

TRAFFIC IMPACT MITIGATION FOR NEW DEVELOPMENTS: A WAY TO REDUCE TRAFFIC CONGESTION IN MAJOR CITIES

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New developments are one of the major causes of traffic congestion in many of the major cities of developing countries, due to the absence of adequate mitigation measures. The purpose of this paper is to review the various measures that are being taken to mitigate the traffic impact of developments and to make suggestions for the wider and more effective implementation of these measures. The process of traffic impact mitigation in Bangkok is examined in detail, together with two case studies in Bangkok.

Mitigation measures can be divided into two categories: those related to land use and those related to transportation. It was found that measures related to land use were effective in reducing congestion in the area surrounding a development, while traffic-related measures were useful in alleviating site-specific impacts. Both must be implemented by city administrations, developers and traffic consultants, working cooperatively. The present study also shows that in the city centre of Bangkok the ineffective implementation of measures related to land is one of the major causes of traffic congestion. It is recommended that the Bangkok Metropolitan Administration (BMA) should develop more explicit policy tools for mitigating the traffic impact of new developments in Bangkok. Although the procedures used by BMA are not very effective, they can reduce the traffic impact to a certain degree, and similar procedures could therefore be adopted for the same purpose in other cities of the region where laws and regulations are not well formulated. For such action to be effective, it is necessary to incorporate all possible mitigation

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measures into the integrated land-use and transportation planning of the city. Although this has been recognized, and taken account of in the city planning policies of the major cities of many developing countries, as in Bangkok, it has not received sufficient attention. Also, many developing countries have been slow to establish a sound institutional mechanism to incorporate and implement zoning laws or land-use controls for systematic land-use planning. It is hoped that the present study can provide an insight into ways of developing more comprehensive and innovative measures to mitigate the traffic impact of new developments in the major cities of developing countries in the future.

INTRODUCTION

Traffic congestion is reaching intolerable levels in many metropolitan areas in both developed and developing countries. New building developments are considered one of the major causes of congestion-related problems in these cities, owing to inadequate mitigation measures. The purpose of this paper is to review the various measures that are being taken to mitigate the traffic impact of developments and to make suggestions for the wider and more effective implementation of these measures. The roles of the different parties involved in a traffic impact study of a development project are identified, and two case studies conducted in Bangkok are discussed. It is hoped that the present study can provide an insight into ways of developing more comprehensive and innovative measures to mitigate traffic impact of new developments in the major cities of developing countries in the future.

The study is divided into four sections. The first reviews the current traffic impact mitigation process. An analysis of all possible mitigation measures is made in the second, together with an examination of their effectiveness. The measures taken by the Bangkok Metropolitan Administration (BMA) to mitigate the traffic impact of new developments are described in detail in the third section, and two case studies are discussed. Conclusions are drawn in the fourth section, based on the review of the mitigation methods in practice, the theoretical concept of traffic impact mitigation, and the experience of and lessons learned from Bangkok.

I. REVIEW OF THE TRAFFIC IMPACT MITIGATION PROCESS

New developments generate new or additional traffic. Traffic impact mitigation is a process aimed at minimizing the impact of this new or additional traffic on the road system surrounding a new development. The process of traffic impact mitigation is carried out in two major phases: traffic impact assessment and the application of mitigation methodologies. The overall process is a cooperative effort by the developer, city administration and the traffic analyst or consultant.

A. Traffic impact assessment

The traffic impact assessment of a proposed development is undertaken by a traffic analyst who conducts an impact study. The impact study was made a requirement in urban areas in an attempt to control unplanned growth and unmanageable traffic loads. However, a traffic impact study is not required for all developments. A study may be necessary if a new development is expected to generate at least 100 new inbound or outbound trips during the peak period of the day along the peak direction of traffic. This corresponds to developments of substantial size. But in some cases, smaller developments that may create traffic hazards or which are located in traffic-congested areas may also necessitate a traffic impact study. Sometimes, the metropolitan authorities may request a traffic impact study for reasons relating to city planning policies.

The traffic impact study for a new development is undertaken to assess whether the road network surrounding the proposed development will be able to handle the additional traffic while still maintaining an acceptable level of service. The main functions of a traffic impact study are:

- (a) To determine the existing traffic conditions on the network surrounding the proposed development;
- (b) To estimate the traffic likely to be generated by the proposed development;
- (c) To assess the impact of additional traffic on the existing and future road network system;

- (d) To identify roadway improvements and changes in the site plan of the proposed development necessary to minimize traffic impact.

A traffic impact study generally contains the following elements:

- (a) A description of the proposed development and its access routes;
- (b) Details of existing and probable future traffic conditions;
- (c) An estimation of the traffic likely to be generated by the development as proposed;
- (d) Traffic impact and capacity analysis;
- (e) Recommendations on improvements to mitigate the impact;
- (f) An assessment of the degree of compliance with city regulations of the proposed development.

The traffic impact study may reveal many traffic-related deficiencies that need to be corrected. In some cases, the deficiencies may be so critical that the design of the project may need to be changed. An impact study may recommend many types of improvements such as additional traffic lanes, pedestrian walkways, making possible U-turns, changes in lighting, and so forth, to minimize the impact of the additional traffic caused by the proposed development.

B. Mitigation methods in practice

Measures for dealing with the traffic impact problem may differ in different situations; various mitigation methods are in use in many major cities. However, these different methodologies have many common elements. Most mitigation measures can be integrated into land-use and transportation system planning, provided proper coordination among state and city administration authorities takes place.

There are a number of technical solutions available, which are used at present to mitigate the traffic impact caused by new developments in urban areas. These include the drawing-up of a master plan, zoning ordinances, building regulations and by-laws, the issuing of permits, and charging impact fees. The common strategies are discussed below.

(a) *Land use growth control*

In many countries, the government controls the location of developments, often by some form of zoning regulations, in order to slow down or restrict development in urban areas.

