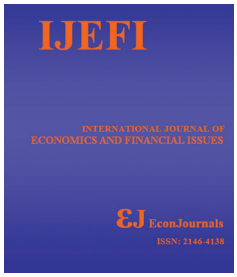

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Enhancing a Better Operation Management of Indonesian Toll Road

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ABSTRACT

In line with Indonesian Government policy to develop toll road network extensively, the operation of existing toll road need to be improved to ensure a safety, smooth and efficient of toll traffic flow. One of its aspect related to toll operation and service system applied. Minimum service standard (MSS) are some parameters that adopted to measure the performance of toll road and consists of road condition, average traffic speed, accessibility, mobility, safety and support unit/emergency or accident response. To enhance the toll road service in Indonesia, the MSS need to be revised. The revision including improvement of values of indicators and their measurement methods as well as add some new substances and indicators. Expectation of increasing this MSS are to increase the quality and level of service of the toll roads, both in safety and comfort given to the user as well as consider the effect of the toll road to the environments surrounding. This paper describe the aspects that was considered in improving the MSS, both the parameters and its measurements, including their standard and references. Finally, the revision draft of MSS that proposed to be adopted by Ministry of Public Work is also presented.

Keywords: Indonesian Toll Road Minimum Service Standard, Operation System, Accessibility, Mobility
JEL Classifications: M000

1. INTRODUCTION

In accordance with Indonesian Government policy to extensively develop toll road network as part of national road, the existing toll network has to be optimally operated to accommodate traffic flow smooth, safe and efficient. One of the operation aspects is related to minimum service standard (MSS) applied.

MSS is some of the parameter related to physical condition of the toll road and service given to the user. In this case, the MSS is indicator that used to be seen from operator and user perspective point of view. From operator side, MSS is considered as level of performance, whereas from user side, MSS can be considered as level of service. The complete MSS parameter are include: Road condition (skid resistance, roughness and number of potholes), Average traffic speed, accessibility (transaction time and number of toll gate), mobility (response of emergency), safety (condition of traffic sign, marking, guide post/reflector, road lighting, fence, accident handling, law enforcement) and supporting units (ambulance, rescue, patrols, information/communication system). MSS is regulated in Ministry of Public Work Regulation No 392/PRT/M/2005 about Toll Road MSS, as shown in Table 1.

In order to improve toll road quality and service, this MSS need to be improved as well. This could be done by reviewing parameter and measurement method in existing MSS. The expectation of improved MSS are to improve quality and level of service, both in term of safety and comfort and also to include the impact of the toll road to the surrounding environment.

Table 1: Toll road minimum service standard

No	Service substance	Minimum service standard			Goal for user
		Indicator	Scope	Measurement	
1	Toll road condition	Skid resistance	Toll road segment	> 0,33 µm	Safety
		Roughness	Toll road segment	IRI≤4 m/km	Comfort and safety
		No potholes	Toll road segment	100%	Comfort and safety
2	Average speed	Average speed	Urban toll road	≥1,6 times average speed in non-toll road	Smooth flow
			Rural toll road	≥1,8 times average speed in non-toll road	
3	Accessibility	Average transaction time	Open system toll gate	≤8 s for each vehicle	Smooth flow
			Close system toll gate	≤5 s for each vehicle	
			Entrance gate		
			Exit gate	≤10 s for each vehicle	
		Number of toll gate	Open system capacity	≥450 veh/hour/gate	Smooth flow
			Close system capacity		
			Entrance gate	≥500 veh/hour/gate	
			Exit gate	≥300 veh/hour/gate	
4	Mobility	Traffic obstruction handling	Patrol observation area	30 min per cycle	Smooth flow
			From information received until arrive at location	≤30 min	
			Handling due to vehicle broken	Towing the vehicle to closest toll gate (free of charge)	
			Towing vehicle patrolPatroli Kendaraan Derek	30 min per observation cycle	
5	Safety	Traffic facility			
		Signal	Completeness and clearness of information and regulation	100%	Smooth and safe
		Road marking	Function and usefulness	100% Reflectivity ≥80%	Smooth and safe
		Guide post/reflector	Function and usefulness	100% Reflectivity ≥80%	Smooth and safe
		KM post	Function and usefulness	100%	Smooth and safe
		Traffic lighting in urban road	Fungsi dan Manfaat	100%	Safety and secure
		Fence	Function and usefulness	100%	Safety and secure
		Accident handling	Victim of accident	Free evacuation to nearest reference hospital	Safety and secure
			Accident vehicles	Free towing to vehicle pool (inside toll road)	
		Security and law enforcement	Toll road segment	Availability of Highway Police Patrol in 24 h	Safety and smoothness
6	Rescue and supporting unit	Ambulance	Toll road segment	1 unit per 25 km or minimum 1 unit (completed with first aid equipment and paramedic)	Safety
		Towing vehicle	Toll road segment	1 unit per 5 km or mininimum 1 unit	
			ADT>100.000 veh/day		
			ADT<100.000 veh/day	1 unit per 10 km or minimum 1 unit	
		Highway Police Patrol (HPP)	Toll road segment	1 unit per 15 km or minimum 1 unit	
			ADT>100.000 veh/day		
			ADT<100.000 veh/day	1 unit per 20 km or minimum 1 unit	
		Toll road patrol (operator)	Toll road segment	1 unit per 15 km or minimum 2 unit	Safety and smoothness
		Rescue vehicle	Toll road segment	1 unit per toll road segment (safety tools added)	Safety
		Information system	Information and communication of traffic condition	Every entrance gate	Smoothness

