Proceedings of the Eastern Asia Society for Transportation Studies, Vol.11,2017

# A Study on Idling Behavior of Street Parking in Commercial Area of City Center

Eisuke DOUGAKI [a], Yoshitaka KAJITA [b], Trong Dung NGUYEN [c]

[a] *Graduate School of Environmental Engineering, Hokkai Gakuen University, Sapporo, 064-0926, Japan, Email: dohgaki@cvl.hokkai-s-u.ac.jp*
[b,c] *Graduate School of Civil Engineering, Tokai University, Kanagawa, 259-1292, Japan*
[b] *Email: yokaji@tokai-u.jp*
[c] *Email: trongdungnguyen1988@gmail.com*

**Abstract**: In this report, the phenomenon of idling in vehicle on road at the mall in local city center is analyzed and documented as per survey basis. To confront with global warming, the implementation of what is so-called "Low Carbon Society" is a national policy, as well as an important policy in terms of civil construction of social infrastructure. Investigation result shows that the rate of idling is two third for all type of vehicles and all type of using purposes; a half is seen in the idling rate of vehicle that halt for over 30 minutes; and taxi halting for customers to get in or off (regardless of idling time) sees an idling rate of 95%. Besides, it reveals difference idling rate between vehicles, usage purpose, load & unload goods, stop or parking with or without driver…

*Keywords*: Idling, Street parking, Statistics

## 1. PURPOSE

Nowadays, environmental issue play an important part in a number of aspects, such as society, economy, technology, science, as well as civil engineering – a part of the industry which is responsible for installing social infrastructure. There are many environmental conservation in transport sector such as reducing emission, preventing noise or vibration, etc…, in which, reducing CO2 emission plays a vital role. Developing electric cars or reducing fuel consumption, which is fundamentally in mechanical engineering field, has been carried out as a solution to the issue. Besides, traffic management is another measure with no less importance.

This research will aim at stating actual situation of idling together with on-street parking. Basing on documented data, statistic all the related traffic characteristics, analyze and show those characteristics.

## 2. HISTORY OF RESEARCH

Trends of research related to the environment and traffic (low-carbon society), in around 20 years since 1990, in the Anthology of Construction Theory, Anthology of Theory - Research Construction Plan, Anthology of Urban PlanningTheory, International transportation and traffic safety Construction Academic Journal has shown the objective of this research.

If the research topic related to the idling of the on-street parking with the fuel and CO2 emissions consumption, the references are just limited to 1), 2). However, since this research also includes the environmental and traffic issues (low-carbon society), above researches are taken as the references for the whole of this research in this particular field. Accordingly, the references will not only be limited to the academic theoretical documents, but also add further necessary reports and explanations.

Relevant researches:

1) The research of using vehicles (car /public transport) and urban residence status
2) The research related to actualizing low-carbon society based on the appropriate solutions the vehicles such as public vehicles
3) The research related to “the storage objects”
4) Research of operating characteristics or fuel consumption of cars
5) Classification research related to CO2 emissions of airplane, the methodology of the tax regulation or accumulation.

Documentary report on urban environment or global warmin*g*. Global warming was first introduced in 1990 in an "Action Plan to prevent the global warming" (in the resolution of Cabinet meeting). In 1998, "Law concerning the promotion of solutions to face up with global warming" was decided, the technical studies were started to be published before and after this time. The first research aimed at low-carbon society actualizing in geographical view point, with a keyword of “urban linking” or “urban structure”. The second research focused on the subject of reducing CO2 by modal shift, in other words, it was a traffic modal shift from personal cars to public vehicle. The third research showed actions taken to prevent gas emission relating to storage objects, namely public warehouses or truck transportation. The fourth research brought out issue of road transportation environment and fuel consumption, whose keywords were road equipment, petrol consumption, and transportation speed. The fifth research related to the methodology of promoting the reduction of CO2 or the related tax regulation. Finally, research No.6 is not an academic thesis but report, commentary and documentation of academic journals. In 2005, 2007 and 2009, “Traffic Public Learning” magazine issued a special collection focusing on “The model of urban environment”, global warming and transportation. Moreover, in 1998, 2004 and 2007, it also published a special collection of comments/recommendations on regulations/ standards and transportation-energy, which was transportation of global environmental times.

This research will not have any direct references about research within the scope of idling of on-street parking, but would be inclined to be an expansion of the research No.4.

## 3. OVERVIEW OF INVESTIGATION

### 3.1. Constant investigation of license plates

The overview of this investigation was shown in Table 1. A survey was carried out during 12 days in 2008 and 2010. The survey method was to constantly investigate (license plates) in a period from 8:00 to 19:00, recorded figure was 3.493 vehicles in 2 years. All the objectives were 4-wheel cars. Parking area with 1.6-kilometer width in Sapporo city is in the city center. (PT survey was conducted in two small areas in the city center), the main investigating location was a street of approximately 800meter length around the downtown area. The investigation did not include the using area of the works along the road, but in 2008 we mainly investigated in the area of the office, and in 2010 we mainly investigated in commercial areas. Picture 1 is the state of parking (taxi was parked to wait for passengers) on the road in the investigation area.

Table 1. Overview of investigation

| | Contents |
|---|---|
| Time | June, 2008 ~ October, 2008 n = 2.181 |
| | September, 2010 n = 1.312 |
| | Investigation time 8:00 ~ 19:00 |
| Location | Sapporo city centre |
| | Road length: about 800m |
| | 2008: business areas |
| | 2010: commercial areas |
| Number of Car | 2008: 2,181 cars |
| | 2010: 1,312 cars |

Picture 1. Taxi was parked to wait for passengers

### 3.2. The investigation items and category classification

During the investigation, there were 15 articles recorded the characteristics of the car parking, but only one relating to the analysis of this research is shown in Table 2. (Table 2 just shows 11 related articles only).

