Abstract: This study attempts to evaluate the effectiveness of a mobility management (MM) measure utilizing a circulation system of “Green-community voucher” (i.e. a community currency) on encouraging the citizen to shift to public transport. Green-community voucher circulation system collects the funds for developing a solar power plant, and provides discount service for the customers in local shop. The system is expected to contribute both of the revitalization of local stores and the reduction of GHG emission in the region. At the same time, an MM measure has been conducted to make the customers to change their car-use behavior to local stores. About 130 vouchers were sold for the first three months, and about 30% of sold vouchers were consumed. As a revitalization effect of the MM measure, one-third participants highly intended to switch the daily shopping destination from large shopping complexes to local stores. In terms of the impacts on travel behavior, it promoted to switch from private car to bike/walk for shopping. Furthermore, the MM combining with Green-community voucher system induced a synergistic effect of CO2 emission-reduction. These results show the MM measure could realize a well-balanced region between low-carbon and revitalization.

Key Words: Community Voucher, Mobility Management, Revitalization, Low-Carbon Community

1. INTRODUCTION

Japanese government has created a higher target of greenhouse gas reduction, 25 percent reduction by 2020, and 80% reduction by 2050, compared with 1990, and accordingly various measures to achieve "Low carbon society" have been implemented throughout the nation. While Mobility Management (MM) that urges individuals a voluntary behavior modification by communication technique, is often counted on meeting the target at the regional/city level.
MM is a concept to promote sustainable transport and manage the demand for car use by changing travellers’ attitudes and behaviour. At the core of Mobility Management are "soft" measures like information and communication, organising services and coordinating activities of different partners. "Soft" measures most often enhance the effectiveness of "hard" measures within urban transport (e.g., new tram lines, new roads and new bike lanes). MM measures (in comparison to "hard" measures) do not necessarily require large financial investments and may have a high benefit-cost ratio.

A various types of MM have been applied to commuters (i.e. Eco-commuting), residents and students in school to promote public transport use.

Now Japan is facing two shrink issues, “depopulation” and “lifeless city centers”. The population of Japan changed to a decrease after peaking in 2005. The issue of “lifeless city centers” has been revealed for long time. In the most part of Japan, the shopping street has been worn out because of decrease of visitors, increase of vacant store, difficulty of finding successors, and so on. The Commercial statistics, provided by Ministry of economy, trade and industry shows that number of small and medium-sized shops has been decreased since 1982. Recently, about 400 shopping streets (small-stores complex) gave up their business in one year.

In order to recover the situation, stores, central and local government has tried to revitalize local shopping street and stores. Recently, the MM measure has been popular to be applied with city planning and operation. Suzuki et al. (2009) executed the shopping mobility management measure to activate the downtown in Asakura City, Fukuoka. The result shows that the measure can lead residents to increase their shopping opportunity, and consequently contributes to economically vitalize the downtown. Miyagawa et al. (2009) also dealt with shopping behavior in downtown of Kyoto. The result of citizen’s questionnaire shows the respondents increased their visit frequency, and they decreased car use but increased the use of public transportation to downtown owing to MM communications.

In order to remain the effect of MM measures for longer time, it seems important to promote individuals continuously to look back on their daily behavior and recurrently to monitor the effects on the region with a mid/long-term aspect. However, because of a heavy burden for the program organization of MM and a difficulty of securing the budget over the years, it is not rare that MM programs fade out with the years. Thus, to make MM programs stable, it maybe indispensable to give a constant pleasure or satisfaction to citizens.

Hiraoka et. al (2005) introduce the approach to build low-carbon society synchronizing with the consumption behavior, operated in Yasu City, about 30 kilometers east of Kyoto. Community voucher system of the city achieves to coexist providing benefit to citizens and obtain environmental conservation fund. Citizens buy the voucher, and use at local stores. A part of the amount of purchase in the store is converted to an environmental conservation fund. The cooperation may also secure sustainability.

