

Environmental Impact by Short Distance Trip

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1. Introduction

Fujii (2011) calculated and compared energy, CO₂ emission and cost to move for short distance by gasoline, hybrid and electric vehicles, and found that energy consumption and CO₂ emission of an electric vehicle were the both merely several 10% lower than a gasoline vehicle of the similar size. It was also found that cost for move by using an electric vehicle is higher than a gasoline vehicle considering the purchase price and running cost (gas or electricity).

Fujii (2013) calculated and compared cost to move for short distance by small, mid and large gasoline vehicles, scooter, city bike, running, walking and public transportation and found that scooter was the cheapest way. City bike and small car followed. Cost for walking and running were higher than even small car considering the foods to replenish the energy for the move.

This paper mixes the above two papers, includes tax and inspection for cars and insurance, and focuses to calculate cost. Environmental impacts for the moving methods are compared assuming that the cost has a positive correlation with environmental impact.

Environmental impact means not only CO₂ emission but also pollution of water and air, degradation of landscape, deforestation, consumption of energy and mineral resources etc., thus, LCA is impossible.

2. Calculation process

Nissan Moco, DBA-MG225 as an example of small cars, can run 20.2 km/L (JC08 mode). Cost for gas is 7.4 JPY/km assuming gas retail price of 150 JPY. Retail price of Moco is between 1050-1520 kJPY. Purchase cost is 12.9 JPY/km by using 1290 kJPY, the median value, and assuming that the car is used for 100000 km. Tax for the small car is 7200 JPY/y or 0.72 JPY/km assuming that the annual mileage is 10000 km/y. Costs for car inspection and voluntary insurance are 2.5 JPY/km and 2 JPY/km assuming that car inspection fee is 50 kJPY/2 y and premier for the voluntary insurance is 20 kJPY/y. Note that the gas price includes tax to make and maintain roads.

MPG, retail price and tax are 20.0 km/L (JC08), 1629 kJPY and 39.5 kJPY for Toyota Carolla Axio 1.5G CVT 4WD as an example of popular cars. Car inspection fee and insurance were assumed to be 130 kJPY/2y and 30 kJPY/y.

MPG, retail price and tax are 5.6 km/L (JC08), 11040 kJPY and 88 kJPY/y for Land Rover ABA-LS5S as an example of big cars. Car inspection fee and insurance were assumed to be 180 kJPY/2y and 40 kJPY/y.

Retail price of Nissan LEAF X as an example of electric vehicles is 3760 kJPY and price of electricity is 2.8 JPY/km for off-peak rate or 5.7 JPY/km for peak rate (Fujii, 2011). Quick charge may cost much more (Fujii, 2011). The same tax, car inspection and insurance as the popular car were assumed. Charging instruments cost 99750 JPY.

Honda Insight XL, a hybrid car, costs 2250 kJPY and its MPG is 23.2 km/L. The same tax, car inspection and insurance as the popular car were assumed.

MPG of Honda Super Cub, an example of scooter, is 110.0 km/L. The retail price of the scooter is 190 kJPY and tax is 1000 JPY/y. Insurance, annual mileage and total mileage before disposal were assumed to be 30 kJPY/y, 10000 km/y and 100000 km.

A city bike was assumed to be sold at 20 kJPY. Annual mileage, total mileage before disposal and insurance were assumed to be 2000 km/y, 20000 km and 3 kJPY/y. Energy consumption and cost for foods to replenish the energy are 84 kJ/km and 10 JPY/km (Fujii, 2013), respectively.

Retail price of a sports bike was assumed to be 500 kJPY. The other costs were assumed to be the same as the city bike.

It was assumed that a pair of running shoes costs 10 kJPY and disposed at 10000 km for running. Energy consumption and its cost are 252 kJ/km and 30 JPY/km (Fujii, 2013), respectively. Everything for walking is the same as those for running (Fujii 2013).

For an example of public transportation, 1 km walking, 4 km bus, 4 km subway and then 1 km walking were assumed. The cost for the bus and subway is 34 JPY/km because the author pays 340 JPY for this commute. Subtle costs for shoes and foods were added for the walking parts.

3. Results and discussions

The cost for the scooter is the cheapest (Fig. 1). City bike and small car follows. Cost for the big car is significantly expensive. Costs for popular car, electric vehicle, hybrid vehicle, sports bike, running, walking and public transportation are almost the same, or cost for electric vehicles are slightly expensive and costs for running and waking are slightly cheap.

Assuming a positive correlation between cost and environmental impact, the following findings are noted.

- (1) Environmental impacts of scooter, city bike and small car are small.
- (2) Environmental impact of electric vehicle is severer than popular car or hybrid car.
- (3) Environmental impacts of sports bike, running, walking and

public transportation are as large as that of popular car or hybrid car.

There would be no need to explain (1). (2) is because electric vehicle is expensive due to expenses for research, new functional materials and public relation cost. Sports bike is expensive because of expenses for research and new materials. Running and walking need foods whose production needs much petroleum, water and land space. Public transportation fee includes every cost such as purchase and maintain costs of cars, gas, salary for drivers and employees, insurance etc.

