

## Analysis of Signage Strategies to Reduce Misuse of Disabled Parking at a University Campus

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**Abstract:** This study is designed to investigate the potential to apply persuasive concepts available from social cognitive theory to improve the compliance of parking rules by the general public. A physical trial has been conducted at a university campus in Japan, where the permit parking signage system catering to individuals with disabilities was systematically modified during an eight-month period of reversal design experiment. The relationships between illegal parking ratios and conditions setting are analyzed using analysis of variance (ANOVA). The results indicate that the level of violations reduced to the lowest value with addition of the supplementary signage and a picture-message. At certain sites, the allocated disabled parking spaces were observed with a rate illegal use of 5% or less when there were ground marking, signage and a picture-message. Observations have also indicated that the level of violations in the afternoons is higher than in the mornings. This type of information could be useful in the design of patrol for parking management. Our study can help local government officials decide how to provide effective signage strategy to reduce misuse of disabled parking and provide data to other countries that are considering using this strategy.

### 1. Introduction

Prevention of misuse of parking allocated for persons with disabilities is a challenge faced by many car park managers [1]. Although various kinds of policing strategies often coupled with a regime of fines are applied in many western countries to prevent misuse, illegal parking rates in disabled parking spaces were as high as 76% [2]. Over 1,800 drivers on average per year between the years of 2010 and 2014 were penalized for parking illegally in spaces reserved for disabled parking permit holders in greater Dublin [3].

Different from western countries, there is no legal framework to allow such control methods in Japan. On the basis of concepts put forward by social scientists such as Tittle [4] about the potential to use the fear of societal censure to modify personal behavior, the Japanese government formalized the parking permit system for disabled individuals in 2006, without adopting punitive methods to deter illegal parking [5]. The legal framework for successful operation of this parking permit system in Japan is reliant on traditionally well-entrenched social norms of self-respect and honor of individuals [6]. Instead of punitive measures, the Japanese government decided to explore other strategies such as pavement markings, vertical signs and descriptive messages as methods of reducing illegal use of disabled parking. However, the effect of signage strategies in Japan is not clear.

Supplementary signage may play an important role in preventing illegal use of disabled parking spaces by making able-bodied drivers realize the difficulties they would inflict to those in need of physical assistance for their mobility. Cope et al. [7] observed that baseline violation rate with surface markings to be 69.3%. However, violation rate reduced to only about 57.3% with the addition of vertical signs in their study. Then, when they added the warning message “this space is

monitored by concerned citizens” to the vertical sign, the violation rate plummeted to 27.1%. For further investigation of differential effects of including descriptive messages, Cope and Allred [8] repeated the comparison with and without the additional message on the vertical sign. That study has also shown that inclusion of warning message has been able to reduce violations. Zhang and White [9] examined a differential comparison between the standard van sign and an intervention sign (pictorial representation of a ramp-equipped van) to determine which one is more effective. They found that the intervention signs could moderately reduce the ratio of illegal parking. In addition, Lu et al. [10] investigated the effect of signs of disabled parking in one university campus in China. They also found out that the illegal usage ratio decreased from 64.5% to 21.7% when warning signs were set up at disabled parking spaces. However, these previous studies ignored an important factor: penalties. Penalties associated with illegal use of disabled parking spaces in most countries [5,11,12], leading to low violation rates committed by unauthorized drivers. Therefore, the effect of ground markings and other signs were still not clear.

This paper investigates the potential to apply persuasive concepts available from social cognitive theory [13] to improve the compliance of parking rules by a method in which variables were manipulated month-by-month. This method may assist in strengthening the likelihood of self-compliance by able-bodied drivers in relation to the use of disabled parking spaces. Different signage options (in addition to the international wheelchair symbol) used to represent the disabled parking spaces have been introduced in the study area and compliance levels have been measured. Observations reveal that it is possible to improve the level of compliance through better communication of objectives (i.e. reserving parking spaces for a specified group of individuals), even though there is no policing system or punitive measures.

