implementation of the recommended measures. The measures mentioned below on consumption of fuel in the transport sector have been discussed at length and approved in the same committee.

3.2 STAGGERED WORKING HOURS AND INTRODUCTION OF 'SCHOOL BUS SERVICES' IN THE CITY

(a) Staggered Working Hours
The City of Nairobi has a population of 850,000 persons. Of this, total active labor force is estimated at 373,700 persons, or approximately 47%.

The present working hours were established before independence. and since then, there has been no change except in the private
sector where most of the offices are closed on Saturdays. Most of the offices start their working day at 8:15 a.m. and end at 4:30 or 5:00 p.m. with a lunch break of one hour and half hours from 12:30 p.m. to 2:00 p.m.

Since most of the offices, manufacturing establishments, construction industry, wholesale and retail trade open almost simultaneously and go for lunch break at the same time, there is a high degree of traffic congestion during the morning and the lunch break. (See figure 1 in the appendix.)

Most of these establishments open almost at the same time because most of the parents drop their children off at school, which opens at 8:00 a.m. During school vacations the traffic flow is quite uncongested. In view of this, it is believed that if the starting times for schools were different from the starting times for offices, substantial difference can be achieved.

To conserve fuel and improve traffic flow in the city, it is proposed that the working hours of the following categories be changed to as follows:

Starting hours for the primary and secondary schools should be changed from 8:00 to 7:30 a.m. For the public sector, which includes Central Government, Parastatal bodies, Nairobi City
Council and majority controlled by Public Sector, the working hours should begin from 8:15 a.m. The Private Sector, which includes agriculture, industry, mining, quarry, manufacturing, electricity and water, Community Social and Personnel Services should start the working day at 8:45 a.m.; and for the wholesale, retail trade, hotels and restaurants (Kiosks not included) financial institutions, banks, insurance, real estate and other business services should open at 9:15 a.m., correspondingly each of these institutions will have the same closing hour differences. In the public sector, it is also proposed that the five working days per week be introduced (from Monday to Friday) and the lunch hour to three quarters of an hour only. This measure will discourage the civil servants from traveling long distances for lunch. Detailed breakdown for each category mentioned above has been given in annex 2. In carrying out these breakdowns, the basic factor taken into account is the creation of minimum disruption as far as interrelationship of work is concerned. Due to the absence of reliable car ownership statistics of each sector is concerned, the actual impact on the road cannot be determined until such time when the scheme is operational.

To keep the town center lively during Saturdays, the owners of the restaurants, cafeterias, cinema halls and retail shops will be encouraged to keep their business open. However, in order not to congest the central area on Saturdays, several streets in
the centers will be closed to the private motor vehicles and only high occupancy vehicles be permitted.

3.3 INTRODUCTION OF SCHOOL BUS SERVICES FOR SECONDARY AND PRIMARY SCHOOLS

The government, in collaboration with the City Council of Nairobi, is presently carrying out a survey to determine the possibility of introducing a school bus service in the city. The survey among other things would indicate the travel patterns of secondary, primary and nursery school children, the distance traveled and the possible routes these buses should take, and the number of buses that would be required. In the same questionnaire, the parents have been requested to indicate whether they would be prepared to pay the bus fares to and from the school and drop their children at the collection points (to be decided at a later date based upon the response of the survey).

While the survey results are being awaited, Kenya Bus Service will be requested to carry out a comprehensive exercise of retraining their best drivers and test them before giving them the responsibility of driving children to school. It is also envisaged that each bus will have an auxiliary staff or a class teacher to take care of the children while they are enrouted.
3.4 OTHER CONSERVATION MEASURES

Other conservation measures the Government intends to take in the field of transport are as follows:

a) By establishing transport authority, it would recognize 'Matatus' operations and create high occupancy vehicle lanes in the Central Business District.

b) Encourage motor traders to import saloon cars and high occupancy vehicles propelled by diesel engines. It is proposed that this measure will be carried out by reducing import duty on diesel propelled engines.

c) Through appropriate legislation, reduce the speed limit to 90 k.p.h.

d) Encourage vehicle owners to keep their vehicles in an efficient running condition by abolishing duty and sales tax on essential functional spare parts.

e) An outright ban on importing vehicles propelled by high octane gas whose capacity exceeds 2.0 litre engine.

f) Abolish tax allowances on the use of large cars on company business.