ANALYSIS OF VEHICLE OPERATING COSTS USING METHOD (PACIFIC CONSULTANT INTERNATIONAL) PCI ON SEMARANG TOLL ROAD SECTION A AND NON-TOLL ROAD (KRAPYAK-JATINGALEH)

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Abstract. The Semarang toll road is the only toll road network in the city of Semarang at this time. The construction of toll roads aims to reduce congestion and improve travel time efficiency. In addition, the benefit of toll roads is that toll road users will benefit in the form of vehicle operational cost savings (BOK) and time compared to if they pass through non-toll roads. For alternative routes or non-toll roads, conventional roads can be chosen by motorists without passing through toll roads. This study aims to calculate vehicle operating costs (BOK), vehicle operating cost benefits (BKBOK) using the Pacific Consultant International (PCI) method as a limit to determine toll rates and analyze the comparison of Vehicle Operating Costs (BOK) on toll and non-toll roads. . Data collection techniques in this study used primary and secondary data collection techniques. The analysis was carried out using an interactive analysis model. The calculation of vehicle operating costs using the PCI method is taken from the lowest vehicle operating costs from various speed variations. For toll roads, the lowest vehicle operating costs occur at a speed of 60 km/hour with a total BOK of Rp. 6,803.54. Meanwhile, for non-toll roads, the lowest vehicle operating costs occur at a speed of 60 km/hour with a total BOK of Rp. 10,641.27. According to the analysis we have obtained, toll roads are cheaper than non-toll roads. For road users in the city of Semarang, it is recommended to use the Semarang section A toll road compared to non-toll roads, because vehicle operating costs are more efficient and have a much faster travel time.

Keywords: BOK, BKBOK, speed, PCI, Toll Road

1. Introduction

Semarang City is one of the metropolitan cities in Indonesia, as well as the capital of Central Java Province. The city with the nickname Atlas city, is located on the north coast of the island of Java with a very strategic position, which is in the middle of the route between Jakarta and Surabaya. Road construction in Semarang City has been going well in all sectors and the results have been felt by the local community. The Semarang toll road is the only toll road network in the city of Semarang at this time. The construction of toll roads aims to reduce traffic congestion in the city of Semarang and increase travel time efficiency [1]. According to Law no. 38/2004 concerning roads, article 43 paragraph 3, toll road users are subject to the obligation to pay the tolls used for the return of investment, maintenance and development of toll roads. Toll road users will benefit from savings in vehicle operating costs (BOK) and time compared to using non-toll roads. For alternative routes or non-toll roads this is meant by conventional roads which can be selected by motorists without passing through the section A toll road.

The route chosen for the nearest non-toll road is through Jalan Siliwangi - Jalan Pamularsih Raya - Jalan Kaligarang - Jalan Kelud Raya - Jalan Manoreh Raya - Jalan Talang Sari - Jalan Pawiyatan Luhur – Karang Rejo highway with a distance of 11 km. In addition to a longer distance than toll roads, the situation of non-toll roads is more congested because this alternative road only has 1 lane for 2 directions and there are traffic lights which slow down travel time. Meanwhile, the selection of the Semarang Toll Road Section A compared to alternative/non-toll roads depends on the travel time and traffic smoothness, because the toll road has 2 lanes of traffic for 2 directions with a road width of 3.6 m which is smoother than the non-toll road. Toll and do not pass the traffic light. The geometric condition of the section A toll road has slopes and slopes. Heavy vehicles are only capable of traveling at low speeds, so the small vehicles behind them (class I vehicles) do not can precede and the occurrence of vehicle queues which will slightly affect the vehicle operating costs (BOK) as well as the Vehicle Operational Cost Profit (BKBOK). Therefore, it is necessary to conduct a study to determine the vehicle operating costs (BOK) and the Vehicle Operating Cost Advantages (BKBOK) for road users, if crossing the Semarang toll road section A.

II. RESEARCH METHODS

Research design is the framework used to carry out research [2]. Research design provides procedures for obtaining the information needed to develop or solve research problems. Research design is the basis for conducting a research, therefore a good research design will produce effective and efficient research. In this study, using a descriptive method. Where according to [3]. states that "descriptive research is more specific by focusing on certain aspects and often shows the relationship between various variables".

