The14th International Conference on QiR
(Quality in Research)

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In conjunction with :

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PREFACE

WELCOME FROM THE RECTOR OF UNIVERSITAS INDONESIA

It is both a pleasure and honor for me to welcome you all to the 14th International Conference on QiR (Quality in Research) 2015. Globalization today results in very competitive atmosphere in all aspects. This flourishing competition should consider the harmony and balance between human needs and the environment quality for creating favorable sustainable future. Steps to ensure the preservation of the environment for our future generations are slowly but surely taken. This fragile balance between the development and innovation of mankind as an effort to enhance their quality of life with its harmony with nature must be maintained as a way to achieve sustainable future - helping us make products and services more efficient, design better buildings, produce safer cars and keep people healthier.

Nowadays, scientists and researchers, hand in hand with industrial experts are creating and developing new green technologies that give us hope for a Sustainable Future. Great minds in Engineering, Architecture and Design areas especially has came up with ideas such as Green Architecture that has the capability to cut down urban resource use dramatically, and making urban expansion sustainable; New Nuclear Material; Waste-Sourced Biofuel/Pyrolysis, where technology is now able to turn biomass waste such as paper, grass or wood chips into gas and eventually ethanol; Biomimicry, that has given the rise to self-healing materials. This in turn will give longer lives to most consumer goods, and thereby reducing the demand for raw materials and waste; and many more innovations that should be encouraged for the motivation of current and future development.

These Green and Smart Technologies can help protect, conserve and even restore our precious shared environment. To develop this technology, we need to combine engineering, scientific or technological approaches, with ecology, economics and the social sciences and humanities. The Green and Smart Technologies innovation field is now wide open and offers exciting new territories to explore and develop. Creative thinking by our top technical and scientific researchers is giving us a more and more treasures of new workable ideas. However, innovations require more than just brilliant ideas. Innovations require resources, skills, technology, knowledge, tools, techniques and so much more. But most of all, innovations require people. People are the driving force behind every need of change, changes that are aimed to improve mankind's quality of life, to enhance their living conditions or to simply make life easier and more comfortable.

This conference is about learning of the fundamental aspects which can transform the world and society, thinking ahead to possible challenges facing the globe, discovering innovations related to opportunities for industry, and most importantly, this conference is about bringing together interdisciplinary people to accelerate activities in many areas simultaneously. This is what makes the conference exceptional this year in terms of potential impact from this networking.

I extend my sincere thanks to the Faculty of Engineering Universitas Indonesia, supporting parties and institutions for their participation and contributions in QiR 2015. I would also thank the people of Mataram especially our colleagues from Universitas Mataram and STMIK Lombok for their gracious support and hospitality. Additionally, I extend a hearty thank you to the members of the organizing committees for dedicating their valuable time so that each one of us enjoys an exceptional conference program over the next several days. May we have a successful, stimulating, fruitful and rewarding conference.

Prof. Dr. Ir. Muhammad Anis, M.Met.
Rector
Universitas Indonesia

PREFACE

WELCOME FROM THE DEAN OF FACULTY OF ENGINEERING UNIVERSITAS INDONESIA

Welcome to the 14th International Conference on QiR (Quality in Research) 2015. The Faculty of Engineering Universitas Indonesia is proud that this year we could once again held an international conference of this grand scale. This two-day, biennial conference is presented together with our co-hosts Universitas Mataram and STMIK Lombok and speaks to the importance of fostering relationships among national and international front liners, thinkers, academics, executives, government and business officials, practitioners and leaders across the globe in an effort to share knowledge and best practices as part of a worldwide network.

For almost twenty years, the first definition of sustainable development and sustainability includes sentences like 'much remain to be done in the areas of sustainability' or 'the underlying science is still far from exact and we all still need to make a big effort' are common introducing and/or concluding phrases in both literature and scientific forums. I envisioned that QiR will be a platform where academicians, scientists, researchers and practitioners from engineering, architecture, design, and community services to share, discuss, and move forward with their findings and innovations. I hope that the intellectual discourse will result in future collaborations between universities, research institutions and industry both locally and internationally. In particular it is expected that focus will be given to issues on innovations for the enhancement of human life and the environment.