(b) *Building regulations*

Building regulations are applied to regulate the intensity of land use by enforcing standards in building coverage and construction. Some of them are, however, concerned with fire protection and structural safety. These regulations also have an influence on reducing the traffic impact.

(c) *Impact fees*

Impact fees are the charges assessed against new developments to recover costs incurred by a city administration in providing the public facilities required to serve the new development. These fees are paid by the developer of the proposed development.

(d) *Negotiated agreements*

Developers lend assistance to transportation projects in the form of rights-of-way, technical assistance, financing and monetary contributions.

(e) *Impact exactions*

These are charges (land and/or fees) imposed on developers for improvements of the new development as conditions of regulatory approval by the authority.

The strategy of land use regulation (a) is applied to control the types and densities of development while the strategy regarding building control regulations (b) is useful to control the intensity of development and to ensure adherence to building standards. Strategies (c), (d) and (e) represent complementary funding sources for additional roadway facilities and other improvements needed to accommodate the traffic generated by new developments.

C. Responsible parties in the traffic impact mitigation process

There are three main parties involved in the implementation of traffic impact mitigation measures for a new development: the developer, the city administration and the traffic analyst or consultant. The roles of each of these parties vary from locality to locality. Each city administration must deal with traffic impact mitigation measures according to its particular circumstances.

For the efficient implementation of mitigation measures, it is necessary to define clearly the roles and responsibilities of each of these three parties. In general, the state and city authorities responsible are reluctant to bear the expenses of additional infrastructure improvements to facilitate the traffic generated by new developments. Thus, in many cities, impact fees for developments have been established to fund such improvements. In some cases, schemes for the shared funding of network improvements by the public and private sectors have been introduced.

However, in the process of negotiation, both the developer and the city administration or municipality try to reduce their share of the contribution for the improvements. It is therefore the responsibility of the analyst to provide comprehensive and accurate information to work out the fair share of each party. The developers must be willing to contribute in an equitable way to the planning and funding of the transportation improvements required to serve the new traffic generated by developments such as shopping centres, and housing estates.

II. ANALYSIS OF MITIGATION MEASURES

A. Identification of mitigation measures

Transportation and land use are interrelated. In essence, while land use generates traffic, the existence of transport facilities makes some locations more attractive than others for urban development and thus influences land-use development. Therefore, it is recognized that new developments tend to change traffic behaviour as well as land-use patterns. Hence, whatever measure is taken to mitigate traffic impact should address both of these changes.

Mitigation measures can be categorized into two broad groups, land use-related and transportation-related. Again, measures related to land use can be divided into two subgroups namely, land-use planning measures and land-use growth management measures. Similarly, transportation measures can be divided into two subgroups; namely, traffic-related measures and pricing/financial measures. Table 1 shows the classification of the different mitigation methods according to these groupings.

Table 1. Traffic impact mitigation methods for new developments

<i>Land-use measures</i>		<i>Transportation measures</i>	
<i>Land-use planning</i>	<i>Land-use growth management</i>	<i>Traffic-related measures</i>	<i>Pricing/financial measures</i>
<ol style="list-style-type: none"> 1. Land-use and transportation coordination 2. Regional and local plans 3. Land-use policy planning 4. Development of analytical tools 	<ol style="list-style-type: none"> 1. Zoning regulations 2. Performance zoning 3. Phased development policy 4. Areas of critical planning 	<ol style="list-style-type: none"> 1. Improvements within the site: access improvements, internal circulation, parking facilities, demand management, provision of adequate parking arrangements, etc. 2. Road network capacity improvements: intersection, arterial road, and expressway interchange improvements, etc. 	<ol style="list-style-type: none"> 1. Impact fees 2. Negotiated development agreements 3. Impact exactions 4. Shared funds 5. Private sector contributions

Measures related to land use are effective at the site selection stage of a development. In other words, the developer should follow the city policy and regulations on land-use management established by the government and city administration in selecting the site for the development. Once a site has been selected, the traffic impact of the development is assessed by conducting a traffic impact study. Based on the findings of the study, transportation measures are recommended to mitigate the traffic impact on the surrounding network. Primarily, these improvements are related to the traffic flow within the site, and may include access locations, internal circulation, parking facilities, and so forth. Pricing measures may also be recommended as a source of funding for additional infrastructure facilities and other improvements that are required on the road network to handle the traffic generated by new developments.

1. Land-use measures

(a) Land-use planning measures

Land-use planning is a very useful tool to guide the development of a city and to attain the desired land-use pattern. The most commonly used planning tools include master plans, strategic/structure plans and local area plans. These plans should be formulated by adopting integrated land-use and transportation planning strategies to address transportation-related issues. Though this is not a new concept, owing to a lack of resources it has not always received sufficient attention. The following are some of the land-use planning measures which are in current use in many countries:

- (i) Land-use and transportation coordination;
- (ii) Regional and local plans;
- (iii) Land-use policy planning;
- (iv) Development of analytical tools.

(b) Land-use growth management measures

Land-use growth management measures are intended to control the density of development so that trip generation by different land uses remains within the capacity limits of the existing infrastructure. These measures limit the growth of traffic congestion through controlling the land use by imposing traffic-related conditions for real estate

development. The land-use growth management techniques are particularly important for developing strategies to deal with traffic congestion in urban areas where new developments are likely to take place. These techniques are not aimed at halting new developments, but rather to ensure their location in areas where the impact will not be critical. However, their implementation is often influenced by vested interests.

The following are the most commonly used techniques for land-use growth management in many cities of developed, as well as some developing, countries.

(i) *Land-use zoning regulations*

Zoning regulates the use of land by defining the purposes for which the land can be used and what can be built on that land. Some zoning ordinances apply “bulk” control over land and buildings with the aim of controlling the density of population and the generation of traffic. Zoning regulations are usually passed by local authorities, although in some countries provincial or central governments retain the power to approve zoning regulations;

(ii) *Performance zoning laws*

Performance zoning augments traditional zoning laws by establishing incentives for local developers when they buy land in low density areas, as opposed to restricting land use by traditional density and usage-control measures;

(iii) *Phased development*

This regulates the timing of and geographical distribution of development by tying it to existing municipal infrastructure and services. Each project can be ranked based on its proximity to other facilities such as public transportation, retail services and utilities. The permission for development is granted based on the ranking of the projects, with an annual limit on commercial development permits;

(iv) *Areas of critical planning*

This is an attempt to protect mainly coastal areas and other unsafe land. Critical area programmes are comprehensive, combining many different techniques to determine the impact of a prospective development. The goal of critical area planning is to strike a balance between development pressure and resource conservation.

