MULTI CRITERIA ANALYSIS FOR PRIORITIZING
THE ROAD MAINTENANCE PROGRAM

Rusmadi SUYUTI
Research Staff
Directorate of Transportation Technology, BPPT
BPPT 2nd Building, 10th Floor
Jalan MH Thamrin No.8, Jakarta Pusat 10340
Indonesia
Fax: +62-21-316-9345
E-mail: rusmadi@transkom.as.bppt.go.id

Abstract: The provision of good-quality infrastructure is essential to the maintenance and promotion of economic development, and road infrastructure is perhaps the most important component of infrastructure needs. It is imperative to secure adequate levels of road maintenance, so that the road infrastructure continues to provide maximum capacity. Rehabilitating and maintaining road have also higher impact to economic regional development and would support the distribution basic necessity of the people. Without maintenance, expensive assets quickly deteriorate, and operating cost will increase substantially. Since the yearly budget of road maintenance is very limited which cannot cover all roads to be maintained, so the program for prioritizing road links to be selected for the periodic road maintenance needs to be done. A methodology needs to be used for selecting prioritized road links for road maintenance program. This study is giving the alternative methods for prioritizing the secondary road maintenance program. The objective of the study is to determine prioritized secondary road that needs to be periodically maintained. Methodology of multi criteria analysis using some criteria parameters is used to identify prioritized road links to be selected for the road maintenance program. Study case used in this study is urban roads in Kota Bekasi, Jawa Barat, Indonesia.

1. INTRODUCTION

It is extremely important to ensure that the economy viability of one country is maintained to the highest level. The provision of good-quality infrastructure is essential to the maintenance and promotion of economic development, and road infrastructure is perhaps the most important component of infrastructure needs. While social economic growth has been spectacular, the growth of the road network has not really kept in pace, and capacity limitations remain a potential problem for continued growth in the country.

In this context, it is imperative to secure adequate levels of road maintenance, so that the limited road infrastructure continues to provide maximum capacity. Without maintenance, expensive assets quickly deteroriate, and operating cost will increase substantially. The economic costs of poor maintenance (in quantity or in quality) are extremely high.

Rehabilitating and maintaining urban / secondary road have higher impact to economic regional development and would support the distribution basic necessity of the people in

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surrounding area. Road maintenance program can be divided into 2 (two) type, namely: routine maintenance and periodic maintenance. Because of budget contraint, not all road links in one region will be covered in road maintenance program. Some selection criteria needs to be undertaken to select the priority road links that will be covered in yearly budget of road maintenance program.

This study proposes a methodology to select some potential road links that needs to be covered in road maintenance program. The case study used is the road maintenance program of urban / secondary road in Kota Bekasi, West Java Province, Indonesia.

2. METHODOLOGY

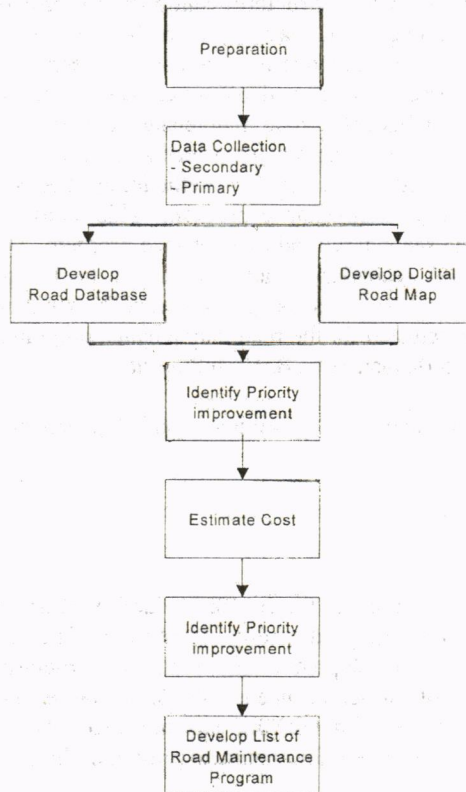The approach and methodology used to perform the study is shown in Figure 1. below.

Figure 1. Approach and Methodology Study

As shown in Figure 1 the study approach used can be categorised into the following: Preparation of Study, Data Collection, Development of Road Database, Development of Digital Road Map, Identification of Prioritized Improvement, Calculation of Cost Estimation and Identification of Funding resources.

Further details on the approach and methodology used for each step are explained below.

