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NEW ENVIRONMENTAL IMPACT ASSESSMENT METHOD FOR ROAD TRAFFIC NOISE IN JAPAN

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ABSTRACT
In Japan, the environmental impact assessment (EIA) law was enforced in June 1999, and the revised environmental quality standards for noise were enforced in April 1999. In these circumstances, it was urgent for the road administration to establish a new EIA method for road traffic noise. This paper gives an overview of the Japanese EIA process, by presenting the method proposed by PWRI of the Ministry of Construction as an example. Its procedure consists of the following main steps: 1) selection of evaluation items; 2) selection of survey, prediction and evaluation methods; 3) survey; 4) prediction; 5) planning of countermeasures; and 6) evaluation. In this method, the ASJ Model 1998 developed by the Acoustical Society of Japan is adopted as a standard prediction model.

1 - INTRODUCTION

In the past few years, significant developments have occurred in the management of environmental noise in Japan [1]. Firstly, the "Environmental Impact Assessment (EIA) Law" was issued in June 1997 and enforced in June 1999. Until that time, the Japanese EIA had been conducted based on the guidelines approved by the Cabinet in 1972, and Japan had been the only OECD country without an EIA law. Secondly, the "Environmental Quality Standards for Noise (EQSN)" were revised in September 1998 and enforced in April 1999. In the revised standards, L_{Aeq} has replaced L_{50}, which had been used as a noise index since 1971.

These events have required road administrators and researchers on noise problems to establish both a new EIA technical procedure and a new prediction model for road traffic noise. The EIA procedure has been studied by Public Works Research Institute (PWRI) of the Ministry of Construction, and the prediction model of "ASJ Model 1998" [e.g. 2-5] by the Acoustical Society of Japan.

This paper presents an outline of the EIA technical procedure proposed by PWRI, which integrates the ASJ Model 1998 as a standard prediction model.

2 - TECHNICAL PROCEDURE OF EIA FOR ROAD TRAFFIC NOISE

Fig. 1 shows a technical procedure of EIA for road traffic noise. Each stage in the procedure will be explained briefly in the following.

2.1 - Screening

In the Japanese EIA, screening is a process for determining whether or not an EIA should be conducted on national roads between 7.5 km and 10 km in length. An EIA must be carried out on all national roads over 10 km in length and all expressways. For further details the reader should refer to Ref. [1].

2.2 - Scoping

Scoping is a process for planning the EIA. Firstly, evaluation items, e.g. noise, air quality, flora and fauna, are selected considering both the characteristics of the road project and the natural and social conditions

in the surrounding areas. Road traffic noise is selected when residences exist around the proposed road or may exist in the future. Secondly, the entire route is classified into several road sections according to both its road structure and its roadside condition such as the area category of the EQSN (see Table 1) and the average height and density of the buildings. Finally, the methods for survey and prediction are selected for each of the road sections, while the evaluation method is selected for the entire route.

2.3 - Conducting the EIA

The EIA is conducted according to the methods planned in the scoping stage. The methods might be re-examined if new information is obtained during the surveying process.
Since the Japanese EIA is project-specific [6] and conducted at the late stage of road planning, the planning of detailed countermeasures is required by using the noise prediction method with high accuracy. The actual methods for survey, prediction, and evaluation, as well as the planning concepts of countermeasures, will be introduced in Section 3.

2.4 - Preparation of draft EIS

The environmental impact statement (EIS) is a report of the EIA, which includes the methods and the consequences of survey, prediction, and evaluation as well as the planned countermeasures.

3 - METHODS FOR SURVEY, PREDICTION AND EVALUATION AND PLANNING OF COUNTERMEASURES

3.1 - Standard survey method

Survey Information

Noise Situation. L_{Aeq} of the daytime and the night-time (see Table 1) is measured as a baseline condition in the project area.
Roadside Situation. Parameters for prediction are surveyed: 1) the average height and density of the roadside buildings (see Ref. [5]); and 2) the ground property of the roadside areas (see Ref. [4] and [7]).

Survey Method

Noise Situation. L_{Aeq} is measured according to the method provided in the EQSN:

1. Evaluation is made by selecting a day or days when the average yearly noise condition can be observed;

2. Measurement is carried out based on the Japanese Industrial Standards Z8731, which was revised in March 1999, in principle, to make it meet the provisions of ISO 1996-1, 2; and

3. Measurement might be substituted by estimation of noise level from information on traffic volume, composition, and speed, e.g. using the ASJ Model 1998.

Roadside Situation. The parameters mentioned above are determined through field survey, or collection of residential maps and aerial photographs.

3.2 - Standard prediction method

Traffic Conditions for Prediction

Target Year for the Prediction. The target year for the prediction is 2020, which is the design year for the prediction of traffic volume for all road projects being planned in Japan.
Traffic Volume. The traffic volumes of large vehicles and small vehicles are determined for both the daytime and the night-time, based on the design daily traffic volume and the hourly fluctuation pattern of the volume obtained from an existing road with similar traffic conditions.
Average Speed of Vehicles. The average speeds of the two types of vehicles are determined, in principle, according to the provisions of the Road Traffic Law.

