

## Development of Parameters of Road Conditions based on Road User/Citizen Satisfaction

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### Abstract

The study focused on the parameters of road conditions in a city road network in Indonesia. It also assessed the satisfaction level of road users/citizens within two streets in Cimahi city, Indonesia. In achieving this objective, literature reviews and opinions of 30 road users/citizens for each street were sampled using two key questions. The data collected were analysed using descriptive statistics. The analysis revealed that the satisfaction level of road users/citizens is 2.53 and 1.67 respectively, which conforms to the result of a road condition survey in the two streets. The reasons for satisfaction based on the road users'/citizens' perspective were the good physical conditions of the road/drainage. In contrast, the reasons for dissatisfaction were unstable physical road conditions related to city maintenance activities, late/deferred maintenance and inappropriate maintenance. Road users/citizens found such maintenance activities contributed to four specific physical conditions of roads/drainage in the city: a small volume of pavement distress in scattered areas, moving road deterioration, seasonal floods and water ponds and the rapid decay of newly paved roads. The physical conditions also conform to the result of a road conditions survey for the two streets. Besides this, other physical conditions of roads/drainage contributing to unstable road conditions found by an expert are unconnected road networks due to natural disasters. The study recommended the five physical conditions of roads/drainage as a new set of parameters for road conditions for the city network in Indonesia. The new set of road condition parameters can be applied to benchmark and compare a city road condition for each parameter and also display the derived overall road performance.

*Keywords:* Parameters of Road Conditions; Road User/Citizen Satisfaction; Physical Conditions of Roads/Drainage; Maintenance Activity

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### 1. Introduction

For a road agency, maintaining a road/drainage network is a vital task. A lack of proper and timely maintenance will result in a reduction of stable road conditions and unreliable road transportation services. This condition, in the end, will lead to heavy and costly maintenance. Since the resources available to maintain road networks are limited, careful monitoring and planning and the optimization of maintenance strategies should take place. In order to be able to spend the available resources for road maintenance in an optimal way, pavement maintenance systems are essential [1]. A pavement management system (PMS) is a systematic asset management practice introduced in 1970. It consists of four elements: data collection, a data storage process, data analysis (PMS software, data analysis, performance prediction) and maintenance programming (budget prediction, engineering plan, action plan). Basically, PMS relies on a set of parameters of road conditions to be collected, stored and analysed. However, a study stated that there is a problem of communication among stakeholders regarding the parameters of road conditions [2]. A study by WSDOT also showed that PMS is associated with many costs for training, software development, data collection, etc. These cause fundamental challenges for many road agencies both in developed countries and developing countries in fully applying PMS.

#### 1.1. Statement of the problem

The present parameter of road conditions in Indonesia is a percentage of the total length of stable road in the network, which has been used as an indicator for city government performance reports. However, the parameter does not sufficiently represent road users'/citizens' demands for high quality road conditions in the present and in the future. Road users'/citizens' complaints about roads received by the city road agency tend to increase each year. It has also been observed that, although some cities use a visual road conditions survey, a lack of proper measurement and documentation exists due to the limitations of inspectors or survey data. The present parameters of road conditions (length of good road, International Roughness Index (IRI), rut depth, Pavement Condition Index (PCI), skid resistance, accident rate, maintenance cost, road user cost, etc.) do not include all aspects of concern for road users/citizens. Some are too technical and government performance oriented.

Therefore, there is a need to assess the satisfaction level of road users/citizens in terms of city road conditions and to investigate the reasons for this satisfaction level. This information will be useful to improve parameters of road conditions used for making decision of city road/drainage maintenance activities.

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## 1.2. Goal

To develop a new set of parameters of road conditions for the city network in Indonesia based on the road user/citizen satisfaction.

## 1.3. Objectives

The objectives of this study are described.

- To assess the satisfaction level of road users/citizens in terms of road conditions.
- To determine the reasons for satisfaction/dissatisfaction on the part of road users/citizens regarding road conditions.

