

Road User Cost of Rural Low-Volume Roads Servicing Agricultural Areas in Malaysia

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ABSTRACT

Road systems are vital to economic growth of an area. High road user cost (RUC) can potentially negate the economics benefit and impede growth. This is crucial for rural areas, where most activities are related to agriculture and other modes of transportation are limited. The road user cost consists of the vehicle operation cost (VOC) and travel time cost. VOC is influenced by road quality performance as well as fuel prices. Travel time cost is the economic loss of due time spent during travel, and this is related to the vehicular speeds. The objective of this study is to ascertain the road user cost on rural low volume roads servicing agricultural areas in Malaysia in three cases, namely where there is no road improvement undertaken, rehabilitation works undertaken, and upgrading works undertaken. This study also examines the impact of changes of fuel prices on RUC. Two rural low volume minor roads servicing agricultural areas under the Federal Land Development Authority programme selected for this study. The roads are Jalan Felda Kemahang and Jalan Felda Jengka. In order to determine the road user cost, the traffic volume must be obtained. A manual classified traffic count survey was carried out for duration 16 hours along the roadway. The road condition is measured by the international road roughness index (IRI) in the unit of m/km, by using a profiling device. It was found if the road condition is poor the road user cost is estimated 12.903 million RM/year for Jalan Felda Kemahang. For Jalan Felda Kemahang road rehabilitation reduces the RUC by 6%. As for road upgrading works for Jalan Felda Kemahang can reduce RUC by 26%. In terms of fuel price increase, it was found that the RUC increased by 2% and by 6% for Jalan Felda Kemahang and Jalan Felda Jengka respectively.

Keywords: *Transportation economics; rural low volume road; agricultural roads*

INTRODUCTION

Road systems are vital to economic activities and economic growth of an area. High road user cost (RUC) can potentially negate the economics benefit and impede growth. This is crucial for rural areas, where most activities are related to agriculture and other modes of transportation are limited. Measurable changes in traffic efficiency, land use, and investment activity have shown to have positive effects such as improved connectivity and economic growth. (Krupík 2025).

In Malaysia, the lack of economic opportunity in the rural areas have caused migration to urban areas, despite the high cost of living, with the rural population dropping to 21.3% as of 2023. The agricultural sector in Malaysia can potentially revive the rural economy and reduce the cost of food production. Unfortunately, the sector is

showing decline based on a study by Khazanah Research Institute which reported that the agriculture sector's contribution to the Malaysian economy has been on a declining from 20.3% in 1985 to 8.7% in 2016, and Malaysia's food imports rose to a record high of RM47.3b as of November 2017 (Gin Bee 2019). To improve the agricultural sector, the competition between imported food and locally produced must be addressed. A strategy must be implemented which take into consideration the road infrastructure, to reduce the cost of local produce and ensure food security in Malaysia. The results of a study on low volume roads in Sarawak, Malaysia indicated an urgent need for initiatives by road agencies to review the development and design suitability of low volume roads alongside recording and gathering historical data on the existing low volume roads (Buking et al. 2024).

Road infrastructure influences urbanization of rural areas, which transforms rural land for agriculture, leading

to improved commercialization and food security, and driving the modernization of agricultural value chains, increase demand, prices, employment, and productivity for agricultural products (Sakketa 2023). Transporting resources such as manpower, machinery, fertilizers, agricultural produce, and others.

Literature studies highlight evidence that confirms that rural roads are important for poverty reduction and can increase agricultural productivity and market access. Due to their impact on welfare, evidence shows that low-volume rural feeder roads are more essential to poor rural households than high-speed roads for major traffic (Jouanjean 2013). Study of the investments in roads in China, show the greatest returns to investments came from the construction of low-volume rural roads. The benefit/cost ratios of rural low volume roads were four times greater for national Gross Domestic Product (GDP) than investments in 'high-quality' roads. A review of rural transportation studies emphasized the need to focus rural transport investments on the lower end of the rural road network mobility needs of smallholder farmers (Sieber et al. 2016).