2. REVIEW OF EXISTING MINIMUM SEVICE STANDARD

Based on operational practice and general comments point of view from user and other stakeholders, it was revealed that there are some MSS weaknesses, i.e., incomplete indicators and no sanction of uncomply MSS.

Karsaman (2009) give initial proposal about some parameter and its measurement that could be considered to improve the MSS, including recommendation for further action to apply it. The proposal consists of:

1. Road condition should use segmented measurement/interval per 100 m and maximum values of roughness, as well as add type of defects such as rutting, cracking etc.

2. Speed of traffic should use absolute values of speed as minimum 50% of design speed, i.e., 60-40 kph
3. Transaction time and number of required booths should be based on maximum queuing length of 10-20 vehicles
4. Safety should use some additional facilities such as anti-glare
5. Unit of accident assistance and services support, should add some facilities such as install variable message sign (VMS), emergency phone
6. Other, should carry out Customer Satisfaction Index survey every year.

However, considering the length of all toll roads in Indonesia and the consequences of cost that has to be borne by the operators, the improved MSS could be adopted in staging with some transition period.

Further study by Weningtyas (2009), elaborating the issues and use survey to user and agency involved as stake holder. According to operator, there are some difficulty to fulfill some indicator, such as fence due to vandalism or stolen. On the other hand, user are not fully understand about MSS and can not chek whether they are already fulfilled.

Other detail comment about some indicators are including the response time and observation area is not adequate and its equipment need to be completed, road marking indicator and its reflector need improvement, lighting indicator need to be maintained, and for fence parameter, there are some problem such as lack of supervising and poor fence quality selection, lack of maintenance, budget constraint for replacement and also problems from external aspects such as vandalism, increasing demand for crossing, Finally, for supporting unit facility, there was unbalance between demand and supply and inadequate emergency equipment as well as less complete equipment of first aid. Furthermore, there are some new indicators recommended to be considered such as:

2.1. Condition of Toll Road Service

2.1.1. Pavement condition

Road pavement condition expected by user is they do not wet, especially on the edge. The good pavement condition according to user are they do not slippery, not too roughness, not bumpy and no potholes. The existing MSS parameter just assesses roughness, skid resistance and number of potholes. They still not measure bumpiness; therefore they need to add assessment criteria to fulfill it.

2.1.2. Rest area condition

The facilities expected by respondent are availability of fuel station, restaurant, praying hall, good and clean toilet as well as easy use for user and convenience environment.

2.2. Security and Safety Substance

There are many obstacles experienced for toll traffic such as poor lighting system at night or bad weather condition, vehicles bad condition, undisciplined driver (heavy vehicle occupy right lane, passing through shoulder or left lane) or have faster or slower speed unsuitable regulation and natural disaster such as landslide etc., therefore, its need some additional parameter to face those unwanted condition. Furthermore, the indicators should have assistance and help services such as Help Information System and heavy equipment required for heavy vehicles accidents such as truck.

2.3. Customer Satisfaction Survey as Evaluation System of MSS

The customer satisfaction survey is considered required for certain reason, viz:

1. This information is good to increase services level
2. Operator and user need to understand their own right and obligation, so they can give correction if there is unsuitable condition related to level of MSS.
3. As an input operator performance in giving the services
4. The main factor for service are comfort, convenience, smoothness and safety
5. MSS should accommodates the satisfaction of toll road user.