In accordance to this year's theme, this conference will cover a wide range of green and smart technology issues, especially state of the art information and knowledge of new innovations, ideas, creative methods or applications which can be implemented to enhance the human life with various smart technologies developed to improve mankind's quality of life and green technologies to make sure that we make a contribution to keeping our environment for our future generations. The itinerary for the two days has been carefully planned to ensure a lively exchange of ideas and the development of innovative strategies and there will be many opportunities for everyone in attendance to share their expertise with, and learn from, peers from around the world.

We foresee more and more challenges in our future. Challenges in how to improve our life, how can we enhance our society, how can we make our lives and the lives or our society better? These challenges should be answered together by developing collaborations for future research in various engineering and design areas. Let's make this conference an international media for exchange of knowledge, experience and research as well as the review of progress and discussion on the state of the art and future trend of prospective collaboration and networking in broad field of eco-based technology development.

My deepest appreciation to our sponsors, supported parties and various contributors for their never ending supports of this conference. I would also like to convey my gratitude to all of our distinguished speakers for making the time to share their knowledge with us. To our fellow researchers and/or practitioners from Indonesia and overseas, welcome and enjoy your stay in this amazing island, Lombok. I would also like to invite all participants in expressing our appreciation to all members of the QiR 2015 organizing committee for their hard work in making this conference another success.

Prof. Dr. Ir. Dedi Priadi, DEA
Dean Faculty of Engineering
Universitas Indonesia

WELCOME FROM THE QiR 2015 ORGANIZING COMMITTEE

Welcome to the 14th International Conference on QiR (Quality in Research) 2015. It is a great pleasure for Faculty of Engineering Universitas Indonesia to be hosting this biennial event with Faculty of Engineering Universitas Mataram and STMIK Lombok, in the spirit of strengthening of cooperation and mutual growth to be world class institution. For the first time, the QiR 2015 is held in Lombok Island, one of Indonesia's beautiful paradise islands. It is with our utmost pleasure to hold this year's QiR 2015 in conjunction with 4th Asian Symposium on Material Processing (ASMP), and International Conference in Saving Energy in Refrigeration and Air Conditioning (ICSERA).

The aim of this International Conference with our selected theme, "Green and Smart Technology for Sustainable Future", is to provide an international forum for exchanging knowledge and research expertise as well as creating a prospective collaboration and networking on various fields of science, engineering and design. We hope this conference can be a kick-off for the strengthened action and partnerships on creating a platform for us; national and international thinkers, academics, government officials, business executives and practitioners, to present and discuss the pivotal role of engineers in innovative products which will reduce environmental impacts, applications in sustainable planning, manufacturing, architecture, and many more to grow and ensure the rising prosperity of our society going into the future. Under this theme, the conference focuses on the innovative contributions in green and smart technology to encourage and motivate current and future development for achieving sustainable future.

Over the period of 18 years, this biennial international conference started from annual national conference and now has become an important place of encounter between scholars and practitioners from different countries, cultures and backgrounds discussing contemporary engineering and design issues dealt in their hometown, country or even region. Serving as a platform for an engineering and design dialogue, this conference will have 21 invited speakers and has gathered more than 500 papers from more than 17 countries all over the world:
86 papers on International Symposium on Civil and Environmental Engineering
129 papers on International Symposium on Mechanical and Maritime Engineering
121 papers on International Symposium on Electrical and Computer Engineering
107 papers on International Symposium on Materials and Metallurgy Engineering
36 papers on International Symposium on Architecture, Interior and Urban Planning
56 papers on International Symposium on Chemical and Bioprocess Engineering
74 papers on International Symposium on Industrial Engineering
21 papers on International Symposium on Community Development

This year, we have a special talkshow planned as a special session within our plenary lecture. This talk show was planned by our alumni with the theme "***Serve Our Country***". After more than five decades of existence, FTUI has in its library hundreds if not thousands undeveloped innovation ideas and research from its faculties, graduates and students, all of which are aimed at enhancing the quality of human life and the environment, especially in Indonesia. We feel that it's time we contribute more to our country by making sure that these innovations and research can be implemented and produced for a better future of our nation. The talk show will feature some of the most prominent figure in Indonesia's government and will discuss how these innovations can be used by the government in areas such as: electrical, oil and gas, IT, mining, design, manufacture and how the industry can be a part of it.