## 2. An Overview of the Parameters of Road Conditions

Variance in the measurement and reporting of road conditions across municipalities are exists. Each road agency uses different parameters depending on the purpose of the use of the information. Initially, road performance is assumed as a pavement condition, which gives services to road users within a specific design period. Furthermore, road performance is divided into 3 parts:

- Safety is determined by friction caused by the contact between wheels and the road surface.
- Structural capacity is a related physical condition of a road, which be influenced by traffic load and the environment.
- Serviceability is related to how pavement provides a service to a road user.

Most of road agencies in Indonesia uses the percentage of stable road conditions in the network as a parameter of road conditions. It is also noticed that not all cities conducted proper measurement and documentation of the parameters due to the high maintenance workload. An insufficient number of personnel and a lack of equipment are claimed as some of the reasons for the high maintenance workload.

Sample in a big country like Australia showed that only 71% of councils collected all the parameters set up in Austroads according to Austroads Report IR-28/02. Moreover, 97% of those that collected condition data employed visual assessment methods. In contrast, 43% collected roughness, although only half used automated means, and 33% collected rut depth. Very few councils collected structural capacity, skid resistance and surface texture data. The following table shows Austroads condition parameters for sealed and unsealed roads. Another key findings in this report is that whilst most councils used indicators based on those in table 1, converting these indicators to remaining life and overall useful life is a significant difficulty and a source of major variation in practice.

Table 1 Condition parameters for sealed local roads and unsealed local roads (Austroads 2001)

Issue	Condition Parameter	Measurement of reporting unit	Priority
<b>For Sealed Local Roads</b>			
Safety	Edge defect	Sum of the length of edge break and edge	1
Safety	Rutting	% length with rutting > 20 mm	1
Serviceability	Roughness	NRM Roughness weighted by area	1
Safety	Skid resistance	% length F60 < 0.12, or SFC50 < 0.35	2
Safety	Surface texture	% length Vp < 34 or texture depth < 0.40 mm	2
Structural capacity	Structural capacity	% areas > 5 years remaining life	2
Structural capacity	Structural capacity	% area of road surface	2
Serviceability	Crocodile cracking	% area of road surface	3
Serviceability	Potholes and pothole patches	Number per km	3
Serviceability	Environmental cracking	% area of road surface	4
<b>For Unsealed Local Roads</b>			
Structural capacity	Gravel loss	Gravel loss in mm	1
Serviceability	Roughness	Roughness weighted by area	2

## 3. Methodology

This research was conducted using two case studies of streets in Cimahi city, West Java province, Indonesia: Mahar martanegara (MM) Street and Kerkof (K) Street. These two streets were recommended by officers of the Cimahi road agency. Moreover, these two streets were selected as case studies due to the similar road function and frequency of reported deterioration.

Two key questions were designed for this study and were directed to the road users/citizens through face to face interviews:

- Are you satisfied with the road conditions in each street? Please rate on a scale 1 to 3 (satisfied – neutral – unsatisfied).
- What are your reasons?

A total of thirty responses (30) for each street were collected and used for the analysis.

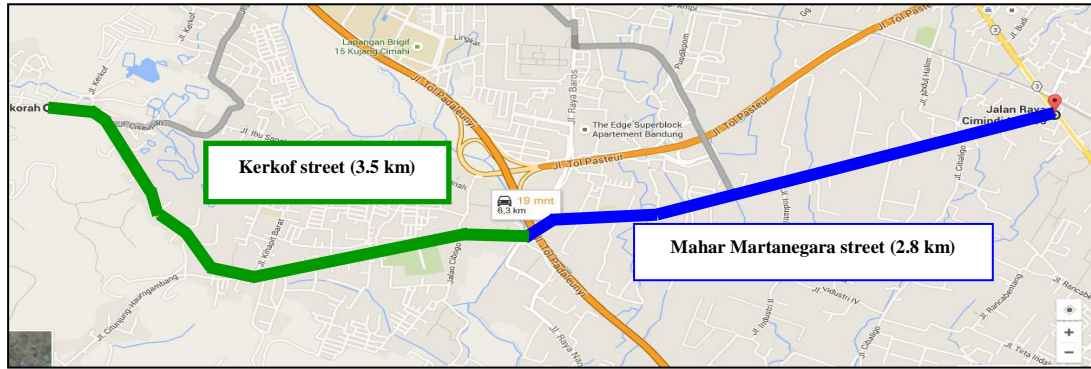


Figure 1 Location of the surveya

The study involved visual road condition surveys and correlation analyses. The investigations were conducted at an interval of 100 meters in total length of road, 6300 meters. The test followed SK No. 77/KPTS/Db/1990 Technical Guidance for Planning and Programming Regency Road developed by the Directorate General of Highways, Ministry of Public Works of Indonesia. The functional and structural performance of the pavement for local roads in Indonesia is commonly determined in terms of subjective distress scoring.