2. Transportation measures

(a) *Traffic-related measures*

(i) *Improvements within the site*

The main improvement measures that can facilitate the smooth flow of traffic within a project site are discussed below.

a. *Access improvements*

These improvements facilitate the traffic flow entering or leaving a site. Potential improvements may include the widening of entrance and exit points, and providing bays (exclusive lanes) for turning movements. Queues should not impede either internal circulation or out-of-site movements. Exit and entrance lanes should have sufficient storage capacity to ensure that the performance and safety of operations are not compromised.

b. *Internal circulation improvements*

These measures facilitate the traffic flow within the site. Proper pavement markings must be made and signs put in place to ensure the safety of operations. The radii of curves should be sufficient to accommodate the turning of large vehicles, while bridges and other landscaping elements should be able to withstand the stress from heavy vehicles. Loading and unloading ramps should also be carefully designed: they should be practical, spacious and, if possible, concealed from public view, to enhance aesthetics.

c. Demand management methods

Demand management measures are applied to reduce the number of vehicles using the road network to go to the site and using its internal network and parking space. Cooperation with the transit authority for the rerouting of buses to pass by the site, and programmes for matching commuters, as well as incentives for ride sharing (for example, bonuses, free parking, special permission to park closer to the entrance, and so forth), have good potential for reducing the number of on-site vehicles.

d. Adequate parking arrangements

These can reduce conflict points within the site and also reduce the accumulation of vehicles at access points. The provision of adequate signs is valuable in managing vehicles in the parking area. Parking layouts should allow sufficient space for the manoeuvring of heavy vehicles, and vertical clearances should be sufficient for over-sized vehicles.

(ii) *Road network capacity improvements*

Various measures for improving the capacity of an existing road network can be adopted. The major ones are discussed here.

a. Intersection improvements

Intersection operation may be improved by redesigning signal phasing, cycle length, coordination of timings, and so forth. In some cases the intersection geometry could be changed by including additional lanes, widening, shifting central reservation, and so forth. When the addition of lanes is not feasible, an underpass or overpass could be constructed to reduce the traffic at the intersection close to the development. Also, the installation of traffic signals at intersections not previously provided with them may be required to handle the additional traffic generated by the site.

b. Arterial road improvements

These include the provision of pedestrian crossings, making U-turns possible, providing walkways and other supplementary facilities. In addition, arterial roads would have to be equipped with proper traffic signs and lane markings to guide drivers.

c. Expressway interchange improvements

If the site is close to an expressway facility, new access ramps may be introduced or existing ramps improved, together with proper channelization in the merging and weaving areas.

(b) *Pricing/financial measures*

Roadway infrastructure improvements are costly and therefore many municipalities and city administrations are not in a position to fund infrastructure improvements to facilitate the traffic generated by new developments. Thus, in many cities, pricing/financial measures have been introduced to levy charges to cover the costs of such improvements. Some of the pricing/financial measures in use are described below:

(i) *Impact fees*

These are charges paid by developers to cover the additional cost of capital improvements required by new developments. In many cities this is a prerequisite for obtaining a permit for a new development;

(ii) *Negotiated development agreements*

Cooperative agreements for infrastructure provision have been made between developers and local authorities or communities. In contrast to impact fees, negotiated agreements are made on a case-by-case basis, giving the developer and the city authority an opportunity to determine the acceptable level of cost-sharing for the required physical improvement measures. This approach is increasing in popularity, as it provides an alternative to the more traditional regulatory approach of zoning laws;

(iii) *Impact exactions*

Impact exactions are charges (land and/or fees) imposed on developers for public improvements made necessary by new developments as a condition for regulatory approval of the development. They can be in the form of obliging the developer to purchase the land required for improvements, or to bear the cost of construction for necessary improvements. Authorities may also require developers to install, at their own expense, improvements such as pedestrian crossings, streets, transit/bus stops, pavements, kerbs and gutters, and other physical elements;

(iv) *Shared fundings*

Network improvements are funded through schemes of shared funding from public and private sector contributions;

(v) *Private sector contributions*

In some cases, voluntary donations or contributions to improve the road network system are made by the private sector.

B. Evaluation of mitigation measures

The mitigation measures described in the previous section are regarded as a set of actions that may be employed to achieve some or all of the following policy objectives:

1. Reduction of congestion;
2. Reduction of points of conflict at access points;
3. Achievement of a smooth flow of traffic within the site;
4. Control of unmanageable traffic loads;
5. Improvement in the level of service of the road network;
6. Improvement of road safety;
7. Reduction of environmental degradation;
8. Improvement of quality of life for residents, pedestrians and visitors.

Although there are other areas of concern, these eight objectives are the major ones. The effectiveness of the policy instruments discussed in the previous section are now examined against each of these policy objectives. The evaluation outcomes are tabulated in table 2. The results

are based on the general understanding of each concept and therefore the findings are illustrative rather than definitive.

It was found that the measures related to land use are useful in achieving objectives such as congestion reduction, control of environmental degradation and for achieving better quality of life. On the other hand, transportation related measures were more effective in improving conditions at the project site and in the surrounding areas, and in reducing the traffic impact. It was observed that the role of land use measures in relieving congestion and in revitalizing urban areas is very important. Since transportation measures can solve only a part of the problem, it is vital that city authorities consider land-use measures during the process of policy planning.