This attempts to evaluate the effectiveness of an MM measure utilizing a circulation system of “Green-community voucher” on encouraging the citizen to shift from private to public transport. Green-community voucher circulation system that is firstly introduced in Ikeda City, Osaka, collects the funds for developing a solar power plant, and provides discount service for the customers in local shop. The system is expected to contribute both of the revitalization of
local stores and the reduction of GHG emission in the region. At the same time, an MM measure has been conducted to make the customers to change their car-use behavior to local stores.

The remaining part of this paper is organized as follows. Section 2 briefly introduces a circulation system of green-community voucher that is newly introduced in this study. Section 3 illustrates the MM measure with utilizing the above system. The changes in attitudes and behavior of the participants in the MM program and the reduction of CO2 emission after the program are evaluated based on questionnaire survey in Section 4. Finally, this study is concluded in Section 5.

2. FUNDAMENTAL SCHEME

"Green-Community Voucher" is a community currency that can be used in shopping complexes and stores within the limited region. And the sales of community currency will be diverted to the fund of a solar power plant development. The circulation system is shown in Figure 1.

![Figure 1 Circulation system of Green-Community Voucher](image_url)

To be concrete about the voucher system, when a resident buys one green-community voucher at 1,000 JPY, the sales is allocated to the fund for the power plant. As an incentive for the participants, the 10 percent extra attaches to the voucher, so that he/she can buy 1,100 JPY worth of goods. The green-community voucher can be used at all the member shops that consist of small and medium-size local shops within the region. Additionally, when the voucher holders buy a commodity of 1,000 JPY in the shops, they can be discounted by 5%. In short, the holders pay the voucher of 50 JPY and the cash of 950 yen. Each shop can decide the upper limit of voucher consumption at a time independently. The shops are not allowed to
cash the used vouchers and should bear them.

This circulation system enables to secure the green fund for local solar power plant and enables the residents to enjoy the benefits of discounting commodities. Furthermore because of environmentally friendly system, the shopkeepers can firstly change their attitudes and expect to pull in more customers and contribute to improving their image.

In the city that we have implemented the voucher system, the solar power plant fund was existed. The voucher system boosts it. Moreover, coordinated with the MM, it is expected additional effects of CO2 reduction and revitalization.

3 EXECUTION OF MOBILITY MANAGEMENT UTILIZING GREEN-COMMUNITY VOUCHER

(1) Outline of Area
The mobility management measure utilizing green-community voucher has been conducted in Ikeda City, 2010. The city is located to the northern part of Osaka Prefecture, where there are the second largest domestic airport and two routes of expressways. Its population is about 100,000 and the growth rate of the population is almost level-offs. Some car manufacturing factories and the precision instrument factories are located in the city. It becomes a bedroom town because it is only about 20 minutes drive from the center of Osaka City. The city has two train stations and the urban facilities such as bank and hospital are accumulated. A local shopping street extends around a station. However, the local shopping street has faced the deactivation problem due to urban sprawl.

Thus, Ikeda City has introduced an MM program since 2008. At first it has applied MM measure at workplaces for commuters at large-scale offices. And then the target of MM was expanded to such as holiday leisure activity and the moving-in citizens.

(2) Synergize of Green-Community Voucher and Mobility Management
The target of green-community voucher was the city resident. The voucher system and MM measure were jointly carried out to promote the changes of citizens’ attitude and behavior for the environmental issues and the public transportation usage and to raise their localism. The communication approach to the citizens was implemented in the following two ways.

The first was utilizing the booklet of voucher. The booklet was trying to recommend the participants appropriate car use including the information of CO2 emission from car use and daily activities, and the higher economy and healthfulness of car free life. Such information was filed in a prominent position, next to the cover, as shown in Figure 2.
The second was an information provision of MM program by local free papers. In order to motivate the residents to join the program, they explained the attractiveness of green-community voucher system, the address list of the shops joining the program, and the acceptable amount of vouchers to use. They also promoted the readers to notice appropriate car usage by figures. Moreover, the free papers recommended a holiday life by using bicycle (i.e. zero carbon emission travel mode) and informed the leisure and recreational spots in the city come round by bicycle. The questionnaires that asked the readers a usual shopping behavior, travel mode choice behavior and their intentions to use of the green-community voucher were also included in the free papers. They were distributed to all households of the city, about 50,000 households.

