Multi-Service Usage Possibility Rate (MP): An indicator for multiple mobility service convenience

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1. Introduction

On-demand services are introduced gradually throughout the world. Each city has usually provided both types of mobility-service that are fixed route services (i.e., conventional mass transit) and on-demand services. It has been improving mobility convenience inside city area. ITF reported[1)] shared mobility would improve the existing public transport network. However, it is difficult for multiple mobility service operators to estimate user' benefit even if they could use multimodal search engine. Fixed route services are easier to understand users' convenience by checking access time from here to stations by utilizing a traditional method. But on-demand services are usually not mass-transit and they are changing the service quality spatio-temporally. And also mixed both types of services make understanding of users' convenience more difficult. Therefore a new indicator would be needed to improve multiple mobility services.

In this study, we propose multi-service usage possibility rate (MP). As a case study, we simulated, by utilizing the proposed indicator, one factory area which already has installed both a fixed route service and an on-demand service. We showed their service convenience spatio-temporally and considered how to improve it by adding a number of vehicles or a new on-demand service by utilizing the proposed indicator.

2. Multi-Service Usage Possibility Rate (MP)

The MP is expressed in terms of users' benefit, that is the possible mobility choices when users are about to move from A to B. We define the usage possibility good when a high percentage of multi-mobility services are available. The MP enables us to identify the convenience in entire area/sub-divisions and time-slot and consists of: *MPd* from the perspective of locations where user demand is generated or concentrated, and *MPh* from the perspective of mobility hubs where the mobility services start and end. Equations (1) (2) show the *MPd* and the *MPh*. When a user demand is generated and moves across ODs, we check the mobility service situation for individual service readiness and the number of available seats and vehicles using a multimodal search function. Equations (3) (4) show the average values in the entire area. **Figure 1** shows a calculation example.

$$MPd_i(\%) = \frac{\sum C_n^{OD}}{N_i \cdot M} \times 100 \quad (1)$$

$$MPh_j(\%) = \sum \frac{C_n^{hub}}{S_n} \times 100 \quad (2)$$

$$MPd_{area} = \overline{MPd_i} \quad (3)$$

$$MPh_{area} = \overline{MPh_j} \quad (4)$$

i	A targeted node of a generation/concentration node
j	A targeted node of a mobility hub node
N_i	The number of demand on i
M	The number of mobility services in an area
n	A user demand generated on node i
C_n^{OD}	The number of usage possibilities to n on i
C_n^{hub}	The number of usage possibilities on j as the nearest hub to n
S_n	The number of searched times of j to n

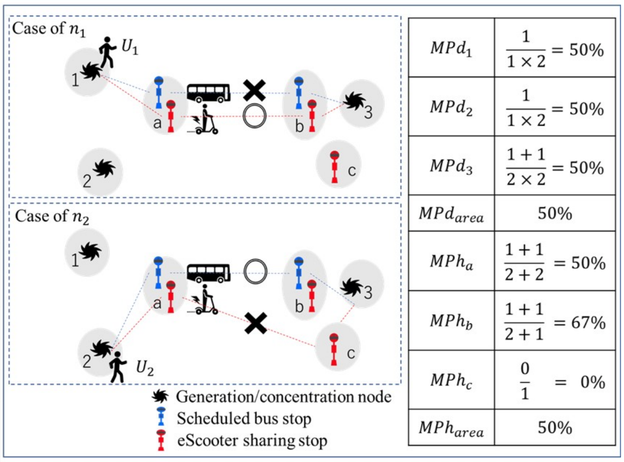

Figure 1. *MP* calculation example

3. Case study

As a case study, we simulated a Toyota Motor Kyushu(TMK) factory which already had a scheduled bus and an eScooter sharing service by one operator and showed the service convenience spatio-temporally by utilizing the simulation results. There are 12 stops for the scheduled bus, 10 ports with charging stations for the eScooter sharing service, and the 11 sub-areas defined based on actual transportation tendencies. TMK has one bus and 60 eScooters vehicles. The multiple service operator recognizes the current surplus of eScooter vehicles. To provide a better transport environment, TMK has been considering the addition of an on-demand service for car commuters and is planning to operate an on-demand bus service in addition to the eScooter service connecting the scheduled bus stops. The on-demand bus service will be operated from 8:00–10:00, and 16:00–18:00 on weekdays. It is practically very difficult to gather all the data in order to calculate *MP*. Therefore, we utilize a simulator and display several types of measurement candidates. In this study, we utilize a multi-mobility simulator whose name is MaaS Blender[2)]. MaaS Blender is an open-source multi-mobility simulation platform which aims to evaluate multiple mobility services by utilizing several mobility simulators.

4. Results

The first simulation is conducted to understand the current situation, using the observed data and actual mode MPd_{area} is calculated. **Figure 2** shows how much the *MPd* and the *MPh* change over the entire target duration reducing the number of eScooters in each sub-area. We see that user demand is large in the central and southeast areas. In the case of 60 vehicles, both the *MPd* and the *MPh* are high values throughout the area. In the case of 10, the *MPd* is slightly higher in value on the south side, but lower in value in the area where the circle size is large. Mobility hubs have high *MPh* values in bus stops (blue sign), low values on eScooter ports (red sigh). This indicates that when the number of eScooter vehicles is as small as 10, the supply cannot meet the demand, and the MPd is low. We can understand that the situation is different between scheduled bus and eScooter sharing services.