In this study, following the guideline, the main components observed were as follows:

a. Type of surface

Based on observation, the type of surface in each segment was recorded as Asphalt (A), Concrete (C), Rocks (R), Gravel (G) or Soil (S)

b. Pavement conditions

Surface conditions of the paved roads being observed were subjectively assessed as follows:

- Good (G) : smooth riding comfort, dense texture.
- Fair (F) : fair roughness, open texture, shallow open surface for less than 50% of the area.
- Fair-Poor (FP) : if difficult to differentiate between fair and poor conditions
- Poor (P) : a rough and exfoliated surface, some damage is deep.
- Very Poor (VP) : cracks and exfoliated pavement, many cracks are deep.

c. Level of pavement distress (% of area)

The type of pavement distress and its severity were measured in intervals of 100 meters using the following rating score.

Table 2 Rating score paved road

TYPE OF DISTRESS	PAVED ROAD			
	1 GOOD	2 FAIR	3 POOR	4 VERY POOR
B. Pothole	0–1	1–5	5–15	>15
C. Uneven surface	0–5	5–10	10–50	>50
D. Crack	0–3	3–12	12–25	>25
E. Rutting	0–3	3–5	5–25	>25

Table 3 Rating score for unpaved road

TYPE OF DISTRESS	UNPAVED ROAD			
	1 GOOD	2 FAIR	3 POOR	4 VERY POOR
F. Potholes	0–3	3–10	10–25	>25
G. Soft spot	0–3	3–10	10–25	>25
H. Surface erosion	0–3	3–10	10–25	>25
I. Rutting	0–5	5–15	15–50	>50
J. Uneven surface	0–3	3–10	10–50	>50

d. Shoulder

The evaluation of shoulders was conducted using the following scoring system.

1 = Good shape and slope

- 2 = Poor shape and slope
- 3 = Shoulder is too high/low < 10 cm, debris/garbage
- 4 = Shoulder is too high/low >10 cm or no road shoulder although it is necessary

e. Superelevation/Cross slope

Superelevation is the vertical distance between the heights of inner and outer edges of highway pavement. The evaluation of the superelevation of the roadway cross slope was measured using the following scoring system.

- 1 = Good: 4%–2%
- 2 = Moderate: 2%–0%, (almost flat)
- 3 = Poor: uneven surface, poor slope
- 4 = Very poor: no shape

f. Drainage

The drainage condition was evaluated using the following scoring system.

- 0 = None, unrequired
- 1 = Good
- 2 = Fair (cleaning is required)
- 3 = Poor (small repair is required)
- 4 = Heavy damage
- 5 = None, but required

#### 4. Method of data analysis

The data collected were analysed using statistical analysis so as to obtain a descriptive statistic. The explanatory analysis was also used to extract the reasons for the satisfaction level. Analysis of road condition surveys was done to confirm road user/citizen perception in terms of existing road conditions on site. The results of the road conditions survey in two streets was then used in a correlation analysis between road drainage conditions and road surface conditions and the planning of the maintenance required. The correlation analysis measured the relationship between the score of drainage (point f) and the total score of the level of pavement distress, for the shoulder and superelevation (points c–e). The planning of possible maintenance required identified the location of the immediate need for road drainage rehabilitation projects.

#### 5. Analysis of data

Below are the analysis and the results of data collected from the face-to-face interviews as extracted from the data collection instrument.

a. *Assessment of the satisfaction level of road users/citizens in terms of the road conditions*

The study showed that the satisfaction levels of road users/citizens in terms of MM street and K street were **2.53** and **1.67**. The satisfaction level of MM street was higher than that of K street, which indicated that MM street has better road conditions compared to K street. To confirm this assumption, the road conditions survey were evaluated.

