

# **BENEFIT EVALUATION OF ROAD REHABILITATION AT NINE PROVINCES IN INDONESIA**

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## **Abstract**

All of project development needs to be evaluated howfar that project gives benefit. Benefit of a project can be form direct benefit or indirect benefit. Road rehabilitation is an action to improve road performance. As result of road rehabilitation is increasing of IRI, road capacity, actual road design speed, and direct benefit rehabilitation have the shape of reduce of Vehicle Operating Cost (VOC), reduce in travel time and efficientcy on maintenance cost of the road. Indirect benefit of road rehabilitation has effect on physical, social, economic, environmental and spatial, as like economic increase, people welfare increase, works opportunities, population growth acceleration, migration growth, social statues increase, changes on product distribution of commodities, loading-unloading, regional development, land use distribution, wide land production especially for agriculture, and changes on accessibility level. This research takes road projects between 1990-1998 in Bengkulu, South Sumatera, Lampung and West Java Provinces. Through direct observation on sample data and simple analysis by multiregression method, correlation method and comparative method between before and after condition of the road rehabilitation project, has result IRI changes up to 140% in average more than condition before rehabilitation, ADT increase 140%. For Lampung and Bengkulu up to 150% - 165%, West Java and Lampung increase 360%-470%. This study also resulting the relation between Speed and IRI such as :  $\text{Speed} = -0,13443 * \text{IRI} + 49,71993$  (R=0,98)

Vehicle composition will changes also especially on car and utility, meanwhile truck and bus tend to decline. After rehabilitation VOC decrease 21-46% average, and BCR 4,38 with benefit around 30 billion rupiahs each link for periode 1990 to 2010. Beside of benefit, the road rehabilitation raise negative impact as like level of traffic accident, productive land for food and crops planted which changes to industrial, residential or other non-agriculture uses.

**Key words: Road Rehabilitation, Project Evaluation, Direct Benefit, Indirect Benefit**

## **I. INTRODUCTION**

### **1.1 Research Background**

Every project development needs to be evaluated howfar that project gives benefit. Benefit of a project can be form direct benefit or indirect benefit. Rehabilitation is an action to improve road performance which result increasing of IRI, road capacity, actual road design speed. and all of that give direct benefit in the shape of reduce of Vehicle Operating Cost (VOC), reduce in travel time and efficientcy on maintenance cost of the road. It gives also indirect benefit in the form of effect on regional development, economic increase, people welfare increase and works opportunities.

Success criteria of the project development can be seen through the changing of indicators before and after project, show by construction services indicators, traffic indicators and social-economic indicators. That indicators get by valuation to the changes of IRI (International Roughness Index), numbers of vehicles (by Traffic Counting-TC), Vehicle Operating Cost (VOC), analysis on social economic gain base on EIRR etc.

Thus evaluation is essential to obtain information of roads and bridges rehabilitation benefit, are it equal with investment value or not ?

## 1.2 Research Objectives

Objectives of this research is :

1. To evaluate the benefit of road and bridge rehabilitation project especially on :
  - Road and bridge constructions level of services.
  - Traffic level of services.
  - Social economic level of services.
2. Resulting simple and sharp method for measuring road rehabilitation benefit.
3. Gives recommendation to whom it may concern with this road project rehabilitation.

## 1.3 Scope of Research

Scope of this reasearch is :

- To identify sample link at four of nine provinces which will become project representatives of the provinces. See Tabel 1 List Of Link to be Surveyed, as road sample group.
- To collect data of road condition from samples complete with photos.
- To collect traffic counting data from Dinas Binamarga each Provinces for link sample
- To collect all of road work information including financial cost, sources of finance, since that road has rehabilitated..
- To collect socio-economic data before and after rehabilitation.
- Collecting data from Sub Dit. Administrasi Bantuan Luar Negeri, Proyek Peningkatan dan Pengawasan Teknik Peningkatan Jalan (Road Betterment Office - RBO) , Dinas Pekerjaan Umum Bina Marga Propinsi where the proyek are.
- Analize direct benefit and indirect benefit of that road rehabilitation projects..
- Conclusion and recommendation for the next project.

Tabel 1 List Of Link to be Surveyed.

Province	Package No.	Link No.	From ... To ...	Based on Fiels KM-POST			Project Cost Rp	Construction Timing		
				From Km..	To Km..	Length (Km)		Constr Period Day)	Start	End
Bengkulu	G-23	13.002	Kepahyang-Curup	61.000	85.000	24.000	11,750,349,922	1171	19/05/90	31/07/92
	N-13	13.008/1	Curup - Km 127	85.000	127.000	42.000	10,656,485,091	900	12/03/91	27/11/93
		13.008/2	Km 127 - Mr.Aman/T.Sawah	127.000	172.000	45.000				
	N-14	13.006/1	Manna - Tanjung Kemuning	143.000	184.300	41.300	12,108,025,029	900	10/04/91	26/09/93
		13.006/2	Tanjung Kemuning - Linau	184.300	230.000	45.700				
			Sub Total			198.000				
South	G-26	15.021/1	Kayu agung - Km 105 PLG	80.000	105.600	25.600	3,655,330,749	720	25/04/90	13/04/92
Sumatera	N-15	15.016	Palembang -kayuagung	10.000	74.000	64.000	16,695,763,546	900	15/03/91	20/08/93
	N-16	15.021/2	Km 105 PLG - Rasuan	105.600	156.050	50.450	6,516,469,806	917	15/03/91	17/09/93
		15.023	Kurungan Nyawa-Martapura	200.000	222.250	22.250				

Province	Package No.	Link No.	From ... To ...	Based on Fiels KM-POST			Project Cost Rp	Construction Timing		
				From Km..	To Km..	Length (Km)		Constr Period Day)	Start	End
	G-30	15.058	Pangkal Pinang - Namang	4.000	24.600	20.600	3,135,575,248	600	28/03/90	06/11/91
		15.059	Namang - Koba	24.600	60.000	35.400				
	N-22	15.060	Koba - Airbara	60.000	69.000	9.000	13,394,584,944	900	15/06/92	07/03/94
		15.061	Airbara - Toboali	69.000	126.000	57.000				
			Sub Total			284.300				
Lampung	G-31	17.002	Tegineneng - Gunungsugih	33.400	58.800	25.400	2,198,087,999	600	02/05/90	22/12/94
		17.003	Gunungsugih-Terbanggi Besar	58.800	70.600	11.800				
	G-32	17.004	Terbanggi Besar - Kota Bumi	70.600	108.000	37.400	4,556,518,794	750	02/05/90	22/05/92
	N-23	17.048	Ketapang - Gunung Labuhan	132.000	176.600	44.600	3,836,511,156	725	18/03/91	11/03/93
			Sub Total			119.200				
West	G-39	22.073	Indramayu - Karangampel	32	53	21.000	9,338,488,840	1219	02/05/90	31/08/93
Java		22.070	kadipaten - Jatibarang	50	92	42.000				
	N-28	22.046/2	Sukanegara - Sindangbarang	107.7	174	66.300	5,497,119,561	840	17/12/90	18/03/93
			Sub Total			129.300				
			TOTAL LENGTH OF LINKS TO BE SURVEYED			730.80				

## II. RESEARCH METHOD

### 2.1 Approach Framework

Framework of this research can be seen on figure 1.