From number ② to ⑪ are variable numbers explaining whether idling exists or not. The content will be explained in below analysis.

Table 2. The investigation items and category classification

| Item | Category Classification |
|---|---|
| ①Idling | Continuous, Stop, Intermittent |
| ②Length of parking time | Arrival time, Departure time |
| ③Vehicles | Passenger car, truck and more 7 types |
| ④Purposes | Business, Delivery and more 9 types |
| ⑤Legal/Illegal | Legal, Illegal and more 3 types |
| ⑥Commodity weight | Few, Average, Many and more 4 types |
| ⑦Times of freight handling | 1 times, 2 times and more 4 types |
| ⑧Distance | Surrounding area, Other cities and more 4 types |
| ⑨Private/Service | Private , Service |
| ⑩Emergence signal light | Equipped, Non-equipped and more 3 types |
| ⑪Genders of drivers | Male, Female |

## 4. RESULTS OF THE ANALYSIS

### 4.1. The phenomenon of idling

#### 4.1.1. Classification and car parking idling rate

Figure 1 and Figure 2 show the status of idling in all vehicles. Figure 1 is the result colligating the vehicle unit; Figure 2 shows the result colligating the vehicle units per minute.
Simultaneously, the longitudinal axis is the component rate (%) of 3 classification: "Stop", “Continuous”, "Intermittent". Specifically, “Stop” is considered as the parking in a long time, "Continuous" is divided into two parts "Parking less than 5 minutes" and "Parking over 5 minutes"; "Intermittent" is the stop repeated continuously. These are just the minority, but it can show the actual state of idling phenomenon.

The All horizontal axis show the component rate of categories including “Stop”, "Continuous", is the component ratio(%) after subtracting “Stop”. Moreover, it also has the following meanings:

1) Figure 1: The rate of "Stop” of “All" was 36.5%, whereby we can understand “Continuous” was 63.5%, which accounted two third of the on-street parking. “Continuous" of the parking time here was less than 5 minutes - accounting for 62.1% and more than 5 minutes, including the intermittent (idling) was 37.9%. In the road traffic mode, parking less than 5 minutes is not the object of the legal on-stress parking regulations. According to the current parking regulation, this is an no-parking object (in case the driver parks his car and he can take his car out of the parking space as soon as the traffic controller gives a command), about 60% of parking is legal.
2) If you compare "All" between Figure 1 and Figure 2, the percentage of "the continuous parking less than 5 minutes" decreased from 39.4% to 7.9%. The vehicle units per minute will be a comparison of the number of vehicles × parking time (minute), a large number of vehicles in just a short time results in smaller value, and the result is as can be seen. Moreover, the rate of "Stop" in Figure 1 increases from 36.5% to 46.3% in Figure 2. This is average value of the parking time of "Stop", which means that it is longer than the whole. Furthermore, in "All" of Figure 1, the idling rate of "Parking over 5 minutes" is 22.8%, and in Figure 2 it increases by 1.8 times of the value - 41.5%. The observation method in this research is investigating continuously, but in the interrupted investigation under pre-determined time shows that about 40% of on-stress parking vehicles was observed with the idling state.