Table 4 Satisfaction level of road users/citizens regarding the two observed streets

Satisfaction	MM street		K street		Total Score
	Number of Road Users	Score (scale x number)	Number of Road Users	Score (scale x number)	
1 = Unsatisfied	3	3	10	10	13
2 = Neutral	8	16	20	40	56
3 = Satisfied	19	57	0	0	57
Total	30	76	30	50	126
Average score		2.53		1.67	2.10

b. *Identification of reasons for the satisfaction/dissatisfaction of road users/citizens in terms of the road conditions*

Satisfaction levels were associated with conditions of physical roads/drainage and their functions. Good and well-functioning physical conditions of roads/drainage gave satisfaction to road users/citizens; in contrast, unstable road conditions made road users/citizens unsatisfied. The survey's result showed that respondents associated these conditions with imperfection in maintenance activities. The results were as follows:

- i. Late deferred maintenance. This is related to the slow response of the road agency in repairing poor road conditions. Road users/citizens associated the reasons of this type of maintenance problems with several physical conditions of roads/drainage:

- A small volume of pavement distress in a scattered area  
Concern with the efficiency of limited resources may prevent an immediate response to a small volume of pavement distress, which is scattered in different and far locations. The road agency tends to concentrate repairs in some areas due to a concern with efficiency. Most of the time, the capability of in-house repair work is very limited because of external and internal problems in Cimahi city's road agency. The main cause of this phenomenon is basically related to the poor quality of maintenance. This could be wrong maintenance treatment, poor material quality or poor maintenance construction. Traffic and rainwater factors are always involved in this deterioration scheme.
  - Moving road deterioration  
Cimahi city road agency practices this gradual maintenance work. While repairmen were fixing pavement distress in a specific road segment, pavement conditions in different road segments of the same road network were reducing. Other road segments, which are not repaired, could be changed from a fair to poor condition, which causes a large disparity for surface conditions among road segments in a single road section/street. Hence, when the gradual repair works were not frequent enough to match deterioration rate, moving road deterioration was occurred. The main cause of this phenomenon is basically related to ageing roads and the discontinuity of maintenance treatment; moreover, the influences of heavy vehicle traffic and water infiltration to the pavement are also accelerating the rate of deterioration.
  - Seasonal floods and water ponds caused by the slow drainage of rainwater  
In some areas, small water ponds are experienced by road users after rain. Rainwater does not accumulate in existing ditches due to small inlets, clogged inlets, the higher elevation of inlets compared to road elevation, the small capacity of available ditches and unconnected drainage. The rainwater flows on the roadways during rains and slowly drains from the roadways. In some cases, small water ponds are formed after the rain stops. The water infiltrates to the sub-base and reduces the pavement strength. The main cause of this phenomenon is basically related to an inadequate drainage system, uneven pavement surface or inadequate super elevation in the cross-section of roads (usually 1–2%).
- ii. Inappropriate maintenance treatment. Although maintenance treatment has been performed, many times, it does not solve a road/drainage problem. A poor condition of the road/drainage remains. Road users/citizens also experience that maintenance work is slow and is conducted by unskilled workers causing traffic jams. Road users/citizens associated the reasons of this type of maintenance problems with several physical conditions of roads/drainage:
- Rapid decay of newly repaired pavement  
This is a condition when a newly repaired road segment shows signs of premature pavement distress in less than one year of operation. This should not happen, and something is wrong. It is necessary to determine whether the design or specifications of maintenance treatment/supplied material/equipment or workmanship are inadequate or not. The symptom of this phenomenon can be identified through the occurrence of a weak spot after the maintenance project completion. Furthermore, traffic and rainwater factors are always involved in this type of deterioration.

Enriched the surveys result, author added another cause of dissatisfaction of road conditions. Because of geological conditions in North Cimahi district and cases in other areas in Indonesia, the author considers that unconnected road networks due to natural disasters (erosion, flood, etc.) should be added as a reason. Particularly for unpaved roads, heavy rainfall could cause an unconnected road network. A summary of the overall reasons given by road users/citizens are shown in the following table.