3. DISCUSSION OF PROPOSED NEW MSS

Long list of indicator is obtained from interview survey, where all input from stake holder were accommodated. This list is also refered to literature reviewed. Then the long list is asked again to stake holder in second interview to be revised and focused on technical aspect only. Substance is selected onto the reason which one is more effective and could be used by operator to increase their service.

3.1. Substance of Toll Road Sevice Condition

3.1.1. Pavement condition

Pavement condition assessment for operator is supposed to know the performance of the road their operated and the cause of damage, type of deffect, how to repair etc.

a. Skid resistance
   - Reading is done every 20 m and averaged for 100 m interval. The result finally determined for the whole link. Report is usually present in graph and showing the position at where the value is exceding the tolerance value. It is proposed to show also the value for each interval and the measurement is carried out every year (instead of once in 2 years now).
   - The equipment can be Mu Meter, British Pendulum Test, or Sideway-force Coefficient Routine Investigation Machine. See Table 2 for reference value of the equipment.

b. Roughness
   - In roughness test, although the average value has meet the standard, but in some segment the value could endanger

Table 2: Typical skid resintance value

Value	Rekomendasi
<30	Need repairing
≥30	Accepted for low traffic
31-34	Pavement need routine monitoring
≥35	Accepted for high traffic

Source: www.training.ce.washington.edu, Jayawickrama et al., 1996

user. Therefore the test should have maximum tolerance instead of average values and report should have graphic format to see the segment exceed maximum values

- There are also differences of values boundary in accordance with speed and different values for newly toll road to old toll roads.
- Change of measurement time from once in 2 years to every year.
- Equipment that can be used are National Association of Australian State Road Authorities (NAASRA), Merlin, or Bump integrator.

c. Number of potholes

This parameter is proposed to be changed into pavement surface deffects condition survey which represent all the deffects such as cracking, deformation, surface disintegration, polished aggregate, bleeding and utility cut depression. From the survey, it can be known the type of deffect and its main cause. To ease measurement and treatment, the road can be segmented. Furthermore, the pavement surface deffect could be represented by Present Serviceability Index (PSI) which is an index represent service condition of the road. Principally this index was developed to indicate the pavement condition in accordance with the values reffered in pavement deterioration model (curve). By knowing the existing position it is expected that pavement structure can be avoided from drop zone as illustrated in Figure 1.

Formula of PSI for flexible pavement is as follows:

$$PSI = 5,03 - 1,9\log(1+SV) - 0,01(C+P)^{0,5} - 1,38RD^2 \quad [1]$$

Whereas formula of PSI for rigid pavement is as follows:

$$PSI = 5,41 - 1,8\log(1+SV) - 0,09(C+P)^{0,5} \quad [2]$$

where:

SV = Slope variance, C = Cracking, P = Patching and RD = Rut depth

d. Drainage maintenance

Maintenance of drainage is required because water is the main factor of pavement structural damage. The good drainage should dissipate water from pavement surface in 2-24 h. The maintenance should follow Indonesian standard about inspection and road drainage maintenance.

3.1.2. Traffic condition

Service level evaluation is involving some indicator such as traffic speed/travel time; volume/capacity ratio; traffic density and traffic accident.

a. Average speed

To determine the value or limit for average speed, we can compare volume against capacity or degree of saturation approaching 0.8. For Q/C = 0.8 we found average speed for design speed 80 km/h decreased to 56 kph, whereas for design speed of 120 kph become 80 kph. These values need to be met by operator to keep the service (Figure 2).

So, the indicator of MSS which compare the travel time between toll road against its alternative non-toll roads should be replaced by average speed of toll road only. Some additional recommendation are as follows: Measurement is carried at peak and non-peak hours, report is completed by information about situation or condition record to explain the reason and the measurement should be done routine to know the trend of volume traffic and antisipate the widening of the road in the future if required.

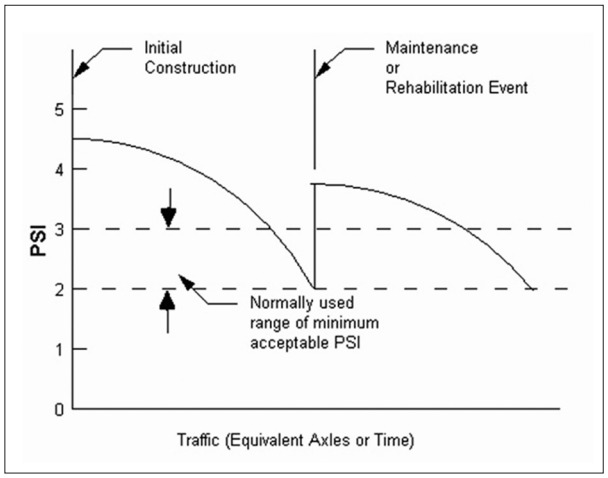
b. Travel time

This survey is done to see the delay received by user at peak hour by comparing the travel times in non-peak against peak hour conditions.