In Malaysia, a portion of the rural low volume roads into agriculture is designated to be under the jurisdiction of the statutory body Federal Land Development Authority (FELDA). The Government established FELDA in 1956 with the intention that development of new lands would provide smallholders with opportunities to cultivate high-value crops employing modern production techniques on economic size holdings (World Bank, 1987). Under this program loans were secured from the World Bank for infrastructure works such as roads and irrigation within the designated areas. The road maintenance of these roads is under the responsibility of the Federal Government, under the purview of the Ministry of Works. The World Bank impact assessment reported that the recalculated rates of return for Felda Jengka sustained a net flow of benefits. The report also highlighted that certain schemes reported that poor road conditions have led to delays in crop extraction to the detriment (World Bank 1987). Study from Bangladesh suggests that the savings of household transport expenses are quite substantial due to road improvement. Road improvement also has a significant impact on men's agricultural wage, fertilizer price and aggregate crop indices (Khandker et al. 2009).

PROBLEM STATEMENT

Whilst the food and agricultural products prices depends on supply and demand, the transportation cost of goods greatly influences the prices. High transport costs that result from inadequate transport infrastructure are primarily

responsible for the large discrepancies that frequently exist between food prices paid by consumers in urban areas and the prices received by farmers producing these crops in low-income countries (Ahmed et al. 1984).

Lowering transportation cost on the rural low-volume road networks used by local agriculture industries can potentially increase their competitiveness in response to the on-going trade liberalization process at the global scale. The road user cost, an important element of the overall transportation cost, consists of the vehicle operation cost (VOC) and travel time cost. VOC is influenced by road quality performance as it influences fuel consumption. Experiments conducted by Federal Highway Authority, United States provides evidence of roadway characteristics on fuel consumption (FHWA 1982).

Therefore, there is a need to study the impact of road quality performance and fuel prices fluctuation on the transportation cost on the rural low volume road. Travel time cost is the economic loss of due time spent during travel, and this is related to the vehicular speeds. RUC optimization through its impact on the overall agricultural production cost may drive prices to be more competitive. An effective decision-making process considering these costs with regards to infrastructure works and policies is necessary to ensure sustainability of agriculture as an industry.

STUDY AIM & OBJECTIVES

The aim of this study is to quantify the importance of road improvements, and its potential impact to costs in the rural agricultural areas. The study is intended to provide the possible outcomes from decisions to be taken by executive agencies or policy makers on their impact on transportation costs. Ultimately the aim is to reduce the cost of local agricultural goods as much as possible, to compete with imported agricultural goods.

Therefore, to achieve this aim, the objective of ascertaining the road user cost of rural low volume roads servicing agricultural areas in Malaysia is selected. The road user costs consist of the vehicle operating cost and productivity cost due to time spent in travel. The main objective is further divided into the following objectives:

1. To determine road user cost of roads at existing rural low-volume road without any improvements, other than with minor routine maintenance, such as pothole patching.
2. To determine road user cost of roads that undergone rehabilitation works and compare with that with that existing.

3. To determine road user cost of roads that undergone road upgrading works and compare with that with that existing.
4. To determine the impact of changes of fuel prices on RUC.

ROAD CONDITION IMPACT ON VEHICLE OPERATING COST

The quality of a road depends on the defects such deformation, cracking, rutting, and others. To encapsulate all these defects a standard measurement of road user comfort is needed. Therefore, the International Roughness Index (IRI) was established as measure to rate quality. This is a measure of the total vertical displacement along a given 1km length or road.

A literature study reported that majority of the literature reviewed, pavement roughness was reported to have a positive relationship with fuel consumption and its costs, such that an increase in pavement roughness resulted in increased fuel consumption costs. The review also highlighted studies that show roughness impact on engine oil consumption, tire wear, and vehicle maintenance (Robbins et al. 2015).