2.1. Preparation of Study

The activity is to prepare, understand and formulate the objective of road maintenance program which is keeping secondary roads in good condition, producing digital road map and preparing priority rehabilitation and maintenance program.

2.2. Data Collection

The activity is to collect both primary and secondary data which is used to update existing condition of road network including traffic volume and road surface condition.

Secondary data that are needed are as follows:
- Road network map and database
- Road maintenance program
- Unit price for road maintenance
- Road surface condition
- Yearly budget for road maintenance, etc

In addition to secondary data, primary data are also collected which are of the following:
- Traffic count survey in road links to collect information on: traffic volume, traffic composition and V/C ratio. Those surveys will be undertaken at the selected priority road links at week days.
- Road inventory survey to identify road and pavement condition such as: pavement condition, surface condition, road width and road length. Those survey will be undertaken at the same location as traffic survey.
- Field survey to take pictures of the existing condition of the road especially surface condition.

2.3. Development of Road Database

The activity is to prepare database of secondary road which are then inputted into the computer using standard form which contain some items, such as: road length, road width, surface condition, pavement type, road name, road function, road status, link number and remarks.

The standard form used are based on the simplified of the Urban Road Management System (URMS) from Ministry of Public Works. Road Database is used as a factor to prioritize for the road maintenance program.

2.4. Development of Digital Road Map

The activity is to apply road database to digital road map in appropriate scale by user friendly software. Each link of road in digital map is related to database information on that link. Digital road map is plotted for both the existing condition and the location of proposed road maintenance program.

2.5. Identification of Prioritized Improvement

This activity is to identify each section of road link that needs maintenance and rehabilitation works. Based upon secondary and primary data. Each section of road will be evaluated then priority list for maintenance and rehabilitation will be developed. The priority is set according to the most urgent section of road in terms of VCR, pavement condition and road function.

2.6.Calculation of Cost Estimation

In this activity the cost of rehabilitation and maintenance of each priority road link will be calculated based on some parameters such as:
- Type of the maintenance program
- Type of payment
- Road geometric design
- Road maintenance's unit price
- Monetary crisis correction factor

2.7.Identification of Funding Resources

In this activity fund resources of each priority improvement of road should be identified. The fund could be from central government (APBN), local government (APBD) or foreign aid (loan, grant).

3. DATA COLLECTION AND ANALYSIS

Primary and secondary data are needed to collect for the purpose of updating the existing condition of road network including traffic volume and road surface condition.

3.1.Secondary Data

Secondary data that have been collected from Kota Bekasi are as follows:
- Road network map
- Road network database, which covers: link number, road name, road status, road function, road length, road width, pavement type, pavement condition
- Road maintenance program in the past
- Road maintenance program in the future
- Unit price for road maintenance
- Yearly budget for road maintenance

The secondary data are collected from the relevant central and local government institutions, namely: Agency for the development planning (Bappeda), Ministry of Public Works, etc.

In addition to the secondary data, primary data are also collected on the selected roads in order to review the secondary data with the actual condition on each link. The location of the primary survey are selected based on the criteria parameters. The result of the primary and secondary data will be used as input to update the road existing condition and in turns to sort the selected roads into the priority road maintenance program.

3.2.Primary Data

The primary survey that was undertaken are of the followings:

Traffic Count Surveys

The objective of this survey is to calculate the number of vehicles that pass the road surveyed. The characteristics of the survey are:

- Count vehicle volumes
- Count vehicle compositions
- On road links and intersections
- 16 hours count
- 1 (one) weekday
- 1 (one) post per link
- Type of vehicle surveyed: light vehicle (car, minibus, jeep, etc), heavy vehicles (truck, bus), motor cycle and unmotorized vehicle.

Traffic count survey result can be provided in the number of vehicles or in pcu (passenger car unit during one day (AADT) or peak hour). For this objective pcu factor will be used which is based on Indonesian Highway Capacity Manual (IHCM). The result can also be described in Volume – Capacity Ratio (VCR) after the value of road capacity is obtained. The VCR give description of the level of service of the road links.

Road Inventory Survey

The objective of this survey is to check the actual pavement condition of the road links surveyed include the bridge condition on the road links. For this purpose, each road link will be segmented every 100 metres. The characteristics of the survey are as follows:

- draw cross section
- draw situation map includes the surrounding land use
- pavement surface condition (area unit/m2)
- vehicle speeds
- calculate road capacity
- bridge inventory survey, include: width, span, column, guard rail / hand rail condition, fench, floor
- take pictures on: surface condition, traffic condition, bridge condition, land use condition

The road inventory survey is undertaken using standard survey form from Ministry of Public Works. The result of the survey can be used to calculate budget needed for road maintenance program.