## **2. Methodology**

### **2.1. Location**

The possibility of illegal parking on campus was high because there were insufficient regular spaces to satisfy the ever-increasing demand by teachers and students. Cars and bicycles haphazardly occupying the space were a common occurrence and inconvenienced intended users. The campus has 713 regular parking spaces and is therefore obliged to reserve a minimum of 10 spaces for persons with disabilities according to the minimum standards adopted in Japan. The campus has surpassed this requirement and has 16 such spaces. These disabled parking spaces are distributed in 7 areas on campus. Some of them were temporarily relocated away from their regular locations near entrances of classrooms because of building renovations during the survey period. Four popular parking locations for persons with disabilities are chosen for the study. The two spaces at PP1 are in front of a lecture theatre block and the space at PP2 is near to the entrance of the student center and also close to the student administration building. These two parking locations are readily visible to the public. However, PP3 (one space) and PP4 (one space) are hidden from public view and are somewhat distant from entrances of main buildings. Hardly anyone would notice parking violations occurring in these two concealed locations.

### **2.2. Conditions Setting**

A modified reversal (ababacba) design [6,14] was used in four disabled parking spaces in this experiment. Two sign conditions (a ground marking and a ground marking combined with a vertical sign) were alternated. A picture-message was added to the signpost during the ground marking and vertical-sign condition and then removed. The experimental investigation was chosen from October to December in 2015 (Autumn term), and April to August in 2016 (Spring term) at the university campus. Therefore, there were in total eight months in the experimental survey.

Condition a (Month 1, 3, 5, 8): All disabled parking spaces under observation had a 1.49×1.49 m size international wheelchair symbol painted in white on the ground. The sign posts next to PP2 and PP3, seen in Fig. 4, were removed as well. There were no other identification methods implemented in this condition.

Condition b (Month 2, 4, 7): A clearly visible vertical sign of the wheelchair symbol in blue color mounted on a post (at a height of about 1.5 m) was added to the identification of observed disabled parking spaces. Therefore, there were two identification signs in this condition: the wheelchair symbol on the ground as well as the one displayed on a vertical sign.

Condition c (Month 6): A picture-message display was added to Condition b. The picture-message was placed below the vertical sign (at a height of about 1.2 m). This display had a color photo of an infant looking directly at the observer with a pointed finger and in a speech bubble an admonishing warning: "Those who park here cause severe inconvenience to disabled people by taking their space" in red print. This display was added this month to explore the possibility to apply lessons from social cognitive theory similar to an earlier attempt by Cope and Allred [8]. The photo of a baby was used to grab the attention while arousing a sense of sympathy and embarrassment. Furthermore, there was a positive effect from the presence of preschool-age children on behaviors of adults reported by Preston & de Waal [15] and Hong, Kwon & Jeon [16].

### **2.3. Procedure**

The experiment was carried out during the two peak periods of parking during weekdays. Each period was 1.5 hours long, the morning peak from 8:30 a.m. to 10:00 a.m. and the afternoon peak from 3:00 p.m. to 4:30 p.m.. Observations were not made during weekends and holidays as few students and teachers were present.

One observer was allocated to observe the two adjoining parking spaces in PP1. The other locations had only one space to monitor and a single observer was allocated to each. Thus, four observers in total were required to observe the four parking locations. The observers were positioned at a distance away from the parking lot to monitor in an unobtrusive manner to avoid influencing the parking behavior of drivers during the survey period. An illegal parking event was recorded only when the driver actually got out of the vehicle and went inside the building at campus. After the driver parked their car in the disabled parking space and got out of the car, the observers went to the space to examine for proper parking authorization and to record data. Paper records were made about (a) the start and end of occupancy time in parking spaces, (b) the type of users (coding as people appeared to be able-bodied, and individuals with disabilities: wheelchair or crutch users and persons showing mild difficulty) and (c) the type of parking permits or other proof displayed (if any). It is worth noting that people who are appeared to be able-bodied and displayed a parking permit can have a genuine reason such as temporary or non-visible difficulties (such as a chronic back pain or asthma). Therefore, the illegal parking in this survey was determined as people who appeared to be able-bodied without parking permits. For the purpose of data-collection validity, four observers were arranged to be trained for a month to observe and record data in one disabled parking space before the actual survey. When all records from four observers were consistent and correct, the experimental survey started.