METHODOLOGY

STUDY SITE

Two rural low-volume minor roads servicing agricultural areas under the FELDA programme were selected for this study. The roads are Jalan Felda Kemahang and Jalan Felda Jengka, designated under the FELDA road, in which the maintenance is under the federal government jurisdiction. The road section specifically chosen for the study is a paved two-way two lane road, with lane width of approximately 5.5m, which correspond to R2 standard according to Malaysia design standards, although it could not be ascertained if this was the standard considered in the original design. The length of the data collection for the road section taken for this study is 1km. However, for the purpose of cost estimation the road performance data for 1 km is taken as representative for the entire road. The study length is taken as 9km based on the entirety of Jalan Felda Jengka which measured as 9km. To have similar comparison, Jalan Felda Kemahang was also taken as 9km. Both sites considered to have rolling terrain instead of flat. While both sites have mainly palm oil fruit plantation, the Felda Jengka has considerably more and visible throughout the road section.

STUDY SCENARIO ALTERNATIVES

The study involves 3 alternatives with each alternative two different fuel prices namely from 2023 and from 2024.

Alternative 1 is essentially the “Do nothing alternative” which limits to only routine maintenance of the road includes patching of potholes and cracks. The routine maintenance does not improve the current road performance but intended not to allow the performance to deteriorate further. However, the limitation to this is that the road performance will eventually deteriorate, and routine maintenance is no longer practical to be carried out.

Alternative 2 involves pavement rehabilitation, which is a long-term solution when compared to routine maintenance. In typical pavement rehabilitation works, one lane is closed for a stretch of road spanning 500m -1km, and work on them is carried frequently at night to avoid disruption to traffic. However, for low traffic volume, work during the day is also acceptable. A common rehabilitation method is the mill and pave method, which is adopted in this study. This method involves milling, which removes the damaged surfacing of the road, followed by laying of the asphalt layer by using a paver.

Alternative 3 is the road upgrading alternative which involves upgrading from R2 standard with a carriageway width of 5.5m to road with R3 standard complying to 6m carriageway width. It should be noted this study is limited to a general evaluation which assumes the usual outcomes of road upgrading, with the result of shortened travel time due to allowances for greater speed and reduced distance. No geometric design was carried out to verify the actual outcome of the road upgrading exercise. This alternative involves realigning the road to shorten travel times as well as increasing the design speed from 60km/h to a higher speed of 70km/h. In actual upgrading, considerations such as road safety audit flood mitigation measures, and additional lanes at selected areas may be applied. However, due to the limitations of this study, the upgrading design is only reflected as a reduction of the travel distance by 1km, and the improvement road surface quality measured by IRI of 2m/km. The IRI value adopted is based on the minimum government requirements of new and upgraded federal roads. This alternative serves as a benchmark comparison to the other two alternatives.

DATA COLLECTION METHOD

The data collection includes traffic data sourced from Public Works Department (PWD), Malaysia. The source data is part of a study on rehabilitation methods that involves pavement recycling on FELDA roads of category R3. To determine the road user cost, the traffic volume

Vehicle Type & Classification	6.00am to 7.00am	7.00am to 8.00am	8.00am to 9.00am	9.00am to 10.00am	10.00am to 11.00pm	11.00pm to 12.00pm	12.00pm to 1.00pm	1.00pm to 2.00pm	2.00pm to 3.00pm	3.00pm to 4.00pm	4.00pm to 5.00pm	5.00pm to 6.00pm	6.00pm to 7.00pm	7.00pm to 8.00pm	8.00pm to 9.00pm	9.00pm to 10.00pm	TOTAL
Motocar & Taxis																	
Motocycles																	
Lorries & Large Vans (Medium 2-axles)																	
Lorries & Large Vans (Heavy 3-axies & above)																	
Buses																	
TOTAL																	

FIGURE 1. Manual classified traffic count form

must be obtained. A manual classified traffic count survey was carried out for duration 16 hours along the roadway. Five vehicle classification was utilized for the survey, namely passenger car, motorcycles, medium lorry, heavy lorry, and bus. Vans and sport utility vehicles are placed under the same category as passenger car. It should be noted that the traffic count was limited to only one day for both directions, having two teams for each direction. The traffic data for both directions is then added together. The manual traffic count survey was carried out using hand tally counter tool and started from 6am to 10pm. Figure 1 shows the manual traffic count form used in the study. Due to limited traffic count survey, traffic variations due to other factors could not be fully accounted for.