3.1.3. Toll gate service condition

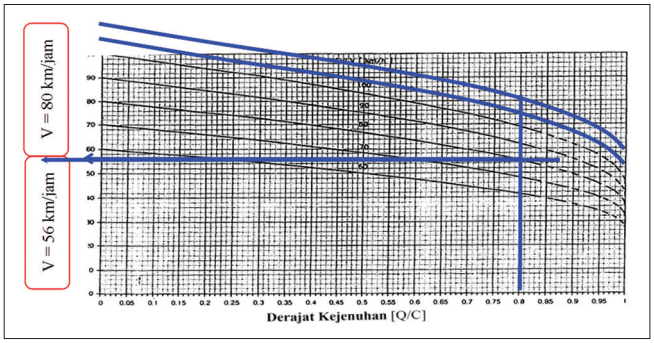
The previous MSS stated the transaction time as indicator. However, this indicator can not give the real time of time required in the process occur in the gate, including queueing. There are some externality out of operator control. However, with the implementation of usage smart card or electronic toll card (ETC), the transaction time standard need to be ajusted and shortened in accordance with the ability of ETC. Furthermore, the frequency

Figure 1: Pavement performance concept using Present Serviceability Index (PSI)



(Source www.training.ce.washington.edu, Hveem and Carmany, 1998)

Figure 2: Correlation of Degree of Saturation with Free Flow Speed



(Source: Indonesia Highway Capacity Manual IHCM, 1997)

Table 3: List of indicators and proposed draft MSS

No	Service substance	Indicator	Scope	Measurement	Standard references	Equipment	Frecuency	Description
1	Toll road service condition	Pavement condition	Roughness	Average IRI ≤4 m/km and maximum IRI per interval <6 m/km	SNI 03-3426-1994	NAASRA	Per semester	Interval is every 100 m, and reported in graphic form
					Pavement tools consortium Roadnote 18	Merlin IRI=1,913+0,0490D		
					Roadnote 18	Bump integrator IRI=a+bVR+cVR2		
			Skid resistant	SRV ≥0,35 mm	SNI 03-6748-2002[b]	MU Meter	Per semester	Measurement included in road shoulder
					SNI 03-4427-1997[b]	Bristish Pendulum test $SRV_{35}=(100+t)/135\times SRV_t$		
					Skidding resistance. Design Manual for Roads and Bridges, HD 28/94	Sideway-force Coefficient Routine Investigation Machine (SCRIM)		
			Surface deffect	90% no deffects	Pd T-12 2004B[b]	Flexible pavement road condition survey	Every day	Report on type of defect and its caused every segment
					AASHTO 1993 Roadnote 18	Rigid pavement road condition survey		
			Present service ability Index	PSI new pavement: 4,5 PSI old pavement: 4,0	AASHTO 1993 Pavement tools consortium	Combined IRI and road deffects	Per semester	-
			Drainage maintenance	Water dissipate from surface at 1 day	AASHTO 1993	Field survey (visual)	Per semester	-
		Traffic flow condition	Average minimum speed	Design speed 120 kph: Minimum speed=80 kph	IHCM	Field survey (visual) Roadnote 11[b]	Every month each segment	At peak and non-peak and indicate the problems
				Design speed=80 kph: Minimum speed=56 kph	IHCM			
			Travel Time	Distance/speed	Just different unit	Field survey (visual)	Same with Vmin	Difference travel time at peak and non-peak hours
			Density	Maximum density=16 (LOS C or V/C=0,8)	USHCM MKJI	Field survey (visual)	Same with Vmin	-
		Rest area condition	Facilities completion	Fuel station, toilet, restoran, Mushola	UU and PP	Field survey (visual)	Start of operation	-
			Facilities condition	Access ramp, lighting				
		Toll gate service condition	Transaction time	Open system: ≤8 s/veh	Wohl and Martin 1976	Field Survey (visual)	Every month	-

(Contd..)