### **2.4. Statistical Analysis**

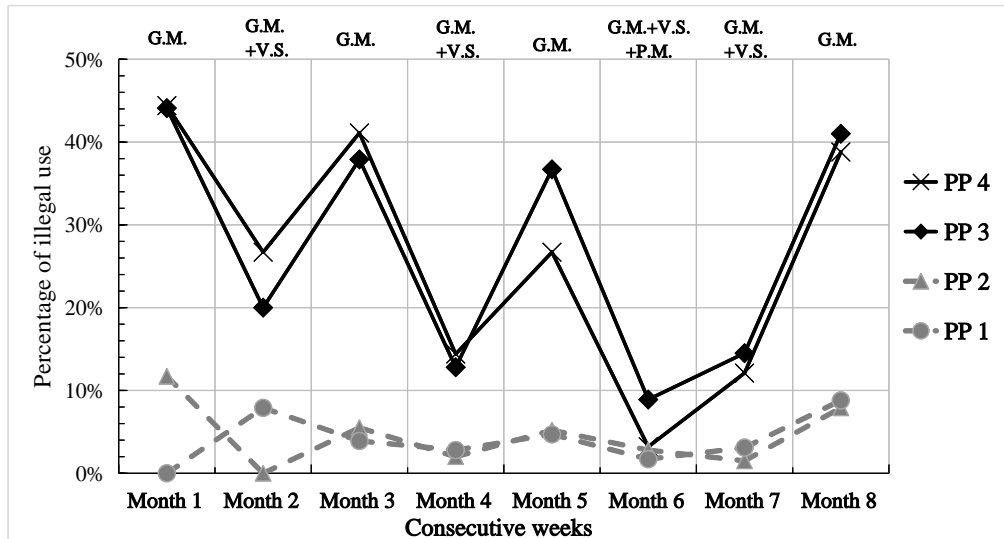
Any relationships between illegal parking ratios and conditions setting were analyzed using analysis of variance (the one-way ANOVA) as the data were normally distributed. Statistical analysis was calculated with IBM SPSS Statistics 21 for Windows<sup>TM</sup> and  $\alpha$ -value of 0.05 was applied to assess statistical significance. In the analysis, the P-value was chosen by Bonferroni Correction.

## **3. Results**

### **3.1. Illegal parking ratios in the experimental period**

Figure 1 shows the variation of illegal parking over the eight months, i.e. for the different stages of the experiment. In this diagram, the amount of legitimate use of the parking locations is not shown as that aspect will be discussed later in this section. Month 1 (ground marking only) values of illegal use were as shown previously in Figure 6. There is a noticeable reduction in the illegal use

in Month 2 except at PP1 where the value was zero in Month 1. The general reduction in violations in Month 2 is seemingly a positive response from motorists to the addition of the vertical sign installed that month. The violation percentages decreased from about 44% in the first month to 20.0% in PP3 and to 26.7% in PP4 in Month 2. The violation amounts in Month 2 in PP1 and PP2 were at 7.9% and 0% respectively. If we consider average values of PP1 and PP2 (as they are in a similar environment), they remain steady at an average of 5.0% violation rate from Month 1 to Month 2.



Note: G.M.: Ground marking, V.S.: Vertical sign, P.M.: Picture message.

Fig.1. Illegal use of parking reserved for persons with disabilities over eight months of the experiment

From Month 3 to Month 5, singular ground marking and ground marking combined with a vertical sign were alternated. The percentages of illegal use decreased from 37.9% in PP3 and 41.1% in PP4 to 12.8% and 14.4% respectively when the vertical sign was added. Then the percentages increased again to 36.7% in PP3 and 26.7% in PP4 when only the ground marking was in place. The trends in illegal use in PP1 and PP2 were the same as with PP3 and PP4, though there were slight differences in the percentages.

In Month 6, violation percentages reduced even further and reached the lowest level observed during all stages of the experiment. This is when three identifiers were available at disabled parking spaces: (i) the surface painting of the wheelchair symbol; (ii) the vertical sign with the wheelchair symbol and (iii) a secondary notice board with the color picture of an infant and its disapproving caption, as described earlier. The percentages of illegal use in PP1- PP4 in Month 6 were 1.7%, 2.8%, 8.9% and 3.2% respectively. Violation amount in PP4 approached the amounts observed in PP1 and PP2. Even in PP3, it was observed that the amount of illegal use was lowest value from Month 1 to 6. Interestingly, this month, observers reported that some able-bodied drivers who began the illegal parking process at PP1 and PP4 react to the signs and aborted the illegal maneuver to vacate the reserved spaces. All of them noticed and read the picture-message, then returned to their vehicles and drove away. However, the survey is unable to provide quantitative measurements of such situations.

