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A COMPARATIVE ANALYSIS OF TRAFFIC IMPACT ASSESSMENT IN THE PHILIPPINES, JAPAN AND SOUTH KOREA: IMPLEMENTATION AND THE USE OF COMPUTER SIMULATION AS AN ANALYTICAL TOOL

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ABSTRACT

Traffic impact assessment (TIA) has become a necessity as cities and municipalities become aware of the potential impacts of new development on traffic flow. This paper compares the experiences of Japan and South Korea in the practice of TIA with that of the Philippines. The comparison is made with respect to their respective guidelines including the related laws and the TIA evaluation process followed in these countries. Four functions identified by the Institute of Transportation Engineers (ITE) are cited including forecasting and level of service analysis, and the tools developed and employed in aid of these functions are discussed. Computer simulation is presented as an invaluable tool for the analysis of traffic impact and examples are used to illustrate the utility of simulation including a comparison of simulation models condensed from the Japanese guidelines. Finally, recommendations on the application or implementation of TIA in the Philippines are proposed.

Key words: traffic impact analysis, comparison, practice, experience, simulation

I. INTRODUCTION

Cities and key municipalities in the Philippines continue to undergo development even with the present economic slowdown. This development is felt at different paces according to their potential and capability for growth. As areas become urbanized people come face to face with traffic congestion. This is true as roads originally designed for less traffic becomes constricted and the demand for road space finally overtakes its supply.

Traffic impact assessment or traffic impact analysis (TIA) has become more relevant in the light of this continual development as planners and engineers seek to alleviate if not totally solve the problems concerning traffic congestion in growing cities and towns or municipalities.

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Haar (1984) justifies the comparison of different systems as: "the primary value of foreign exploration lies not so much in the discovery of readily transportable concepts, technologies, or techniques, ... but rather in the stimulus of insightful reflection of culture and experiences." As such, this paper seeks to derive insights based on the experiences of Japan and South Korea. Japan presents an opportunity to relate the experiences of a developed country that is perceived to have applied TIA in various aspects of its development while South Korea offers more than ten years of know-how in the conduct of TIA. In this paper, the authors present a comparison between the TIA systems and practices in the Philippines with those of Japan and South Korea. However, since much of the Philippine system is perceived to be a derivative of U.S. examples, it cannot be avoided that American references be used in the course of discussion.

II. RATIONALE AND OBJECTIVES

The primary objective of the study is to critique the Philippine guidelines for traffic impact assessment. In particular, the authors attempt this through the following:

a) Comparison of Philippine guidelines with those of Japan and South Korea;
b) Demonstrate the effectiveness of computer simulation as a tool in traffic impact analysis;
c) Recommend areas for improvement in the Philippine guidelines based on the experiences of other countries.

Comparison among guidelines will be made according to the following points:

- Guidelines – its availability, detail and evolution;
- Experiences – implementation and evaluation of traffic impact analysis including problems encountered;
- Tools – use of various software in impact analysis;
- Monitoring – realization of project and the proposed countermeasures for transportation and traffic related problems.

III. RESEARCH FRAMEWORK

Based on the objectives of the study as discussed in the previous section, the framework for this study is developed and is shown in Figure 1.