My deepest gratitude: to all of our speakers, participants, contributors, partners, exhibitors and professional associations, who have given this conference their generous support. I would also like to thank all members of the Organizing Committee, our International Advisory Board and distinguished Reviewers for all of their support and advice. We also

owe our success to the full support of the Rector of Universitas Indonesia and the Dean of Faculty of Engineering. Last but not least, a special thanks to our co-hosts, Universitas Mataram and STMIK Lombok for all of their immense supports in making this conference a success.

Allow me to wish all of you a meaningful and rewarding conference. We wish you a pleasant and memorable stay in Lombok. Thank you and we hope to see you again at the QiR 2017.

Dr. Fitri Yuli Zulkifli, ST., MSc.
General Chair of QiR 2015 Organizing Committee

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Development of Low Cost Vehicles for Rural Areas in Indonesia

Endang Widjajanti[1,a], Ismono Kusmaryono[1,b], and Karyawan[2,c]

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Keywords: Goods and passenger vehicles; Low cost; Rural

Abstract. The directive of previous president of Republic of Indonesia about "Program Pro Rakyat Klaster IV" (Pro-People's Programme Cluster IV) should be followed with the development of low cost rural vehicles to enhance economic activities in the rural area, agricultural sector, and small scale industries. Low cost rural transport policy implementation give positive impact, those are can absorbs domestic components, goods distribution, rural people movements and enhance the rural economy. This paper discusses the development of low cost freight and passenger vehicles in order to support of the presidential policy. The result of the study is the development of the specifications of the rural vehicles which can carry passengers and goods together.

Background

The directive of previous president of Republic of Indonesia about "Program Pro Rakyat Klaster IV" (Pro-People's Programme Cluster IV) and Presidential Decree No.10 of 2011 on the Coordination of Improvement and Expansion Pro-People's Programme Team, would require the development of vehicles that can boost economic activities in rural area, agricultural sector , and small scale industries.
One of the developments to support the policy is the development of low cost passenger and freight vehicles which means vehicles which can carry passengers and goods together. The vehicles are environmentally friendly so will get the advantage of tax incentives given to energy-efficient vehicles.

Objective

To develop low cost passenger and freight vehicles as the rural public transport vehicles and to formulate the regulations requirements following the development.

Methodology

The argumentations of rural public transport vehicles development are:

1) Directives President of the Pro-People's Programme Cluster IV;
2) Presidential Decree No.10 of 2011 on the Coordination of Improvement and Expansion Pro-People's Programme Team;
3) Vehicles that can boost economic activities in rural area, agricultural sector , and small scale industries.
4) Embryo of national motor vehicle industry, and is expected to perform mass production as soon as possible

The objectives of the program's rural public transport is the manufacture of 4-wheeled vehicles with the following criteria:

1) The maximum engine power of 900 cc;
2) Fuel consumption of 22 km / liter;

3) Fuel "dual fuel" Petrol and CNG ;
4) The price of 50-55 million rupiah;
5) 60% local content;
6) Using Indonesian Brand

Analysis

Rural public transport vehicles specifications. Analysis of motor vehicle specifications in accordance with the existing rural road conditions include analysis of power engine, traction wheels to the road surface as well as the roads pavement conditions in rural areas. The classification of roads in rural areas is presented in Table 1.

Table 1. Rural road terrain and gradient classification

Road terrain	Gradient [%]	Gradient [°]
Flat	≤ 3	< 2˚
Hill	3 s/d 25	2˚ - 15˚
Mountainous	≥ 25	>15˚

Source: Analysis Result

Rolling resistance (F_{roll}). The magnitude of the resistance of the wheels on motor vehicles affected by the road surface condition and the type of tires Good pavement roads will have a smaller value than the soft dirt road surface. Rolling resistance coefficient value based on a variety of road surface conditions are presented in Table 2.

Power requirement of motor vehicles. Based on Table 1 above, the power requirement of motor vehicles for certain pavement conditions with a maximum weight of 1200 kg for the 3-wheeled vehicles and 1500 kg for 4-wheeled vehicles at a maximum speed of 50 kph could be calculated, as shown in Table 2.