FIGURE 2. Walking Profiler roughness measurement

Road roughness data indicates road condition by impact to road users in terms of ride quality, user cost, and safety. Measurement of roughness on the standard scale, derived from the longitudinal profile of the road. A study to select a common roughness measure to be used throughout the world, resulted in establishment of the International Roughness Index (IRI) by the World Bank (Gillespie et al. 1986). The road condition is measured IRI in the unit of m/km, by using a profiling device either vehicle mounted or walking type. The device used in this study is the walking profiler supplied by the Australian Road Research Board (ARRB) as shown in Figure 2. The

device measures vertical profile of the road over a fixed distance. The changes of the vertical profile over a unit of distance simulate the bumpiness of a particular road. The testing personnel shall walk along the test road for 1km, and IRI data is produced for every 10m. However, the data is continuously recorded, and IRI data for shorter intervals are possible. The resulting IRI data samples numbered 100 values per direction, and 200 values for both directions. IRI values are categorized based on Malaysia's Public Works Department rating on federal roads which ranges from good, fair poor, and bad. The IRI values of less than 2.5 m/km is considered good, while the IRI values of greater than 4.5m/km is considered bad.

ANALYSIS METHOD

The analysis of this study utilizes the Roads Economic Decision Model (RED) Model Tool developed by the World Bank under the Sub-Saharan Africa Transport Policy Program. The RED Model Tool performs the economic evaluation of improvements and maintenance projects. The model computes the benefits accruing to normal, generated, as a function of a reduction in vehicle operating and time costs as well as safety benefits. The model is presented in a series of Excel workbooks that collect all user inputs, present the results in a user-friendly manner. The road user cost is calculated based on roughness impact to vehicle operating cost and speed as shown in Figure 3.

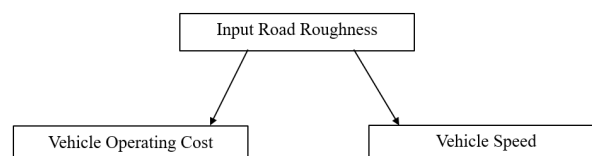


FIGURE 3. Road User Cost Input-Output

To calculate vehicle operating costs and speeds for a given level of service, the relationships between vehicle operating costs and speeds to road roughness have to be defined, using cubic polynomials, for up to nine vehicle types; three terrain types; and three road types (Archondo-Callao 1999).

The road user cost studied is combination of VOC and travel time derived from speed which are shown in equation (1) and equation (2) respectively. The travel time measures productivity loss based on the economic value of time of the passengers. Below is the model used for VOC and Vehicle Speeds obtained from World Bank Africa Transport Technical Note SSATP Note No. 18, (Archondo-Callao, 1999).

$$\text{VOC} = a_0 + a_1(\text{IRI}) + a_2(\text{IRI}_2) + a_3(\text{IRI}_3) \quad (1)$$

where IRI denotes International Roughness Index, and a_0 , a_1 , a_2 , and a_3 are coefficients specific to vehicle and terrain type.

$$\text{Speed} = b_0 + b_1(\text{IRI}) + b_2(\text{IRI}_2) + b_3(\text{IRI}_3) \quad (2)$$

where b_0 , b_1 , b_2 , and b_3 are coefficients specific to vehicle and terrain type.