The next stages of the experiment involved systematically removing the additional signs. In Month 7, the percentage of time occupied by violators at locations PP1 to PP4 were 3.1%, 1.5%, 14.5%, and 12.1% respectively. Corresponding values in last month were somewhat changed for PP1 and PP2 at 8.8% and 7.9%. However, for PP3 and PP4, the values were 41.0% and 38.8% respectively, which shows a high level of illegal use.

In a more detailed comparison, the one-way ANOVA test shows significant differences between illegal parking ratios and conditions setting in two types of parking spaces (see Table 1). Significant effects for conditions setting in PP3 and PP4 spaces and medium significant effects for conditions setting in PP1 and PP2 spaces were found.

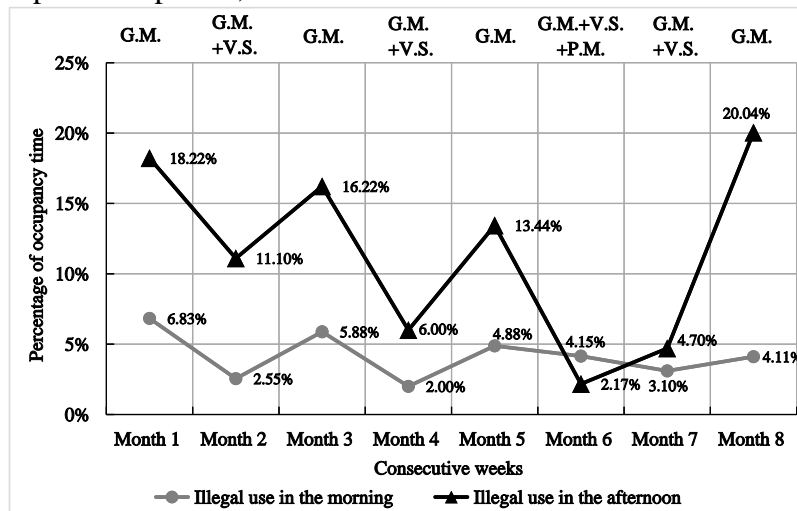
Table 1 The results of one-way ANOVA test

	Variable	N	$\bar{x} \pm s$	F	P
PP3 and PP4 (hidden from public view)	G.M.	162	0.3905 $\pm$ 0.0511	115.68	<0.001**
	G.M.+V.S.	120	0.1741 $\pm$ 0.0493		
	G.M.+V.S.+P.M.	42	0.0603 $\pm$ 0.0219		
PP1 and PP2 (visible to the public)	G.M.	162	0.0713 $\pm$ 0.0319	57.17	0.005*
	G.M.+V.S.	120	0.0367 $\pm$ 0.0243		
	G.M.+V.S.+P.M.	42	0.0200 $\pm$ 0.0338		

\*\*p<0.001, \*p<0.05

### 3.2. Illegal parking during morning and afternoon

Figure 2 provides a comparison of illegal use of the permit parking system as a percentage of total occupancy time during morning and afternoon observation periods to offer a brief look at temporal variations during the day. For the purpose of this figure, average values of percentages were computed by considering all four parking locations. The graphs show that there is a noticeable difference in the magnitudes of illegal occupancy between the morning and afternoon periods. There were more violations in the afternoon than in the morning except in Month 6, a condition specific to this particular campus case study. On the other hand, the underlying pattern, for the variation over the experiment period, remains similar to the trends observed in Figure 1.



Note: G.M.: Ground marking, V.S.: Vertical sign, P.M.: Picture message.

Fig.2. Time of day effect - Illegal parking as a percentage of total occupancy time in the morning and afternoon

Table 2 shows the one-way ANOVA test about significant differences between illegal parking ratios and conditions setting in the mornings and afternoons. Significant effects for conditions setting in the afternoons and tiny significant effects for conditions setting in the mornings were found.