Through this method, it is hoped that researchers can produce an accurate picture of the effect of speed on vehicle operating costs (BOK) on the Semarang Toll Road section A andnon-toll roads. The case study in this study is the Semarang toll road section A Krapyak - Jatingaleh located in the city of Semarang with a toll road length of 8 km. In this study, the calculation of vehicle operating costs from existing (non-toll) roads
was also carried out as a comparison material and to get the value of savings from vehicle operating costs and time value. The length of the existing road itself is 11 km.

III. RESULTS AND DISCUSSION

A. The need for tire consumption, fuel consumption, labor requirements and so on can be seen in the table

Jenis Kendaraan	Kendaraan Representatif (yang diambil)	Harga (dalam Rupiah)
Golongan 1	Toyota Avanza 1.3E MT	Rp. 199.900.000,00
	Ukuran Ban 185/70 R14	Rp. 721.000,00
	Mekanik	Rp. 5000,00/Jam
	Bensin (Pertalite) Minyak Pelumas (TMO 15W40) 4 liter	Rp. 7.650,00 Rp. 180.000,00

Source: [4],[5][6]

B. Toll and Non-Toll Road Speed Data

- Toll road

Waktu Survey	Jam	Lokasi	Panjang/ Ruas(KM)	Hasil Survey	
				Waktu Tempuh (menit)	Kecepatan Tempuh (KM/jam)
Senin	09.00	Krapyak-Jatingaleh	8,00	6,50	72
Selasa	09.00	Krapyak-Jatingaleh	8,00	6,59	71
Sabtu	09.00	Krapyak-Jatingaleh	8,00	6,32	74
Minggu	09.00	Krapyak-Jatingaleh	8,00	6,24	75

- Non-Toll Road

Waktu Survey	Jam	Lokasi	Panjang/ Ruas(KM)	Hasil Survey	
				Waktu Tempuh (menit)	Kecepatan Tempuh (KM/jam)
Senin	10.30	Krapyak-Jatingaleh	11,00	25,04	50
Selasa	10.30	Krapyak-Jatingaleh	11,00	24,69	48
Sabtu	10.30	Krapyak-Jatingaleh	11,00	22,50	53
Minggu	10.30	Krapyak-Jatingaleh	11,00	26,41	49

C. The results of several BOK components on toll roads. More details can be seen in the table

Calculation of Variable Vehicle Operating Costs on Toll Roads (per 1000 km)

Kecepatan	Konsumsi Bahan Bakar	Konsumsi Minyak Pelumas	Konsumsi Ban	Biaya Pemeliharaan		Depresiasi	Bunga Modal	Asuransi
				Suku Cadang	Tenaga Kerja			
50	69,4094	0,85413	0,0487733	0,0008767	0,54367	0,004	0,006	0,00152
55	67,6795	0,84968	0,0531973	0,0009087	0,56177	0,003809524	0,005454545	0,001381818
60	68,1376	0,85973	0,0576213	0,0009407	0,57987	0,003636364	0,005	0,001266667
65	70,7837	0,88428	0,0620453	0,0009727	0,59797	0,003478261	0,004615385	0,001169231
70	75,6178	0,92333	0,0664693	0,0010047	0,61607	0,003333333	0,004285714	0,001085714
71	76,84718	0,93288	0,0673541	0,0010111	0,61969	0,003305785	0,004225352	0,001070423
72	78,16408	0,94301	0,0682389	0,0010175	0,62331	0,003278689	0,004166667	0,001055556
74	81,06044	0,96501	0,0700085	0,0010303	0,63055	0,003225806	0,004054054	0,001027027
75	82,6399	0,97688	0,0708933	0,0010367	0,63417	0,0032	0,004	0,001013333
80	91,85	1,04493	0,0753173	0,0010687	0,65227	0,003076923	0,00375	0,00095
85	103,2481	1,12748	0,0797413	0,0011007	0,67037	0,002962963	0,003529412	0,000894118
90	116,8342	1,22453	0,0841653	0,0011327	0,68847	0,002857143	0,003333333	0,000844444
95	132,6083	1,33608	0,0885893	0,0011647	0,70657	0,002758621	0,003157895	0,0008
100	150,5704	1,46213	0,0930133	0,0011967	0,72467	0,002666667	0,003	0,00076
110	193,0586	1,75773	0,1018613	0,0012607	0,76087	0,0025	0,002727273	0,000690909

can be seen at speeds of 50 to 110 speeds, fuel consumption, lubricating oil consumption, tire consumption, maintenance costs, depreciation, capital interest, and insurance costs, the cost calculation is increasing. Therefore it can be concluded that the higher the speed, the more the cost.