Figure 1 Approach Framework

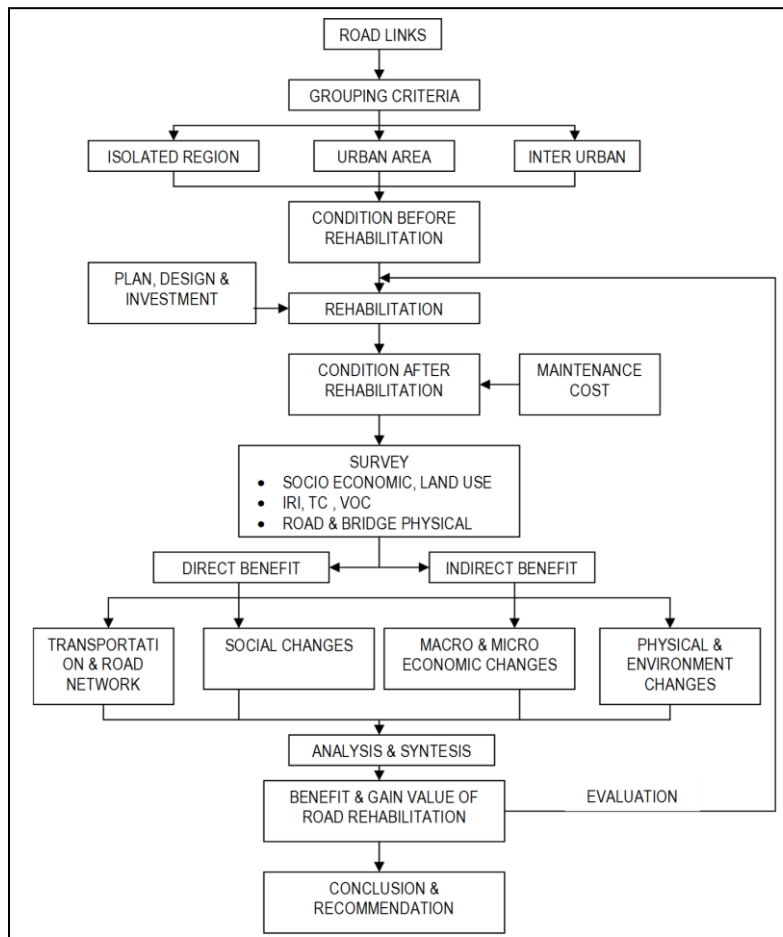
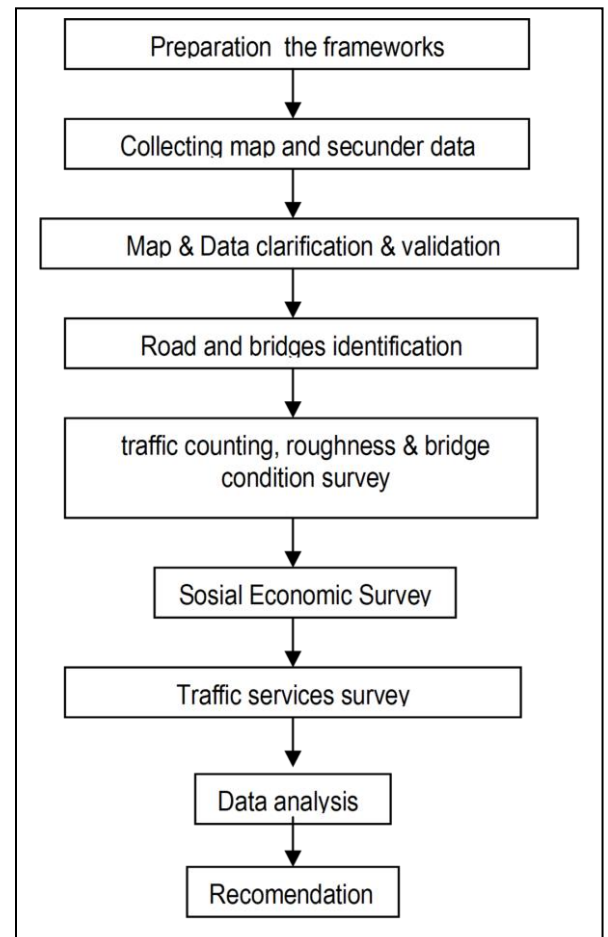


Figure 2 Steps of Research



## 2.2 Data Collecting

Some data must be collect such as:

1. Data of links number or node number of the road object.
2. Data of road and bridge condition as like length, wide, road function, road class, bridge class, bridge condition etc.
3. Data of traffic characteristic as like volume, speed, density, time headway, distance headway as well distribute by time, direction, and vehicle type.
4. Others of supporting data:
  - Statistical data of the case study
  - Data of transportation facillity (numbers of bus, truck, car etc)
  - Data of road and bridge length
  - Data of goods and wages per unit
  - Historical data of road and handling plan of the road
  - Data of traffic flow development
  - Data of economic facillity around the road links
  - Data of before and after road and bridge project
  - Data of traffic volume, speed, and density
  - Data of traffic accident

## 2.3 Survey Method

1. Traffic Counting Survey
  - Traffic counting obtain at trunk road and junction
  - Using standart sheet for TC survey
  - TC at trunk road for 16 hours since 06.00 - 22.00 local time.
2. IRI Survey
  - Use standart sheet for RCI survey
  - Taking photos of the road from both sides, leght and across.
3. Bridge Survey
  - Use standar sheet for manually bridge survey.
  - Taking photos of the bridge from both sides, leght and across.
4. VOC Survey
  - Use questioner sheet
  - Numbers of responden minimum 30 respondens for each link
5. Speed Survey
  - Use four wheel car for floating survey to collect data speed by
6. Social economic Survey, land use, physical and environment
  - Use observation sheet, check list and questionnaire and photographic technic (comparison between before and after project).
  - Collect secondary data of socio economic, land use, physical and environment data

## III. ANALYSIS AND RESULT

### 3.1. Benefit Indicator of Road rehabilitation

Some indicators will be use for valuation thats benefit are :

A. Indicator of transportation and roadway benefit

1. Changes on IRI
2. Changes on Traffic volume (ADT)
3. Changes on speed
4. Changes on vehicle composition
5. Changes on Vehicle Operating Cost (VOC)
6. Changes on maintenance cost
7. Benefit cost analysis (base on VOC and maintenance cost) and EIRR of the roadway.