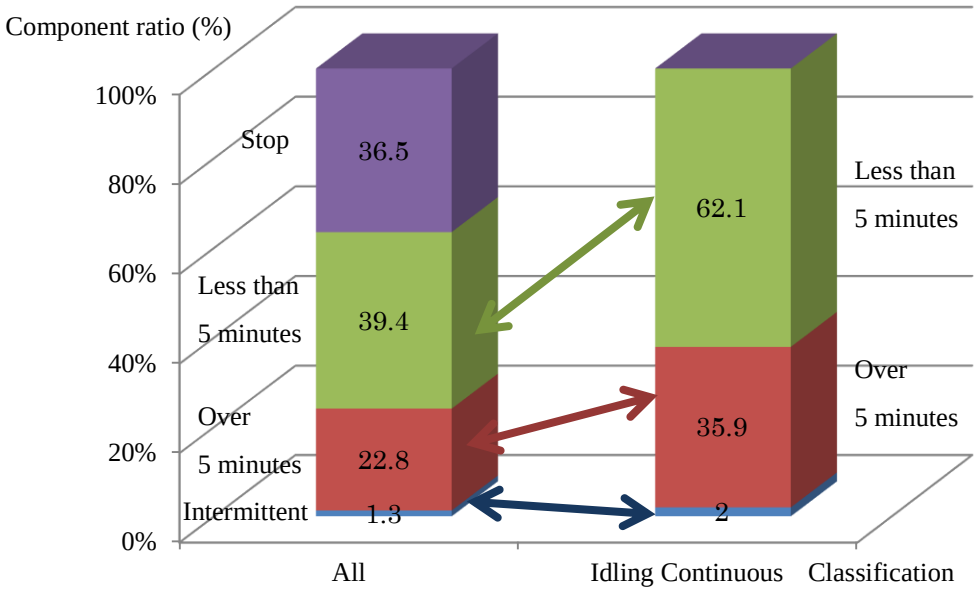


Figure 1. Idling rate base on vehicle unit

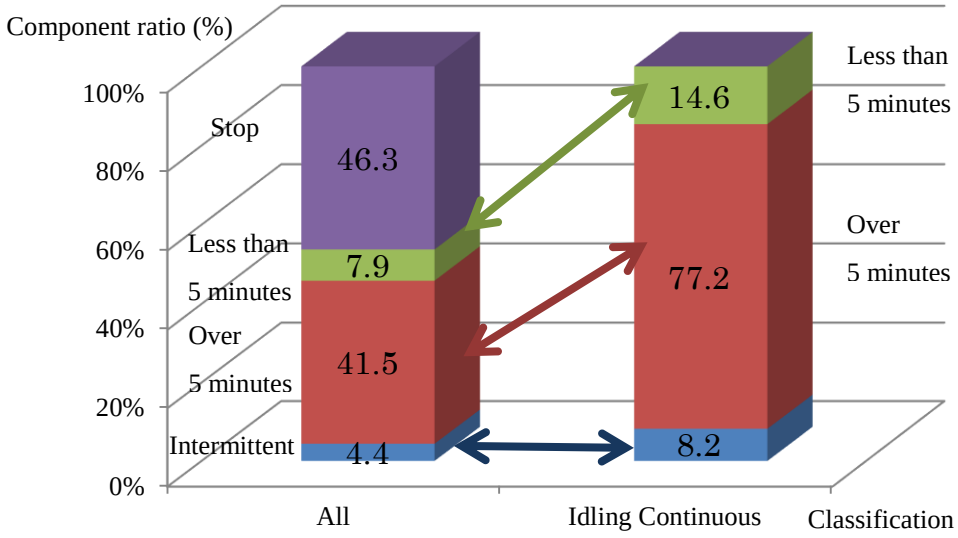


Figure 2. Idling rate base on vehicle unit per minute

3) In "Continuous" of Figure 2, the idling rate of "Parking over 5 minutes" of 35.7% per vehicle is 77.2%, and 85.4% with inclusion of interruption. This figure shows the highlight of the idling time of the long time parking.

### 4.1.2. The rate of idling of the short time parking

In Table 3, there are about 1952 vehicles with the parking time less than 5 minutes, it shows the numbers of 3 classification of idling: "Stop, Continuous and the Intermitten", with the component ratio (%) basing on the value of assembling units of minutes per unit of minute and the number of vehicles. Moreover:

1) The rate of "Stop" in the vehicle unit is 29.0%, less than 36.5% of "All" in Figure 1 - 7.5%. In general, in the parking at the level of 5 minutes, if we consider idling continuous as usual issue, this value can easily be explained. Evaluating the numbers of 29.0% big or small is not necessary, yet even the parking timeless than 5 minutes with the rate about 30% could lead to greater potential.
2) The rate 42.3% of "Stop" in the vehicle units per minute is 13.3% higher than 29.0% of the vehicle unit. This means that despite the parking time shorter than 5 minutes, "Stop" in the longer parking time still accounts for large proportion. Average parking time including "Stop" is 3.3 minutes, including "Continuous" in 1.8 minutes, which accounts for 1.8 times increase of the average parking time(= 3.3 ÷ 1.8), becoming an increase of 2.4 times for the number of idling vehicles (= 70.4 ÷ 29.0).

Table 3. Idling classification with parking time less than 5 minutes

| Classification | Stop | Continuous | Intermittent | Total |
|---|---|---|---|---|
| Vehicle unit | | | | |
| Real number | 567 | 1.374 | 11 | 1,952 |
| Component ratio(%) | 29.0 | 70.4 | 0.6 | 100 |
| Vehicle units per minute | | | | |
| Real number | 1.868 | 2.508 | 38 | 4.414 |
| Component ratio(%) | 42.3 | 56.8 | 0.9 | 100 |
| Average parking time(minute) | 3.3 | 1.8 | 3.5 | 2.3 |

### 4.2. The idling rate of vehicles

Figure 3 shows the component rate of kinds of vehicle type (a) and of vehicles that have the continuity idling on total vehicle units. There are 5 vehicle classifications shown on the chart, except for bus, ambulance, and others.

The constitution of vehicles type (a) in the longitudinal axis is the component rate of 3.345 vehicles except for route bus, idling of the constitution vehicles type (b) is the component rate of 2.076 vehicles have the continuity idling (= "Continuous" + "Intermittent"

among those vehicles. In comparison of the component rate of the two categories, there is no major difference between the vehicles type RV and the vehicles for commercial use; whereas, there are the significant differences between the vans and taxi. As can be seen in Figure 4 (idling rate of each vehicle types), the idling rate of taxi is 94.5%; in contrast the idling rate of the van is42.0%. The idling rate is calculated by the following formula (1a)

$$\text{Idling rate}(\%) = \frac{A}{B} \times 100 \qquad (1a)$$

Specifically:

A: (“Continuous” + “Intermittent”) of the vehicle or the number of minutes of the vehicles

