

# 論文内容の要旨

## 1. BACKGROUND

In the early 1975 in Indonesia, municipal road infrastructure is rapidly built primarily using asphalt hot mix pavement technique. For 10-15 years, good services of municipal roads were enjoyed. However in the end of 1990 when traffic increased and city land-use change, the road conditions started to decreased. The needs for proper maintenance, rehabilitation and reconstruction program raised, which answered by national road agency attempt to adopt available Pavement Management System from The American Association of State Highway and Transportation Officials (AASHTO) and Highway Development Management (HDM) World Bank. However, the application was hampered with too large road network and limited capacity of national road agency to manage the whole road network. As consequence many municipal road sections had been untouched with proper maintenance and rapidly deteriorated. During decentralization periods based on Act No. 38 year 2004, the management of municipal road was shared to provincial and regency/city government as to closer distance of road agency to the actual municipal road condition.

However few city governments have capacity to manage their municipal road network and many remain struggle with local limitation in management. World Bank (1988) mentioned the requirement of technical, financial and institutional for sustainably deal with road deterioration. On the other hand, citizen demands for municipal road network to facilitate mobilization of passengers as well as goods inside the city and between cities are unstoppable driven by need for economic growth as represented by increase of traffic. Hence, there is continuous necessity to ensure good (physical) condition of road section as well as to deal with the increased demand as to deliver desired services to road users. The fact that city government efforts to preserve road network have not yet given satisfying result to the road user is creating citizen complaint/dissatisfaction to the management practice of city road agency as recorded in many newspaper media.

## **2. OBJECTIVE**

In order to seek suitable form of sustainable municipal pavement management system in Indonesia, first there is necessity to clarify citizen dissatisfaction to the stability of municipal road conditions and in the same time to understand current road management practice used by city government to preserve their road network. Therefore the objective of this study is as follow:

1. To refine our current understanding of association between municipal road conditions stability and road management of a city road section in Indonesia through
  - a. clarification of citizen dissatisfaction to the stability of municipal road conditions
  - b. investigation of the causes or effects of increasing/declining trend of municipal road conditions
  - c. analysis to discover what hampered city government in ensuring good conditions of municipal roads over the time.
2. Further, the study attempts to overcome the difficulty with complexity of real situation faced by city road agency in managing municipal road conditions.

## **2. LITERATURE STUDY**

### **Road pavement**

The main component of road section is pavement roadways. Pavement is the actual travel surface especially made durable and serviceable to withstand the traffic load commuting upon it. Like all structures, pavement deteriorates over time and has designed lifespan whether 20 or 40 years for flexible and rigid pavement. Typically, pavement deteriorates at an ever-increasing rate due to several factors affecting pavement performance as shown in Figure 1.

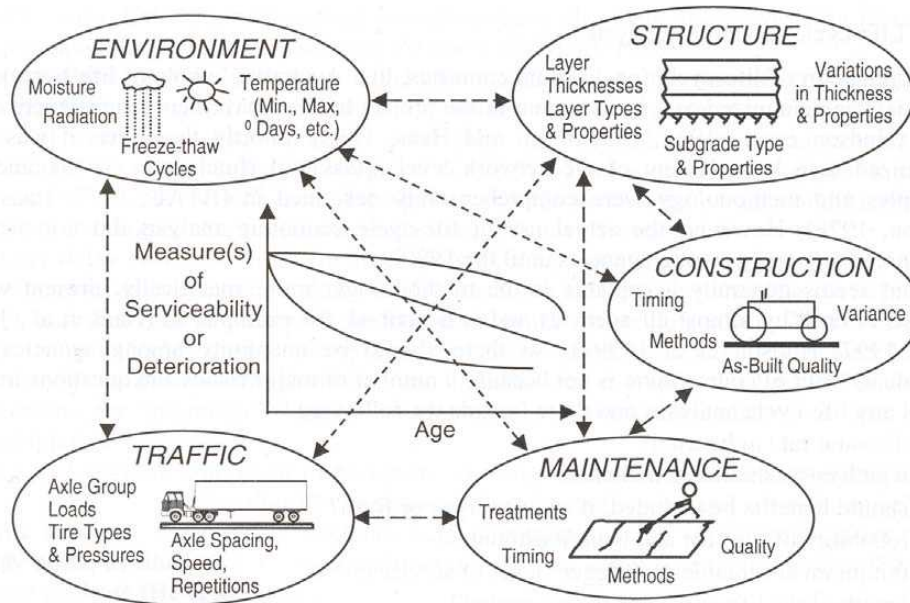


Figure 1 Factors affecting pavement performance (Haas 2003)

Ability to recognize and deal with all these factors over a life cycle municipal road is required to develop by city road agencies. Causes of each pavement distresses are mainly obtained through investigation on site related to these factors. Maintenance suggestion then recommended based on this findings and capacity of road agencies.

### Life cycle management of municipal roads

The life cycle of a municipal road can be represented in several phases: original road development, maintenance and operation phase and demolition phase. Here, demolition phase may be eliminated since reconstruction of new pavement will always be conducted to facilitate the traffic flow. Each phase requires sound management and continuous commitment in order not to inherit bad effect to the performance of pavement.