Table 5 Reasons given by road users/citizens

Reasons for satisfaction: good and well-functioning physical conditions of roads/drainage.		
Reasons for dissatisfaction: unstable road conditions.		
Caused by	Description	Physical conditions of road/drainage
Late/deferred maintenance :	<ul style="list-style-type: none"> <li>• A slow response of the road agency to repair</li> </ul>	<ul style="list-style-type: none"> <li>• A small volume of pavement distress in a scattered area</li> </ul>
		<ul style="list-style-type: none"> <li>• Moving road deterioration</li> </ul>
		<ul style="list-style-type: none"> <li>• Seasonal floods and water ponds caused by slow drainage of rainwater</li> </ul>
Inappropriate maintenance :	<ul style="list-style-type: none"> <li>• The maintenance treatment did not solve the road/drainage problem</li> </ul>	<ul style="list-style-type: none"> <li>• Rapid decay of a newly paved road</li> </ul>
	<ul style="list-style-type: none"> <li>• A slow process of repair and unskilled workers</li> </ul>	
Natural disasters:	<ul style="list-style-type: none"> <li>• Unconnected road network</li> </ul>	<ul style="list-style-type: none"> <li>• Unconnected road network</li> </ul>

*The development of a new set of parameters for road conditions for the city network in Indonesia based on road user/citizen satisfaction.*

From the survey result, the physical conditions of road that cause road users dissatisfaction can be identified and used as parameter for conditions of road. The number of opinions for the proposed parameter for conditions of roads for each street showed that seasonal flooding was the main physical condition that disturbed most road users/citizens in both streets. Small pavement distress in a scattered area was the second parameter that occurred in both streets. All road users/citizens perceived that all the parameters occurred in K street. While result of MM street showed more variation, only 17 and 16 respondents respectively experienced moving road deterioration and rapid decay of a newly paved road in MM street. All respondents also agreed that they had never experienced an unconnected road network in both streets.

Table 6 Number of opinions

Proposed parameter for conditions of roads	Number of opinions		Other sources
	MM	K	
• A small volume of pavement distress in a scattered area	23	30	
• Moving road deterioration	17	30	Interview
• Seasonal floods and water ponds caused by slow drainage of rainwater	<b>30</b>	<b>30</b>	
• Rapid decay of a newly paved road	16	30	
• Unconnected road network	0	0	Newspaper articles

Based on the column of conditions of road surface, the ratio of the length of roads in Good : Fair : Poor conditions was calculated. The ratio of the length of roads in Good : Fair : Poor conditions for MM and K street is 75 : 14.3 : 10.7 and 31.4 : 34.4 : 34.3 respectively. The length of road in good condition for MM street was longer than that for K street. This positive correlation of satisfaction level and existing road conditions indicated that the reasons for the satisfaction/dissatisfaction of road users/citizens can be used as a basis to develop a new set of parameters for road conditions.



Figure 2 Left: Water ponds in MM and K street, Right: Pavement distress in MM and K street

Observed physical conditions of roads:

- i. A small volume of distress in a scattered area

The bigger rating of pavement distress showed poor conditions. From both road survey conditions tables, small pavement distress and many types of distress can be identified.

## ii. Seasonal floods and/or water ponds

Correlation analyses of the data showed a closely dependent relationship between drainage conditions and pavement distress/other component conditions: 0.53 in M Street and 0.74 in K Street.

## iii. Moving road deterioration

From the result of the road condition survey in K street, a segmental condition of the road can be observed: STA. 1+300 – 2+000 and STA. 3+100 – 3+500. These conditions indicated gradual maintenance, which, in the end, could lead to moving road deterioration.

## iv. Rapid decay of newly paved road

Some newly paved road repairs in 2013 showed some pavement distress as shown in the Figure 2.