B: (A + “Stop”) of the vehicle unit or vehicle units per minute

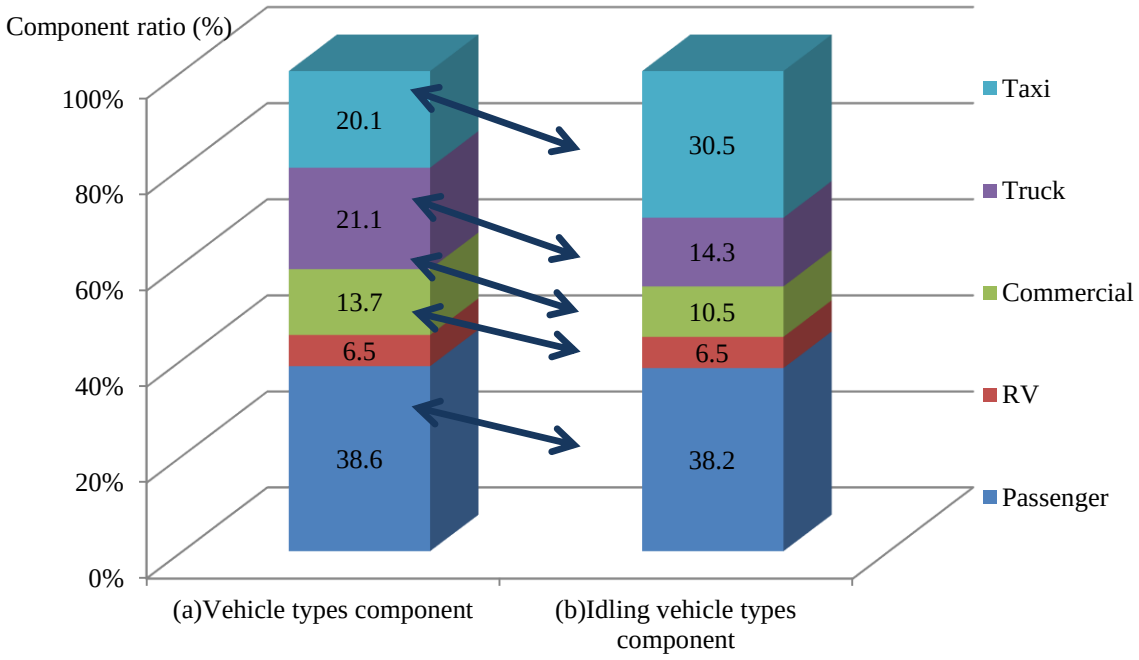


Figure 3. Component ratio of vehicle types

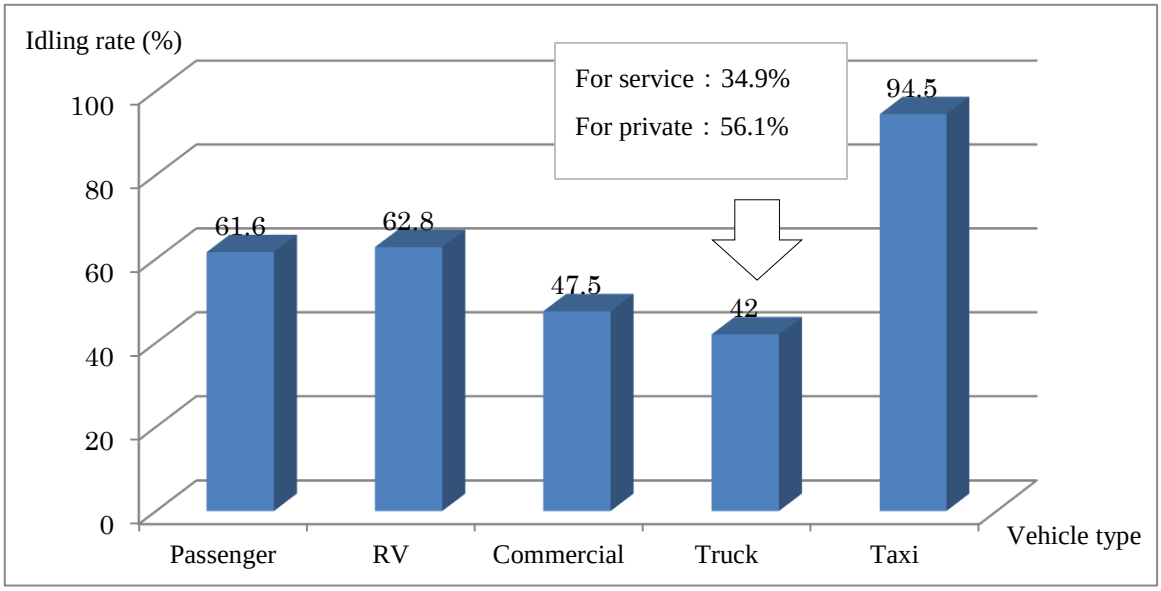


Figure 4. Idling rate based on vehicle types

In my point of view, the low idling rate of the vans is the result of the strong encouragement of the halt idling in the whole transportation or self-reliance in reducing energy consumption of business operators. In contrast, I think that the idling rate at high level of taxi caused by small movements of pending time for the passenger to get into or the necessity of furnishing air conditioner for passengers; moreover, the fuel costs just make up a small portion in business operating cost. However, even in vans the rate of idling is also 20% lower than rate of families and individuals (in Figure 4, for Business: 34.9%, for Private: 56.1%), result of the business is still high.

### 4.3. The idling rate in each purposes

Table 4 shows the average parking time "Av.t (minutes)" and the idling rate "R.idle", with "Component ratio (%)" of the number of parking vehicles for different purposes (except the route buses and taxis). The average parking time Av.t shows "Stop" and "Continuos" of the vehicles. In terms of purpose, there are 8 classification including "Other", in which 5 classification of "Business", "Delivery", "Construction", "Private", "Pick up" make up a portion of 90%. In addition, the survey results also show the reality that certain industries, such as "Eating", "Rest", also make up more or less a percentage. Moreover, Figure 5 is the component rate of assembling the vehicles' number of minutes and idling of the vehicles for each purposes.

1) The idling rate in "Pick up" is the highest, 85.9%. Average of parking time for this purpose is 5.7 minutes, which tends to cause a "the halt" in a longer-time parking. Generally, in "Pick up", "Seeing off" has a short parking idling time as the vehicle

just stop for passengers to get off but "Meeting on return" has a long parking time due to time for waiting passengers, so “Stop” rate is higher. In Figure 5, the rate of the numbers of vehicle of "Pick up" makes up a portion of 26.2% of the whole purpose, a big percentage of "Delivery" purpose. Since 2006, the confirmation of illegal parking has been responsible by private supervisors, so the illegal parking situations are mainly parking without the drivers inside the vehicles, and the long time parking situations with driver inside the vehicles is difficult to become the object of parking regulation. This is a major problem in the traffic management.

2) The idling rate in "Delivery" is 43.1%, lower than the average 54.1%. Parking time, "Stop" and "Continuous" also at the level of 10 minutes, an effective road possession. However, the component rate of the unit of minutes on the vehicle (Figure 5) is 34%, a big proportion of idling of parking.