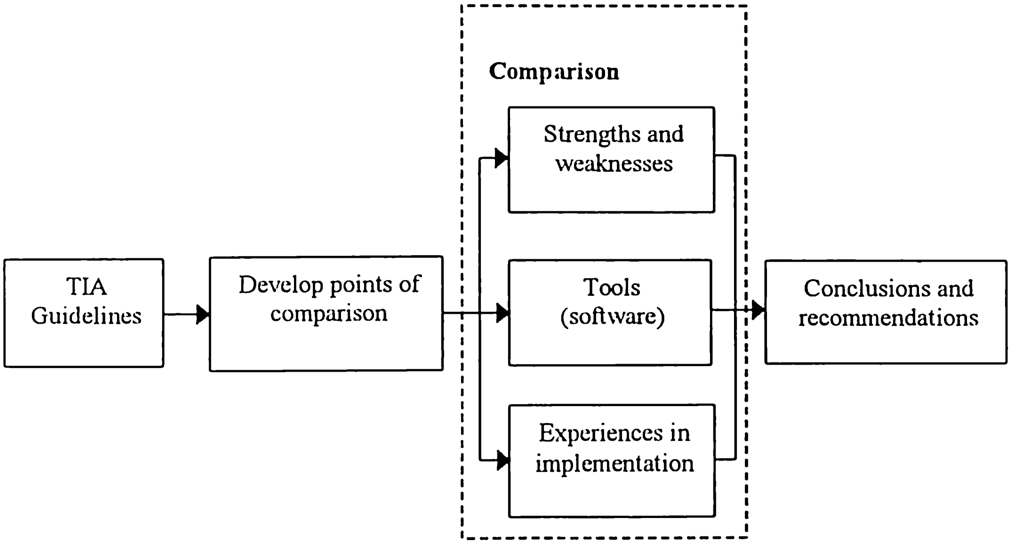

Figure 1 Research framework

The framework incorporates all points that will be discussed in this paper particularly regarding the perceived strengths and weaknesses of developed guidelines, the tools for analysis and variations in experiences on the conduct of TIA. Discussions on strengths and weaknesses will tackle comprehensiveness and completeness (i.e., detail) of the guidelines, as well as its clarity. The comparison of tools will be limited to the context of analytical software (e.g., simulation) used for effective and efficient analysis of various scenarios. Note that there are other software tools used in TIA such as those employed for forecasting traffic over the planning period. These will not be considered for now.

IV. THE PRACTICE OF TRAFFIC IMPACT ASSESSMENT

4.1 TIA Guidelines

Traffic Impact Assessment Guidelines for the Philippines were developed by a study team from the University of the Philippines National Center for Transportation Studies (NCTS) and assisted by funding from the Japan International Cooperation Agency (JICA). These guidelines were completed in March 2001 and though proposed for use by local governments, have not been institutionalized as yet except in the case of Laguna province located to the south of Metro Manila.

The Laguna provincial government actually pre-empted the development of formal TIA guidelines by passing a resolution (Resolution No. 28, Series 2000) requiring developers to submit a TIA report according to a set of rules and regulations implementing the traffic impact assessment system

(Provincial Ordinance No. 2, Series 2000). Note that the NCTS completed the research on TIA in March 2001. Thus, it is with interest that we ask how Laguna could have evaluated TIA reports when it has been admitted by the province's committee of municipal planning officers that they cannot even distinguish a simple traffic report from a TIA.

South Korea developed their guidelines in the 1980's and has since undertaken regular revisions for its further improvement and in response to various changes through the years. The Korean guidelines form part of a system of laws laid down in aid of planning. Such laws include the Urban Planning Law, the Urban Traffic Improvement Promotion Law, the Environment Transportation Disaster Impact Assessment Law and the Parking Lot Law.

Japan recently published formal guidelines for the conduct of traffic impact assessment. The committee who worked on the guidelines was composed of representatives from government agencies, the academe and the general public. The report was completed in March 2001 and is geared for use by the police for assessing traffic impacts. Most provisions point to existing guidelines or regulations like the "Traffic Plan Manual for Large-Scale Development Districts," by the City Traffic Research Section of the Ministry of Land, Infrastructure and Transport, as well as those in each prefecture.

4.2 Requiring TIA for Various Types of Development

The institutionalization of the TIA guidelines is a requisite to proper implementation and effective evaluation. This aspect provides the legal foundation for the conduct of TIA by assuring local government of its necessity (i.e., awareness of the merits of TIA, especially the benefits it will bring to the public) and imposing on the developers and planners the responsibility to address concerns on deterioration in traffic flow and safety due to their projects.

The NCTS Study Team (2001) provided a framework for the institutionalization of TIA. This is shown in the diagram in Figure 2, where three general cases for requiring TIA are referred to as the base cases: site development in a critical area, urban renewal or industrial site development, and rezoning.