1. In management practice during original road development phase (recognition of public needs – feasibility – design – construction), the management determines required functions which will later affecting pavement performance, i.e.: design speed, design capacity, and maximum traffic load. The decision made with concern with many factors such as city size, projected traffic, geological condition, etc. Hence, any conditions which fall under projection of future needs for certain design road lifespan (20-40 years) can still be acceptable to provide riding comfort and safety for road user.
2. After original road being constructed, the road shall be ready for operation and expose to carry traffic and environment in order to provide the design levels of

service. Several controls to the traffic and preservation of drainage are commonly the main concern for involved actors, such as traffic management control, weight restriction, road cleaning, etc.

3. The management during maintenance is emphasized on better prioritization of MR&R program. Well known guidance for road maintenance and rehabilitation management has been referred for national road network M&R management in many country which then adapt for provincial and city/municipal condition, such as: The Pavement Design and Management Guide (the Transportation Association of Canada, 1997), the Pavement Management Guide (American Association of State Highway and Transportation Officials, AASHTO 2001). Fundamental principles of pavement management here can be represented by doing right thing at the right place, using the right type of material, with the right construction, with the right design details and all for the lowest total cost.

### **3. SURVEY METHODS**

The investigation was carried out in two stages: data collection and data analysis. Data was collected through interviews, reviews of planning, design and construction related documents, review on newspaper and cross-check field investigation. The first objective of the data collection was to elicit citizen dissatisfaction to the stability of road conditions that supported by evidences. The second objective was to capture an overview of the current road management practice used by the actors involved in life cycle of municipal road. The respondents were divided into agencies in the Cimahi city government, the police department, contractors, supervision consultants and road users. Documents mainly collected from the Highway department of Cimahi city government, beside records on newspapers. Field investigation was conducted in two cases studies which consist of road survey condition, manual traffic counting, hammer test for measuring concrete strength, and rainfall data collection.

The second part of the data collection phase was to review all collected data. The collected data was analyzed in the following steps:

1. To investigate citizen dissatisfaction to the stability of municipal road conditions which supported by evidences.
2. To identify current road management practice used by city government to preserve the road network which supported by evidences.
3. To identify possible causes of the identified problems of the stability of municipal road conditions and management factors that hampered city government

4. To proposed and modified current pavement management system in Cimahi city government in conformance with the basic principles of lifecycle municipal road (asset) management.

#### 4. PROBLEM DEFINITION

According to records of newspaper and field survey November and December 2014 on the two street cases, road user dissatisfaction to the Cimahi city road conditions can be classified into four:

- a. *Rapid decay of newly repaired pavement.* It was a condition when a newly repaired road segment show signs of premature pavement distress less than one year of operation.
- b. *Road deterioration on the move.* While gradual road repairmen fixes pavement distress in one location/segment of a street, pavement conditions in different location/segment changes, as example change from fair to poor condition which causes a large disparity on surface conditions between road segments in a single road section/street.
- c. *Many small volume of pavement distress in scattered location.* Concern to efficiency of limited resources may prevent immediate response to small volume of pavement distress which scattered in different location. Most of the time, capability of in-house repair work was very limited because external and internal problems in the Cimahi city's HD.
- d. *Slow drain of roadways during rainy days.* In some area after raining, small water pond had been experienced by road user. Rainfall were not collected into the existing ditches instead flowing on the roadways during rainy days and slowly drained from the roadways. In some cases, small water ponds were formed after rain stopped which infiltrate to the sub-base and reduced the pavement strength.

The analysis of current road management practices was conducted by classified the answer into 11 (eleven) subjects related to mandated levels of service, pavement inventory, presence of pavement performance prediction, identification of needs and prioritization, budgeting, project design, project implementation, and performance monitoring/road operation. From this analysis we can identified the causes and factor that hampered the road management to preserve road in good conditions.

### **Mandated levels of service**

1. Are there any standards levels of service (LoS) referred by HD?

Result: SPM for road (2)

Discussion: HD goal is in line to the compliance of National regulation.

2. Did HD translate the standard into a minimum road condition levels?

Result: Good-Fair-Poor-Very Poor (1)

Discussion: It is essential for HD to derive clear measures of what level of service is the HD expected or mandated to provide, e.g., the minimum acceptable LoS, trigger values for specific pavement preservation treatment, target LoS, and minimum safety-related LoS. The current rating condition is based on subjective observation of percentages area of pavement distress. It is still useful because it provide comparable measure to previous year condition.

However looking at the surrounding environment of the Cimahi city pavement, any type of condition rating taken should consider the following aspects into account:

- The severity and density of different pavement distresses: potholes, rutting, crack, etc
- Correction factor due to influence by other road component condition, such as shoulder condition, drainage condition, slope, land-use change, horizontal and vertical alignment.

At first, it is more likely to adopt a simple condition rating, such as Indonesian Guidance SK No. 77/KPTS/Db/1990 or Pavement Condition Index (PCI) AASHTO which can be conducted through manual observation.