Table 4. Statistic of each purposes

| Classification | Component ratio(%) | R.idle(%) | Av.t(minutes) | |
|---|---|---|---|---|
| | | | Stop | Continuous |
| 1. Business | 21.1 | 41.7 | 12.2 | 8.8 |
| 2. Delivery | 34.4 | 43.1 | 10.3 | 10.1 |
| 3. Construction | 0.8 | 57.1 | 12.7 | 12.3 |
| 4. Private | 17.2 | 48.5 | 12.1 | 9.0 |
| 5. Pickup | 16.5 | 85.9 | 16.7 | 5.7 |
| 6. Rest | 7.1 | 72.4 | 12.7 | 8.8 |
| 7. Eating | 0.1 | 25.0 | 20.0 | 6.0 |
| 8. Other | 2.9 | 83.3 | 11.3 | 6.9 |
| All | 100 | 54.1 | 11.6 | 8.2 |

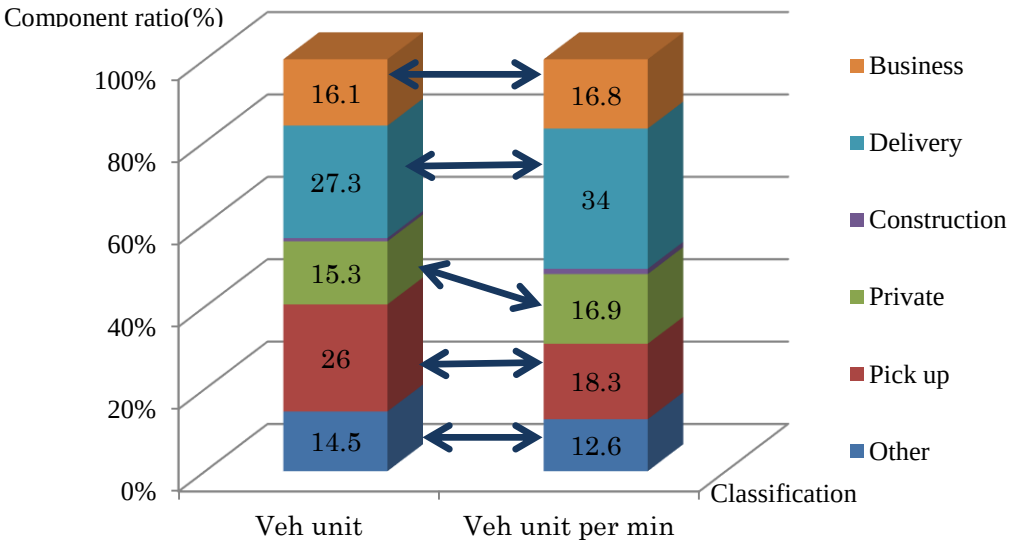


Figure 5. Idling rate based on purposes

### 4.4. The idling rate of different length of parking time

Chart 6 shows the classification idling of the different length of parking time. Horizontal axis of the chart is the length of parking time (minutes), the longitudinal axis is the component idling rate(%) of idling categories. In this statistics, the limit of vehicles includes 4 kinds of vehicles: passenger car, RV vehicles, the vehicles for commercial use and vans, with an exclusion of impact of taxi which often has a high idling rate. In general, we can be able to estimate the correlation between the idling rate and the length of parking time, the idling rate at parking time having different length are also different: 61.8% for 5 minutes or less, 45.5% for 15 minutes or less, 45.6% 30 minutes or less," 46.3% for 60 minutes or less, and we can understand that the idling rate at the parking time (oval dashed line) with timing from 5 minutes to 60 minutes is almost at the certain level around 45%. Even in the parking time of over 60 minutes, the state of idling rate is almost one third (including interruption).

Moreover, the numeric values in the investigation of the idling time indifferent parking time lengths are shown in chart 5. "Vehicle unit" (n1) is a number of vehicles idling continuously (including interruption), and (n2) is its component rate. Vehicle units per minute"(m1) is the quantity of minutes of continuous idling vehicles, and (m2) is its corresponding component rate. In addition, in 61.1% of the number of vehicle, statistical value of the number of minutes of vehicle 5 minutes parking or less is 16.9%, but in 26.1% the statistical value of the number of vehicle in 15 minutes parking 15 minutes is 30.2%, even according to statistics "~ 30 minutes " to "~ 60 minutes " make up 43.0 %, pointed out amount of idling time by the long time parking within a small amount.