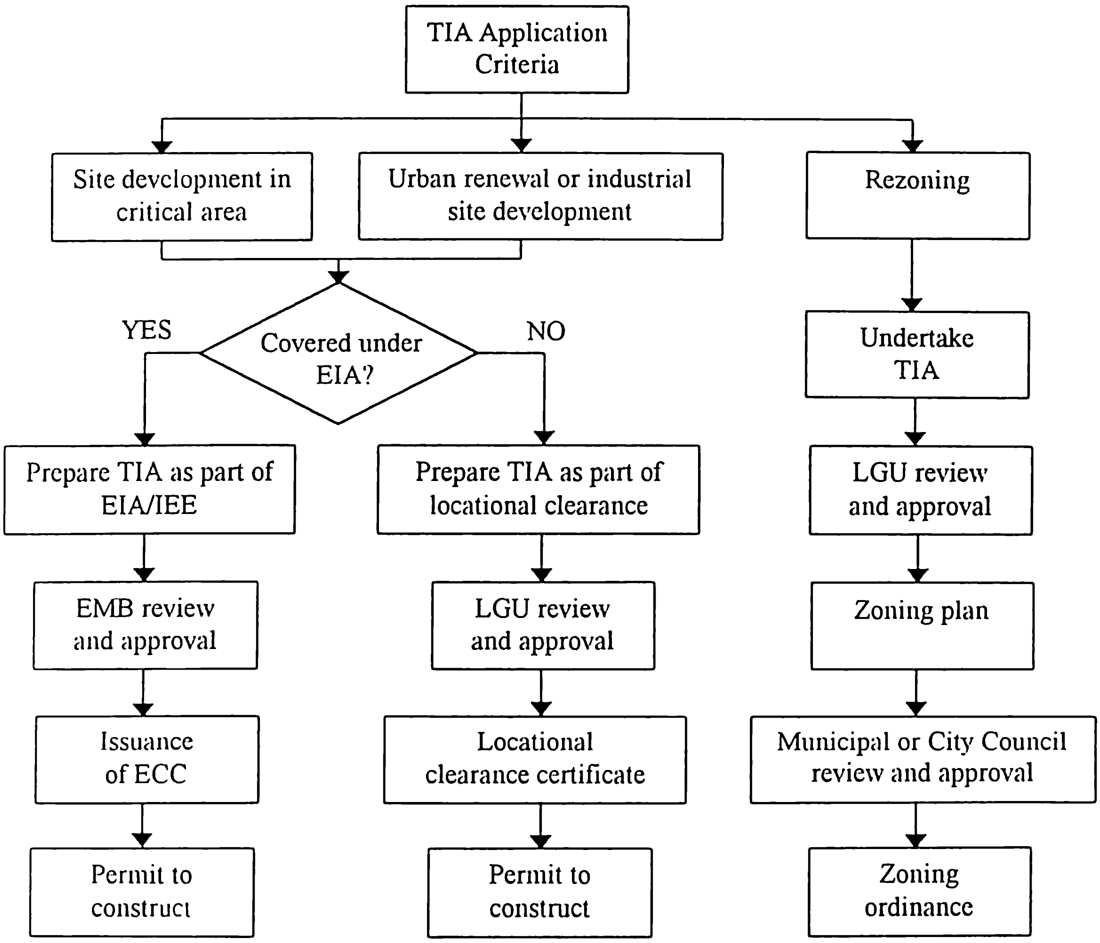

Figure 2 Institutionalizing TIA in the Philippine context.

The framework shown in Figure 2 covers most if not all types of developments. It also takes into consideration the two paths for mainstreaming TIA in existing systems. One is through the EIA system and another is through local government process. Note that only projects that are deemed to be environmentally critical undergo the EIA. Therefore, most other developments fall under the responsibility of the local governments for assessment.

Philippine guidelines, while not including an explicit classification, refer to the classification as detailed in the Institute of Transportation Engineer's (ITE) Trip Generation Manual. A similar classification may also be derived from the National Building Code. The minimum standards for parking found in this code are outlined according to the type of facility.

Japan's guidelines cover most types of developments and classify these into the following:

- o Housing facilities
- o Academic facilities
- o Medical facilities
- o Amusement facilities
- o Meeting hall facilities
- o Lodging facilities
- o Shops
- o Offices
- o Plants and workshops

Such a classification is based on the "Traffic Plan Manual for Large-Scale Development Districts" issued by the City Traffic Research Section, City Bureau of the Ministry of Land, Infrastructure and Transport.

TIA is required for most developments in Korea as stipulated in the laws mentioned in the previous section. The system of laws provides a firm foundation for requiring developers to undertake TIA. Under this system, TIA to be undertaken is classified according to a general type of development. Building TIA is undertaken for large-scale facilities, apartments, shopping malls and the like. Site planning TIA is done for urban planning and detailed planning. Highway TIA is undertaken for road construction, extension and rehabilitation.

4.3 Implementation, Tools and the TIA Report

Despite TIA being formally required only in one province (i.e., Laguna) and several cities and municipalities (again most notably those in the province of Laguna), TIA has been undertaken within the context of the Environmental Impact Assessment (EIA) required by law. Most traffic studies are required as part of the Environmental Impact Statement submitted to the Environmental Management Bureau (EMB) of the Department of Environment and Natural Resources (DENR), as a prerequisite to getting an Environmental Compliance Certificate (ECC).

In Japan and South Korea, there are many qualified and experienced engineers and planners who can undertake traffic impact assessment. Also, because TIA is required for most developments, consultancy firms maintain a staff that is knowledgeable and experienced in this endeavor. Cities in particular, have planning offices that are staffed by competent, qualified engineers and planners. Also, the governments have a good working relationship with the academe with university professor and researchers often working as part of a committee involved in planning (including traffic assessment).