**B. Indicator of Social changes benefit**

1. Changes on population growth acceleration
2. Changes on migration acceleration
3. Social statues changes

**C. Indicator of Economic changes benefit**

1. Changes on GRDP growth acceleration
2. Changes on production distribution for each commodity
3. Changes on level of load and unload handling

**D. Indicator on physical and environmental physics benefit**

1. Changes on land distribution (land use pattern)
2. Changes on productive land
3. Changes on accessibilty

**3.2. Transportation and roadway benefit**

1. Changes on IRI

As result survey and IRI data evaluation for condition before and after project at 1998, it can see table 3.2.1 and figure 3.

**Table 3.2.1 ADT and IRI Improvement**

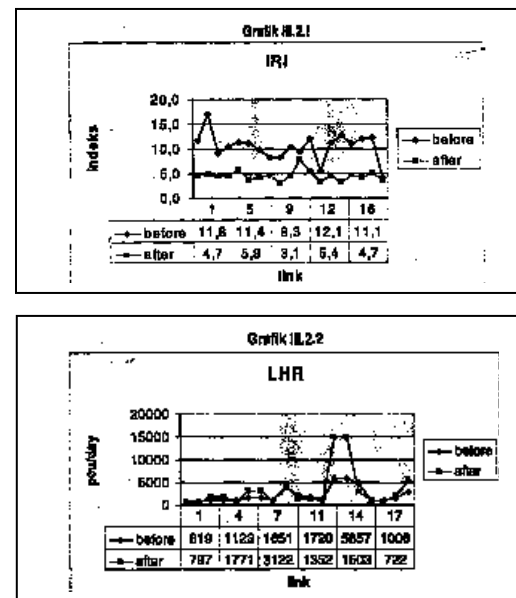
NO	LOCATION	INCREASE (%)			
		EVALUATION		SURVEY	
		ADT	IRI	ADT	IRI
1	Bengkulu	46,58	150,75	170,36	156,18
2	Sumatera Selatan	222,37	115,71	200,45	171,99
3	Lampung	98,86	165,05	367,14	142,58
4	Jawa Barat	150,36	135,00	470,47	137,07
	Average	129,54	141,63	302,105	151,94

2. Changes on Average Daily Traffic (ADT)

Base on survey and Binamarga data analysis, the increasing of IRI will push indreasing ADT, especially for South Sumatera, Lampung and West Java which increase more than 3 times after rehabilitation.

See figure 3. Actually the increasing of ADT more influenced by population and GRDP growth, so for future forecast the ADT use multi regression approach with numbers of population and GRDP as independent variable. For relation between IRI and ADT before and after project see Figure 3.

**Figure 3 ADT and IRI Improvement**



3. Changes on speed

One of road rehabilitation objective is speed increased. As result survey at some roads links which have increased, the increase of IRI automatically make increase on speed (travel speed). See Table 3.2.2 and 3.2.3 and Figure 4 .

Figure 4 The Relationship between Speed & IRI

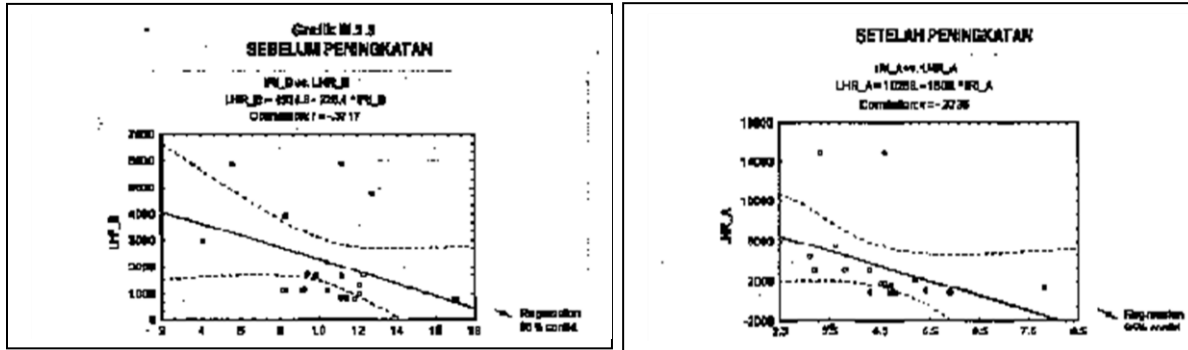


Table 3.2.2 Relationship between IRI and Travel Speed

IRI	Speed	IRI	Speed	IRI	Speed
6,42	45,00	7,17	43,71	4,23	57,86
6,42	44,12	5,78	56,32	6,52	55,38
6,42	38,12	5,34	48,86	10,27	55,71
6,88	37,09	6,70	53,25	7,79	60,00
5,66	45,35	6,70	48,14	6,59	43,20
5,83	43,06	5,34	57,22	6,60	51,43
5,28	45,00	5,34	55,50	7,44	41,67

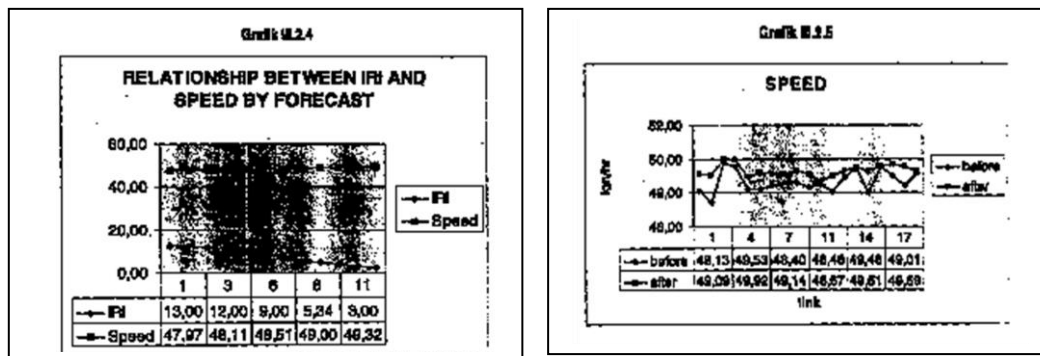
Table 3.2.3 Relationship IRI and Travel Speed (forecast)

IRI	13,00	12,30	12,00	11,00	10,00	9,00	8,20	5,34	4,70	4,00	3,00	2,00
SPEED	47,97	48,07	48,11	48,24	48,37	48,51	48,62	49,00	49,09	49,18	49,32	49,45

Base on that data can conclude a formula relationship between IRI and Travel Speed. See the formula below :

$$Speed = -0,13443 \times IRI + 49,71993 \quad R = 0.98$$

Figure 5 Relationship IRI and Travel Speed (forecast)



#### 4. Changes on vehicle composition

Table 3.2.7 show the changes of vehicle composition before and after project. It show the numbers of sedan, passenger car and mini-bus which it ordinary private vehicle increased in numbers, but for bus and truck which it ordinary commercial vehicle tend to decrease, except in the links at South Sumatera, Lampung and Java. Meanwhile the road links in P.Bangka and Bengkulu only private car has increase. So private car get more benefit from this rehabilitation project, meanwhile commercial car only a little bit use this road improvement.