Table 3: (*Continued...*)

No	Service substance	Indicator	Scope	Measurement	Standard references	Equipment	Frecuency	Description
				Close system: ≤7 s/veh (entry) Close system: ≤11 s/veh (exit)				
			Maximum length of queueing	% number of booths exceed 10 queueing veh	-	Field survey (visual)	Every month	-
		Booth capacity	Minimum number of booths	Estimated based on vehicle arrival level	Wohl and Martin, 1976	Field survey (visual)	Every day	-
	Safety and security	Traffic flow management equipment completeness	Signing	Number 100% and	-	Field survey (visual)	Every day	For marking: there is premarking at overlay. References is detailed design or safety audit results
				Reflektifity ≥80%	AASHTO M 268-84 1990			
			Marking	Number 100% and Reflektifity ≥80%	- AASHTO M 268-84 1990	Field survey (visual)		
			Guide post	Number 100% and Reflektifity ≥80%	- AASHTO M 268-84 1990	Field survey (visual)		
			Km post	Number 100%	-	Field survey (visual)		
			Road lighting	Lighting quality	RSNI Sxx-2005 Spec urban road lighting[b]	Field survey (visual)		
			Anti-Glare	Function and condition	-	Field survey (visual)		
			Barrier	Number 100%	-	Field survey (visual)		
		Communication equipment	Information system	Position, number and condition	-	Field survey (visual)	Every day	
		Accident handling equipment	Observation area	30 min every cycle	-	Field survey (visual)	Every day	Segmented every 25 km
			Respons time	≤30 min	-	Field survey (visual)	Every day	
			Broken vehicle handling	Free towing into nearest toll gate or workshop	-	Field survey (visual)	Every day	
			Towing vehicle Patrol	30 min per cycle	-	Field survey (visual)	Every day	Segmented every 25 km
			Free evacuation to hospital	In accordance with number of victim need to handled	-	Report from hospital	Every day	Need follow-up to monitor up to 30 days
			Free towing to vehicle pool	In accoradance with number of veh required	-	Report from operator	Every day	-
			Ambulance	1 unit/25 km or minimum 1 unit	-	Report from operator	Every day	Including standard First Aid equipment and Paramedic-
			Towing vehicles	ADT >100.000 veh/day: per 5 km ≥1 unit	-	Report from operator	Every day	-
				ADT ≤100.000 veh/day: per 10 km ≥1 unit	-	Report from operator		-
			Highway Police	ADT >100.000 veh/day: per 5 km ≥1 unit	-	Report from police	Every day	-

(Contd..)

Table 3: (*Continued...*)

No	Service substance	Indicator	Scope	Measurement	Standard references	Equipment	Frecuency	Description
				ADT≤100.000 veh/day: per 10 km ≥1 unit	-	Report from operator		-
			Highway patrol (operator)	Per 15 km ≥2 unit	-	Report from operator	Every day	-
			Rescue vehicle	1 unit per toll link	-	Report from operator	Every day	-
			CCTV	Number, condition	-	Report from operator	Every day	-
		Detection equipement for violation handling	Law enforcement	-	-			Illegal towing, crime and other violation -
			Fence of ROW	100%	-	Field survey (visual)	Once every year	Fence material should be solid to prevent people or animal passing
		Accident mitigation	Safety audit	Operation period	Pd T-17 2005B[b]	Field survey (visual)	Toll newly operated	-
			Decreasing accident fatality	%/year		Fatality formula	Once a year	-
3	Environment condition	Air polution	CO	10.000 ug/Nm^3 per 24 h	SNI 19-4846-1998[b]	NDIR (non-dispersive infrared)	Once every year	-
			NO_2	100 ug/Nm^3 per year	SNI 19-4841-1998[b]	Spektrofometer		
			H_2S	-	SNI 19-4844-1998[b]	Spektrofometer		
			O_3	50 ug/Nm^3 per year	SNI 19-4842-1998[b]	Spektrofometer		
			HC	160 ug/Nm^3 per 3 h	SNI 19-4843-1998[b]	Kromatograp		
			Dust particle	<10 µm: 150 ug/Nm^3 <2,5 µm: 15 ug/Nm^3	SNI 19-4840-1998[b]	High volume air sampler (HVS)		
		Noise	Leq and L10	Depend on land use surrounding area	SNI 19-6878-2002[b] AASHTO T262-82 1990	Sound level meter (SLM)-ANSI tipe 2	Once every year	-
4	Customer satisfaction evaluation	Average score of SERVQUAL	Score of SERVQUAL	SERVQUAL score > -2 (light gap)	Zheitaml et al. (1990)	Questionnaire	Once every year	-

NAASRA: National Association of Australian State Road Authorities, IRI: International Roughness Index, IHCM: Indonesia Highway Capacity Manual, MSS: Minimum service standard

of measurement should be more often, as many as required to check accurateness.