Table 2. Power requirement of motor vehicles at a maximum speed of 50 Kph

Terrain	Type of Pavement	Rolling Resistance Coefficients	Minimum Power Requirement, HP			
		(μ)	R3	R3(LG)	R4	R4(LG-WD)
Flat	Good Pavement, RCI >5	0.01	8.2	8.6	8.8	9.8
	Poor Pavement, RCI <5	0.04	9.1	9.5	9.6	11.1
	Good Soil, CBR>5	0.08	10	11	11.4	12.6
	Poor Soil, CBR <5	0.20	13.8	14,4	15.1	17.3
Hill	Good Pavement, RCI >5	0.01	13.7	14.7	20.1	22.3
	Poor Pavement, RCI <5	0.04	15.1	16	21.3	23.8
	Good Soil, CBR>5	0.08	16.4	17.4	23.5	25.7
	Poor Soil, CBR <5	0.20	18.1	20.6	27.7	31.8
Mountaneous	Good Pavement, RCI >5	0.01	18.6	19	27.2	29.5
	Poor Pavement, RCI <5	0.04	19.6	20.1	28.5	30.4
	Good Soil, CBR>5	0.08	20.7	21.3	30.1	33.1
	Poor Soil, CBR <5	0.20	23.9	24.8	35.8	38.9

Source: Analysis Result

Note: **R3**: 3-wheeled Vehicles, **R3(LG)**: 3-wheeled Vehicles with Low Gear, **R4**: 4-wheeled Vehicles**, R4(LG-4WD):** 4-wheeled Vehicles with Low Gear & 4 Wheel Drive

Capacity and power of Three-wheeled vehicles based on equipments and spare-parts availibility. The capacity and power of three-wheeled vehicles based on equipments and spare-parts availibility is presented in Table 3.

Table 3. Capacity and power of three-wheeled vehicles

Capacity	Power, HP
150 cc	10
200 cc	13.5
250 cc	16

Source : http://www.kaisar-motorcycles.com/front/index.php/products/motor-roda-tiga/standart

Based on the availability in the market, the suitability of three-wheeled and four-wheeled vehicles capacity are presented in Table 4.

Table 4. Suitability

Terrain	Type of Pavement	Capacity			
		R3	R3(LG)	R4	R4(LG-4WD)
Flat	Good Pavement	150 cc	150 cc	600 cc	600 cc
	Poor Pavement	150 cc	150 cc	600 cc	600 cc
	Good Soil	150 cc	200 cc	600 cc	600 cc
	Poor Soil	200 cc	250 cc	600 cc	600 cc
Hill	Good Pavement	200 cc	250 cc	600 cc	600 cc
	Poor Pavement	-	250 cc	-	600 cc
	Good Soil	-	-	-	600 cc
	Poor Soil	-	-	-	600 cc
Mountaneous	Good Pavement	-	-	-	600 cc
	Poor Pavement	-	-	-	800 cc
	Good Soil	-	-	-	800 cc
	Poor Soil	-	-	-	800 cc

Source: Analysis Result

Development of low cost passenger and freight vehicles as the rural public transport vehicles. Development of low cost passenger and freight vehicles as the rural public transport vehicles. divided into two types of vehicles, namely the three-wheeled vehicles and four-wheeled vehicles.

Table 5. Development of Vehicles

Terrain	Type of Pavement	R3	R4	
		Capacity R3(LG)	Capacity	Wheel Drive
Flat	Good Pavement	150 cc	600 cc	R4*)
	Poor Pavement	150 cc	600 cc	R4*)
	Good Soil	200 cc	600 cc	R4*)
	Poor Soil	250 cc	600 cc	R4*)
Hill	Good Pavement	250 cc	600 cc	R4*)
	Poor Pavement	-*)	600 cc	R4(LG-4WD) **)
	Good Soil	-*)	600 cc	R4(LG-4WD) **)
	Poor Soil	-*)	600 cc	R4(LG-4WD) **)
Mountaneous	Good Pavement	-*)	600 cc	R4(LG-4WD) **)
	Poor Pavement	-*)	800 cc	R4(LG-4WD) **)
	Good Soil	-*)	800 cc	R4(LG-4WD) **)
	Poor Soil	-*)	800 cc	R4(LG-4WD) **)

Source: Analysis Result

Recommendation of Low Cost Passenger and Freight Vehicles as the Rural Public Transport Vehicles

Three-wheeled vehicles. The construction of vehicles is a modification from tricycle vehicles. The vehicles can carry 2 passengers and the cargo with the maximum payload of 800 kg placed in the back of passengers. The technical specifications are presented in Table 6 and the design sketches are presented in Fig. 1.