A review of the literature reveals that recently in many cities, rather than relying on traditional transportation measures, land-use management measures have been seriously considered to reduce congestion. Wachs (1990) describes the experience of Southern California in regulating traffic by controlling land use. He mentions that in Los Angeles the emphasis in transportation planning shifted from facility construction to transportation system management, and land-use was controlled with a view to slowing down the growth of traffic congestion. Two major policy instruments, direct land-use regulation and impact exaction, were also under consideration to reduce the traffic congestion caused by new developments rather than relying on improvements to highways and transit facilities.

The importance of a regional perspective is stressed by Meyer (1990) in the context of traffic congestion in the state of Massachusetts, United States of America. He observes that many of the transportation and land-use measures were focused on a specific site or at most a part of the metropolitan area. He argues that congestion in many cases was an area-wide phenomenon that required consideration from a regional perspective. A ten-point congestion relief programme was developed for eastern Massachusetts. The actions included in this programme were aimed at reducing the existing level of congestion and avoiding future congestion through land-use management. He highlights the vital role of land-use management in regulating the location, geographic pattern, density, quality and rate of growth of development.

Table 2. Evaluation of traffic impact mitigation methods: relationship between policy instruments and policy objectives

<i>Policy instruments</i>	<i>Policy objectives</i>							
	<i>Reduction of congestion</i>	<i>Reduction of points of conflict at access point</i>	<i>Achievement of a smooth flow of traffic</i>	<i>Control of unmanageable traffic loads</i>	<i>Improvement in the level of service of the road network</i>	<i>Improvement of road safety</i>	<i>Reduction of environmental degradation</i>	<i>Improvement of quality of life</i>
Land-use measures								
Land-use Planning	A	C	C	B	B	B	A	A
Land-use growth management	A	C	C	B	B	B	A	A
Transportation measures								
Traffic-related								
1. Improvements within the site	C	B	A	A	C	C	C	C
2. Road network capacity improvements	B	B	B	B	A	A	C	C
Pricing/financial	C	A	B	B	A	C	B	C

Note: A: very strong positive relationship B: strong positive relationship C: weak positive relationship

III. TRAFFIC IMPACT MITIGATION PROCESS IN BANGKOK

A. Land-use measures

1. Land-use planning and regulation in Thailand

The process of development planning in Thailand is directed towards the formulation and implementation of five-year national development plans. The national socio-economic development plans for the country are prepared by the National Economic and Social Development Board. The main urban land-use policies in the Seventh National Economic and Social Development Plan for the period 1992 to 1996 were concerned with: land-use planning and its administration; the revision of laws and regulations; the formulation of appropriate general and specific plans for target development areas; a spatial development framework and basic infrastructure; the conservation and preservation of historical sites; the defining of industrial zones; and environmental protection (Mekvichai 1998).

The Eighth National Economic and Social Development Plan for the period 1997 to 2001 is currently being implemented. There has been no fundamental change from the previous plan. The policies in this plan include the following areas related to urban land-use planning: the development of the Bangkok Metropolitan Region; traffic problems in the Bangkok Metropolitan Area (BMA); guidelines for efficient land-use planning; environmental problems and environmental conservation; the designation of cultural preservation areas and green belt areas; and the coordination of the public and private sectors in organizing and managing urban planning (Association of Southeast Asian Nations (ASEAN), Association for Planning and Housing (AAPH) 1999).

The rapid growth of Thailand's urban settlements has led to uncontrolled urban sprawl and contributed to many environmental, social and economic problems. The Government realized the need to regulate land-use and the quality of development. The regulatory tasks can be categorized into three groups:

(a) *Land-use planning*

The Department of Town and Country Planning (DTCP) under the Ministry of the Interior and Local Government is responsible for urban and community land-use planning. This is carried out through the offices of the mayors in the cities, the presidents of sanitary district councils, and provincial governors for all other areas;

(b) *Building construction and use controls*

The Department of Public Works and Local Government approves and oversees building construction and use;

(c) *Land subdivision controls*

The Department of Land is the sole authority responsible for approving and overseeing land subdivisions for housing, commercial areas, and industrial projects (Mekvichai 1998).

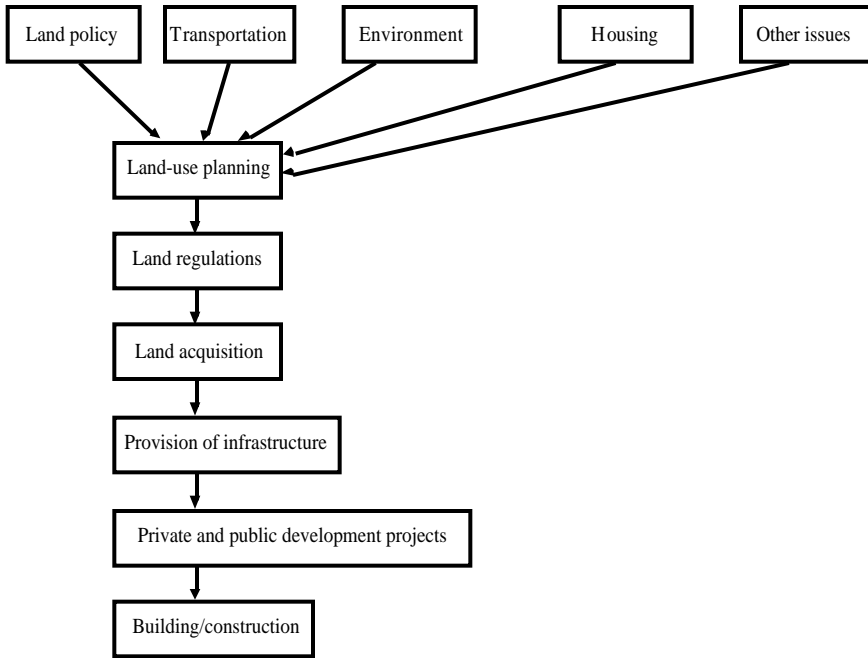
For useful and effective land-use planning, all land development projects by the public and private sectors at all levels are supposed to follow the framework illustrated in figure 1. However, the various agencies involved in urban land development and related works carry out their works within their own areas of responsibility. Coordination among these agencies is weak, in particular with respect to project implementation. Figure 2 describes the actual process of land development in Thailand.