INPUT PARAMETERS

The roughness has been shown to have impact on the vehicle operating cost parameters based on literature study by Robbins et al. (Robbins et al. 2015). The vehicle operating costs parameters consisting of vehicle price, tires, fuel, lubricating oil, maintenance labor, and crew wages are shown in Table 1. The market unit prices are based on approximate estimations, whilst wages and labor are based on minimum wage as published by the Ministry of Human Resource, Malaysia. Due to changes and volatility in fuel prices, both the fuel price in 2023 and fuel price in 2024 are considered. However, it cannot be confirmed what type

of fuel the passenger cars used, as it is expected that different proportions of passenger cars used different fuel such RON95, RON97, and diesel. For this study all passenger cars are assumed to use RON95 due to its frequent usage. The fuel prices are based on prices published by the Ministry of Finance, Malaysia. It should be noted that for vehicle, lubricating oil, and tire price data is obtained based on popular brands without in-depth market price analysis. The travel time cost encapsulates the loss of productivity. The number of passengers not including the driver is considered. The driver and crew are already considered in the VOC. The basis is the minimum hourly wage allowed in Malaysia. Minimum wage is considered acceptable due to its location in rural areas.

For this study the alternatives are assumed to have insignificant differences in accidents occurrences due to the low traffic volume. Whilst the accident rate is not considered in the calculation of VOC and travel time cost, it may be considered in the further economic analysis when considering the overall cost of infrastructure investment.

Although economic analysis involves many factors, the study is limited to only the impacts due to VOC and fuel costs which has direct impact on the cost of transportation of goods.

TABLE 1. Vehicle Operating Cost Economic or Financial Unit Costs Parameters

Vehicle	New Vehicle	New Tire	Fuel 2023	Fuel 2024	Lubricating Oil	Maintenance Labor	Crew Wages
Description	(RM/vehicle)	(RM/tire)	(RM/liter)	(RM/liter)	(RM/liter)	(RM/hr)	(RM/hr)
Motorcycle	2,500	100.00	2.05	2.05	40.00	7.20	7.20
Medium Car	35,000	200.00	2.05	2.05	40.00	7.20	7.20
Medium Truck	150,000	500.00	2.15	3.25	40.00	7.20	7.20
Heavy Truck	350,000	500.00	2.15	3.25	40.00	7.20	7.20
Medium Bus	350,000	500.00	2.15	3.25	40.00	7.20	7.20

RESULTS ANALYSIS AND DISCUSSION

ANALYSIS OF THE ROAD CONDITION

Road condition is evaluated in term of IRI in the unit of m/km, with higher values denoting worse condition. The profiler device measures the vertical rise and fall of the road elevation over 1km distance. Defects such as cracks, deformation, and potholes contribute to increase of IRI, and thus reducing the road user comfort. Table 2 shows

the IRI observations for both Felda Jengka and Felda Kemahang. The IRI adopted into the model is based on average IRI of both lanes at an interval of 10m. The IRI reading for alternative 1, which is observed before rehabilitation is carried out shows of the IRI of exceeding 4.5 m/km, indicating bad performance. The IRI reading for alternative 2 shows reading of less than 2.5 m/km which is considered good performance. For alternative 3, since upgrading works were not actually carried out, it is assumed to be 2 m/km. This is minimum requirement upgrading construction works based on local national specifications.

TABLE 2. IRI measurement

Method	Alternative 1 (Without Rehabilitation)				Alternative 2 (With Rehabilitation)			
	IRI, m/km				IRI, m/km			
Site	Felda Jengka		Felda Kemahang		Felda Jengka		Felda Kemahang	
Direction	1	2	1	2	1	2	1	2
Average	5.08	5.43	5.58	4.78	2.23	1.91	2.42	2.32
Maximum	18.10	15.44	14.30	10.03	5.81	5.18	4.78	5.24
Minimum	1.82	1.48	1.57	1.34	0.92	0.54	1.03	0.92
Median	4.44	4.70	5.23	4.28	2.13	1.69	2.35	2.26
Adopted	5.26		5.18		2.07		2.37	