Such is not the case in the Philippines where there are only a handful of experts capable of traffic impact assessment. In the private sector, only a few companies have the capability to conduct TIA as outlined in the guidelines. For most cases, a traffic report stating the current situation is often taken to be a TIA. Such practice clearly disregards the potential problems that can be caused by developments in the future. This scarcity of expertise in the Philippines spills over to the government especially at the city or municipal level. The DPWH and the DOTC have competent planners and engineers but local governments often have people who have very limited or no experience in terms of transportation planning and traffic engineering.

The Institute of Transportation Engineers (ITE, 1999) mention four functions "critical in the engineering and planning evaluation of all highway and land use development projects." These include traffic forecasting, intersection and arterial level of service analysis, mitigation, and impact fee evaluation. The Japanese guidelines conveniently identify main items for traffic assessment for all types of development in its classification. These include the entrance/exit (or access/egress), parking, road traffic, and pedestrian and bicycles.

Many tools have been developed to facilitate the undertaking of these functions. With the exception of impact fees, which remains a controversial issue in many countries, computer software have been developed for forecasting traffic, optimizing intersection signal settings, analyzing facility levels of service, and simulating traffic in a network.

In the Japanese and Korean guidelines, it is not clearly stated which software would be used in the assessment process. Thus, consultant may use any software as a tool for analysis. In Korea, the only requirement is for consultants to include in the report the factors applied in Transyt-7F. Such is to allow the checking of values used as parameters. This practice should be applied for all software used in doing forecasting and analysis. The parameters and assumptions made should be clearly stated in the TIA report in order for them to be verified as reasonable. Note that computer programs usually include default values for such parameters as saturation flow rates, acceleration rates, and vehicle occupancy.

In the Philippines, computer simulation is seldom used when doing analysis of various scenarios involving traffic. Most analysis is done using spreadsheets and formulas derived from the U.S. Highway Capacity Manual. It is no surprise that the more popular software used in government planning offices and in private consultancy firms are those used for forecasting traffic. However, these are only used for major projects and often, forecasting is be done by simply assuming a linear increase in traffic.

4.4 Evaluation of TIA Reports

The evaluation of TIA reports requires a certain degree of expertise as well as experience to be able to understand and critique the assessment. In the Philippines, the expertise and experience for evaluating TIA reports are scarce especially on the provincial and city/municipal level. The presence of civil engineers and urban and regional planners in the provincial, city and municipal engineering office, as well as the planning and development offices do not translate into capability. Most Filipino civil engineers are schooled with a curriculum emphasizing structures and construction, while planners usually do not have the background to analyze traffic.

The UPNCTSFI Study Team (2001) suggested that at the city or municipal level an evaluation committee be composed of a representative of the City/Municipal Planning and Development Office, the City/Municipal Engineer's Office, the Environment and Natural Resources Office, and other qualified persons who may be appointed by the mayor. It is ideal that the evaluators have enough knowledge to review TIA reports and are able to determine their completeness according to minimum requirements set by the guidelines, and their adequacy according to the recommendations made to counter potential problems in the planning/analytical horizon.

The flowchart for the evaluation process in South Korea is shown in Figure 3. In South Korea, there are two types of committees: the Central Deliberation Council and the Rural Deliberation Council. For the first council, the chair is the chief of the Surface Transportation Bureau of the Ministry of Construction and Transportation. The committee can consist of 29 to 50 members, including 14 members designated by the minister of MOCT. Meanwhile, the rural council is chaired by the head of the bureau or office in charge of transportation operations in the city or prefecture. It can consist of 21 to 40 members, including 10 members designated by the chairperson. Both councils' members are usually experts in traffic, urban planning, and architecture as well as some people who are recommended by Non-Government Organizations (NGO).

When a TIA is disapproved in Korea, they are usually classified into three cases:

Case 1: Re-discussion – critical mistakes or shortcomings in the forecasts, analysis and recommendations. The developer is asked to re-submit a TIA report as well as an "Assessment Supplementary Report."

Case 2: Conditional approval – minor mistakes or shortcomings in the forecasts, analysis and recommendations. The developer is asked to submit correction or clarifications to the original TIA report.

Case 3: Report of condition – substantial mistakes or shortcomings but not so serious as to require a re-submission of the TIA report. The developer is asked to submit improvements and supplementary items, and the council confirms compliance.