D. Variable Calculation Table for Vehicle Operating Costs on Non-Toll Roads (per 1000 km)

Kecepatan	Konsumsi Bahan Bakar	Konsumsi Minyak Pelumas	Konsumsi Ban	Biaya Pemeliharaan		Depresiasi	Bunga Modal	Asuransi
				Suku Cadang	Tenaga Kerja			
45	95,30207	1,12178	0,0352827	0,0008447	0,52557	0,004210526	0,006666667	0,001688889
48	91,90775	1,10291	0,0379371	0,0008639	0,53643	0,004081633	0,00625	0,001583333
49	91,00403	1,0981	0,0388219	0,0008703	0,54005	0,004040404	0,006122449	0,00155102
50	90,21417	1,09403	0,0397067	0,0008767	0,54367	0,004	0,006	0,00152
53	88,52775	1,08626	0,0423611	0,0008959	0,55453	0,003883495	0,005660377	0,001433962
55	87,97277	1,08478	0,0441307	0,0009087	0,56177	0,003809524	0,005454545	0,001381818
60	88,57787	1,09403	0,0485547	0,0009407	0,57987	0,003636364	0,005	0,001266667
65	92,02947	1,12178	0,0529787	0,0009727	0,59797	0,003478261	0,004615385	0,001169231
70	98,32757	1,16803	0,0574027	0,0010047	0,61607	0,003333333	0,004285714	0,001085714
75	107,47217	1,23278	0,0618267	0,0010367	0,63417	0,0032	0,004	0,001013333
80	119,46327	1,31603	0,0662507	0,0010687	0,65227	0,003076923	0,00375	0,00095
85	134,30087	1,41778	0,0706747	0,0011007	0,67037	0,002962963	0,003529412	0,000894118
90	151,98497	1,53803	0,0750987	0,0011327	0,68847	0,002857143	0,003333333	0,000844444
95	172,51557	1,67678	0,0795227	0,0011647	0,70657	0,002758621	0,003157895	0,0008
100	195,89267	1,83403	0,0839467	0,0011967	0,72467	0,002666667	0,003	0,00076

it can be concluded that at a speed of 45 to 55 fuel consumption, lubricating oil consumption, depreciation, capital interest, insurance, the cost calculation decreases, and for tire consumption and maintenance costs at a speed of 45 to 55 the cost calculation increases. Then at the speed of 66 to 100 all the cost calculation variables are increasing.

E. Calculation of Vehicle Operational Costs using the PCI formula [5].

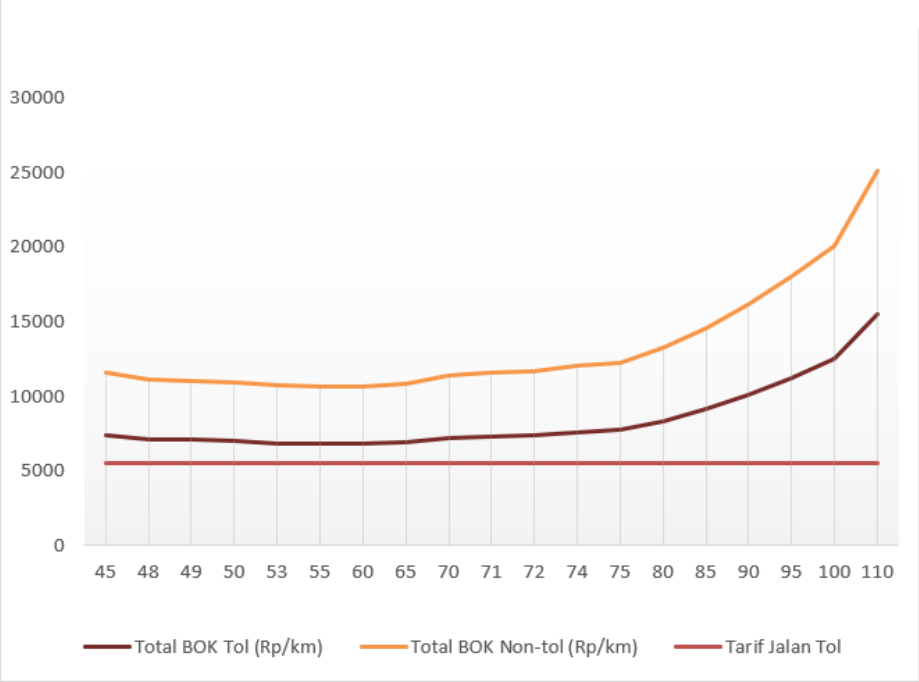
Table of Calculation of Vehicle Operational Costs on Toll Roads per KM