### **Pavement inventory**

3. How frequent HD collects and records the actual road condition in a year?

Result: No schedule; individual data collection (0)

Discussion: The data collection was not reliable and inaccurate. The proposal submit to the City mayor 2014 to set up an in-house team including a schedule timetable for inspection of road and drainage condition is a good solution to ensure:

- Continuity of accurate and detailed information
- Reasonable resource allocation within the available time.

4. Did HD collectively update the road inventory?

Result: Once a year, but low accuracy (1)

Discussion: Updating report and documentation seems not yet a habit in HD. Automated mapping by applying Geographical Information System (GIS), centralized database, and smart phone application is likely required, which then should be validated in a routine internal HD meeting. It may offers practicability and few additional jobs to the current HD staff except for maintaining the automation system

#### **Presence of pavement performance prediction**

5. Did HD have a pavement performance prediction model?

Result: No (0)

Discussion: Providing more information to the engineers including pavement condition rating, trend of deterioration, type of distress, Annual Average Daily Traffic (AADT), truck volume, age of road, surface type, location, and maintenance issues could assist in better engineering judgment for preventive treatment and costlier maintenance.

Unplanned preservation may create continuous burden for HD staffs because it could increases difficulty on supply of material/equipment/labor, costlier preservation, less continuity of financial support, insufficient time for design/implementation process and to nurture a professional contractor/consultant.

#### **Identification of needs and prioritization**

6. How did HD identify the right roads to be maintained in a year? (right section at the right time)

Result: Depend mainly on public report related to deteriorated road/drainage (2)

Discussion: The fact that HD often depends mainly on the recapitulation of public reports collected from the previous year implies that pavement more likely receives maintenance after a hazard exists. Public reports represent public needs, but may not always represent the urgency in the network. However under limited number of staffs, preoccupied staffs to produce well-documented pavement inventory and to do proper investigation, it is an innovative solution to compile public aspirations from Pesduk and other communication media as a way to build an inventory list of deteriorated road and drainage. It demonstrated a responsive management to public

needs. Further, this compilation of public reports should be formalized into Standard Operating Procedure in HD to ensure its continuity of good practice.

From another point of view, each road section in the network requires equal attention. In the future, combination of the recapitulation of public request and the result of review for each road section shall provide better technical basis to justify the right section to be maintained. The review can be done simultaneously with updating road ledger process in interval 3 years. Road class can be referred as basic priorities, after that prioritizing worst condition (very poor condition) may be an option. Further, identification and prioritization of needs could be effectively accomplished by utilization of pavement management software. Formalize a clear criteria for selection and standard operation procedure are necessary.

7. How did HD determine the right treatment?

Result: Engineering judgment, available resource (2)

Discussion: Under circumstances of undeveloped data documentation and limited time/resource for design, trial based design may sound risky and wasting cost, but it is acceptable because road users can still passed the road section.

HD' option to limit the type of maintenance treatment is very reasonable. Consequently, supervision during construction may need to be improved to ensure a smooth riding surface, risk of cracks and final elevation of road to the drainage inlet and housing. In the future, it is necessary to enrich the knowledge to other technological innovation through training or collaboration with Indonesian Road Research Institute or company promotion of innovation in maintenance techniques.

### **Budgeting**

8. How the budgeting activity is conducted?

Result: Discussion with Urban Planning agency, Public Work department, Financial department (2)

Discussion: It is a good practice to make coordination with other agencies. However the discussion should always put priority to the approved and mandated standards and levels of service.

### **Project Design**



9. How the design being conducted?

Result: Contractual for package of works (1)

Discussion: Current design process is aimed to provide budget plan for construction, estimate the cost, provide the technical specification and drawing. Because limited time for project design usually it is not sufficient for contractor which caused contractor to deal with many unexpected conditions on site. This will affected quality of construction. Giving sufficient time for project design and develop a minimum requirement of design document is necessary. Available guidance can be referred.

**Project Implementation**

10. How the construction being conducted?

Result: In house management and Contractual with supervision (1)

Discussion: In house management requires to create work schedule and better management of labor material and equipment. It good start to based on reported road deterioration, but it would be even better if routine observation to road conditions is conducted. During construction, several unexpected condition occurred, especially related to the weather, traffic disturbance and social disturbance. This situation required to be reported in the construction reports. Supervisor need to have a check list of quality control on site and make sure to bridge communication between designer, client and contractor.

**Performance monitoring/ Road operation**

11. How the road being operated?

Result: Weak control for traffic and road cleaning (0)

Discussion: Improvement of traffic control especially for heavy vehicles in necessary. Road cleaning is also required to control problem of clogged ditches, garbage collection, road cleaning, etc. Coordination with other agencies is necessary such as with Police department and Cleaning department.

## 5. PROPOSED PAVEMENT MANAGEMENT SYSTEM FOR THE CIMAHY CITY GOVERNMENT

Basically proposed pavement management system for the Cimahi city government shall involved eight activities: (1) review of original road construction (2) establishment of levels of service (3) identification of needs (4) prioritization of needs (5) budgeting (6) project design (7) project implementation (8) road operation and control.



Figure 2 Proposed municipal road management for Cimahi city

By following this concept, the road agencies shall than identified the specific measure of action considering the available resources in each location.