Table 2 The results of one-way ANOVA test between mornings and afternoons

	Variable	N	$\bar{x} \pm s$	F	P
Afternoons	G.M.	132	0.1679 $\pm$ 0.0328	87.34	<0.001**
	G.M.+V.S.	240	0.0703 $\pm$ 0.0406		
	G.M.+V.S.+P.M.	84	0.0217 $\pm$ 0.0087		
Mornings	G.M.	132	0.0543 $\pm$ 0.0205	9.25	0.078
	G.M.+V.S.	240	0.0255 $\pm$ 0.0115		
	G.M.+V.S.+P.M.	84	0.0415 $\pm$ 0.0128		

Note: \*\*p<0.001, \*p<0.05

## 4. Discussion

A physical trial has been conducted at a university campus in Japan, where the permit parking signage system catering to individuals with disabilities was systematically modified during an eight-month period of experimentation. Measurements and the graphs presented in previous sections show that additional signage in the form of a vertical sign has been able to almost halve the level of violations at the worst offending sites although the strategy has not made much difference to the sites where the level of violations was already relatively low. The addition of the persuasive picture-message in the next stage halved the amount of violations yet again.

The above results indicate the effectiveness of the combined signs strategy to discourage illegal use of disabled parking locations. This finding is in agreement with experience in countries such as the United States as reported by Cope et al. [7] about the effectiveness of adding vertical signs to supplement the mandatory surface marking. The experiment has established that compliance of parking rules could be achieved through persuasive measures. The addition of a picture-message implying cognisant social implications rather than legal sanctions appeared to have the greatest impact on illegal parking behavior compared to the ground marking or vertical sign conditions. Authorities in Japan are reluctant to pursue punitive measures to manage parking infringements and therefore could benefit from further investigating such persuasive approaches.

Due to the short time since having adopted the disabled parking system in Japan, it is doubtful whether the mandatory wheelchair symbol alone near a parking space effectively communicates the relevant social implications in detail beyond the obvious message that the identified space can be used by a wheelchair user. There are also problems caused by a lack of awareness about the list of approved personal attributes to be eligible for a permit to use such a space. Nevertheless, signage strategies have successfully increased the probability of public attention and have thus made the decision to misuse these spaces by able-bodied people less likely.

Lack of a distinct pattern in the amount of parking by permitted motorists during the eight month period is an indication that the overall demand for disabled parking is less than the national average used as the guide for determination of the number of parking spaces on campus. For example, Lu et al. [10] have observed a much higher level of disabled parking demand at a shopping center site in this city. The campus parking system complies with the national standard of allocating a minimum of 2% of spaces for the permit parking system. Either way, it is interesting to note that even when designated parking spaces are unoccupied for about 80% to 90% of the time, the potential violator population responded positively to the additional signs. Nevertheless, the methodology followed in this research work can be applied to better forecast the effectiveness of introducing supplementary signage at other venues such as shopping centers where system conditions may be different.

The current study did not focus on the effectiveness of ground marking, sign and message strategies in other places and this is a potential area for improvement of project results. In addition, because of design limitations, the reversal experiment in this survey is not complete. For example, after the ground-sign condition in Month 7, it returned to the ground-only condition instead of the ground-sign-message condition. Individuals reading the message in the preceding phase may have attributed more salience to the international symbol following the message condition than when it had been presented alone prior to the message. Future research should focus on these subjects and do further analysis of signage strategy over time and in different environmental settings.

## 5. Conclusion

This study is designed to investigate the potential to apply persuasive concepts available from social cognitive theory to improve the compliance of parking rules by the general public not holding disabled permits. A physical trial has been conducted at a university campus in Japan, where the permit parking signage system catering to individuals with disabilities was systematically modified. The investigation indicates signage strategy can reduce misuse of disabled parking and adding a picture-message implying contingent social rather than legal sanctions appeared to have the great impact on illegal parking behavior.

This study indicates the effectiveness of the combined signs strategy to discourage illegal use of disabled parking locations. The level of violations in the afternoons is higher than in the mornings. This type of information could be useful in the design of patrol for parking management in the campus. Observations related to the usage patterns also show that the violation level is relatively low in high-visibility areas such as near building entrances.

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