(3) Beginning Operation of Green-Community Voucher
The circulation system of green-community voucher has launched in operation since January 2010. The number of local shops joining the system was eighteen. As shown in Figure4, various kinds of local shops participated, such as restaurant, tavern, reuse store, boutique, beauty, stationery store and so on. There was no expiration date of the circulation system of green-community voucher. As shown in Figure 5, small flags were displayed at the member stores for customers to easily recognize their membership of program, and to create atmosphere not to hesitate the vouchers.
4. EVALUATION OF MOBILITY MANAGEMENT USING GREEN-COMMUNITY VOUCHER SYSTEM

(1) Evaluation Viewpoint
This section evaluates the effectiveness of the MM program utilizing Green-Community Voucher by focusing on the environmental impacts, the revitalization of the region, and participants’ travel behavior. A paper-base questionnaire survey to the residents and a face-to-face interview at shops were conducted for the evaluation.
Table 1 Viewpoint of evaluation

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The postcards of questionnaire were printed on the above-mentioned free papers and mailed back. In the questionnaire survey, we asked the respondent’s intention where to use, what to buy, how to access the member shops when you use voucher, as well as their usual shopping behavior before joining the MM program. In the face-to-face interviewing to the shopkeepers, we asked amount sales and usage of vouchers, reaction of users, and so on.

Table 2 Assorted traits of motivation questionnaire to the citizens

| Evaluation of approach whole   | - Do you think the MM program is useful against the global/local   |
|                                |   environment issues?                                              |
|                                | - Enhancement level of member shops and their commodities          |
|                                | - Needs for increasing shops and commodities                       |
| Use intention                  | - Do you want to use the eco-community currency?                   |
|                                | - The expected frequency of use                                     |
|                                | - Shops, commodities and travel modes used before/after the        |
|                                |   introduction of MM program                                       |
| Individual attribute           | - Age                                                               |
|                                | - Gender                                                            |
|                                | - Residential location                                              |
|                                | - Occupation                                                        |

The questionnaire survey was distributed in the beginning of January 2010, just before beginning of the MM program. Total 140 answers were successfully collected in one month. Figure 6 shows the outline of respondents’ characteristics. It is found that the age distribution of respondents accurately reflects the population, and more than 70% respondents are female and about half respondents are housewives, because the MM program relates to the shopping behavior. The results indicate that the MM program with green-community voucher system is highly interested by such kind of customers.
(2) Result of Evaluation
1) Public acceptance of the eco-currency circulation system

At first, we evaluated the whether Green-Community Voucher system was accepted by the citizens or not. Figure 7 shows the respondents’ intentions of the voucher use. About 80 percent respondents showed their positive intensions to use it. This concludes that this system is much acceptable by the citizens.
Figure 8 shows what kind of shops the respondents want to use the voucher in. Many respondents answered their intentions to use it at restaurants and reuse-shop, which they may often visit in daily life.

![Figure 8 Stores wish to use Green-Community Voucher](image)

Figure 9 shows the average turnover of green-community vouchers over the member shops for the first three months. A reuse shop amounted to 58,000 JPY was the highest voucher sales. The total sales of reuse shop and three restaurants, a boutique reached 10,000 JPY or more.

![Figure 9 Sales amount of Green-Community Voucher in each shop](image)
Figure 10 shows how much the voucher was used for the first three months. The total use amount was about 44,000 JPY, and it corresponds to about 30 percent of the value of sales. The four highest-ranked shops of sales occupy the highest ranks of used. However, about restaurant (tavern A), the amount of used was 5,520 JPY, which significantly exceeded the sales of voucher (2,000 JPY). This result represents that Green-Community Voucher has the effect of promoting to visit other various member shops.