Table 7 Result of the road condition survey for Mahar martanegara Street

ROAD CONDITION SURVEY															
Date		: November 2014													
Street		: Mahar Martanegara street													
TIME	KM	ROAD SURFACE			VIDEO MIN	ROAD CONDITION SUMMARY Odometer	5	4	4	4	4	4	4	SCORE (max 29)	Possible repair/ maintenance treatment
		Type	Condt.	Width (m)			Drainage M	Pothole B F	Uneven C G	Crack D H	Rutting E I	Shoulder L J	Slope K K		
9:27		A	G	8	9:14	2+800	1	1	1	1	1	2	8		
		A	G	8	8:55	2+700	1	1	1	1	1	2	8		
		A	G	8	8:35	2+600	1	1	1	1	1	2	8		
		A	G	5	8:13	2+500	4	1	1	1	1	3	2	13	Drainage
		A	G	5	7:50	2+400	5	1	1	1	1	3	2	14	Drainage
		A	G	5	7:32	2+300	5	1	1	1	1	3	2	14	Drainage
		A	G	5	7:19	2+200	3	1	1	1	1	3	2	12	
		A	G	5	7:01	2+100	3	1	1	1	1	2	2	11	
		A	F	6	6:50	2+000	4	1	1	2	1	2	2	13	Drainage Repair
		A	F	6	6:30	1+900	2	2	2	3	1	2	2	14	Drainage Rehab
		A	F	6	6:13	1+800	3	1	2	3	1	1	2	13	Drainage Rehab
		C	G	6	5:30	1+700	3	1	2	1	1	2	2	12	
		A	P	6	5:06	1+600	3	1	2	2	1	2	2	13	Drainage Rehab
		A	P	6	4:51	1+500	5	4	2	2	1	4	2	20	Drainage Rehab
		A	P	6	4:30	1+400	5	2	2	2	1	4	2	18	Drainage Rehab
		C	G	6	4:08	1+300	4	1	2	2	1	3	2	15	Drainage Repair
		C	G	6	3:52	1+200	3	1	2	2	1	2	2	13	Drainage Repair
		C	G	6	3:45	1+100	2	1	1	1	1	3	2	11	
		C	G	6	3:32	1+000	2	1	1	2	1	2	2	11	
		A	G	5	3:14	0+900	2	1	1	1	1	2	2	10	
		A	G	5	3:08	0+800	2	1	1	1	1	2	2	10	
		A	G	5	2:58	0+700	2	1	2	1	1	3	2	12	Repair
		A	G	6	2:48	0+600	3	1	2	1	1	3	2	13	Drainage Repair
		A	G	6	2:36	0+500	4	1	1	1	1	3	2	13	Drainage
		A	G	6	2:10	0+400	3	1	2	1	1	2	2	12	
		A	G	6	1:54	0+300	2	1	2	1	1	2	2	11	
		A	G	6	1:25	0+200	2	2	1	1	1	2	2	11	
		A	G	6	1:07	0+100	3	1	1	1	1	2	2	11	
9:17		A	F	6	0:26	0+000	2	2	3	1	1	2	2	13	Drainage Repair

TYPE OF SURFACE : A: Asphalt, C: Concrete, R:Rocks, G: Gravel, S:Soil

PAVEMENT CONDITION : G: Good, F:Fair, P: Poor, VP:Very Poor

SURFACE CONDITION OF PAVED Rd : G: dense texture, F: open texture, P: rough and exfoliate, VP: crack and exfoliate

SHOULDER FOR PAVED ROAD : 1. good shape and slope, 2. poor shape and slope, 3. high/low &lt;10 cm, debris/garbage, 4. &gt;10 cm or no road shoulder

SUPERELEVATION/CS-SLOPE : 1. 4%-2%, 2. 2%-flat, 3. flat but uneven, 4. no shape

DRAINAGE : 0: none, unrequired, 1: good, 2: fair (cleaning is required), 3: poor (small repair is required), 4: heavy damage, 5: none, but required

LEVEL OF PAVEMENT DISTRESS (% OF AREA)

TYPE OF DISTRESS	PAVED ROAD			
	1 GOOD	2 FAIR	3 POOR	4 VERY POOR
B. Pothole	0-1	1-5	5-15	>15
C. Uneven surface	0-5	5-10	10-50	>50
D. Crack	0-3	3-12	12-25	>25
E. Rutting	0-3	3-5	5-25	>25