3.3. Data Analysis

Based on data collected from both secondary and primary data, analysis are then undertaken to select the priority improvement roads. Methodology used is described in Figure 2. below.
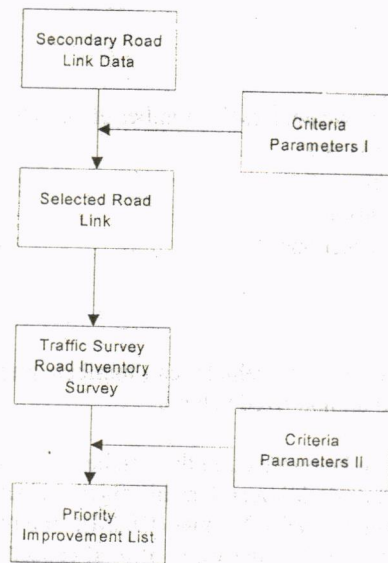
Figure 2. Priority Improvement Selection Method

As described in Figure 2. above, the criteria parameters for the methodology to identify prioritized road links to be selected for the road maintenance program can be divided into two types, namely: criteria parameters I and criteria parameters II.

This activity is to identify each section of road link that needs maintenance and rehabilitation works. Based upon secondary and primary data, each section of road will be evaluated then priority list for maintenance and rehabilitation will be developed. The priority is set according to the most urgent section of road in terms of VCR, pavement condition and road function.

Criteria Parameters I

From the list of road links, priority road links will be selected for the use in the further consideration using qualitative parameters. Some qualitative parameters are used to select the priority roads, namely:

- Road/pavement condition
- Road access from housing to work places, shopping centre, hospital, market
- Road access from Kota Bekasi to DKI Jakarta as the capital city of Indonesia
- Proposed program from local government
- Proposed program from other sources

The result of this step is then discussed with local government to obtain some input or comment which will be taken into account for further process.

Traffic survey and road inventory survey as explained before will then be undertaken at the final road priority links so that road maintenance program for each priority links can be determined using criteria parameters II.

Criteria Parameters II

Criteria parameters II are proposed to obtain road maintenance program for each fiscal year. For this purpose secondary data from relevant agencies and primary data from traffic survey and road inventory survey will be used as primary consideration.

Parameters used at this step are the following:

- Road function   percentage   10 %
    - Arteri Sekunder   value = 3
    - Kolektor Sekunder   value = 2
    - Lokal Sekunder   value = 1

- Road surface condition .   percentage   40 %
    - Damage   value = 5
    - Very Poor   value = 4
    - Poor   value = 3
    - Fair   value = 2
    - Good   value = 1

- V/C ratio   percentage   40 %
    - > 1   value = 5
    - 0.8 – 1   value = 4
    - 0.5 – 0.79   value = 3
    - 0.3 – 0.49   value = 2
    - < 0.3   value = 1

- Integration with Jabotabek Development   percentage   10 %
    - Yes   value = 2
    - No   value = 1

Each priority road link is assessed based on the above criteria and the higher value indicate that those links are more priority than the others.

4. RESULTS

After data analysis was undertaken using a methodology as explained before, a result of prioritized road maintenance program is then obtained. After coordinating with the local government the list of priority road location which is used for further analyis is listed in Table 1. After determining the 22 (twenty two) road links that is considered as prioritize road links, further analysis was undertaken using criteria parameters II to select from those lists the road links that needs to be maintained in the yearly budget of road maintenance.