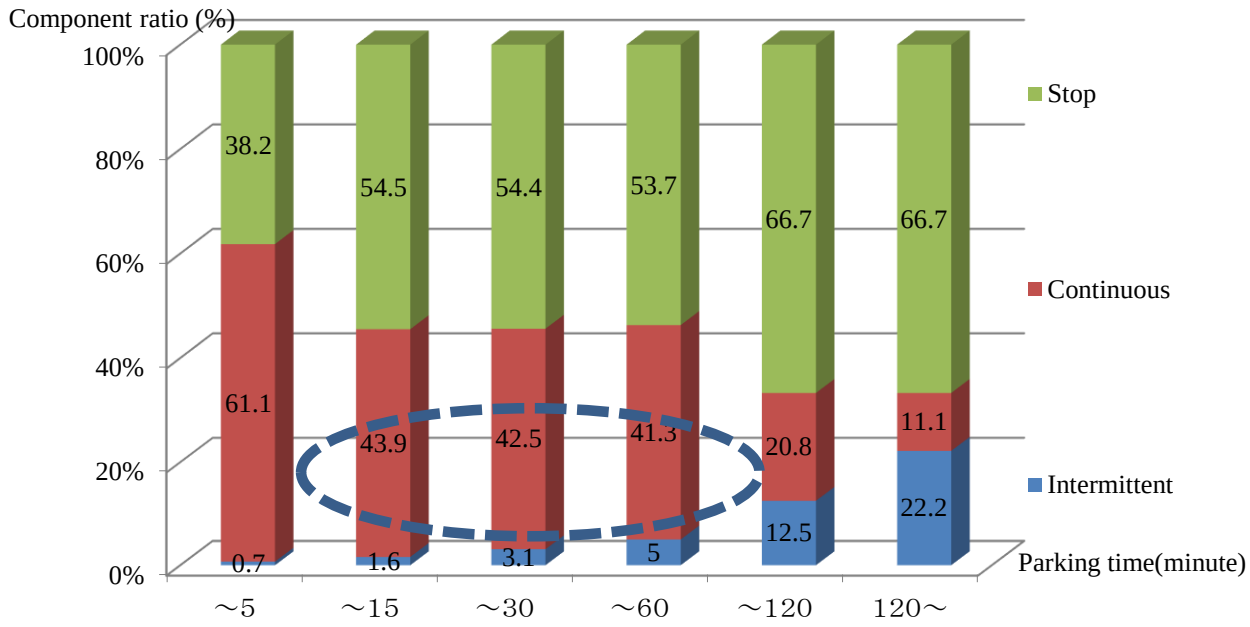


Figure 6. Idling rate based on parking time

Table 5: The idling rate of length of parking time

| Length of time | -5 | -15 | -30 | -60 | 60- | Total |
|---|---|---|---|---|---|---|
| Vehicle unit | | | | | | |
| (n1) | 881 | 378 | 118 | 56 | 11 | 1,442 |
| (n2) | 61.1 | 26.1 | 8.2 | 3.9 | 0.8 | 100% |
| Vehicle units per minute | | | | | | |
| (m1) | 1,942 | 3.477 | 2.511 | 2.438 | 577 | 11.522 |
| (m2) | 16.9 | 30.2 | 21.8 | 21.2 | 5.0 | 100% |

## 5. Analysis of variance in the rate of idling and stop features

### 5.1. The rate of idling and vehicle categorization

Table 6 and Figure 7 show a variety of idling rate basing on idling time of each vehicle, with exclusion of continuous idling factors. Vehicle under survey can be classified as per 2 types: passenger vehicle and RV.

Table 6: Idling rate of each vehicle type

| Classification | -5 | -15 | -30 | -60 | 60- | Average |
|---|---|---|---|---|---|---|
| Passenger vehicle | 68.7 | 51.1 | 49.3 | 52.9 | 23.5 | 61.1 |
| Commercial vehicle | 53.0 | 44.1 | 49.3 | 33.3 | 0 | 47.4 |
| Truck | 48.6 | 34.1 | 33.3 | 25.9 | 20.0 | 40.9 |
| Taxi | 95.7 | 91.4 | 39.0 | 94.6 | 75.0 | 94.5 |
| Average | 66.7 | 52.0 | 95.2 | 55.9 | 28.1 | 61.7 |

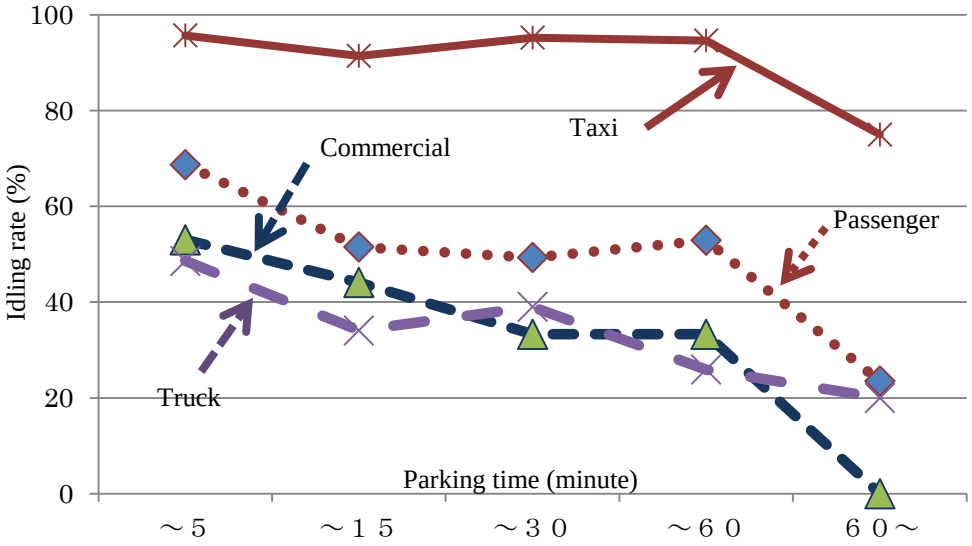


Figure 7. Idling rate based on vehicle types

Table 7: Result of Variance Analysis

| Fluctuation factor | Sum of squares | Degree of freedom | Variance | Variance ratio |
|---|---|---|---|---|
| Time difference | 5,339.9 | 4 | 1,335.0 | 15.0** |
| Vehicle difference | 8,566.7 | 3 | 2,855.6 | 32.2** |
| Error | 1,065.1 | 12 | 88.8 | |
| Total | 14,971.7 | | | |

1) Average rate of idling in Taxi is 94.5%, which is significantly high and independent from short/ long idling time. In this case, idling time above 60 minutes witnesses a rate of 75%.
2) Average idling rate of coach for passenger vehicle is relatively higher than other type of commodity-transported vehicle. To specify, coach witnesses a rate of 61.1%, followed by commercial vehicle and truck with rates of 47% and 40.9% respectively.