TYPE OF DISTRESS	UNPAVED ROAD			
	1 GOOD	2 FAIR	3 POOR	4 VERY POOR
F. Potholes	0-3	3-10	10-25	>25
G. Soft spot	0-3	3-10	10-25	>25
H. Surface erosion	0-3	3-10	10-25	>25
I. Rutting	0-5	5-15	15-50	>50
J. Uneven surface	0-3	3-10	10-50	>50



Table 8 Result of the road condition survey for Kerkof Street

**ROAD CONDITION SURVEY**

Date : November 2014  
Street : Kerkof street

TIME	KM	ROAD SURFACE			VIDEO MIN	ROAD CONDITION SUMMARY Odometer	5	4	4	4	4	4	SCORE (max 29)	Possible repair/maintenance treatment	
		Type	Condt.	Width (m)			Drainage	Pothole	Uneven	Crack	Rutting	Shoulder			Slope
							M	F	G	H	I	J			K
		A	VP	5	10:29	3+500	5	4	4	4	1	4	2	24	Drainage Reconst
		A	VP	5	9:50	3+400	5	4	4	4	1	4	2	24	Drainage Reconst
		A	VP	5	9:35	3+300	5	4	4	4	1	4	2	24	Drainage Reconst
		A	VP	5	9:22	3+200	5	4	4	4	1	4	2	24	Drainage Reconst
		A	VP	5	9:02	3+100	5	4	4	4	1	4	2	24	Drainage Reconst
		C	G	5	8:54	3+000	2	1	3	2	1	3	2	14	Reconst
		C	G	5	8:35	2+900	2	1	1	2	1	3	2	12	
		C	G	5	8:22	2+800	2	1	1	2	1	3	2	12	
		C	F	5	7:58	2+700	2	1	2	3	1	3	2	14	Repair
		C	G	5	7:30	2+600	2	1	1	2	1	2	3	12	
		C	G	5	7:18	2+500	2	1	2	2	1	2	2	12	
		C	G	5	7:00	2+400	2	1	2	2	1	2	2	12	
		C	G	5	6:47	2+300	2	1	2	2	1	2	2	12	
		C	G	5	6:30	2+200	3	1	2	2	1	2	2	13	Drainage Repair
		C	G	5	6:09	2+100	3	1	2	2	1	2	2	13	Drainage Repair
		C	VP	5	5:40	2+000	4	4	4	4	1	4	2	23	Drainage Reconst
		C	VP	5	5:23	1+900	4	4	4	4	1	4	2	23	Drainage Reconst
		C	P	5	4:55	1+800	3	2	3	3	1	3	2	17	Drainage Reconst
		C	P	5	4:40	1+700	3	2	3	2	1	3	2	16	Drainage Reconst
		C	F	5	4:20	1+600	4	2	2	2	1	2	2	15	Drainage Reconst
		C	P	5	4:03	1+500	4	3	3	2	1	2	2	17	Drainage Reconst
		C	P	5	3:51	1+400	4	2	4	4	1	3	2	20	Drainage Reconst
		C	P	5	3:31	1+300	4	2	3	3	1	3	2	18	Drainage Reconst
		C	F	5	3:23	1+200	2	1	3	2	1	2	2	13	Repair
		C	F	5	3:10	1+100	2	1	3	2	1	2	2	13	Repair
		C	F	5	2:50	1+000	2	1	2	2	1	2	2	12	
		C	F	5	2:39	0+900	2	1	2	2	1	2	2	12	
		C	F	5	2:20	0+800	2	2	2	2	1	2	2	13	Rehab
		C	F	5	2:08	0+700	2	1	2	2	1	2	2	12	
		C	F	5	1:55	0+600	2	3	2	2	1	2	2	14	Rehab
		C	G	5	1:39	0+500	3	1	1	2	1	2	2	12	
		C	G	5	1:22	0+400	3	1	1	2	1	0	2	10	
		C	F	5	0:56	0+300	3	1	1	2	1	0	2	10	
		C	F	5	0:46	0+200	3	1	1	2	1	0	2	10	
		A	F	5	0:20	0+100	4	2	2	2	1	4	2	17	Drainage Repair
9:40		A	G	5	0:05	0+000	4	1	1	1	1	4	2	14	Drainage Repair