4. Concluding remarks

Costs for gasoline, electric and hybrid vehicles, scooter, city and sports bikes, walking, running and public transportation were calculated and compared. It was found that environmental impact of scooter was significantly small. City bike and small car followed. That of big car was significantly severe. Those of popular car, electric vehicle, hybrid vehicle, sports bike, running, walking and public transportation were almost the same or those of electric vehicles were slightly large and those of running and walking were slightly small.

Parking cost, commute allowance, maintenance cost, medial cost reduced by walking, time saved by using cars, time wasted by traffic jams etc. can be considered in future for more precise calculation. It can be however at least said that it is a big mistake to think that for example environmental impact of

public transportation is definitely cheaper than small cars.

Airplane, an example of long distance trip, costs 11.9 - 41.0 JPY/km based on Sapporo-Tokyo flight (9800 - 33670 JPY for 822 km, costs for shoes, food etc. were ignored because the fee was expensive and the travel time was short). Scooter and city bike are cheaper and small car is almost the same. Costs for them however become expensive considering ferry boat, tall road, accommodation, foods etc. In particular, an 822 km trip by scooter or city bike would not be practical. Consequently, airplane and railway are practical ways for long trips with low environmental impacts.

The author is not insisting to reduce environmental impacts by any means. The author rather hope that people who want to walk walk and people who want to drive Land Rover drive Land Rover. The author however does not hope that people recommend or force others things with high environmental impacts by mistake or intentionally saying eco-friendly, earth friendly or something like that.

References

Fujii, Y. (2011 in Japanese), More Energy is Needed to Drive Electric Vehicle than Hybrid Vehicle, Proc. MMIJ Fall Meeting, (B), (C), pp. 161-162
 Fujii, Y. (2013 in Japanese), It can't be Said that Environmental Impact of Walking is Smaller than Small Cars, Proc. MMIJ Fall Meeting, pp. 350-351

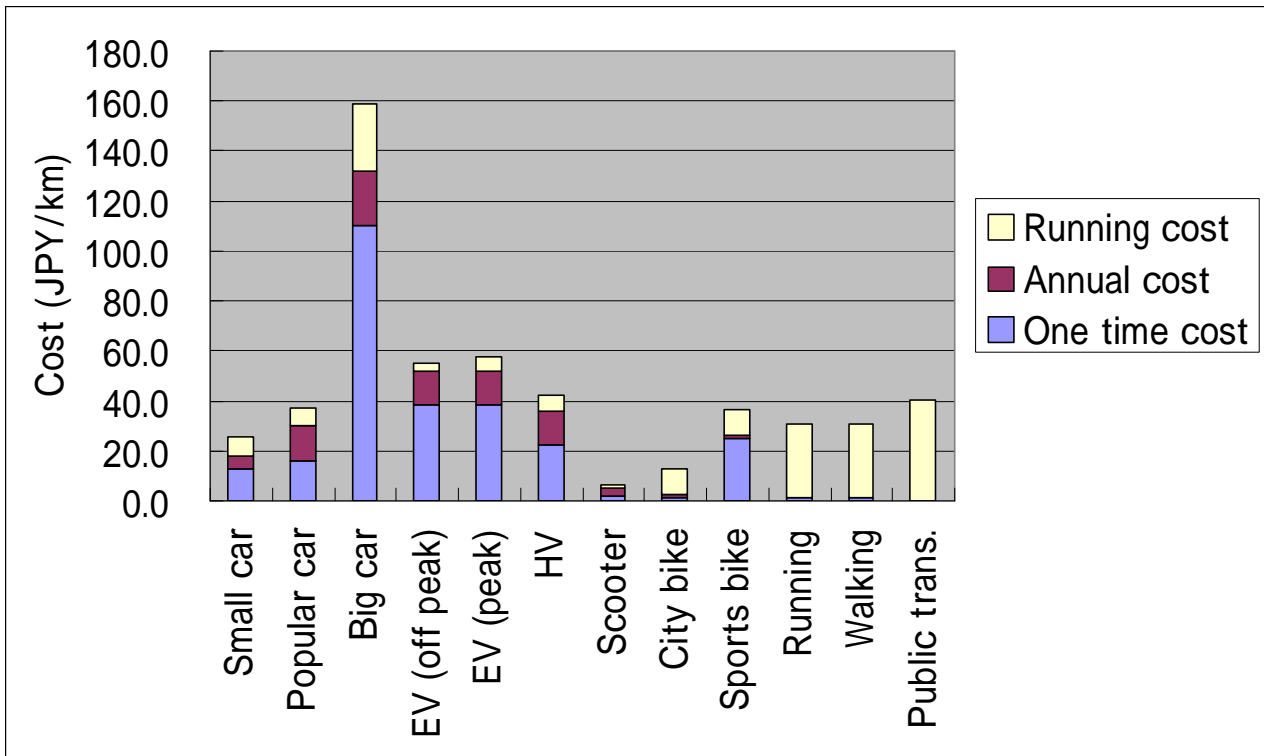


Fig. 1 Comparison of cost to move by various methods.