3.1.4. Close and open gate capacity

To measure capacity, the formula used is:

$$\mu = \frac{3600}{WP} \quad [3]$$

where: μ = Level of service and WP = Service time.

In MSS, if μ is not fulfilled then operator need to add number of booths. Then there should be study on level of arrival of vehicle (λ) to determine minimum number of booths, time of vehicle in queueing and in system, number of vehicle in queueing ($\bar{n}$), number of vehicle in system ($\bar{q}$), time in queueing ($\bar{d}$) and time in system ($\bar{w}$). Those standard should be differensiate between close and open system transaction.

3.1.5. Rest area condition

Cleaness, comfort and secure are relative values which are difficult to be measured. Therefore, the indicator just refer to the completeness of the facilities.

3.1.6. Access road condition

Toll access road according to road laws is defined as the road from toll gate to the nearest junction outside toll road. This road should be still under controll of operator and free from the activities that can disturb toll operation. However, in reality there are some problems occurs such as no control of the disturbing activies in access road and illegal terminal exist which caused congestion in toll gates. Therefore, this problem should be included in MSS as well.

3.2. Safety and Security Substance

3.2.1. Completion of traffic flow management and communication equipment

Number of sign, guide post etc. should be completed based on design or result of safety audit. Information system should be provided a long the toll way, not only at entry gate. There should installed VMS and manual MS as well as emergency telephone.

3.2.2. Observation equipment to handle accidents

The handling of accident victim is started from free evacuation to hospital followed by monitoring condition within 30 days after accident to report the accident statistic. Other indicators are the completion of equipment on ambulance and rescue vehicle. The observation area should follows segmentation, i.e., 25 km every 30 min, therefore for length of toll way more than 25 km, the unit provided should be more than 1 unit. The provision of closed-circuit television is recommended to monitor the condition and maximize handling obstruction, especially if the toll often congested.

3.3. Environment Substance

3.3.1. Air polution

This indicator is agreed by many respondent, however is quite difficult to implement. Therefore the monitor is air ambient in accordance with Air Polution Standard Index (APSI). This index is monitored every 24 h.

3.3.2. Noise polution

Indonesian standard state that noise area is an area between two side and along the road way which have certain degree of noise (Leq) for some time along the day (hour/day).

3.4. Evaluation System Using Customer Satisfaction Survey

The customer satisfaction analysis is proposed to use SERVQUAL method which is based on gap category that was based on user expectation and perception.

3.5. Revision Draft

Having reviewed the proposed MSS explained previously, the list of indicator is recommended and shown on Table 3 completed with references, measurement equipment, frequency and other information. This proposal could be used by Indonesian Toll Road Authority to discuss it, including advantages and disadvantages, with the stake holder such as toll road operators and many others parties.

4. CONCLUSION AND RECOMMENDATION

Indonesian Toll Road MSS need to be improved for a better operation management and service purposes. The revision explained in this paper; however, need to be socialized with user and other institution or parties. Furthermore, due to its extend of consequences, i.e. cost and implementation time, therefore, its application need some transition period.

REFERENCES

Hveem, F.N., Carmany, R.M. (1998), Available from: http://www.training.ce.washington.edu.

Jayawickrama, P.W., Prasanna, R., Senadheera, S.P. (1996), Available from: http://www.training.ce.washington.edu.

Karsaman, R.H. (2009), An effort to upgrade minimum service standard of toll road in Indonesia. Journal of Highway and Bridge, 26, 1-4.

Ministry of Public Work Regulation No. 392/PRT/M/2005 about Toll Road Minimum Service Standard.

Ministry of Public Work. (1997), Indonesian Highway Capacity Manual. Jakarta, Indonesia: Directorate General Highways.

Weningtyas, W. (2009), Evaluation of Toll Road Minimum Service Standard, Magister Thesis of Highway System and Engineering Programme, Institut Teknologi Bandung.

Wohl, M. (1976). Equity considerations of urban transportation planning. Out of cars, Into transit: The Urban Transportation Planning Crisis, 65, 83.

Zeithaml, V., Parasuraman, A., Berry, L.L. (1990) Delivering service quality: balancing customers perceptions and expectations. New York: The Free Press.