JALAN FELDA KEMAHANG

Table 3 shows the financial annual trip cost in terms of millions per year based on 2023 fuel prices. Table 4 shows the trip cost based on 2024 fuel prices. In terms of time cost there is no change between 2024 and 2023 due to no change in minimum wage. In terms of vehicle operating cost there is rise in the fuel prices for heavy vehicles. For the VOC of both years, alternative 1 which only involve routine maintenance without rehabilitation, shows the highest with a value of RM 8.289 million/year for 2023 and increased to RM 8.531 million/year for 2024. For alternative 2, based on 2024 prices the VOC is RM8.106 million/year with a reduction of RM 0.425 million/year. For alternative 2, when based on 2023 fuel prices the reduction is 0.419 million/year. Therefore, it can be inferred that road quality improvement in the situation of increase of fuel prices, brings better savings in road user cost. For the total road user cost, the lowest for both cases was found to be alternative 3 with 10.481 million for 2023 and 10.694 million for 2024. The reduction by 2.452 million stems from the reduction of the overall length and subsequent travel time of which is typically involved in upgrading works

TABLE 3. Road User Cost for Felda Kemahang based on 2023 Fuel price

Vehicle type	Traffic	VOC	TIME	TOTAL
	(veh/day)	(M RM/year)	(M RM/year)	(M RM/year)
Alternative 1 (Routine Maintenance)				
Car Medium	2887	5.902	3.714	9.616
Motorcycle	1551	0.693	0.669	1.362
Bus Medium	17	0.114	0.231	0.344
Truck Medium	185	1.052	0	1.052
Truck Heavy	47	0.528	0	0.528
Total	4687	8.289	4.614	12.903
Alternative 2 (Rehabilitation)				
Car Medium	2887	5.684	3.763	9.447
Motorcycle	1551	0.655	0.678	1.333
Bus Medium	17	0.099	0.231	0.33
Truck Medium	185	0.957	0	0.957
Truck Heavy	47	0.475	0	0.475
Total	4687	7.87	4.672	12.542
Alternative 3 (Upgrading)				
Car Medium	2887	4.979	2.865	7.843
Motorcycle	1551	0.617	0.522	1.14
Bus Medium	17	0.085	0.176	0.261
Truck Medium	185	0.824	0	0.824
Truck Heavy	47	0.414	0	0.414
Total	4687	6.918	3.563	10.481

TABLE 4. Road User Cost for Felda Kemahang based on 2024 Fuel price

Vehicle type	Traffic (veh/day)	VOC (M RM/year)	TIME (M RM/year)	TOTAL (M RM/year)
Alternative 1 (Routine Maintenance)				
Car Medium	2887	5.902	3.714	9.616
Motorcycle	1551	0.693	0.669	1.362
Bus Medium	17	0.124	0.231	0.355
Truck Medium	185	1.208	0.000	1.208
Truck Heavy	47	0.605	0.000	0.605
Total	4687	8.531	4.614	13.146
Alternative 2 (Rehabilitation)				
Car Medium	2887	5.684	3.763	9.447
Motorcycle	1551	0.655	0.678	1.333
Bus Medium	17	0.109	0.231	0.340
Truck Medium	185	1.107	0.000	1.107
Truck Heavy	47	0.551	0.000	0.551
Total	4687	8.106	4.672	12.778
Alternative 3 (Upgrading)				
Car Medium	2887	4.979	2.865	7.843
Motorcycle	1551	0.617	0.522	1.140
Bus Medium	17	0.095	0.176	0.271
Truck Medium	185	0.958	0.000	0.958
Truck Heavy	47	0.482	0.000	0.482
Total	4687	7.131	3.563	10.694

JALAN FELDA JENGKA

Table 5 shows the road user cost findings for Jalan Felda Jengka. It can be noted that for this site the daily traffic is significantly lower when compared to Jalan Felda Kemahang, resulting in low economic cost. For both 2023 and 2024 the highest total RUC is alternative 1 with 4.336 million for 2023 and 4.626 million for 2024. For alternative 2, rehabilitation resulted in cost reduction of 0.252 million and 0.263 million for 2023 and 2024 fuel prices respectively. Alternative 3 utilizing road upgrading reduces RUC by 0.454 million and 0.461 million for 2023 and 2024 fuel prices respectively.