The structure of the process just described is essentially similar to what must be applied to the Philippine case. However, as was discussed in the precious sections, it is necessary to develop the capability for doing TIA and it is evident that the composition of the committee for the Philippine case would require experience and competence in TIA for them to effectively evaluate reports.

V. COMPUTER SIMULATION

5.1 Introduction

Computer simulation has been a widely used analytical instrument as it has provided engineers and planners with a tool for modeling and evaluating various scenarios involving traffic. Among the simulation programs in use are TRAF-NETSIM, PARAMICS and tiss-NET. Regidor (1995) discussed the advantages and disadvantages of computer simulation over more traditional approaches like mathematical modeling and direct experimentation in the Philippine context. For the purposes of this paper, we focus on the pros and cons of simulation as a tool including the cost and capability requirements.

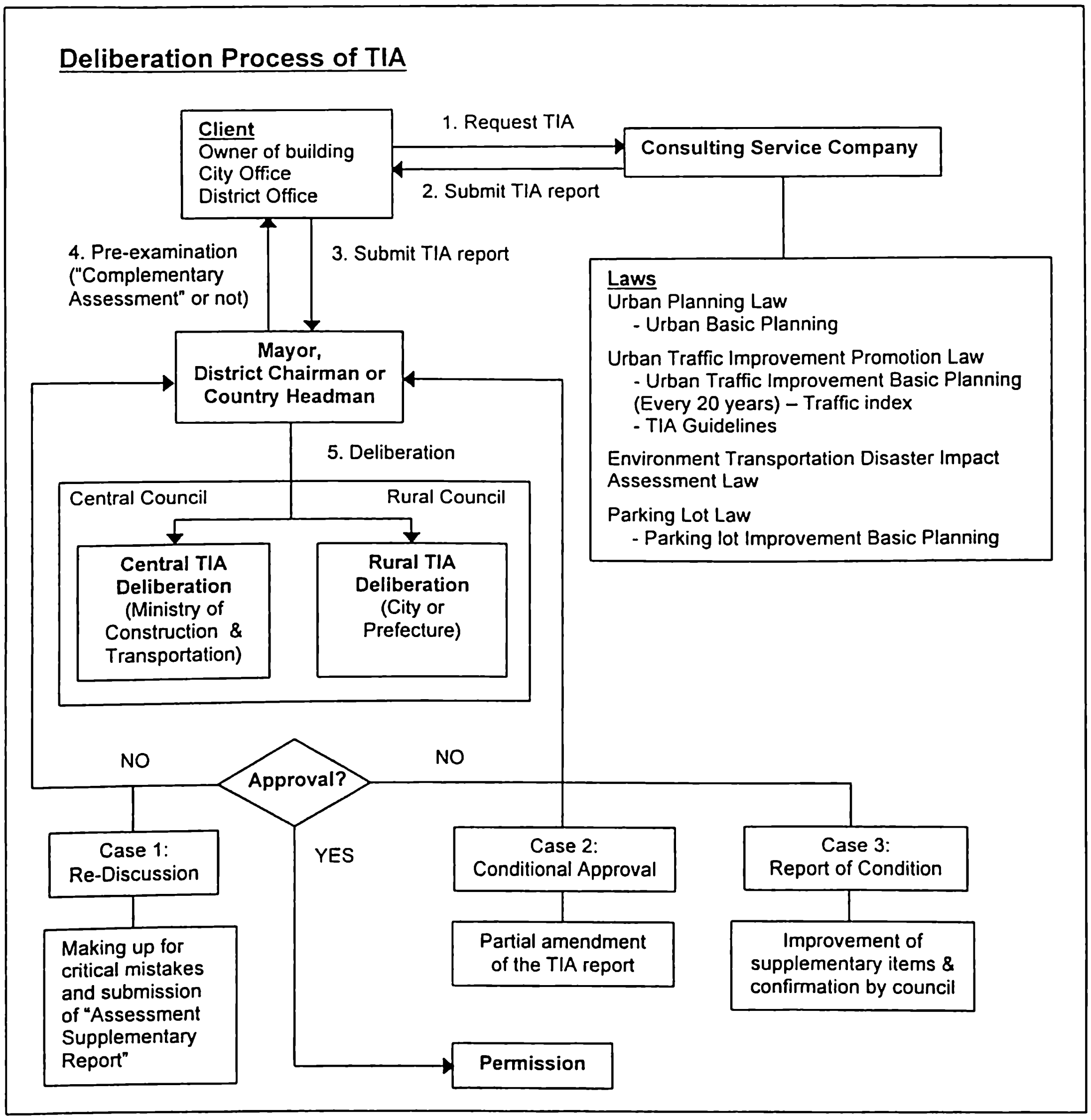

Figure 3 TIA evaluation process in South Korea.