#### 5. Changes on Vehicle Operating Cost (VOC)

In this reseach did not deed special case to calculate the changes on Vehicle Operating Cost (VOC) caused by changes of IRI (as road rehabilitation result). For next calculation of rehabilitation benefit use standart formula which have prepared by other research before. See Tabel 3.2.8

Table 3.2.7 Vehicle Composition Changes Before and After Project

No:	PROVINCE	LINK No:	Year	Sedan	Pickup Pax car	Combi M.Bus	Bus	Truck	Heavy Truck	ADT		
				1	2	3	4	5	6			
1	BENGKULU	130081	Before	0,113	0,553	0,158	0,055	0,116	0,005	819		
			After	0,092	0,663	0,104	0,039	0,100	0,001	797		
		130082	Before	0,113	0,553	0,158	0,055	0,116	0,005	819		
			After	0,092	0,663	0,104	0,039	0,100	0,001	797		
		130061	before	0,115	0,484	0,130	0,064	0,204	0,002	1123		
			After	0,139	0,476	0,173	0,062	0,140	0,009	1771		
No:	PROVINCE	LINK No:	Year	Sedan	Pickup Pax car	Combi M.Bus	Bus	Truck	Heavy Truck	ADT		
				1	2	3	4	5	6			
2	SUMATERA SELATAN	130062	Before	0,115	0,484	0,130	0,064	0,204	0,002	1123		
			After	0,139	0,476	0,173	0,062	0,140	0,009	1771		
		15,016	Before	0,072	0,443	0,227	0,109	0,149	0,001	851		
			After	0,111	0,583	0,239	0,000	0,066	0,000	742		
		150211	Before	0,167	0,270	0,268	0,138	0,157	0,000	1651		
			After	0,199	0,268	0,155	0,081	0,294	0,002	3122		
		150212	Before	0,126	0,280	0,091	0,050	0,145	0,002	1651		
			After	0,067	0,070	0,037	0,002	0,065	0,001	3122		
		15,023	Before	0,181	0,403	0,132	0,072	0,209	0,003	1146		
			After	0,277	0,288	0,152	0,010	0,270	0,005	757		
		15,058	Before	0,292	0,243	0,163	0,169	0,132	0,001	3930		
			After	0,282	0,289	0,161	0,082	0,185	0,001	4434		
		15,059	Before	0,194	0,189	0,226	0,169	0,218	0,004	2178		
			After	0,178	0,224	0,206	0,164	0,218	0,011	1465		
		15,06	Before	0,195	0,181	0,193	0,174	0,254	0,003	1720		
			After	0,165	0,196	0,168	0,138	0,324	0,010	1352		
		15,061	Before	0,204	0,202	0,196	0,142	0,255	0,001	1282		
			After	0,168	0,278	0,176	0,098	0,275	0,005	978		
		3	LAMPUNG	17,002	Before	0,158	0,194	0,118	0,120	0,361	0,051	5857
					After	0,163	0,170	0,116	0,117	0,383	0,051	15030
17,003	Before			0,142	0,232	0,163	0,102	0,165	0,008	5857		
	After			0,037	0,035	0,037	0,038	0,051	0,004	15030		
17,004	Before	0,175	0,286	0,201	0,125	0,204	0,010	4754				
	After	0,182	0,175	0,183	0,189	0,253	0,020	3037				
17,048	Before	0,061	0,618	0,082	0,009	0,225	0,005	842				
	After	0,018	0,485	0,113	0,001	0,380	0,004	1006				
4	JAW A BARAT	22,0462	Before	0,155	0,373	0,242	0,015	0,214	0,001	1006		
			After	0,122	0,406	0,186	0,001	0,285	0,000	722		
		22,07	Before	0,090	0,384	0,196	0,003	0,326	0,001	1678		
			After	0,155	0,303	0,182	0,002	0,337	0,021	2117		
		22,073	Before	0,217	0,311	0,121	0,018	0,173	0,161	2956		
			After	0,400	0,186	0,261	0,039	0,049	0,065	5572		

Source: Analysis



Table 3.2.8 Coefficient for Vehicle Operating Cost Formula (Rupiahs per Vehicle Km)

$$VOC \text{ index} = k1 + k2/V + k3 \cdot V^2 + k4 \cdot V \cdot IRI + k5 \cdot IRI^2$$

Vehicle	k1	k2	k3	k4	k5	Base Cost	R2
Car	0,6838	24,851	0,0000252	0,0001050	0,001737	254,43	0,99
Utility	0,5547	28,008	0,0000927	0,0001410	0,001262	205,85	0,99
Small Bus	0,4872	28,078	0,00001110	0,0003440	0,000832	248,53	0,99
Large Bus	0,5807	20,159	0,00002140	0,0000785	0,002008	381,54	0,99
Light Truck	0,5422	24,086	0,00000956	0,0003420	0,000763	282,36	0,99
Medium Truck	0,5049	20,612	0,00002350	0,0003660	0,000728	387,25	0,99
Heavy Truck	0,5603	16,601	0,00002290	0,0004070	0,000687	521,50	0,99

Source: Road User Cost model, Hoff & Overgaard, May 1992

Figure 6 Graph of VOC changes

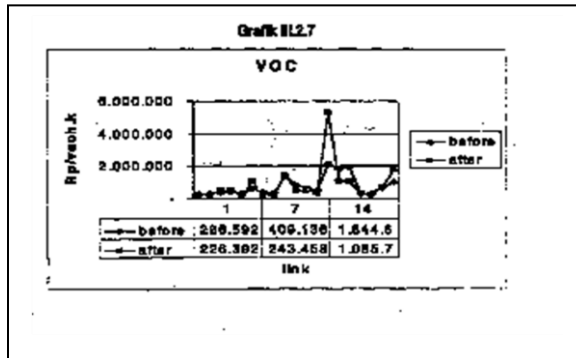
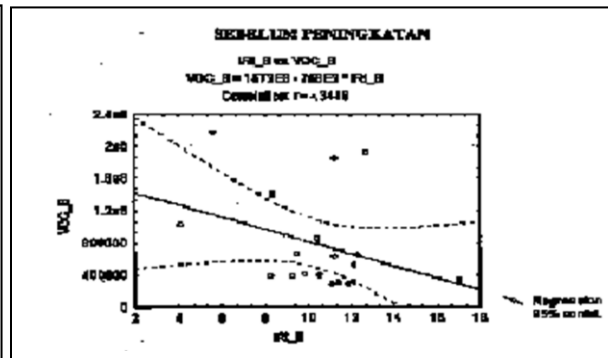


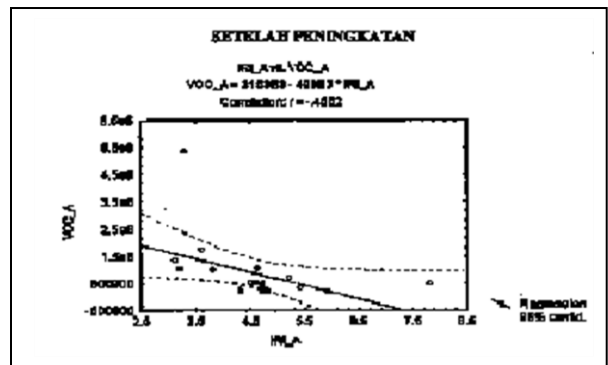
Figure 7 Relationship IRI & VOC



Base on the above observation we can compare the influent of IRI on VOC before and after road rehabilitation. See Figure 7

6. Changes on maintenance cost

It is reasonable, road rehabilitation will reduce maintenance cost, in vice versa if the road does not rehabilitate will needs maintenance cost more over.