Kecepatan	Konsumsi Bahan Bakar	Konsumsi Minyak Pelumas	Konsumsi Ban	Biaya Pemeliharaan		Depresiasi	Bunga Modal	Asuransi	Over head	Total BOK (Rp/km)
				Suku Cadang	Tenaga Kerja					
50	4247,85528	1229,9472	281,32439	4,52264070	21,7468	10,31741919	15,47612878	1215,392	-	7026,582
55	4141,9854	1223,5392	306,84202	4,68771940	22,4708	9,826113514	14,06920799	1104,901818	-	6828,322
60	4170,02112	1238,0112	332,35965	4,85279811	23,1948	9,379471991	12,89677399	1012,826667	-	6803,542
65	4331,96244	1273,3632	357,87729	5,01787682	23,9188	8,971668861	11,90471445	934,9169231	-	6947,933
70	4627,80936	1329,5952	383,39492	5,18295553	24,6428	8,597849325	11,0543777	868,1371429	-	7258,415
71	4703,04741	1343,3472	388,49844	5,21597127	24,7876	8,526792719	10,89868224	855,9098592	-	7340,232
72	4783,64169	1357,9344	393,60197	5,24898701	24,9324	8,456900975	10,74731166	844,0222222	-	7428,586
74	4960,89892	1389,6144	403,80902	5,31501849	25,222	8,320499347	10,45684377	821,2108108	-	7624,848
75	5057,56188	1406,7072	408,91255	5,34803423	25,3668	8,253935352	10,31741919	810,2613333	-	7732,729
80	5621,22	1504,6992	434,43018	5,51311294	26,0908	7,9364763	9,67258049	759,62	-	8369,182
85	6318,78372	1623,5712	459,94781	5,67819165	26,8148	7,642532733	9,103605167	714,9364706	-	9166,478
90	7150,25304	1763,3232	485,46545	5,84327035	27,5388	7,369585136	8,597849325	675,2177778	-	10123,61
95	8115,62796	1923,9552	510,98308	6,00834906	28,2628	7,11546151	8,145330939	639,68	-	11239,78
100	9214,90848	2105,4672	536,50071	6,17342777	28,9868	6,87827946	7,738064392	607,696	-	12514,34
110	11815,1863	2531,1312	587,53597	6,50358518	30,4348	6,448386994	7,034603993	552,4509091	-	15536,72

that at speed 45, vehicle operating costs decrease at speed 60 and increase at speed 65. At point 70, vehicle operating costs increase drastically to speed 100.