5.2 *Choosing the Appropriate Simulation Software*

5.2.1 *Cost Concerns*

There are certain pros and cons regarding the computer simulation in the conduct of traffic impact assessment. Most of the advantages can be associated with its being invaluable as a tool for analysis while most of the disadvantages can be related to the costs and required skill to use the software. Some commercially available traffic simulation programs are listed in Table 1. Beside the software name is the software developer. Table 1 also compares the costs of acquiring commercially available simulation software. Note that add-ons, which may be required to enhance the software, are not included.

Simulation software will have minimum hardware requirements but the acquisition of hardware does not pose a problem for most cities or municipalities. The exceptions would be those that are really constrained in terms of their budgets.

Table 1 Some commercially available traffic simulation software and their prices.

Software Name	Developer	Commercial Price (JPY)	Academic Price (JPY)
AVENUE (Advanced and Visual Evaluator for road Networks in Urban arEas)	University of Tokyo Institute of Industrial Science	3,000,000 (1,200,000)*	None
NETSIM (NETwork SIMulation)	University of Florida	950,000 (380,000)	300,000 (120,000)
PARAMICS (PARAllel MICroscopic traffic Simulator)	Quadstone Limited	870,000 (348,000)	None
tissNET (traffic impact study system for road NETwork)	Saitama University	700,000 (280,000)	None
VISITOK (VIsual SImulator for Transportation system Originated in Kobe)	Kobe University	N.A.	N.A.

*Values in parenthesis are conversions to Philippine Peso using a rate of 0.4PHP = 1 JPY.

5.2.2 *Simulation Software Capability and Validity*

The selection of the appropriate simulation software for use by a local government planning committee for reviewing TIA reports must be consistent with a set of criteria. Such criteria should logically include the technical specifications of the software. These specifications would give us the capacity or capability of the software in modeling, for example, entire road networks. Ideally, the software should be able to model large networks for a comprehensive treatment of traffic impact. It would also be advantageous if the software can be integrated with a geographical information system (GIS) to accurately represent the features of the network.

It has been shown in many cases that simulation can be used for a variety of objectives not limited to TIA. Ei, Sakamoto and Kubota (2001) have shown the effectiveness of using simulation software as a tool for assessing parking policy in Myanmar. Cities in the United States often recommend simulation in addition to the use of common analytical software like HCS2000. Some cities (e.g., City of Cupertino in California) have even required that a particular software be used and provides the developers or consultants with the network (using that software) to use for analysis.

Horiguchi, Kuwahara and Yoshii (2000) proposed criteria for standardizing simulation models. Particular among these are verification and validation. Verification refers to the use of virtual data to relate the software to traffic theory. That is, to determine if the simulation model can replicate various conditions (e.g., free-flowing traffic, congested traffic) satisfactorily. The use of virtual data will assure that there will be no problems regarding data reliability and accuracy. Validation refers to evaluation using real-world data. This will determine the accuracy and effectiveness of the simulation program as a tool for analysis. Such a criteria will be helpful in identifying and recommending simulation software for use in impact assessment and can easily be adapted for use in the Philippines.

5.2.3 Requirements for Using Simulation Software

Once software have been determined to be adequate and recommended for use, it is important to assess the other requirements. Considerations include technical knowledge, skills, and experience for interpretation of results and the hardware to run the simulation program.

Technical knowledge and experience are most critical in order to get substantial and meaningful results from simulation. It is reasonable to assume that anyone with skills in the use of a computer can run software but it takes knowledge and experience to interpret the outputs of simulation. Technical knowledge basically comes from an academic background involving, for example, traffic engineering or transportation and urban planning. Such a background assures an understanding of the fundamental concepts and theories necessary to conduct TIA.

The hardware required for simulation is often overestimated. This is perhaps due to the notion that simulation programs require animation and therefore much processor speed, memory and storage space. This is true for one to avail of the full features of most simulation programs where, for example, a 10-minute simulation can easily generate animation files as large as 30MB granted that a small network is considered. Most simulation software developers indicate the minimum hardware requirements for their products. However, it is anticipated that in order to be able to model and analyze a nig network, it is necessary to have hardware that would be capable of doing so. A good rule of thumb is usually to acquire the best computer that can be afforded.