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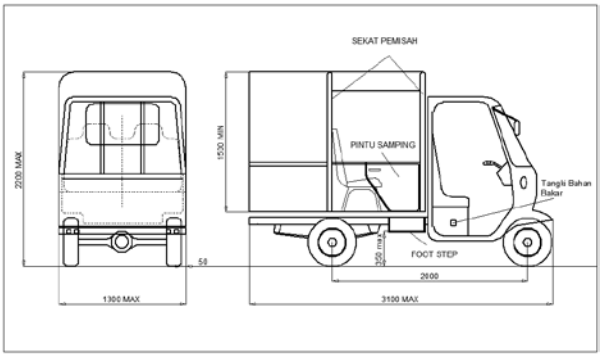
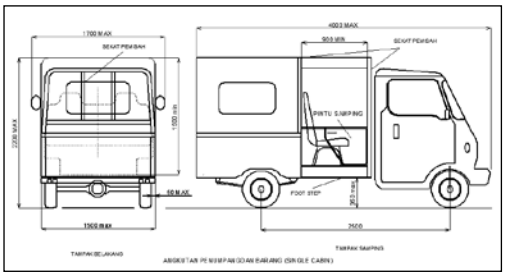


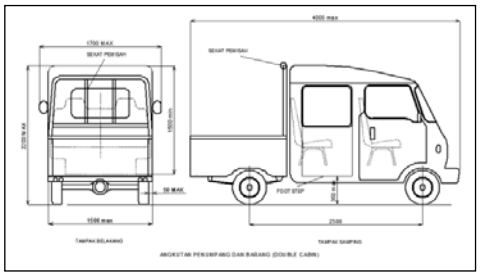
Fig. 1. Design of three-wheeled vehicles

Four-wheeled vehicles. The construction of vehicles is a modification from four-wheeled freight vehicles. Passenger safety aspect in these vehicles is the application of passengers and goods partition screen which is absolutely necessary. The technical specifications are presented in Table 10 and the design sketches are presented in Fig. 2.
Design of vehicle's body is divided into 2 types:

a. *Single Cabin*
   The vehicle's body is made by modifying a freight vehicles cargo bed into closed box using steel tube frame construction and tarp for its cover. The cargo compartment is devided into two forward facing passenger seats space and the goods at rear with a devider in between.
b. *Double Cabin*
   The cab is modified into a four seater cabin. The cargo box is became shorter and less payload in consequence. This configuration has advantages, more comfortable for medium trip passengers, safer for both passenger and goods and higher goods can be loaded since there is no cover on the box.



(a) Single cabin



(b) Double cabin

Fig. 2. Design of four-wheeled vehicles

For poor rural road pavement condition, it need a special vehicle with four wheel drive (4WD). For the reason of passenger safety aspects, this type of vehicle R4 (LG-4WD) is restricted to a maximum of 4 (four) passengers. That is why the double cabin body will be more efficient, cheaper and lighter. Possible types of micro-bus is used if the goods require special handling with the consequences of the vehicle will be heavier and more expensive. The technical specifications are presented in Table 11 and the design sketches are presented in Fig. 3.