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Table 1. Road Link Priority Location in Kota Bekasi

No	Link No.	Road Name	Kecamatan / Sub-District	Length (km)	Function	Status	No. of Lane / Direction	Width (m) ROW	Width (m) Lane Width	Pavement Type	Pavement Condition
1	002	Jl. Dewi Sartika	Bekasi Timur	1.20	LS	Kod	2 / 1	12	4.00	HRS	Sd
2	003	Jl. Pengasingan - Bt.Gebang	Bantar Gebang	7.20	LS	Kod	2 / 2	8	4.00	HRS	Br
3	006	Jl. Bt.Gebang - Cimuning	Bantar Gebang	3.60	LS	Kod	2 / 2	7	3.50	HRS	Sd
4	010	Jl. Jati Asih - Bj.Menteng	Jati Asih	1.20	LS	Kod	2 / 2	8	4.00	HRS	Sd
5	015	Jl. Ps. Kranggan - Lewi Nanggung	Pondok Gede	4.25	LS	Kod	2 / 2	8	4.00	HRS	Sd
6	018	Jl. Pd.Gede - Ps. Kranggan	Pondok Gede	9.70	LS	Kod	2 / 2	8	3.50	HRS	Sd
7	023	Jl. Cibening II - Bj. Rawa Lele	Pondok Gede	2.80	LS	Kod	2 / 2	8	3.50	HRS	Sd
8	025	Jl. Ps. Kincan - Cibening II	Bekasi Selatan	2.10	LS	Kod	2 / 2	8	3.50	HRS	Sd
9	026	Jl. Caman - Cibening II	Bekasi Selatan	1.60	LS	Kod	2 / 2	8	3.50	HRS	Br
10	028	Jl. Pemuda	Bekasi Sel / Barat	3.20	AS	Kod	2 / 2	10	5.00	HRS	Sd
11	029	Jl. Ps.Kincan	Bekasi Barat	2.90	LS	Kod	2 / 2	8	4.00	AC	Sd
12	031	Jl. Pejuang	Bekasi Barat	4.40	LS	Kod	2 / 2	12	7.00	AC	Sd
13	033	Jl. KA. Bungur - Kp. Rorotan	Bekasi Utara	3.00	LS	Kod	2 / 2	8	4.00	HRS	Sd
14	034	Jl. KH. Muktar Tabrani	Bekasi Utara	3.10	LS	Kod	2 / 2	7	4.00	HRS	Br
15	036	Jl. Teluk Pucung - U.Harapan	Bekasi Utara	1.30	LS	Kod	2 / 2	7	4.00	HRS	Sd
16	037	Jl. Perjuangan	Bekasi Sel / Utara	6.20	LS	Kod	2 / 2	8	6.00	HRS	Sd
17	041	Jl. TM. Makam Pahlawan	Bekasi Timur	2.80	LS	Kod	2 / 2	7	5.00	HRS	Sd
18	076	Jl. Pondok Melati	Jati Asih	3.10	LS	Kod	2 / 2	8	3.00	HRS	Sd
19	077	Jl. Rawa Bugel	Bekasi Utara	2.10	LS	Kod	2 / 2	7	3.00	HRS	Sd
20	081	Perumnas IV	Bekasi Timur	3.30	LS	Kod	2 / 2	10	4.00	HRS	Sd
21	084	Jl. Pramuka		1.80	LS	Kod	2 / 2	8	6.00	HRS	Sd
22	00	Kranggan Kulon		1.00	LS	Kod	2 / 2	10	3.00	HRS	Sd
		Total		71.85							

The result of selecting the road link priority is listed on Table 2. From Table 2, it can be seen that some of the prioritized links that needs to be covered in the road maintenance program are as follows:

- Link No.15   Jl. Ps.Kranggan – Lewinanggung
- Link No.10   Jl. Jati Asih – Bj. Menteng
- Link No.18   Jl. Pondok Gede – Ps.Kranggan
- Link No.34   Jl. KH Muhtar Tabrani
- Link No.76   Jl. Pondok Melati

From the results which is shown in Table 2, further process still needs to be carried out which not to be explained in this paper. Those process are of the following: calculation of cost estimation of the road maintenance program, identification of funding resources and planning of yearly road maintenance program.

5. SUMMARY AND CONCLUSSION

As explained before the objective of the study is to prrepare programs of road maintenance for urban / secondary roads in Kota Bekasi, West Java Province, Indonesia. To fulfill that objective, there are some steps that are undertaken, namely:

- Data collection
- Development road database and map
- Identification of prioritized improvement
- Calculation of cost estimation
- Identification of funding resources

Primary and secondary data are needed to collect for the purpose of updating the existing condition of road network system. Primary data are collected on some priority road links based on discussion with central and local government. The type of primary data are: traffic count survey and road inventory survey on the same links. The priority road links are further assessed with 2 (two) steps criteria to determine the most priority road links.