Base on survey has been done, it show the maintenance cost before rehabilitation approximate Rp. 6.350.000,- each km/ year, meanwhile the maintenance cost after rehabilitation average Rp.4.100.000,- each km/year. In the next estimation, maintenance cost for those roads will increase 10%/year. For P.Bangka where it is separate island, maintenance cost tend higher than others. Detail of maintenance cost can see at Table 3.2.7 below :

7. Benefit Cost Analystist, NPV and EIRR of the road way

From the financial side can be see the changes on maintenance cost and vehicle operating cost (VOC). By calculate both cost component, the NPV and EIRR of the roads has been survey, for next 20 years since project has done, that is 1990-2010 periode , with assume 2 times improvement must be done at this periode, show NPV and EIRR are low.

Table 3.2.7 Maintenance Cost (km/year)

NO	TYPE	BEFORE PROJECT (Rp)	AFTER PROJECT (Rp)
	Sumatera and Java		
1	Shoulder maintenance	1.600.000	1.600.000
2	Roadway maintenance	3.500.000	1.250.000
3	Road sign maintenance	750.000	750.000
4	Bridge maintenance	500.000	500.000
	Total	6.350.000	4.100.000
NO	TYPE	BEFORE PROJECT (Rp)	AFTER PROJECT (Rp)
	P.Bangka		
1	Shoulder maintenance	2.000.000	2.000.000
2	Roadway maintenance	4.500.000	1.750.000
3	Road sign maintenance	1.000.000	1.050.000
4	Bridge maintenance	750.000	750.000
	Total	8.250.000	5.500.000

Source: Estimate maintenance cost

It is caused under uses of the roads, below it own capacity. The under uses of the roads is no more change since rehabilitation. So it occurs more caused just under utility factor, not causes the road rehabilitation is not utilize.

The BCR, NPV and IRR for all roads show high point, but some roads show negative.

It must not accures cause the interest (i) for this road rehabilitation project is low enough, that is 2,6%/ year and Gross periode 8 years, for 30 years loan.

Loan condition relatively soft, it means for infrastructure development like this is profitable. Yet because the new road rehabilitation is under utilize, not all of it capacity has used so the benefit which we get is low too, whereas for other roads receive positive result. See table 3.2.8

### 8. Changes on Road and Bridge capacity

Another important manner of the roads rehabilitation is the changes on road and bridge capacity. Base on observation road capacity will increase between 7-14% after rehabilitation, even for for South Sumatera some roads increase 40-60% up to before rehabilitation. Clearly see Table 3.2.9 below:

### 3.3 Social changes benefit

#### 1. Changes on population growth acceleration

Through IRI increases after rehabilitation project, the ADT at that road will improve. The increasing of ADT will push faster immigration and outmigration of the citizen. That condition wil causes added/ substracted population faster, offcourse that added or substract is not causes by natural increase of the population. Actually it often when the numbers of population increase, GRDP increase too at the same time with IRI increase after that rehabilitation project. The relationship between IRI, ADT and Population growth can see at table 3.3.1 and graph on Figure 8 below.

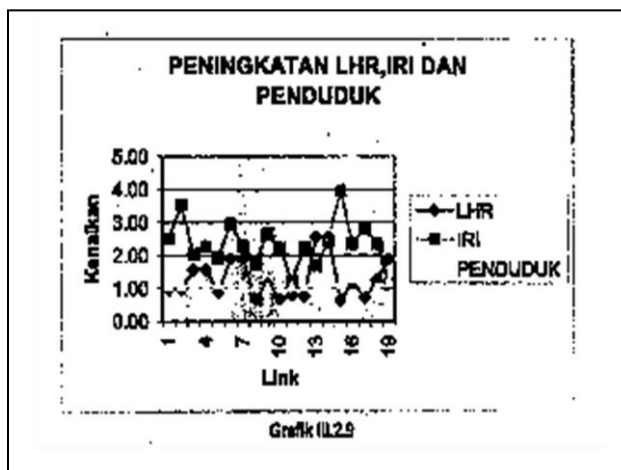
Table 3.2.8 Benefit of Each Road

PROVINC	LINK	BENEFIT	BCR	NPV (Rp)	IRR
Bengkulu	13.006/1	18,187,318,602	2.1178	11,503,173,415	17.03%
	13.006/2	18,187,318,602	3.2898	21,230,285,404	8.96%
	13.008/1	18,187,318,602	1.5360	6,493,691,771	52.58%
	13.008/2	18,187,318,602	1.5471	7,104,548,383	53.69%
South Sumatera	15.016	23,300,073,986	1.4930	16,715,416,335	24.60%
	15.021/1	33,563,861,417	4.2438	24,217,609,960	51.59%
	15.021/2	51,052,228,204	4.9883	37,150,185,008	62.47%
	15.023	6,840,112,297	2.2116	4,430,727,665	19.22%
	15.058	39,125,149,578	5.4081	27,923,287,710	70.89%
	15.059	7,420,307,012	1.5465	4,143,038,188	9.85%
	15.060	10,475,861,616	4.0349	7,671,760,483	80.23%
	15.061	29,087,590,428	2.3305	20,320,312,802	32.05%
	Lampung	17.002	58,879,961,667	10.0445	41,848,978,916
17.003		29,329,337,705	10.0445	20,758,005,063	106.39%
17.004		38,128,791,100	10.0445	27,600,267,536	129.43%
17.048		13,692,680,199	10.0445	9,675,886,653	31.32%
West Java	22.046/2	18,200,892,994	1.6543	11,654,916,777	16.49%
	22.070	47,614,318,694	3.7019	33,998,157,736	52.31%
	22.073	18,690,713,668	3.1212	13,051,474,796	39.82%