![Figure 10 Use state of Green Community Voucher](image)

Figure 10 shows the result of the respondents’ satisfaction with the number of member shops, and Figure 12 shows what kind of shop should be increased, respectively. Because only 18 shops joined the program at the beginning, almost half respondents complained against the small number of member shops. Especially many respondents pointed out their strong requests to include the daily life facilities such as supermarket, restaurant and local shop that provide foods and commodities. There also was a small but strong-mentioned voice to use public transportation. On the whole, a lot of opinions want to enrich the membership of shops were similarly stated by not only the citizens but also the shopkeepers.

![Figure 11 Satisfaction with the number of member shops](image)
2) Effects on local revitalization

After operating the circulation system of green-community voucher, the remarkable changes were observed from the face-to-face interviewing at shops as can be seen in Figure 13. Many shopkeepers expressed “Conversation with the guests increased” with pleasure.

Figure 12 Shop types that the respondents want to add as the member

Figure 13 Changes stated by shopkeepers

Figure 14 shows the perspective on the effects of the MM program with eco-community currency system responded by shops. Many shops stated their future expectations of “advertizing effects” and “improvement of shop’s image”. The shops directly responded neither “increase in sales nor increase of customers”, while they alternatively expected the effects of the MM program that improving the shop’s image and popularity from the viewpoint of CSR.
Figure 14 Expected effects of the MM program with green-community voucher system

Figure 15 shows the increase number of member shops since the voucher was begun to operate. At the beginning, 18 shops re joined. After 6 month, nine stores have become members. During this period, we did not do any special promotion. This result implies that the system and its advantage gradually recognized to shops in the city.

Figure 15 Expansion of member shops

Figure 16 shows the changes of respondent’s intentions of shop use before and after the program. About 30 percent of the respondents show their intentions shift from large-scale shopping complexes, chain stores and mail-order delivery services to small-scale local shops by using the voucher. It is found that the introduction of Green-Community Voucher system contributes to improving the popularity of local shops and consequently increasing the frequency to visit the shops.

Figure 16 Intention of change in shopping stores with/without Green-Community Voucher
3) Effects of Modification of Travel behavior

Figure 17 compares the changes of travel modes by customers before and after the green-community voucher system.

Most responses using the voucher use non-motorized model such as bicycle and walk to shops. Particularly, the number of car users fell in half, while the share of bicycle and walk increased after the introduction of voucher system. This may implies the synergy effect of MM program providing the information that promotes an appropriate car use and the circulation system of eco-community currency. It is feasible that the MM approach proposed in this study will lead to the vital and active city occupied by shopping customers.

![Figure 17 Change of intention in transportation mode when shopping with voucher.](image)

4) Effects on environmental side

According to the results in the previous section, the combination of green-community voucher and mobility management measure may reduce the amount of CO2 emission. One effect comes from the solar power plant funded by the voucher system, another effect is brought by the reduction of car use. The CO2 emission reduction by these two effects is estimated.

The CO2 emission reduction by solar power generation is calculated by the function of the amount of sales of voucher, system availability coefficient, and CO2 emission coefficient, as shown in equation (1).

\[ R_{SE} = V_S \times S_e \times C_c \]  \hspace{1cm} (1)

- \( R_{SE} \): The amount of CO2 emission reduction by solar power generation (Year)
- \( V_S \): The amount of sales of Green-Community Voucher for one year
- \( S_e \): System availability coefficient (0.12)
- \( C_c \): CO2 emission coefficient (referring to the statistics in the region).