Thailand has a number of Acts related to land development and control. These are briefly describe in the following sections.

(a) *Town and Country Planning Act of 1975*

The Town and Country Planning Act of 1975 repealed the earlier City and Town Planning Act of 1952. This Act deals with the following main aspects: the city and local city planning committee; the survey for the comprehensive city plan and the project plan; the formulation and preparation of the comprehensive plan; the enforcement of the comprehensive plan; the enforcement of the project plan; and modifications to buildings.

The planning procedures established under the Town and Country Planning Act of 1975 were amended in 1992 to include a democratic



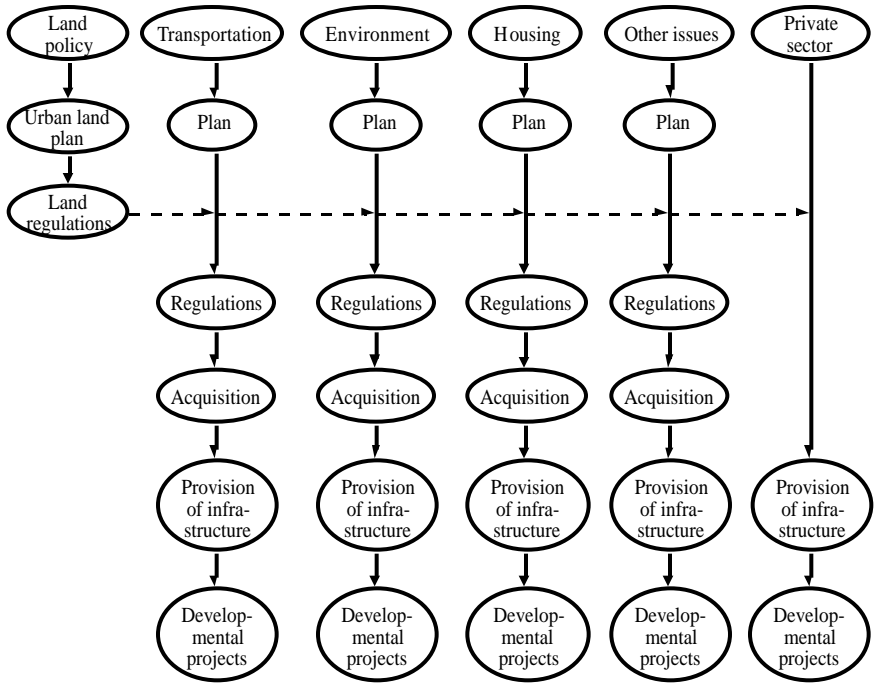
Source: B. Mekvichai, "A review of urban land management in Thailand", in J.H. Ansari and N.V. Einsiedel, eds., *Urban Land Management: Improving Policies and Practices in Developing Countries of Asia* (United Nations Centre for Human Settlements, Nairobi, 1998).

Figure 1. Formal procedure of land development through land-use planning in Thailand

process involving the participation of local residents. Under this Act, the plans are prepared by officials of DTCP with the assistance of concerned local government officials. DTCP has greater responsibility in formulating the plans, but has no control over their implementation. Local authorities have sole responsibility for plan implementation.

(b) *Land Development Act of 1992*

The stipulations of the Land Development Act of 1992 were set by the Land Development Control Board, in accordance with the provisions of Announcement No. 286 of the Revolutionary Council of 24 November 1972. This Act provides the necessary specifications in the following areas: the criteria for making land development diagrams,



Source: B. Mekvichai, "A review of urban land management in Thailand", in J.H. Ansari and N.V. Einsiedel, eds., *Urban Land Management: Improving Policies and Practices in Developing Countries of Asia* (United Nations Centre for Human Settlements, Nairobi, 1998).

Figure 2. Actual procedure of land development in Thailand

projects and methods; the size and area of development land; systems and standards of roads and footpaths; the size of buildings including commercial buildings; road, pavement, access/exit road and footpath standards and dimensions; the size of areas to be left undeveloped in front of buildings; recreational areas in the development; the distances from roads to buildings; the improvements in main roads required; water discharge systems and waste water treatment systems; electrical systems, waterworks systems, telephone systems; standards for infrastructure and public services; and traffic signs and markings.

(c) *Building Control Act of 1992*

This Act replaced the provisions of the Building Control Act of 1979. The Building Control Act of 1992 is concerned with building regulations and the procedures for obtaining a building permit. The specific aspects covered are: building permit application procedures; distances from buildings to other buildings, lands, roads and footpaths; the procedures for the construction of, modifications to, the demolition of, the moving or transfer of any type of building; the appeals Consideration Committee in the Bangkok Metropolitan Area and in the provinces; and penalties and fines.

Further to the provisions contained in this Act, Ministerial Regulation No. 39, issued in 1994, explains the requirements on types of, and procedures for installation of, fire prevention systems, the design of interior elements, and lighting and ventilation systems. Ministerial Regulation No. 41, issued in 1995, provides specifications on parking areas and parking unit dimensions in buildings.

(d) *Enhancement and Conservation of National Environmental Quality Act of 1992*

This Act was passed following the review of the Improvement and Conservation of National Environmental Quality Act of 1975 and its 1978 amendment. The Act provides guidelines on the following areas: the environmental fund; environmental standards; environmental quality management planning; environmental conservation and protection areas; the preparation of reports on environmental impact assessment; and the control of pollutants.

2. Land-use measures in Bangkok

Land-use plans are made to improve the environment for the community, to build a city where the quality of life of its residents is satisfactory, and to provide good living conditions for them, including adequate housing, public spaces and other facilities. With these objectives in view, BMA has prepared its fifth development plan for the period 1997-2001, with the goal of making Bangkok a “pleasant city to live in”. The fifth BMA development plan is based on the following: the Eighth National Economic and Social Development Plan (1997-2001); the Sixth Ministry of Interior Plan (1997-2001); the report on the evaluation of the fourth BMA development plan (1992-1996);

suggestions and recommendations from agencies under the supervision of the BMA; and public needs and public opinion.