3) Idling rates of coach, business car and truck are inversely proportional with idling time. In other words, the higher the time for parking, the lower the idling rate is seen. However, though in coach parking from 5 to 60 minutes show almost no change in idling rates, truck shows an inverse trend with idling rate of parking from 15 to 30 minutes becoming 4.9% higher than that within less than 15 minutes. In this sense, idling rates varying according to parking time and type of vehicle are illustrated in Table 7-Result of variance analysis.
4) Idling rates documented as per vehicle types and time of parking is meaningful only when variance is 1%.

### 5.2. Analysis review of parking features and idling rates

When assuming an equation model to estimate the proportion of idling of some explanatory variables, it is essential to identify statistical significance of the explanatory variables. Specifically, factor ③ to factor ⑪ of Table 2 are considered as explanatory variables, and was confirmed to be meaningful in the process of variance analysis and T-test. The results are shown in Table 8. On analyzing variance of over 3 variables, which includes variable ③,④ and from ⑥ to ⑧, it is to check the differences among average values by conducting T-test of 2 variables ⑤ and from ⑨ to ⑪. In this analysis, time is divided into 5 similar units. Variance analysis result brings about 5 below conclusions

Table 8: Relationship between parking features and idling rates

| Factor | Category number | *5%, **1%, ×有意にあらず |
|---|---|---|
| Two-way analysis of variance | | |
| ③ Vehicles | 4 | Vehicles** (Times**) |
| ④ Purposes | 5 | Purposes** (Times×) |
| ⑥ Commodity weight | 4 | commodity weight** (Times**) |
| ⑦ Times of freight handling | 5 | Times of freight handling×(Times*) |
| ⑧ Distance | 4 | Distance** (Times**) |
| T-test | | |
| ⑤ Legal/Illegal | 2 | T – test ** |
| ⑨ Private car /Service car | 2 | T – test× |
| ⑩ Emergence signal light | 2 | T – test*, 1%× |
| ⑪ Genders of drivers | 2 | T – test× |

1) According to using purposes, there are 5 types (Business, Delivery, Construction, Private car, Pick-up) considered as explanatory variables of the idling operation. Features of the idling system is shown in Table 4 and Figure 5, whereas “parking time" does not make sense.
2) According to commodity weight, there are 4 types (nothing, few, average, many) which show significant impact on the percentage of time. Idling rate decrease when there is an increase of commodity processing issue. On the other hand, idling rate shows no difference within 5 times of freight handling (0 time, 1 time, 2 times, 3 times, 4 times or more) but tends to decrease if more than 5 times of processing is conducted.
3) According to distance, there are 5 types (no getting in or off, surrounding area, urban area of the city, bordering city, other cities) with a relationship between distance and time. The greater the distance to destination, the smaller the rate of idling.

   From T-test result (variance testing for average value)
4) Average value varies depending on whether the parking is legal or illegal. The classification for legal or illegal parking is specified in Section 4 of Article 51 of Road Traffic Law. In accordance with this classification, average idling rates of illegal side is 34.8%; meanwhile 78.2% is seen in illegal side, which is documented from 5 minutes halt to a maximum of 60 minutes parking. Over 60 minute parking illegally results in an idling rate of 62.5%, which is lower than a proportion of 7.1% under the same time of legal parking.
5) The equipping of Emergence signal light, which is in use for warning purpose in the case of emergency as well as commonly furnished in parking areas, as per Standard 3 of Article 41 of the Road Transport Safety),impacts significantly on average idling rate. The rate varies depending on whether the lights are available or not, with 58.35% of light equipped case which is higher than 44.4% of non-equipped cases. For over 60 minute parking in the cases equipped emergence signal light, idling rate is 37.5% comparing to 20.0% of cases without the signal light. This shows a tendency of parking in short period of time of drivers via the relationship between idling and emergence signal lights.
6) According to documented statistics, it is impossible to identify the differences of idling rate as per relationship between genders of drivers in public car and private car.

## 6. SUMMARY

The act of idling due to on-road parking area is depicted as per result of below study.

The study of Transport and environment (one low-emission society, low-carbon society): Since the Act concerning these matters were issued in the 1990s, a number of results have been obtained regarding the form and means of transport for connecting residential areas, private and public means of transport. However, there are quite a limited number of researches concerning on-street parking.

Through statistical analysis, it is to highlight certain points in the idling behavior of on-street-parking areas the street includes the following directives

1) Idling rate of on-street-parking area is 63.5% in terms of vehicle unit, which means that 2 out of 3 vehicles are idle in parking area. Besides, 53.7% percent is found in the number of continuous idling vehicle unit, and the time for idling is a half higher than total time of parking on street.
2) Halting rate in less than 5 minutes, including idling is 62.1%. Without exclusion of legal parking, this rate is not higher than 14.6% in terms of vehicle units per minute. Additionally, to allow a noticeable decrease or even removal of idling vehicle by 29% of idling rate for less than 5 minutes halt, it is crucial to strengthen propaganda education activities.
3) According to idling features as per vehicle units, taxi has the highest proportion of 94.4%. It is unavoidable for short-time halt with customer getting into or off; nevertheless, even in longer period of 30 to 60 minute halt the idling rate does not seem to decline. Apart from this, the middle group of vehicle witnesses the smallest amount of 42.0%. The most special idling rate falls into business car with relatively low percentage.
4) For idling rate, depending on using purposes, pick-up vehicle accounts for the largest proportion of 85.9% and its average value under continuous idling time has a proportion of 26.2% over all other types. Idling rate of delivery vehicle is 11% lower than average rate of all types of purpose. On-street parking for trading is truly a problem, however environmental protection measures need support of business community. In “business” and “private”, idling rate and time is nearly equal to overall average value. The effect of improving the percentage of total value as per these two purposes will means significantly, however it would also be very difficult if there is no sponsorship (Road Transport Association for instance) and no regulations and guidelines available.
5) In the allocation of idling time, idling rate of parking from 5 to 60 minutes almost remain the same at a level of 45.5% to 46.3%, idling rate of longer time is also relatively high.