Prediction Method

Standard Model. The ASJ Model 1998 is used as a standard prediction model to calculate the values of L_{Aeq} of the daytime and the night-time at the prediction points mentioned below. Then, the power levels of the vehicles, in principle, are generally calculated by the future power level equations [3], which take into account the future reduction in noise emissions from vehicles as required by the Noise Emission Regulations in Japan.
Prediction Points. In order to evaluate the compliance with the EQSN, prediction points should be located in both the "space adjacent to an arterial road" (see Table 1) and the remaining area behind it, i.e. behind the roadside buildings. Further, the heights of the prediction points should be determined considering the average height of each floor of the buildings existing in the two areas, respectively.

3.3 - Employment of scale-model experiments and numerical analysis
If the road structure is very complicated so that multiple reflection need to be considered, the ASJ Model 1998 may not be applied to the calculation of the sound propagating around the road. Instead, scale-model experiments and numerical analysis such as BEM might be employed to obtain the sound propagation properties.

3.4 - Evaluation method
Evaluation must be done from the following viewpoints:

1. whether or not the proponent conducts the mitigation measures, i.e. countermeasures against the road traffic noise, in the best practicable way; and

2. whether or not the noise level complies with the EQSN in the "Areas facing Roads" (see Table 1).

(a) General Standard Values

Area category	Standard values	
	Daytime	Night-time
Area A facing roads with two or more lanes	60 dB or less	55 dB or less
Area B facing roads with two or more lanes, And Area C facing roads with one or more lanes	65 dB or less	60 dB or less

Notes:

1. Daytime shall be the period from 6:00 a.m. to 10:00 p.m. and Night-time shall be the period from 10:00 p.m. to 6:00 a.m. of the following day;

2. Area A shall be applied to the area which is used exclusively for residences;

3. Area B shall be applied to the area which is used mainly for residences; and

4. Area C shall be applied to the area which is used for commerce and industry as well as for significant number of residences.

(b) Standard Values in the "Space Adjacent to an Arterial Road"

Standard values	
Daytime	Night-time
70 dB or less	65 dB or less

Notes:

1. The space adjacent to an arterial road is within 20 m from the border of the road area when the road has more than two lanes; and

2. Standards for indoor noise transmitted from the outside (45 dB or less for Daytime, and 40 dB or less for Night-time) can be applied to the residences whose windows are judged as usually closed at their sides most affected by noise.

Table 1: EQSN in the "areas facing roads".

The "areas facing roads" consist of the "space adjacent to an arterial road" together with the remaining area behind it, each of which has a different standard noise value. In addition, the standards for indoor noise can be applied in the limited condition (see Table 1). Then, the indoor noise can be estimated by subtracting the performance of building façade insulation (see Table 2) from the predicted outside noise.

3.5 - Planning of countermeasures against road traffic noise
Planning of Countermeasures and Verification of Their Effectiveness . If the survey and prediction make it clear that the impact on the noise environment is not negligible, the proponent must plan the mitigation measures in the best practicable way, aiming at complying with the EQSN. In that case, the effectiveness of alternative countermeasures must be compared and verified, or a judgement made over whether or not the newest anti-noise techniques should be employed. Furthermore, the proponent must specify 1) who will implement the countermeasures, 2) types of the countermeasures, 3) the effects of the countermeasures and the noise condition after the implementation, and 4) the likely impact on the other environments such as scenery and sunshine.

Examples of Countermeasures. The following are the common countermeasures used: 1) noise barriers, including edge-modified barriers and low-height barriers; 2) roadside earth mounds; 3) drainage asphalt concrete pavement; 4) noise absorption panels; 5) buffer zone; and 6) plantations of shrubs. Most of their noise reduction effects can be calculated by the ASJ Model 1998. Exceptionally, the effects of edge-modified barriers might be analyzed through model experiments and BEM calculation. On the other hand, plantations of shrubs contribute little to actual noise reduction, but they confer a psychological benefit in reducing the perceived nuisance of road traffic noise.
When it is difficult to accomplish the outdoor EQSN in spite of the implementation of the best practicable countermeasures, the proponent should make plans for building façade insulation according to the laws and regulations concerned. Its performance depends on both the exterior wall and the window, shown in Table 2 proposed by the present authors [8].

Types of exterior Wall, Types of window	RC (Reinforced Concrete) or Mortar Siding [2)]	Conventional Wooden Structure
Double Windows, Fixed Window	35/30 dB [3)]	30 dB [4)]
Sound Insulation Sash [1)]	30 dB [5)]	25 dB [4)]

Notes:

1. It includes single-layer sliding windows, airtight casement windows, and pivotal windows;
2. Wooden structure covered with mortars with cracks and gaps are regarded as conventional wooden structure;
3. The sound insulation performance of a double-layer window is set at 35 dB, as long as its total area is less than approximately that of the 1.8 m $\times$1.8 m window and a sound insulation ventilator outlet is used;
4. Repair is necessary for the conventional wooden structure with conspicuous gaps; and
5. The sound insulation performance is set at 25 dB when its total width of moving parts is more than 1.8 m.