F. Table of Calculation of Vehicle Operational Costs on Non-Toll Roads per KM

Kecepatan	Konsumsi Bahan Bakar	Konsumsi Minyak Pelumas	Konsumsi Ban	Biaya Pemeliharaan		Depresiasi	Bunga Modal	Asuransi	Over head	Total BOK (Rp/km)
				Suku Cadang	Tenaga Kerja					
45	7436,420522	2059,58808	259,4760323	6,889305624	26,80407	17,17035789	27,1864	1721,805333	-	11555,34
48	7171,561733	2024,94276	278,9970208	7,045899288	27,35793	16,64473469	25,48725	1614,1925	-	11166,23
49	7101,044461	2016,1116	285,504017	7,098097176	27,54255	16,47660606	24,96710204	1581,249796	-	11059,99
50	7039,411685	2008,63908	292,0110131	7,150295064	27,72717	16,31184	24,46776	1549,6248	-	10965,34
53	6907,820333	1994,37336	311,5320016	7,306888728	28,28103	15,83673786	23,08279245	1461,910189	-	10750,14
55	6864,515243	1991,65608	324,5459939	7,411284504	28,65027	15,53508571	22,24341818	1408,749818	-	10663,31
60	6911,731196	2008,63908	357,0809747	7,672273944	29,57337	14,82894545	20,3898	1291,354	-	10641,27
65	7181,059544	2059,58808	389,6159555	7,933263384	30,49647	14,1842087	18,82135385	1192,019077	-	10893,72
70	7672,500287	2144,50308	422,1509363	8,194252824	31,41957	13,5932	17,47697143	1106,874857	-	11416,71
75	8386,053425	2263,38408	454,6859171	8,455242264	32,34267	13,049472	16,31184	1033,0832	-	12207,37
80	9321,718958	2416,23108	487,2208979	8,716231704	33,26577	12,54756923	15,29235	968,5155	-	13263,51
85	10479,49689	2603,04408	519,7558787	8,977221144	34,18887	12,08284444	14,3928	911,544	-	14583,48
90	11859,38721	2823,82308	552,2908595	9,238210584	35,11197	11,65131429	13,5932	860,9026667	-	16166,00
95	13461,38993	3078,56808	584,8258403	9,499200024	36,03507	11,24954483	12,87776842	815,592	-	18010,04
100	15285,50504	3367,27908	617,3608211	9,760189464	36,95817	10,87456	12,23388	774,8124	-	20114,78



From the graphs of toll and non-toll roads above, it can be concluded that at a speed of 49 the vehicle operating costs decreased, and at a speed of 60 it increased. Vehicle operating costs have increased drastically at speeds of 75 to 110 speeds. Meanwhile, the fixed toll costs or tariffs are Rp. 5500.00.

G. Calculation of BKBOK [6].

Calculation of BKBOK for Toyota Avanza (class I) with a speed on Toll roads of 75 km/hour and Non-Toll roads of 50 km/hour is as follows:

BKBOK = [(BOkn x Dn) – (BOKt Dt)] + [(Dn/Vn – Dt/Vt) x Tv]

= [(10965,34x 11.00) – (7732,729 x 8.00)] + [(11.00/50 – 8.00/75) x. 727,78]

= Rp. 58,839.73

with:

BKBOK : Big Profit for Vehicle Operating Costs (Rp),

BOKn : Vehicle Operation Costs on non-toll roads (Rp/km),

BOKt : Vehicle Operation Costs on toll roads (Rp/km),

Dn : Distance of non-toll roads (km),

Dt : Toll road distance (km),

Vn : Speed on non-toll roads (km/h),

Vt : Speed on the highway (km/h),

Tv : Time Value or the time value of the vehicle (Rp/hour).

IV. CONCLUSION

As the final part of the research, a conclusion is drawn from data processing analysis of vehicle operating costs on the Semarang Toll and Non-Toll roads section A (Krapyak-Jatingaleh).

.1. On Semarang Toll Road Section A and Non-Toll Road (KRAPYAK-JATINGALEH), the variables that affect the calculation of vehicle operating costs are fuel, lubricating oil consumption, insurance, tire consumption, capital interest, depreciation, and maintenance costs, and The most influential variable is speed.

2. Calculation of vehicle operating costs using the PCI method is taken from the lowest vehicle operating costs from various speed variations. For toll roads, the lowest vehicle operating costs occur at a speed of 60 km/hour with a total BOK of Rp. 6,803.54. Meanwhile, for non-toll roads, the lowest vehicle operating costs occur at a speed of 60 km/hour with a total BOK of Rp. 10,641.27.

3. Calculation of the profit for vehicle operating costs (BKBOK) on toll roads and non-toll roads, according to our analysis that toll roads are cheaper than non-toll roads with an amount of Rp. 7,354.97.

4. Comparison between toll roads and non-toll roads has quite a large difference, if passing a toll road with a speed of 75 km/hour has a large vehicle operating cost of Rp. 7,732.73 per one kilometer, while for non-toll roads with a speed of 50 km/hour the vehicle operating costs are Rp. 11,555.34 per one kilometer. The difference in total vehicle operating costs from toll roads and non-toll roads is Rp. 127.108.74 – Rp. 67,361.83 = Rp. 59,746.91. For toll roads, a toll rate of Rp. 5,500.00.

VI. THANK-YOU NOTE

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