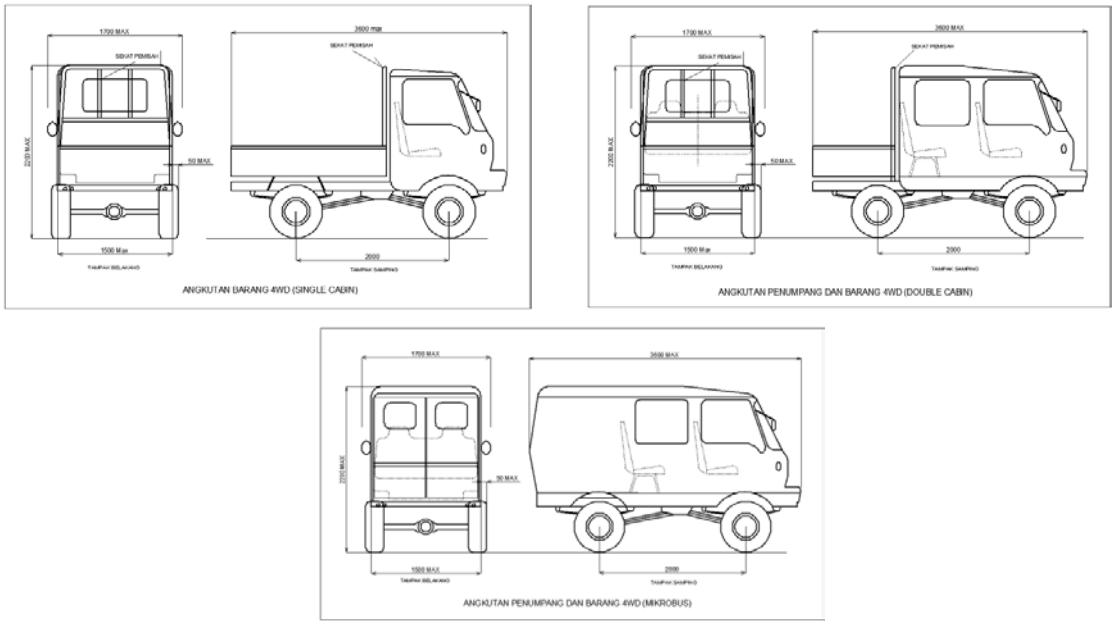


Fig. 3. Design of four-wheeled vehicles R4 (LG-4WD)

Table 6. The Technical Specifications of Four-Wheeled Vehicles

Description	R4		R4(LG-4WD)	
	Specification	Remark	Specification	Remark
Dimension & Weights :				
Overall Length, cm	400		360	
Overall Width, cm	150	170 cm included outside rearview mirror	170	Maximum body width 150 cm.
Overall Height, cm	220		220	
Track Width, cm	140		200	
Wheelbase, cm	250		800	
Maximum loading capacity, kg	800		700	
Gross Vehicle Weight, kg	1500	Maximum	1500	
Seating Capacity	9	8 passenger's seats, 1 seat at cabin	4	
Front tires	R12 s/d R14-70		R14 s/d R15 seri 70	
Rear Tires	R12 s/d R14-70		R14 s/d R15 seri 70	
Maximum speed, km/hr	50		50 km/jam	Gradient max 30%
Max. Climbing ability, km/hr	20	Gradient max 15%	25 cm	
Ground clearance, cm	25			
Engine & Transmission :				
Engine	Gasoline, Diesel	4 stroke engine	Gasoline, Diesel	4 stroke engine
Fuel type	Gasoline, Diesel fuel and gas	Dual fuel	Gasoline, Diesel, gas	Dual fuel
Maximum displacement, cc	900		900 cc	
Minimum Output, HP (KW)/ RPM	22 (17)/ 9500		30 (23)/ 9500	
Transmission type	manual	5 manual, 1 reverse	manual	5 manual, 1 reverse
Transmission Gear Ratio	4,5 - 1	Minimum 4,5 and maximum 1	4,5 - 1	Minimum 4,5 and maximum 1
Low Gear Ratio	≥ 2	Low gear, if equipped	≥ 2	Low gear, if equipped
Final Gear Ratio	≥ 4,8	Minimum	≥ 4,8	minimum
Rear Axle	Rigid		Rigid	
Brakes	Brake Drum		Rigid	
Front Suspention	Independent	Mc. Person strut, coil spring	Leaf spring	
Rear Suspension	Leaf spring		Leaf spring	

Source: Analysis Result

Summary

Development of low cost passenger and freight vehicles which means vehicles which can carry passengers and goods together has the aim of increasing economic activities in rural area, agricultural sector, and small scale industries activities. The rural road terrain and gradient classification will be served by low cost rural vehicles are as follows:

Road terrain	Gradient (%)	Gradient (°)
Flat	≤ 3	< 2˚
Hill	3 s/d 25	2˚ - 15˚
Mountaneous	≥ 25	>15˚

The classification of rural road pavement condition will be served by low cost rural vehicles are: good pavement with RCI >5, poor pavement with RCI <5, good soil with CBR value >5 and poor soil with CBR value CBR <5. General specifications of low cost rural vehicles are: the maximum engine power of 900 cc; fuel consumption of 22 km / liter; Fuel "dual fuel" Petrol and CNG; the price of 50-55 million rupiah; and 60% local content. Type of vehicle developed as the rural public transport vehicles are the three-wheeled freight vehicles and four-wheeled freight vehicles which be modified into passengers and freight vehicles by taking into account safety aspects. Rural road with poor pavement condition need a special vehicle with 4 wheel drive (4WD). For passenger safety aspects of vehicle types R4 (LG-4WD) is restricted to a maximum of 4 (four) passengers.

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