5.3 Examples in the Application of Simulation

In this section, we feature two examples of simulation to illustrate the utility of this tool. One example is derived from the Japanese guidelines and shows the comparison of several simulation programs. Such a comparison reveals the advantages and disadvantages of various models (e.g., limitations and assumptions that have to be made). The other example is derived from a study in the Philippines where the internal circulation and access of a school is evaluated using TRAF-NETSIM.

The Japanese guidelines include a full treatment on traffic simulation (IATSS, 2001). Six traffic simulation programs (i.e., tiss-NET, NETSIM, PARAMICS, AVENUE, VISITOK, and TRAFFICSS) were compared using an example problem concerning a parking facility as illustrated in Figure 4. They were compared using three measures: (1) the maximum number of vehicles in queue along three approaches [A, B, C] of an intersection in the immediate vicinity, (2) the maximum number of vehicles queued from the entrance of the parking facility, and (3) the sectional travel time along 2 selected links [X-Y and W-Z]. Three cases were considered and are as follows:

Case 1: With facility and considering the additional traffic it will generate.
Case 2: With facility and considering 110% of the traffic it will generate.
Case 3: With facility and considering 130% of the traffic it will generate.

The Origin-Destination data was provided for the example and these were inputted to the simulation models. Modifications and assumptions were made for some cases where O-D data cannot be set as desired.

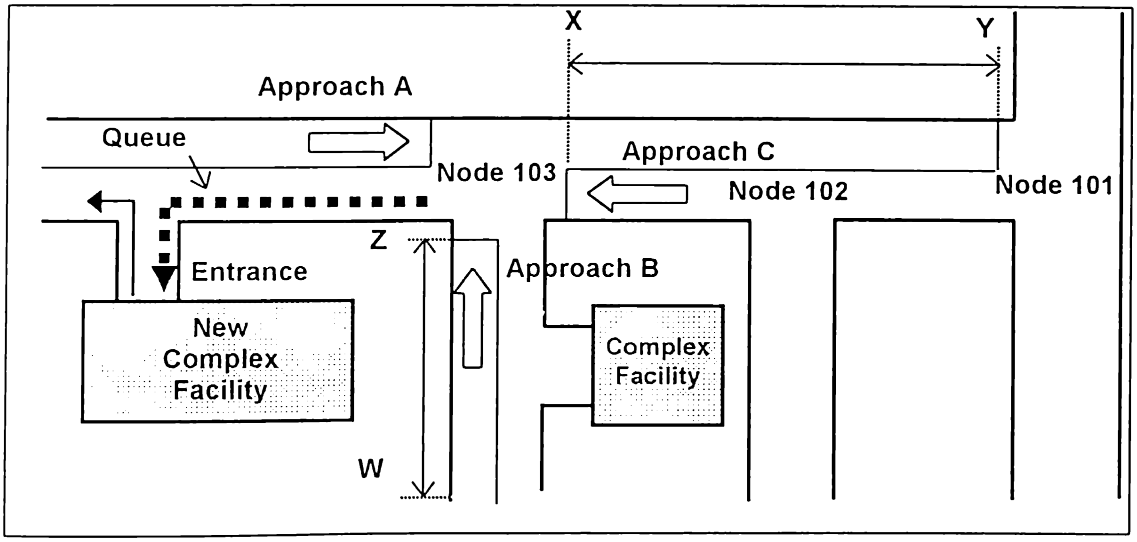

Figure 4 Configuration of comprehensive example for simulation in the Japanese guidelines. (IATSS, 2001)

The results of simulation according to the three measures of comparison are shown and discussed in detail in the Japanese guidelines. In summary, these showed a very wide variance in terms of the outputs of each of the models employed. Such were attributed to, among others, the characteristics of the simulator (e.g., original algorithm), assumptions made by the modeler and the limitations of the simulator (e.g., The absence of a parking model led to the assumption that a parking facility can be approximated by a signalized intersection.).

Subsequently, rather than being conclusive (i.e., stating which simulation program yielded the best result) the guidelines explained that the simulation outputs were only intended to guide future developers of models. Furthermore, recommendations were made based on the observed shortcomings of models used in the example.

In the Philippine case, we consider a specific example involving an academic facility. The access and egress are along a major road and vehicles entering and exiting the school cause congestion at the intersection with the major road. Circulation within the campus as well as at the immediate vicinity including intersections with the major road is modeled using TRAF-NETSIM. The network configuration is shown in Figure 5. Using the simulation model, it is possible to test a number of measures to ease the congestion problem.