TYPE OF SURFACE : A: Asphalt, C: Concrete, R:Rocks, G: Gravel, S:Soil  
 PAVEMENT CONDITION : G: Good, F:Fair, P: Poor, VP:Very Poor  
 SURFACE CONDITION OF PAVED Rd : G: dense texture, F: open texture, P: rough and exfoliate, VP: crack and exfoliate  
 SHOULDER FOR PAVED ROAD : 1. good shape and slope, 2. poor super-elevation, 3. high/low <10 cm, debris/garbage, 4. >10 cm or no road shoulder  
 SUPERELEVATION/CS-SLOPE : 1. 4%-2%, 2. 2%-flat, 3. flat but uneven, 4. no shape  
 DRAINAGE : 0: none, unrequired, 1: good, 2: fair (cleaning is required), 3: poor (small repair is required), 4: heavy damage, 5: none, but required  
 LEVEL OF PAVEMENT DISTRESS (% OF AREA)

TYPE OF DISTRESS	PAVED ROAD			
	1 GOOD	2 FAIR	3 POOR	4 VERY POOR
B. Pothole	0-1	1-5	5-15	>15
C. Uneven surface	0-5	5-10	10-50	>50
D. Crack	0-3	3-12	12-25	>25
E. Rutting	0-3	3-5	5-25	>25

TYPE OF DISTRESS	UNPAVED ROAD			
	1 GOOD	2 FAIR	3 POOR	4 VERY POOR
F. Potholes	0-3	3-10	10-25	>25
G. Soft spot	0-3	3-10	10-25	>25
H. Surface erosion	0-3	3-10	10-25	>25
I. Rutting	0-5	5-15	15-50	>50
J. Uneven surface	0-3	3-10	10-50	>50



## 6. Conclusion

The study has revealed that the satisfaction level of road users/citizens for MM street and K street is 2.53 and 1.67 respectively. This positively correlates with the result of the road condition survey for the two streets. The ratio of the length of road in good : fair : poor conditions for MM and K street is 75 : 14.3 : 10.7 and 31.4 : 34.4 : 34.3 respectively. The length of road in good condition for MM street was longer than that for K street. This positive correlation of satisfaction level and existing road conditions indicated that the reasons for the satisfaction/dissatisfaction of road users/citizens can be used as basis to develop a new set of parameters of road conditions.

As for the reasons for satisfaction/dissatisfaction, the road users'/citizens' perspectives were extracted from the face-to-face interviews. The reasons for satisfaction based on the road users'/citizens' perspective were good and well-functioning physical conditions of roads/drainage. In contrast, the reasons for dissatisfaction were unstable physical road conditions related to city maintenance activities: late/deferred maintenance and inappropriate maintenance. Road users/citizens found that such maintenance activities contributed to four specific physical conditions of roads/drainage in the city: a small volume of pavement distress in a scattered area, moving road deterioration, seasonal floods and water ponds and a rapid decay of newly paved roads. The physical conditions were found in the result of the road conditions survey for the two streets. Besides this, another physical condition of roads/drainage contributing to unstable road conditions found by experts is an unconnected road network due to a natural disaster, although this had not occurred in the two streets.

## 7. Recommendation

The study recommends the five physical conditions of roads/drainage as a new set of parameters of road conditions for the city network in Indonesia. The new set of road condition parameters can be applied to benchmark a city road condition for each parameter and also to display the derived overall road performance. The new set of road condition parameters allows comparisons within the city road network (with the option to display a city's best road condition) for each of the five parameters and the overall road performance.

Further, road performance can be measured as the weighted average of a city's scores on four key dimensions:

- 1) A small volume of pavement distress in a scattered area
- 2) Moving road deterioration
- 3) Seasonal floods and water ponds
- 4) Rapid decay of newly paved road
- 5) An unconnected road network

The scorecards can be used to demonstrate comparative performance. The dimensions are shown on a scale (lowest score to highest score) from 1 to 5, relevant to the possible comparison groups of all city road networks.

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