Table 2: General performances of building façade insulation.

4 - SUMMARY

This paper has presented a technical procedure of the EIA for road traffic noise and a standard method for survey, prediction and evaluation in Japan. In conclusion, we summarize the characteristics of the EIA prediction method:

1. The ASJ Model 1998 is used as a standard model, and scale-model experiments and numerical analysis might be employed to support it;
2. The future power level equation of vehicles is used taking into account the Noise Emission Regulations on vehicles;
3. In order to compare the alternative countermeasures, it is necessary to predict the effects of them with high accuracy; and
4. In order to evaluate the compliance with the EQSN, it is necessary to predict the noise behind the roadside buildings [5] and inside them.

Additionally, since the method presented here is an example, any other method would be applicable only if it meets the EIA Law and the Ministry of Construction's EIA Ordinances.

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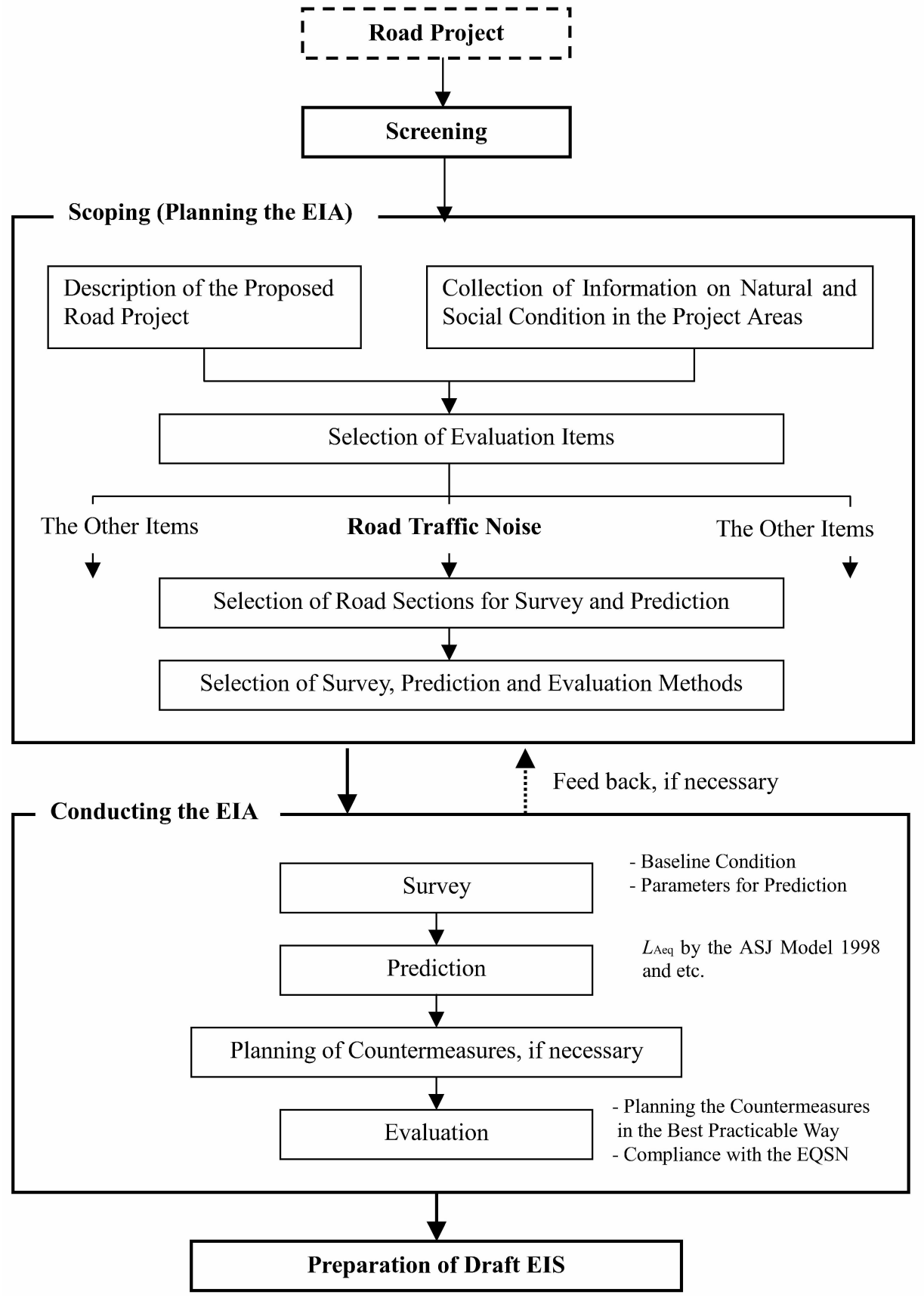

Figure 1: Technical procedure of EIA for road traffic noise.