IMPLICATIONS AND POTENTIAL POLICY
RECOMMENDATIONS

Figure 3 summarizes the findings for all the sites, alternatives, and fuel price comparisons. Based on the figure, it is evident that the traffic volume is a significant factor. The greater the number of road user is affected, the greater the economic impact. The road user cost difference between the alternatives is also greater, with greater traffic. Alternative 1 using just routine maintenance, shows the highest road user cost. This followed by Alternative 2 using road rehabilitation methods, and the lowest is Alternative 3 for upgrading works, which realigns the road to reduce the travelling distance. The rise in fuel cost also added to cost, with sites having more commercial vehicles is greater affected.

TABLE 5. Road User Cost for Felda Jengka

Fuel Price 2023				
	Daily Traffic	VOC	TIME	TOTAL
	(veh/day)	(M RM/year)	(M RM/year)	(M RM/year)
Alternative 1 (Routine Maintenance)	1151	3.271	1.065	4.336
Alternative 2 (Rehabilitation)	1151	3.002	1.081	4.083
Alternative 3 (Upgrading)	1151	2.960	0.922	3.882

Fuel Price 2024				
	Daily Traffic	VOC	TIME	TOTAL
	(veh/day)	(M RM/year)	(M RM/year)	(M RM/year)
Alternative 1 (Routine Maintenance)	1151	3.561	1.065	4.626
Alternative 2 (Rehabilitation)	1151	3.282	1.081	4.363
Alternative 3 (Upgrading)	1151	3.244	0.922	4.166

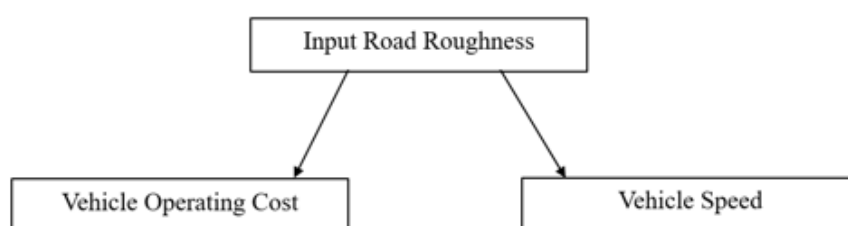


FIGURE 3. Road User Cost across all alternatives and Sites

Based on the current policy, roads gazetted under the FELDA Act are provided with the federal maintenance budget. However, due to limited funds, other locations may be prioritized for rehabilitation and rural low volume agricultural roads may be overlooked. This will potentially result in increased transportation costs for agricultural activities and loss of competitiveness against imports. Policies could be established to identify the rural roads servicing agriculture, to allow for federal maintenance funding and prioritization. Road planning could also be improved to maximize the use of identified roads for agriculture and therefore focus maintenance on certain roads. Proper planning and road upgrading works can also be utilized to shorten travel distances, to reduce transportation costs.

CONCLUSION

Based on the analysis it was found that if the rural low volume roads servicing agricultural areas is properly rehabilitated instead of applying only minimal routine

maintenance, the road condition performance increases and resulting in lower road user costs, inclusive of vehicle operating cost and time productivity cost. It was found that for Jalan Felda Kemahang if the road condition is poor the road user cost is estimated RM12.903 million/year and RM13.146 million/year for 2023 and 2024 fuel prices respectively. As for Jalan Felda Jengka it was estimated at RM4.336 million/year and RM4.626 million/year for 2023 and 2024 fuel prices respectively. For Jalan Felda Kemahang road rehabilitation reduces the RUC by 6% whilst for Jalan Felda Jengka the RUC is reduced by 3%. As for road upgrading works for Jalan Felda Kemahang can reduce RUC by 26%, whilst for Jalan Felda Jengka by 10%. In terms of fuel price increase, it was found that the RUC increased by 2% and by 6% for Jalan Felda Kemahang and Jalan Felda Jengka respectively.