Tabel 3.2.9 Change of Road Capacity

No:	PROVINCE	LINK No:	KAPASITAS (smp/jam)		INCREASE (%)
			BEFORE	AFTER	
1	BENGKULU	130081	1013	1234	121,81
		130082	1013	1234	121,81
		130061	877	1092	124,52
		130062	877	1092	124,52
		15,016	884	1414	159,94
2	SOUTH SUMATERA	150211	835	864	103,45
		150212	983	1405	142,98
		15,023	858	1012	117,92
		15,058	826	1002	121,22
		15,059	723	824	113,84
		15,06	685	750	109,38
3	LAMPUNG	15,061	721	856	118,74
		17,002	611	685	112,02
		17,003	862	1337	155,14
		17,004	782	841	107,52
4	WEST JAVA	17,048	939	1015	108,04
		22.0462	950	1016	106,96
		22,07	842	922	109,57
		22,073	774	1178	152,23

Figure 8 ADT, IRI & Population



**Table 3.3.1 ADT, IRI and Population Increase**

No:	PROVINCE	LINK NO	PENINGKATAN		
			LHR	IRI	PENDUDUK
1	BENGKULU	13,0081	0,97	2,51	1,09
		13,0082	0,97	3,54	1,09
		130,061	1,58	2,04	1,09
		130062	1,58	2,28	1,09
		15,016	0,87	1,93	1,13
		150211	1,89	2,95	1,05
2	SOUTH SUMATERA	150212	1,89	2,28	1,05
		15,023	0,66	1,74	1,05
		15,058	1,13	2,68	1,05
		15,059	0,67	2,21	1,05
		15,06	0,79	1,21	1,05
		15,061	0,76	2,24	1,05
3	LAMPUNG	17,002	2,57	1,70	1,02
		17,003	2,57	2,43	1,02
		17,004	0,64	3,97	1,15
		17,048	1,20	2,36	1,33
4	WEST JAVA	22,0462	0,72	2,81	1,08
		22,07	1,26	2,37	1,04
		22,073	1,88	1,14	1,22

Table 3.3.2.a Relationship of IRI, ADT and Population Growth Before & After Project

No:	PROVINCE	LINK No:	TIME	ADT	IRI	GROWTH (%)	
						DISTRICT	SUB.DIST
1	BENGKULU	130.081	Before	819	11,80	2,11	2,11
			After	797	4,70	0,9	1,56
		130.082	Before	819	17,00	2,11	2,11
			After	797	4,80	0,9	1,56
		130.061	Before	1123	9,20	0,56	0,55
			After	1771	4,50	2,56	0,46
2	SOUTH SUMATERA	130.062	Before	1123	10,50	1,57	3,87
			After	1771	4,60	3,04	3,8
		15.016	Before	851	11,40	1,57	3,87
			After	742	5,90	3,04	3,8
		150.211	Before	1651	11,20	1,57	3,87
			After	3122	3,80	3,04	3,8
150.212	Before	1651	9,80	2,4	1,22		
	After	3122	4,30	0,92	0,96		
3	LAMPUNG	15.023	Before	1146	8,20	0,89	1,58
			After	757	4,70	1,45	0,63
		15.058	Before	3930	8,30	0,89	1,58
			After	4434	3,10	1,45	0,63
		15.059	Before	2178	10,40	0,89	1,58
			After	1465	4,70	1,45	0,63
4	WEST JAVA	15.06	Before	1720	9,40	2,6	1,94
			After	1352	7,80	9,67	15
		15.061	Before	1282	12,10	2,6	1,94
			After	978	5,10	9,67	15
		17,002	Before	5857	5,60	1,1	15,48
			After	15030	3,30	1,76	0,27
3	LAMPUNG	17,003	Before	5857	11,20	1,1	15,48
			After	15030	4,60	1,76	0,27
		17,004	Before	4754	12,70	1,19	1,06
			After	3037	3,20	0,54	1,85
		17,048	Before	842	11,10	1,19	1,06
			After	1006	4,70	0,54	1,85
4	WEST JAVA	22.0462	Before	1006	12,10	3,3	1,88
			After	722	4,30	1,05	0,74
		22.070	Before	1678	12,30	0,73	0,94
			After	2117	5,20	1,38	1,07
		22,073	Before	2956	4,10	0,84	1,79
			After	5572	3,60	1,28	1,37

Tabel 3.3 2.b Relationship of IRI, ADT, Immigration and Outmigration Before & After Project

No:	PROVINCE	LINK No:	TIME	ADT	IRI	IN MIGRATION (%)		OUT MIGRATION (%)	
						DISTRICT	SUB.DIST	DISTRICT	SUB DIST
2	SOUTH SUMATERA	15,016	Before	851	11,40	6,51	2,5	1,04	3,16
			After	742	5,90	0,29	6,09	1,05	7,16
		150.211	Before	1651	11,20	6,51	2,5	1,04	3,16
			After	3122	3,80	0,29	6,09	1,05	7,16
		150.212	Before	1651	9,80	6,51	2,5	1,04	3,16
			After	3122	4,30	0,29	6,09	1,05	7,16
		15.023	Before	1146	8,20	1,67	10,17	2,44	0,48
			After	757	4,70	2,07	1,56	1,05	0,78
		15.058	Before	3930	8,30	2,75	8,8	2,67	2,75
			After	4434	3,10	1,15	2,72	0,58	0,71
		15.059	Before	2178	10,40	2,75	8,8	2,67	2,75
			After	1465	4,70	1,15	2,72	0,58	0,77
15.06	Before	1720	9,40	0,98	4,44	1,19	0,94		
	After	1352	7,80	2,03	1,7	1,01	27,25		
15.061	Before	1282	12,10	0,98	4,44	1,19	0,94		
	After	978	5,40	2,03	1,7	1,01	27,25		
4	WEST JAVA	22,0462	Before	1006	12,10	28,64	12,22	45,03	7,5
			After	722	4,30	10,69	2,19	17,79	1,31
		22,070	Before	1678	12,30				
			After	2117	5,20				
		22,073	Before	2956	4,10	-3,1	-4,95	-1,93	-1,57
			After	5572	3,60	0,67	23,2	23,2	15,11

## 2. Changes on migration

The increase of IRI cause by this rehabilitation project will push the increasing of ADT at roads because level of accessibility was increased. Relationship between road condition increasing and acceleration of migration can see at Table 3.3.2.a & Table 3.3.2b. Through that table, we can see some of roads especially for roads which connecting isolated region, immigration and outmigration number tend to increase in sharp skew, while for inter urban and near urban area the migration number tend to decrease. It may understood cause for region around city, the increasing of road condition make they moving coomuter without permanent migration, while for remote area the increasing of road condition push people to move in or out from they place.

## 3. Social statues changes

Survey result to the resident citizen around the roads which has rehabilitated, they said get double benefit , that is accessibility of transportation and economic advantages by the increasing of thst road condition. Economically, peoples income increase 170% - 250% comparing to the condition before rehabilitation. See table 3.3.3. Off course the increasing of they income will influence they daily life.