Prioritized road links are determined using some criteria, namely:

- Road function   10 %
- Road surface condition   40 %
- VC ratio   40 %
- Integration with Jabotabek development   10 %

Each priority link is assessed with the above criteria and the higher value indicate that those links are more priority than the others.

In the future it is important to maintain the road that will be treated in the road maintenance program. Some important aspect of road infrastructure should be taken into account on road maintenance program, such as:

- Road class
- Traffic volume on the road link
- Drainage system must work properly
- Road maintenance cost

Table 2. The List of Prioritized Road Links from Priority Location in Kota Bekasi

No	Link No.	Road Name	Length (km)	Road Width (m)	Function	RF Value	Pavement Type	Pavement Condition	PC Value	Volume (smp)	Capacity (smp)	VCR	VC Value	Integration Value	Total Value
1	015	Jl. Ps. Kranggan - Lewi Nanggung	4.25	7.00	LS	1	A	RB	5	842	2726	0.31	2	2	3.1
2	010	Jl. Jati Asih - Bj.Menteng	1.20	6.50	LS	1	A	RB	5	676	2321	0.29	1	2	2.7
3	018	Jl. Pd.Gede - Ps. Kranggan	9.70	7.00	LS	1	A	RB	5	342	2726	0.13	1	2	2.7
4	034	Jl. KH. Muktar Tabrani	3.10	7.50	LS	1	A	R	4	1104	2726	0.40	2	2	2.7
5	076	Jl. Pondok Melati	3.10	7.00	LS	1	A	RB	5	511	2813	0.18	1	2	2.7
6	00	Kranggan Kulon	1.00	8.50	LS	1	A	RB	5	188	3306	0.06	1	2	2.6
7	003	Jl. Pengasingan - Bt.Gebang	7.20	6.00	LS	1	A	RB	3	1444	2668	0.54	3	1	2.3
8	026	Jl. Caman - Cibening II	1.60	7.00	LS	1	A	SR	3	1296	2726	0.48	2	2	2.3
9	041	Jl. TM. Makam Pahlawan	2.80	8.50	LS	1	A	SR	2	2074	3042	0.68	3	2	2.3
10	033	Jl. KA. Bungur - Kp. Rorotan	3.00	4.00	LS	1	A	S	2	783	1527	0.51	3	2	2.3
11	031	Jl. Pejuang	4.40	9.00	LS	1	A	S	2	2021	3516	0.57	3	2	2.3
12	028	Jl. Pemuda	3.20	8.00	AS	3	A	S	2	1321	3306	0.40	2	2	2.1
13	077	Jl. Rawa Bugel	2.10	4.00	LS	1	A	S	3	184	1527	0.12	1	2	1.9
14	037	Jl. Perjuangan	6.20	9.00	LS	1	A	SR	2	1196	3625	0.33	2	2	1.9
15	036	Jl. Teluk Pucung - U.Harapan	1.30	8.00	LS	1	A	S	3	689	3516	0.20	1	1	1.8
16	023	Jl. Cibening II - Bj. Rawa Lele	2.80	8.50	LS	1	A	SR	2	694	3306	0.21	1	2	1.5
17	029	Jl. Ps.Kincan	2.90	10.00	LS	1	A	S	2	905	3741	0.24	1	2	1.5
18	025	Jl. Ps. Kincan - Cibening II	2.10	9.00	LS	1	A	S	2	931	3516	0.26	1	2	1.5
19	002	Jl. Dewi Sartika	1.20	6.50	LS	1	A	S	2	208	1551	0.13	1	1	1.4
20	006	Jl. Bt.Gebang - Cimuning	3.60	7.50	LS	1	A	S	2	204	2321	0.09	1	1	1.4
21	081	Perumnas IV	3.30	4.00	LS	1	A	S	2	0	1527	0.00	1	1	1.4
22	084	Jl. Pramuka	1.80	6.00	LS	1	A	S	2	0	2372	0.00	1	1	1.4
		Total	71.85												

REFERENCES

Japan International Cooperation Agency (JICA) (1999) **Study of Short-Term Secondary Road Maintenance Program for Jabotabek (Jakarta, Bogor, Tangerang, Bekasi)** PT. Innerindo Dinamika.

Shierly, LH (2000) **Penuntun Praktis Perencanaan Teknik Jalan Raya**. Politeknik Negeri Bandung Jurusan Teknik Sipil.

Silvia, S (1994) **Dasar-dasar Perencanaan Geometrik Jalan**. Penerbit Nova Bandung