The Fifth Plan has the following major components: a plan for urban system and land-use development; a plan for traffic and transportation system development; and a plan for an environmental management system.

Although the plan for Bangkok incorporates the zoning of allowable types of land use, enforcement is inconsistent. Planning tools did not appear to be effective in the areas of control, and limitation of the scale or location of development projects, and consequently failed to limit the traffic and environmental impacts of new development projects. The failure to control development has led to the uncontrolled growth of commercial developments in the city centre. As a result, these developments have caused additional traffic loads on the already saturated traffic system, with a further deterioration in the traffic congestion situation in these areas.

B. Transportation measures

1. Traffic-related measures

A report on the traffic impact study undertaken has to be submitted to BMA in connection with the approval of new commercial developments that are expected to cause traffic-related problems. The levels of generated traffic and the size and type of developments that require a traffic impact study are not however, clearly specified. Nor are guidelines given for the preparation of these reports. The traffic impact study is initiated by the Building Control Division under the Department of Public Works of BMA.

All buildings, including commercial developments, have to follow all relevant specifications given in the building and other relevant codes, established by the Building Control Division (BCD) of BMA, in their planning and design procedures. These codes were prepared in accordance with the Building Control Act of 1979, the Town and Country planning Act of 1975, and with reference to the Land Development Act of 1992. The project plans, design details and drawings prepared in accordance with the given specifications are submitted to BMA with the request for permission to proceed with construction. Developments

designed with more than 300 parking units in their parking areas are then forwarded to the Traffic Engineering Division (TED) under the Department of Traffic and Transportation of BMA for the assessment of the traffic impact and the access capacity of the proposed development. Such developments are required to conduct a detailed traffic impact study.

The required traffic impact study is normally conducted by a traffic consultant/analyst on behalf of the developer. According to the recommendations made by the traffic analyst/consultant, the TED of BMA assists the developer in selecting the appropriate infrastructure improvements needed for the road network to carry the additional traffic generated by the development. BMA emphasizes the following mitigation measures for developments along major roads:

- (a) Number of access points limited to two along major roads to reduce conflict points;
- (b) Pedestrian walkways;
- (c) U-turn facilities for in-and-out traffic;
- (d) Channelization measures for traffic along main roads;
- (e) Areas for taxi drop-off and pick-up;
- (f) Sufficient pavement areas for pedestrian use;
- (g) Slip lanes and short lanes for in-and-out traffic.

Apart from these, TED can also instruct the developer to adjust the size of access roads, levels, slopes, turning points, parking, U-turn areas and any other elements that may facilitate traffic flow, stability, security, aesthetics, discipline or urban planning. When TED comes to an agreement with the developer on the improvements required to mitigate the traffic impact of the development, it reports back to BCD to proceed with the required approval procedures. This process of traffic impact mitigation for new developments is shown in figure 3. Since there are no established BMA rules for traffic impact mitigation, factors such as the influence of the developer, social factors, and political factors can affect this assessment process directly or indirectly. Nevertheless, in the absence of any guidelines or regulations BMA tries to implement mitigation measures by negotiation with developers.

Detailed traffic impact studies are generally required for the following types of new development in Bangkok:

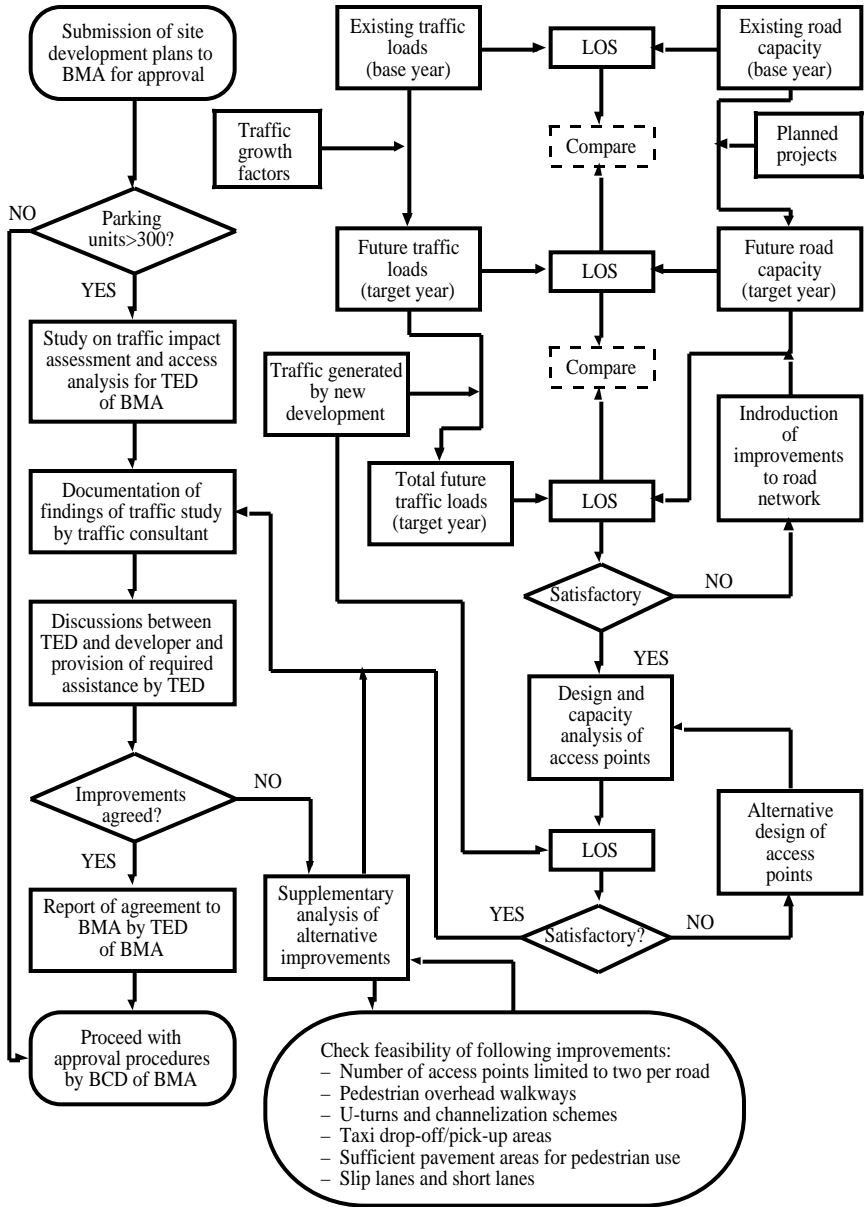


Figure 3. Process of traffic impact mitigation for new developments in Bangkok

- (a) All public transportation projects;
- (b) All developments located in traffic-sensitive areas and historically important areas;
- (c) All developments located close to critical junctions, intersections and interchanges;
- (d) High-rise buildings which are expected to generate considerable traffic.

2. Pricing/financial measures

The city planning policy of BMA does not incorporate any pricing/financial measures to be imposed on developers. However, BMA requests developers to bear the total cost of the agreed infrastructure improvements to support the additional traffic generated by new developments. This arrangement is somewhere between a negotiated agreement and an impact exaction, but cannot be classified as either. Once BMA and a developer come to an agreement about cost sharing, the permit for the proposed development is issued under the agreed conditions.

C. Case studies in Bangkok

1. Outline of case studies

A brief outline of two case studies conducted in Bangkok are given below, together with their recommended traffic impact mitigation measures.

(a) The case study 1 – shopping centre A

Proposed shopping centre A is to be located within the BMA area. The project site is a triangular plot in a critical location, with a highway, a railway line and a residential area as boundaries. The highway in front of the site has a flyover above the railway crossing together with an at-grade U-turn. The development was designed with a single access point, which was very narrow as land space was limited at that point.

An impact area around the development, including all critical road sections and intersections, was selected for traffic impact assessment. This selection was primarily based on the level of service

(LOS) of the road network system. Thus, an impact area with road sections with low LOS reflected by higher traffic loads, and intersections with long delays and queues were selected.

A traffic impact study was conducted in compliance with the requirement of the policy of BMA for the approval of new developments. Traffic impact analysis indicated that traffic growth due to the development in the target year (4 years from the base year) would be around 3 per cent. The acceptable limit of traffic growth due to the development was assumed to be 5 per cent of the total traffic forecast for the road network in the target year. It was expected that the forecast additional traffic due to the development could be supported by the increased capacity of the road network resulting from the implementation of committed highway projects.

It was thus concluded that shopping centre A would not have any serious adverse impact on the road network.

However, the following improvements were recommended in the traffic impact study for the management of traffic at the access point to the shopping centre with proper turning facilities, in order to reduce conflicts and allow the smooth flow of traffic along the major highway in front of the shopping centre:

- (i) Improvements within the site:
 - a. Access improvement with a 40 m slip lane for incoming traffic;
 - b. An additional lane for outgoing traffic with a merging length of 50 m;
 - c. Internal circulation arrangements and a parking area.
- (ii) Road network capacity improvements:
 - d. An additional lane for a planned U-turn facility and related other improvements;
 - e. Channelization schemes for the U-turn facility.

The developer was requested by BMA to acquire land from the State Railway Authority and the other private owners for improvements (a) and (b). Also, the construction costs of improvement (d) had to be

borne by the developer. After a number of meetings between the developer and BMA, it was decided that BMA would grant approval on condition that the developer should buy the land required for the above improvements and bear the related construction costs of infrastructure improvements.

(b) Case study 2 – convention centre B

Proposed convention centre B is also located within the BMA area, but away from the central business district. At present, the road network adjacent to the project area is composed of minor feeder roads. However, there are a number of committed projects in the project area which are at the planning stage. Among them are a highway project and an expressway project planned along one side of the proposed convention centre.

There are four access points designed for the development: one is to the east and a second to the west of the proposed highway; the two others are connected to minor roads. The location planned for a ramp to the new expressway project was very close to the west entrance, which could cause conflicts in the future.

Traffic impact analysis indicated that convention centre B would not have an adverse impact on the traffic flow along the highway network. The growth of traffic along the proposed highway due to the development was estimated to be within the acceptable levels. It was believed that the implementation of future highway projects would enable the additional traffic generated by the convention centre to be accommodated by the system.

Considering the site location, the availability of space and the major corridor traffic and capacity, the following two types of facility improvements were recommended to improve future traffic conditions on the proposed highway. These improvements were also considered to be generally beneficial.

- (i) Improvements within the site:
 - a. Access improvement with a 3 m wide and 30 m long slip lane for incoming traffic;
 - b. An additional slip lane of 30 m length and 3 m width for outgoing traffic;

- c. Internal circulation arrangements and a parking area.
- (ii) Road network capacity improvements:
 - d. Improvement of adjacent intersections;
 - e. Channelization schemes for the U-turn facility.

It was agreed that the additional costs of these infrastructure facilities were to be borne by the developer. A number of meetings took place between BMA, the developer, the traffic consultant and officials from the Expressway and Transit Authority of Thailand (ETA), at which the location of the ramp and the improvement measures required to reduce conflict at access points to the development were discussed. Finally, ETA agreed to relocate the ramp further away from the development in order to reduce conflicts at the access points and at the ramp entrance.

2. Analysis of case studies: evaluation and suggestions

The above case studies were analysed using the method of evaluation of policy instruments and policy objectives described in Section 3, and the results are summarized below.

(a) Analysis of case study 1

- (i) Since the location of proposed shopping centre A was critical, the impact on the adjacent road network was likely to be significant. If land-use measures had been being enforced a location such as this, for this type of development, would have been an unlikely choice. This case clearly illustrates the need for coordination between land-use and transportation planning. Due to the lack of strict regulations, financially viable developers can choose any location in Bangkok for their developments. These are consequently springing up all over the city and have become one of the major causes of severe traffic congestion both there and in the adjacent urban areas. If proper land-use planning had been used, such a situation could have been avoided.