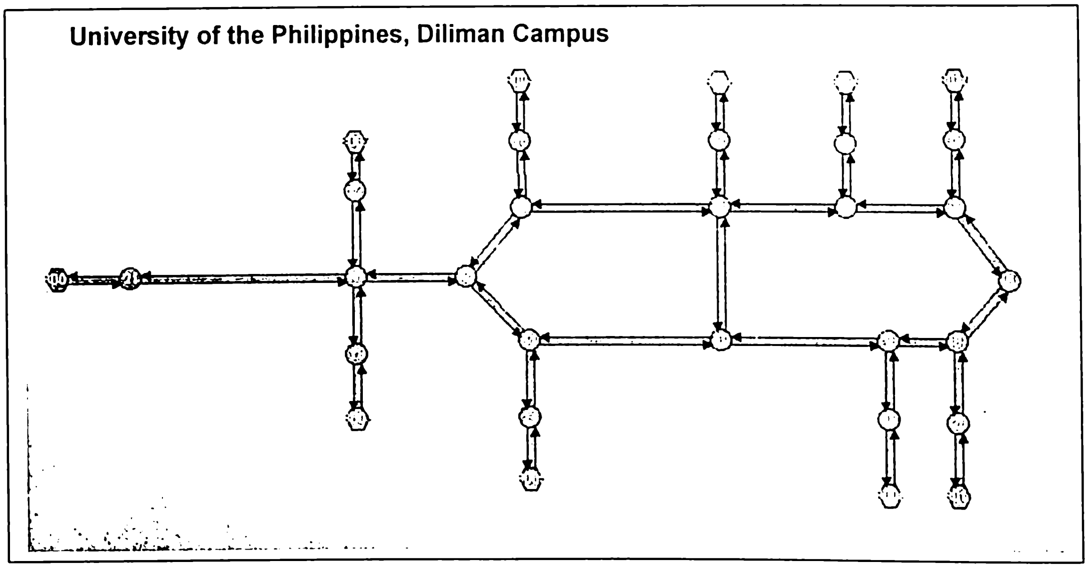

Figure 5 TRAF-NETSIM network for University of the Philippines-Diliman.

It is noticeable from the TRAF-NETSIM model that parking is not adequately represented in the configuration. This follows the experience in the Japanese example where the parking facility was approximated using a signalized intersection.

It is again emphasized that in employing simulation in traffic impact assessment, one must be aware of the limitations in particular software. It was mentioned in section 5.2.2 that certain criteria needs to be followed in the process of selecting and recommending software for use in TIA. We may add to that certain features such as the inclusion of a parking model (rather than approximate using a traffic signal), overtaking and the use of O-D data for input.

The relationship between traffic impact assessment and the analysis (i.e., using simulation) becomes critical in terms of the recommendations made as a product of the analytical results. If the model is very conservative (e.g., no overtaking therefore longer queues), then the countermeasure to ease congestion may become costly such as the provision of an additional lane. If the model cannot effectively represent the entrance and exit points of facilities along the roadways (i.e., leading to parking facilities in these establishments), then it will misjudge the effects of these sources and sinks. The objective is to come up with a simulation model that would neither overestimate nor underestimate the real-world phenomena it intends to represent, in order to come up with recommendations that will be effective in solving potential problems as well as cost-efficient.

VI. CONCLUSIONS AND RECOMMENDATIONS

In the preceding sections, we were able to accomplish the objectives of this paper. The paper was able to compare TIA in the Philippines with that of Japan and South Korea. This was done following the points of comparison identified earlier. The development of guidelines for each country was discussed including the laws that require the conduct of TIA for various types of development. The discussion on implementation touched on the availability of people who can conduct TIA (i.e., capability in terms of expertise). The TIA evaluation process was then discussed and a detailed deliberation process applied in South Korea was presented.

The tools employed in the conduct of TIA were discussed in the context of the four elements or functions in impact assessment identified by the ITE: forecasting, intersection and arterial level of service analysis, mitigation and impact fees. Popular programs used for forecasting and LOS analysis were identified. It was pointed out that it is important to choose a simulation model that can closely approximate real world conditions. From the results of the comparison of simulation models detailed in the Japanese guidelines, it was clear that certain factors tend to limit models. These include their characteristics (i.e., original algorithm), and the assumptions made by the modeler in the absence of certain features like a parking model and overtaking.

Not all projects will require TIA and consequently, simulation. However, the emphasis should be placed in a local government developing a capability for traffic impact assessment and using that capability effectively. It is important to realize the importance of planning and instill a sense for medium- and long-term benefits. Too often, solutions to problems are offered on short-term, stopgap measures when simply, the problem could have been avoided if a TIA was undertaken and its recommendations considered seriously.

VII. ACKNOWLEDGEMENTS

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