The road user cost reduction of 6% and 3% could potentially have an impact on transportation cost, which influences the prices of agricultural goods. Since significant capital is necessary to develop the agriculture sector, the profit derived from having good road infrastructure will attract further investments in the sector. With cities in

Malaysia located near major ports, competition with import goods is inevitable. However, this can be turned into an advantage. By providing good infrastructure and logistics, agricultural sector in Malaysia have potential to become a major exporter of local produce. It must be noted that this study has several limitations such as the limited data, variations, and in-depth considerations of alternatives. Further studies are recommended to be carried as to verify these findings.

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DECLARATION OF COMPETING INTEREST

None.

REFERENCES

- Ahmed, R. & Rustagi, N. 1987. Marketing and price incentives in African and Asian countries: A comparison. In Elz, D. (ed.). *Agricultural Marketing Strategy and Pricing Policy*, pp. 104–118. Washington, D.C.: World Bank.
- Archondo-Callao, R. 1999. *Roads Economic Decision Model (RED) for economic evaluation of low-volume roads*. Africa Transport Technical Note, SSATP Note No. 18. Washington, D.C.: World Bank.
- Chan @ Ron Buking, R.A., Borhan, M.N. & Rahmat, R.A.A.O.K. 2024. Evaluation of sustainable development for low-volume roads in Sarawak. *Jurnal Kejuruteraan* 36(4): 1373–1384. [https://doi.org/10.17576/jkukm-2024-36\(4\)-04](https://doi.org/10.17576/jkukm-2024-36(4)-04)
- Federal Highway Administration. See Zaniewski et al. (1982).
- Jouanjean, M.-A. 2013. *Targeting infrastructure development to foster agricultural trade and market integration in developing countries: An analytical review*. London: Overseas Development Institute.
- Khandker, S.R., Bakht, Z. & Koolwal, G.B. 2009. The poverty impact of rural roads: Evidence from Bangladesh. *Economic Development and Cultural Change* 57(4): 685–722. <https://doi.org/10.1086/598765>
- Krupik, P. 2026. The impact of road infrastructure development on selected environmental, economic, and social indicators. *Civil and Environmental Engineering* 22(1): 272–281. <https://doi.org/10.2478/cee-2026-0022>
- Robbins, M.M. & Tran, N. 2015. *Literature review: The impact of pavement roughness on vehicle operating costs*. NCAT Report 15-02. Auburn, Alabama: National Center for Asphalt Technology, Auburn University.
- Sakketa, T.G. 2023. Urbanisation and rural development in sub-Saharan Africa: A review of pathways and impacts. *Research in Globalization* 6: 100133. <https://doi.org/10.1016/j.resglo.2023.100133>
- Sayers, M.W., Gillespie, T.D. & Paterson, W.D.O. 1986. *Guidelines for conducting and calibrating road roughness measurements*. World Bank Technical Paper No. 46. Washington, D.C.: World Bank.
- Sieber, N. & Allen, H. 2016. Impacts of rural roads on poverty and equity. *Transport and Communications Bulletin for Asia and the Pacific* 86: 23–40.
- World Bank. 1987. *The Jengka Triangle projects in Malaysia: Impact evaluation report*. Washington, D.C.: World Bank, Operations Evaluation Department.
- Yap, G.B. 2019. *Food supply chain in Malaysia: Review of agricultural policies, public institutional set-up and food regulations*. Kuala Lumpur: Khazanah Research Institute.
- Zaniewski, J.P., Butler, B.C., Cunningham, G., Elkins, G.E., Paggi, M.S. & Machemehl, R. 1982. *Vehicle operating costs, fuel consumption, and pavement type and condition factors*. Report No. FHWA-PL-82-001. Austin, Texas: Texas Research and Development Foundation for the Federal Highway Administration.