## 3.4 Economic changes benefit

### 1. Changes on GRDP growth acceleration

When that road rehabilitation has done, directly will influence to the GRDP of construction sector. After this project has done then utilized with expectation the numbers of ADT will increase, it means the activity will increase too so GRDP of transportation sector will improve, more over make chain effect to others sector which relate with road uses will increase. Thus the road rehabilitation project will give big effect to GRDP. Beside GRDP, road rehabilitation project also

influence to PAD (Regional Revenue) especially obtain through tax and retribution from any activity around the roads.

## 2. Changes on level of load and unload handling

According to the increasing of IRI and ADT, we expect the level of load and unload goods at port will improve, especially for commodities which will inter insuler and uses that roads as backbone for their tranportation. This relationship can see at table 4.4.2 below:

## 3. Changes on Land Price

One of direct benefit of the road rehabilitation which people feels is chane on land price arroun that road. This increasing in associated with accessibility level which can give by better road condition. Base on survey which has done, the increasing of land price is significant, that is increase 260% - 460 % average if comparing with land price before this rehabilitation project, even at South Sumatera the increasing of land price is very fantastic, that is 11 times. Off course the land price increase is not just influent by road rehabilitation as like social effect of increasing income. The increasing of land price off course will push the changes on activity pattern of the residence citizen and it means push the change of land use pattern.

Tabel 3.3.3 Road Rehabilitation Influence to Social & Economic Changes

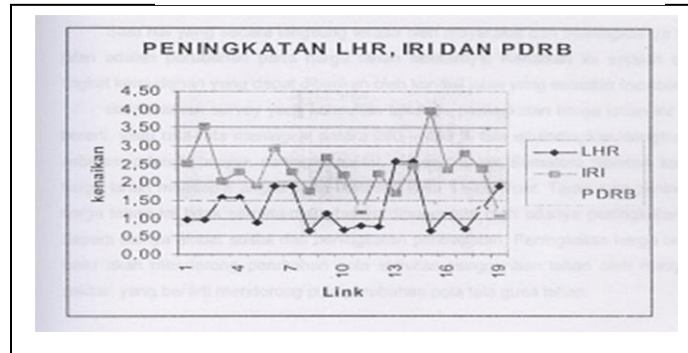
Province	Package No.	Link No.	From ... To ...	Length Km	Avg of ADT Increase	Avg of IRI Increase	Avg of Income Increase	Avg of Land price Increase	Avg of Travel Time Decrease	Avg of Accessibility Increase
Bengkulu	G-22	13.001	Kembanghari - Kepahyang	43.400		0.95				
	G-23	13.002	Kepahyang-Curup	24.000		0.69				
	N-13	13.008/1	Curup - Km 127	42.000	4.14	1.84	2.94	2.88	0.47	1.71
		13.008/2	Km 127 - Mr.Aman/T.Sawah	45.000		2.47	2.94	2.88	0.47	1.71
	N-14	13.006/1	Manna - Tanjung Kemuning	41.300	1.59	1.63	1.67	1.99	0.45	1.36
		13.006/2	Tanjung Kemuning - Linau	45.700	1.82	1.80				
		Sub Total	241.400	1.70	1.56	2.52	2.58	0.46	1.60	
South	G-26	15.021/1	Kayu agung - Km 105 PLB	25.600	2.44	2.12	2.22	1.92	0.55	1.55
Sumatera	N-15	15.016	Palembang -kayuagung	64.000	1.25	1.59				
		N-16	15.021/2	Km 105 PLB - Rasuan	50.450	0.50	1.70	2.22	1.92	0.55
		15.023	Kurungan Nyawa-Martapura	22.250	5.12	1.54	2.54	2.62	0.48	1.86
	G-30	15.058	Pangkal Pinang - Namang	20.600	4.90	1.24	1.90	21.42	0.50	2.00
		15.059	Namang - Koba	35.400	7.03	1.55	1.90	21.42	0.50	2.00
	N-22	15.06	Koba - Airbara	9.000	3.03	1.76	2.06	13.97	0.50	1.56
15.061		Airbara - Toboali	57.000	2.81	2.27	2.06	13.97	0.50	1.56	
		Sub Total	284.300	2.00	1.72	2.13	11.03	0.51	1.72	
Lampung	G-31	17.002	Tegineneng - Gunungsugih	25.400	3.61	1.32				
		17.003	Gunungsugih-Terbanggi Besar	11.800	4.05	1.72				
	G-32	17.004	Terbanggi Besar - Kota Bumi	37.400	3.35	1.24	1.41	3.05	0.51	1.64
	N-23	17.048	Ketapang - Gunung Labuhan	44.600		1.42	2.00	3.46	0.55	1.53
		Sub Total	119.200	3.67	1.43	1.71	3.26	0.53	1.59	
West	G-39	22.073	Indramayu - Karangampel	21.000	5.02	0.62	2.54	2.62	0.48	1.86
Java	N-28	22.07	kadipaten - Jatibarang	42.000	6.01	1.86	1.90	6.67	0.48	1.55
		22.046/2	Sukanegara - Sindangbarang	66.300	3.08	1.63				
		Sub Total	129.300	4.70	1.37	2.22	4.64	0.48	1.70	

Source : IRMS & Survev 1998

Table 3.4.1 Increasing of ADT ,IRI and GRDP

No:	PROVINCE	LINK NO	INCREASE		
			ADT	IRI	GRDP
1	BENGKULU	13,0081	0,97	2,51	1,43
		13,0082	0,97	3,54	1,43
		130061	1,58	2,04	1,43
		130062	1,58	2,28	1,43
		15,016	0,87	1,93	1,40
2	SOUTH SUMATERA	150211	1,89	2,95	1,37
		150212	1,89	2,28	1,37
		15,023	0,66	1,74	1,37
		15,058	1,13	2,68	1,34
3	LAMPUNG	17,002	2,57	1,70	1,30
		17,003	2,57	2,43	1,30
		17,004	0,64	3,97	1,31
		17,048	1,20	2,36	1,28
		22,0462	0,72	2,81	1,42
4	WEST JAVA	22,07	1,26	2,37	1,27
		22,073	1,88	1,14	1,21

Figure 4.2.10 ADT, IRI & GRDP



Tabel 3.4.2 ADT, IRI & loading & unloading

NO	REGION	ROAD CONDITION (%)		LOAD & UNLOAD			
		ADT	IRI	BEFORE PROJECT		AFTER PROJECT	
				LOAD	UNLOAD	LOAD	UNLOAD
1	Bengkulu	46.58	150.75			46,484	26,618
2	South Sumatera	222.37	115.71	35,381	14,858		
3	Lampung	98.86	165.05	1,027,550	3,644,210	625,604	5,661,490
4	West Java	150.36	135			1,478,614	104,752

### 3.5 Benefit on Physical and Environment Changes

#### 1. Changes on land use

Increasing of road condition indirectly will push changes on activity pattern. The change of activity pattern will push changes on land use and spatial as like the shift of agriculture land to resident, industrial or another non agriculture land uses. Data obtain show the shift of land use more faster associate with increasing of roads condition, it is clearly on acceleration number of land use changes.