From the T-test about the difference between variance analysis and average value, types of vehicle, purpose of using, loaded weight and processing, distance to destination, legal and illegal parking play a role of explanatory variables on ground of idling rate. Though the amount of fuel consumption for idling in on-road parking area is almost inessential, for private users the cost of this is difficult to be realized. Besides, it can also be a burden for business office.

Parking regulation Road Traffic Law in 2006 has been strengthened under the surveillance of People's Supervisor; nonetheless this could not help to remove the case of parking over regulated time at non-legalized parking area. This is a limitation of on-road-parking-area control the regulation of Road Traffic Law. If national measures on reducing CO2 emission is enacted, it is also essential to have guidance on minimize idling halt on driving.

## REFERENCES


Kumiko, N., Toshimichi, M., Keiko, Y. (2011) Examination of Compact Layout City Measure that Considers Change of Travel Behavior Before and after Relocation and the Influence of Providing Information for Car Use Reduction. *Infrastructure Planning Review*, 67(3), 300-310.

Hidenobu, N., Akinori, M. (2008) A Study on the Energy Consumption in Residential and Traffic Sector in Case of Practicing a Compact City Policy. *Japan Society of Civil Engineers*, 64(1), 1-10.

Hiroyuki, O., Satoshi, F. (2007) An Experimental Study on Effects of Providing Objective Information about Reduction of CO2 emission due to Pro-Environmental Behavior. *Journal of Japan Society of Civil Engineers*, Ser. G (Environmental Research) 63(2), 159-167.

Yuki, K., Keisuke, M., Yuichi, M., Yoshinori, K., Shinji, K. (2005) Establishment of a Macroscopic Estimation Equation for Actual Fuel Consumption of Petrol-Fuelled Passenger Vehicles. *Proceedings of Japan Society of Civil Engineering*, 793 41-48.

Kenji, M., Masaaki, T. (2007) A Study on the Influence of the idling stop at signals on the traffic smoothness. *Proceedings of Japan Society of Civil Engineers*, 24, 775-780.

Nodoka, O., Masayuki, M., Yoshiharu, N. (2003) Prediction of air quality improvement impact by future regulations of automobile exhaust gas. *Proceedings of Japan Society of Civil Engineers*, 20, 277-282.

Masanobu, K., Kiyoyuki, M., Keiko, H. (2005) A Macro Analysis of CO2 emission reduction by truck transport efficiency promotion. *Proceedings of Japan Society of Civil Engineers*, 22, 761-766.

Kouichirou, H., Hideki, F., Hironao, K. (2002) The Study of Vehicle Routing Problem Considering Car Gas Emission. *Proceedings of Japan Society of Civil Engineers*, 19, 275-282.

Yuruzu, M., Hiroki, S. (1999) An Intertemporal General Equilibrium Analysis of CO2 Emissions Problem. *Proceedings of Japan Society of Civil Engineers*, 16, 431-442.

Kenichiro, E., Masayoshi, T., Shigeru, K. (1999) Vehicle Fuel Consumption Estimation Model for Impact Analysis of Changing Car Related Tax. *Proceedings of Japan Society of Civil Engineers*, 16, 455-463.

Tadashi, I., Haruo, I. (1996) Regional and temporal analysis of car usage by car gasoline consumption modeling. *Proceedings of Japan Society of Civil Engineers*, 13, 525-533.

Keisuke, M., Kenichi, Y. (2009) A Study on the Medium-Term Effects of Regional Travel Speed on CO2 Emissions of Passenger Cars. *The City Planning Institute of Japan*, 8-2(0), 64-69.

Kenichi, Y., Keisuke, M. (2009) An Analysis of the Factors of Automobile CO_2 Emission Change by Municipalities. *City planning review, Special issue, Papers on city planning*, 44(3), 109-114.

Yukimsa, M. (2009) Influence of gasoline prices on travel/driving behavior focusing on level of service of public transportation: Changes of car-use under fuel prices rising at August 2008. *City planning review, Special issue, Papers on city planning, 44(3), 523-528.*

Keisuke, M. (2007) A Study on Developing Visions of Future Transport Systems toward Low Carbon Society in Japan. *City planning review, Special issue, Papers on city planning*, 42(3), 889-894.

Yoji, T., Tetsuro, H., Ryuta, K. (2003) A Study of Traffic and Environmental Effects of Cooperative Delivery System in CBD : A Case Study in Marunouchi Area. *City planning review, Special issue, Papers on city planning*, 38(3), 361-366.

Akimasa, F., Toshiyuki, O. (2002) Influence of Urban Form on Transportation Energy Consumption in Hiroshima Metropolitan Area. *City planning review, Special issue, Papers on city planning*, 37, 151-156.

Akinori, M., Hirotaka, K. (2000) An Efficiency on Transportation Energy of Public Transport and City Character. *City planning review, Special issue, Papers on city planning*, 35, 511-516.

Yuto, H., Akira, H., Takeshi, K. (1999) Study on the Effects on Energy Consumption by Vehicle Trips in a Compact City - Using the 1975 and 1992 Person Trip Data of Utsunomiya City -. *City planning review, Special issue, Papers on city planning*, 34, 241-246.

Akinori, M., Hirotaka, K. (1998) A Comparison of the Urban Structure Impact upon Transportation Energy. *City planning review, Special issue, Papers on city planning*, 30, 685-690.

(2009) Estimation of vehicle CO2 emission by driving conditions at expressways. *Japan Society of Traffic Engineers*, 44(4), 76-85.

(2008) A study on the short-term changes of traffic volume and CO2 emissions after building highways. *Japan Society of Traffic Engineers*, 43(3), 53-63.