- (ii) The access point to the site was very narrow as planned, which would have caused incoming traffic congestion, spreading back to the road network. Improvements within the site, together with an additional lane for U-turns, could help to relieve the queuing. A thorough understanding between BMA and the developer is crucial to the proper planning of the negotiated improvements.
- (iii) An additional lane would help in the smooth merging of outgoing traffic with external traffic. However, the acquisition of the land required for this from private owners could be costly and time-consuming, if indeed private owners could be persuaded to sell. If BMA had had strict written regulations on new developments, the developer may never have purchased the site for this kind of development.

(b) *Analysis of case study 2*

- (i) In the case of convention centre B, one of the access points to the development was designed in such a way that it was too close to the planned ramp to the new expressway. Negotiations with ETA resulted in the location planned for the ramp being changed, rather than the access point to the development. This illustrates the willingness of the authorities to change the designs of major road projects, rather than force developers to alter their plans by implementing strict laws on developments.
- (ii) Since the proposed convention centre was to be located away from the central business district, it was likely to attract extra traffic to the planned expressway and generate revenue for ETA by way of toll charges. Due to the unique characteristics of this development, it was expected that traffic would be attracted from all over the metropolitan area and congestion was not anticipated in any one area, nor at specific access points to the development. The measures proposed for easing pressure at access points were therefore believed to be sufficient to counteract the adverse impact of the development on the proposed highway.

3. Summary of analysis of case studies

Table 3 summarizes the mitigation measures proposed in the above case studies. It is clear that due to the lack of land-use measures the following problems are likely to arise in the project area and surrounding areas:

Table 3. Summary of traffic impact mitigation measures proposed in case studies

		<i>Case study</i>	
		<i>Shopping centre A</i>	<i>Convention centre B</i>
Land-use measures	Land-use planning measures	–	–
	Land-use growth management measures	–	–
Transportation measures	Traffic-related measures	1. Improvements within the site: (a) access improvements; (b) internal circulation arrangements; (c) parking facilities. 2. Road network capacity improvements: (a) additional lane for U-turns; (b) addition of short lanes; (c) channelization schemes for U-turn facility.	1. Improvements within the site: (a) access improvements; (b) internal circulation arrangements; (c) parking facilities. 2. Road network capacity improvements: (a) intersection improvements; (b) U-turns to proposed highway; (c) channelization schemes for U-turn facility.
	Pricing/financial measures	1. Impact exactions 2. Acquisition of required land 3. Bearing of costs of improvements	1. Impact exactions 2. Acquisition of required land 3. Bearing of costs of improvements

- (a) Problems of traffic congestion;
- (b) An unsatisfactory level of service provided by the road network;
- (c) Environmental problems; and

- (d) Adverse effects on the quality of life of the local community.

These problems will definitely aggravate the present situation in BMA further. It has been estimated that in 1995 traffic congestion in Bangkok led to the loss of 91,461 billion baht (Tangpaisankit 1998), despite investment by the Government of 1 billion baht in the construction of expressways and main roads during the period of the seventh National Economic and Social Development Plan (1992-1996). It is clear that in focusing on the supply side alone, the problem of the uncontrolled growth of developments has been overlooked. The importance of land-use measures has been ignored in master plans and regional plans, yet in a major city such as Bangkok, transportation measures alone can provide only short-term solutions. Sustainable improvements can only be achieved through long-term land-use planning.

IV. CONCLUSIONS AND RECOMMENDATIONS

This study has shown that land-use measures are effective in reducing congestion in the area surrounding a development, while traffic-related measures are useful for alleviating site-specific impacts. In other words, land-use measures are important for relieving congestion, and they serve to revitalize urban areas, whereas transportation measures can only partially solve the problem. It is essential to incorporate land-use measures in the process of traffic impact mitigation for new developments in major cities. It was noted that for impact mitigation to be effective, land-use measures should be used at the start of the mitigation process, while transportation measures should be introduced at a later stage, when the site plans are finalized. Both types of measure need to be implemented, as they are complementary.

This study has also shown that ineffective implementation of land-use measures is one of the major causes of traffic congestion in the city centre of Bangkok. The uncontrolled growth of commercial developments negatively affects the quality of city life and aggravates environmental and safety problems. In Bangkok attention has always focused on the supply of roads and road infrastructure and the management of demand to alleviate the traffic congestion problem. It is important to understand that new developments are major contributors to the traffic congestion problem. BMA needs to develop more explicit

policy tools to mitigate the traffic impact of new developments in Bangkok. This could be done by looking at the traffic levels of the road network system in the city area and identifying sensitive areas which require attention. Also, guidelines and specifications on the level of generated traffic and the size and type of developments that require a traffic impact study should be provided.

The procedures for the mitigation of the traffic impact of new developments used by BMA are based on the provisions of the Building Control and Land Development Act of 1992. Although they are not very effective, they can reduce the traffic impact to a certain degree, and similar procedures could therefore be adopted for the same purpose in other cities of the region where laws and regulations are not well formulated.

For such action to be effective, it is necessary to incorporate all possible mitigation measures into integrated land-use and transportation planning. Although this has been recognized, and taken account of in the city planning policies of the major cities of many developing countries, as in Bangkok, it has not received sufficient attention. The relationship between traffic and land use has been incorporated into the regional and city transportation planning models in many cities, but seldom applied to local development projects. Moreover, many developing countries have been slow to establish a sound institutional mechanism to incorporate and implement zoning laws or land-use controls as part of a systematic land-use planning process.

More effort needs to be devoted to developing analytical tools which will permit the detailed evaluation of alternative methods of mitigating the traffic impact of new developments. More project-level case studies are needed, to examine the effects of traffic impact mitigation methods. This will require major research initiatives in the future.

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