#### 2. Changes on the wide of production land and production level for each commodity

In relation with changes on land use pattern, data obtain for Province Bengkulu, especially for Kabupaten Rejang Lebong show statistically the wide of padi harvest tend to decrease after road rehabilitation. This decreasing around 15-25% comparing with condition before rehabilitation, as well production numbers also decrease between 12-14%. For South Sumatera, especially for Kabupaten Komerling Ulu (OKU) the wide farm crops and production numbers decrease 8 – 11%, and this decreasing continued until 1997.

But for Kabupaten Bangka and Pangkal Pinang, the occres is positive influence, whereas the wide of padi harvest and production numbers of wetland padis and dryland padis increase 60-120% average, even for kecamatan Pangkalan Baru increase till 300% or 3 times to condition before road rehabilitation.

For Lampung, especially at Kabupaten Lampung Utara and Tengah the wide of wetland padis harvest increase 13-30 % average, and production numbers increase till 10 -17 %. While dryland padis decrease till 14-15% and production numbers decrease 70% comparing to condition before road rehabilitation. At Kabupaten Lampung Selatan wide wetland padis increase 5,5 times and production numbers increase 11 times, in other side dryland padis decrease 84 - 90 % if comparing with condition before road rehabilitation.

At west Java, especially at Kecamatan Sukanagara and Tanggeung, Kabupaten Cianjur, the wide of wetland padis harvest increase arroun 11%, and production numbers increase till 17 %. While dryland padis decreas till 25% and production numbers decrease 19% if comparing between after and before road rehabilitation. The relationship of ADT, IRI and production level of main commodities show at Table 3.5.3 below.

Tabel 3.5.3 ADT, IRI & Production Level of Main Commodities

No	REGION	ROAD CONDITION (%)		MAIN COMMODITIES			
		LHR	IRI	DISTRICT		SUB DISTRICT	
				TYPE	%	TYPE	%
1	Bengkulu	46,58	150,75	Padi Sawah	(12-14)	Padi sawah	(15-25)
2	Sumatera Selatan	222,37	115,71	Palawija	(8-11)	Padi sawah	60-120
3	Lampung	98,86	165,05	Padi sawah	10 -17	Padi Ladang	(70)
4	Jawa Barat	150,36	135,00	Padi sawah	17	Padi Ladang	(19)

### 3. Changes on accessibility level

One of expect benefit from road rehabilitation is good and stable road length added. In fact it occurs, for examples for West Java especially at Kabupaten Majalengka the road leghth with good and stable condition increase from 76 Km in 1990 - 1993 periode become 756 Km at 1997. The added of good road length make the ratio between road length and wide region (as an indicator of accessibility) increase. At Majalengka this ratio increase from 0,00063 to 0,00628 Km/Km2. It show the level of accessibility for this region becomes better.

Peoples opinion also said that after road rehabilitation the level of accessibility increase 1,6 - 1,7 times comparing with condition before rehabilitation. They also said that travel time of road user increase 40 - 55 %

### 3.6 Benefit on Bridge condition increase

The main benefit of the bridge rehabilitation is obtain well maintain for level of service of the bridge, so it can services traffic increase in that road whereas the bridge are. In average after rehabilitation the capacity of the bridge increase 7-52% , it utilize to avoid bottle neck arroun the bridge which it can substract road performance.

## IV. CONCLUSION AND RECOMENDATION

### 4.1. Road Rehabilitation Benefit

Base on the above discussion can take some conclusion in relation with road rehabilitation which has been done between 1990 – 1998 in Bengkulu, South Sumatera, Lampung.and West Java provinces. Directl benefit is:

1. IRI changes with increase 140% in average than condition before rehabilitation, even for South Sumatera increase till 222%.
2. Changes on traffic volume (ADT), in relation with IRI of the road, ADT increase 140 % in average, even for Lampung and Bengkulu increase till 150% - 165%. But the fantastic increasing occures in West Java and Lampung whereas increase between 360%-470%.
3. Changes on travel speed, in relation with IRI increasing occurs increasing on travel speed so we get formula as below:

$$\text{Speed} = -0,13443 * \text{IRI} + 49,71993$$

$$R = 0,98$$

4. Changes on vehicle composition, very interesting is base on evaluation the numbers of sedan, passenger car and mini-bus which it ordinary private vehicle increased in numbers, but for bus and truck which it ordinary commercial vehicle tend to decrease, except in the

links at South Sumatera, Lampung and Java. Meanwhile the road links in P.Bangka and Bengkulu only private car has increase. So private car get more benefit from this rehabilitation project, meanwhile commercial car only a little bit use this road improvement. May be it occurs cause the condition of commercial vehicle is not yet suitable.

5. Change on Vehicle Operating Cost (VOC) . The VOC decrease 21-46 % in average comparing with VOC before road rehabilitation
6. Change on Road Maintenance Cost. Better road after rehabilitation will subtract maintenance cost and it an economic advantage for road operator. After rehabilitation maintenance cost reduce 35% in average.
7. BCR and EIRR of the roads. In average BCR of the road rehabilitation project is 4,38 with average benefit 30 milyar rupiahs each link if calculate since 1990 till 2010. This condition is very good to support transportation system improvement and regional economic activity improvement.

Beside direct benefit as it has mentioned, that road rehabilitation also gives indirect benefit, such as:

1. Social changes benefit: Changes on population growth acceleration, Changes on migration acceleration, Social statues changes etc.
2. Economic changes benefit: Changes on GRDP growth acceleration, Changes on production distribution for each commodity, Changes on level of load and unload goods handling at port, etc.
3. Physical and environmental benefit: Changes on land distribution (land use pattern), Changes on productive land Changes on accessibility

#### **4.2. Road Rehabilitation Impact**

In relation with road rehabilitation, beside it gives us benefit, we must wary about impact will rise, as like:

1. Level of traffic accident, needs to wary about this happen
2. Changes of wide productive land especially for food and crops, wherea at some region tend to occurs the decreasing of wide harvest land and production numbers of wetland padis and dryland padis, also crops, especially arroun the road near urban area wherea many land change to industries, residence and other non agriculture use.
3. The increasing of accessibility will push migration level, if it is not following with economic distribution and development as like distribution of social economic facility, will push copious inmigration to urban area which it raise social problem
4. The following impact causes the increasing of land price will push acceleration on people activities pattern and it means acceleration on land use pattern changes.

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The double blind review process for the ConCERN 2014 has been completed. All the abstracts submitted to the conference from various countries were peer reviewed by the International Scientific Committee. Based on the recommendations of the reviewers, we are very pleased to inform you that your paper:

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Title : BENEFIT EVALUATION OF ROAD REHABILITATION AT  
NINE PROVINCES IN INDONESIA

Decision : ACCEPTED for Oral presentation.

Reviewer's Comments : Abstract needs to be rewritten

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