The CO2 emission reduction by modifying shopping travel behavior is at first estimated by multiplying the respondents’ CO2 emission caused by the changes of destinations, travel modes and travel frequency with the related expansion ratio as shown in equation (2). And the average shopping trip length is calculated by using the average travel time obtained from 4th
Keihanshin (Osaka-Kyoto-Kobe area) Person Trip Survey in 2000, and the average travel speed of cars in Ikeda city obtained from National Road Traffic Census in 2005. The effects estimated in this study are assumed to be homogenous cross all households and areas in Ikeda City, because of its compact urban structure. In fact, the member shops that concentrate around Ikeda-station and Ishibashi-station can be accessed by all customers on foot and by bicycle. The revision of this assumption should remain as a future work, since this study does not focus on developing the method of region-wide CO2 emission.

\[
R_{SD} = \sum_{i,m,n} \left( (U_{bi} \cdot D_{ti}^n - U_{ai} \cdot D_{ti}^n) \times F_q \right) \times I_u \times E_x \quad (2)
\]

- \( R_{SD} \): The amount of CO2 emission reduction by change of travel modes (year)
- \( U_{bi} \): CO2 emission unit from travel mode before individual \( i \) use Green-Community Voucher
- \( U_{ai} \): CO2 emission unit from travel mode when individual \( i \) use Green-Community Voucher
- \( D_t \): Shopping trip length to destination
- \( F_q \): Frequency of shopping using Green-Community Voucher
- \( I_u \): Ratio of customers who have intentions to use Green-Community Voucher
- \( E_x \): Expansion rate

The CO2 reduction by establishing a solar power plant was estimated about 0.3t-CO2/year, and that by travel behavior changes for shopping was 590t-CO2/year. The latter effect that caused by MM program with eco-community currency system is much higher than the former direct effect of plant. It represents that the MM program newly proposed in this study by combining the green-community voucher circulation system and the traditional MM measure sounds promising.

5. CONCLUSION

This paper newly proposed and firstly carried out a new mobility management program combing with the circulation system of Green-Community Voucher that aimed to secure solar power plant developing fund. The effects were evaluated in terms of citizens' environmental attitude and behavior, local revitalization, the changes of travel mode choice behavior in a local Japanese city. The feasibility of well-coordinated execution of an eco-community currency and mobility management was examined based on such rich data.

The Green-Community Voucher was friendly accepted by the citizens, and moreover, it became gone start more than our previous expectation. Meanwhile, there were a lot of voices from citizens and shopkeepers to hope for the expansion of the joining stores. Consequently, the number of member shops is still in a tendency of increasing. Now it has reached to about 40 shops, and more than 20 shops out of them were increased without any special promotion.

In the future, it is necessary to form the spiral up system, in which as the number of member increases, the citizens' convenience rises, the popularity level of the voucher is enhanced, the use of the voucher increases, and then the effectiveness of advertising and image enhancement becomes more efficient, and consequently it feeds back to the increase of member shops.
From the viewpoint of local revitalization, we confirmed through an empirical case study that the participants in this MM program shows their intention to change the visiting shops from large-scale complexes to small or medium-scale local shops. Moreover, the MM promotes the individuals who bus voucher to visit local shops more frequently. In addition, many member shops improve more communications with the customers by using the eco-community currency. These results represent that it is possible for shops not only to contribute to increasing their sales, but also raising their environmental attitudes.

Furthermore, from the viewpoint of the effects on travel behavior change, the travel mode shift from private car to non-motorized is plausible after the introduction of the MM program. The voucher may contribute not only to the decline of the negative CO2 impact but also calling back customers’ flow around local shopping streets under the concept of "live by walking city".

Finally, from the viewpoint on an environment, the CO2 emission reduction by travel behavioral changes is far larger than that by the development of a solar power plant. It indicates that the synergy effect coordinated with the mobility management is non-negligible. However, these effects were obtained under the condition that shops are more convenient by public and non-motorized travel modes rather than private car. We should accumulate more cases in various regions.

We believe that the result of this cased study indicates a likelihood that “low carbon region development” and “local revitalization” could coexist. But, there is no guarantee to generalize the findings in a local Japanese city to other Asian cities with heterogeneous backgrounds and situations. The revised MM program will be applied to Asian countries that face both issues of city vitalization and environmental issues in future toward “a low carbon world”.

REFERENCES