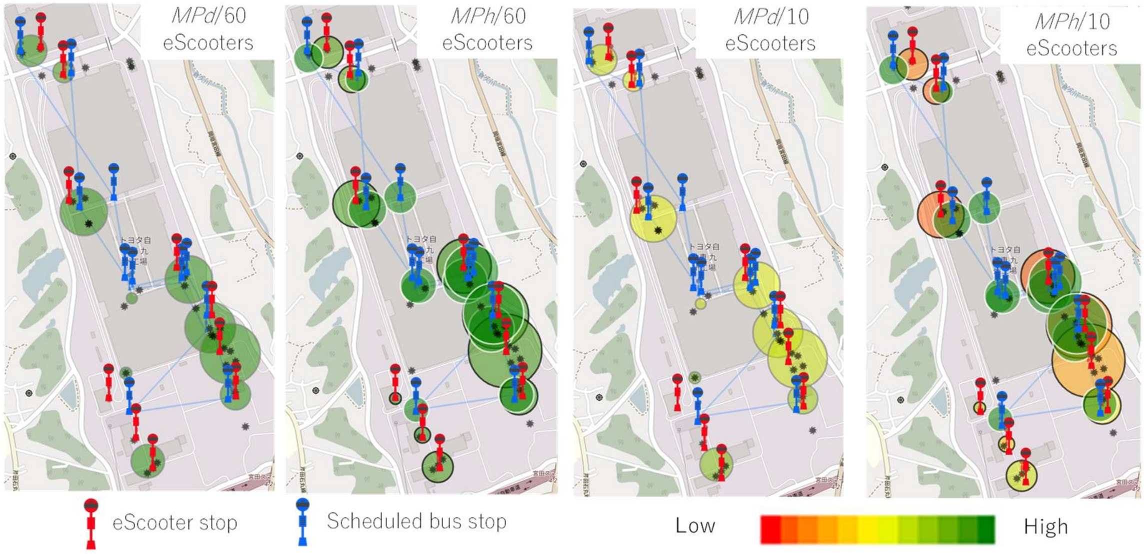

Figure 2. ***MP*** **Distribution inside TMK factory**

Next, we look for improvement directions and compare the simulation results by selecting actual modes, and the shortest arrival time mode, with the number of vehicles in eScooter sharing set to 10. While ratio of eScooter in MPd_{area} ranged 9.5–20.5% from 7:00 to 17:00 when choosing the actual mode, the use of the shortest arrival time model shows a significant improvement, ratio of eScooter in MPd_{area} ranging 28.0–38.3%. From the above results, we find that even if the number of eScooters is reduced, it may be possible to operate, while maintaining the high *MPd,* by communicating to members that eScooters are useful for reaching the destination in faster time.

TMK considers adding a station type on-demand service for car commuters. We simulate another six cases changing number of eScooters and an on-demand bus and consider what kind of services should be provided in this area. **Figure 3** shows that the MPd_{area} increases during the time when the on-demand bus is introduced in the area. **Figure 4** shows in Case 4, where there is no eScooter, we find that the on-demand bus service is used in some quantity, but in Case 5-6, the amount of usage decreases. Especially in Case 6 where there are 60 eScooters, the eScooter service is almost selected. Because it is necessary to wait 5 minutes and on-demand bus service runs only among existing bus stops. Thus, many users select the eScooter sharing service.

Based on these results, the following two directions for improving can be considered. The first option is to reduce the number of eScooter vehicles and change the on-demand bus system from the station type to the Door to Door system. The eScooter sharing service has no waiting time, so users do not select the current on-demand service. Therefore, we adopt an on-demand policy, such as direct delivery from the parking space gate to users' workplaces. The second option is to rethink the introduction of the on-demand bus service and appeal to car commuters that the eScooter sharing service enables them to move in the shortest time without large changing the eScooter resources. In a case where it is not possible to switch from the current on-demand system among bus stops to the direct policy for political reasons, we believe that we can provide better service in the target area by rethinking the introduction of the on-demand buses and promoting the use of eScooter.

Case	Number of Scheduled buses	Number of eScooters	Number of On-demand buses
1	1	0	0
2	1	10	0
3	1	60	0
4	1	0	1
5	1	10	1
6	1	60	1

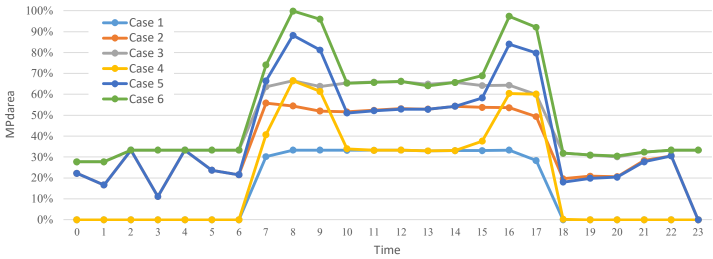

Figure 3. Hourly MPd per month in Case 1-6

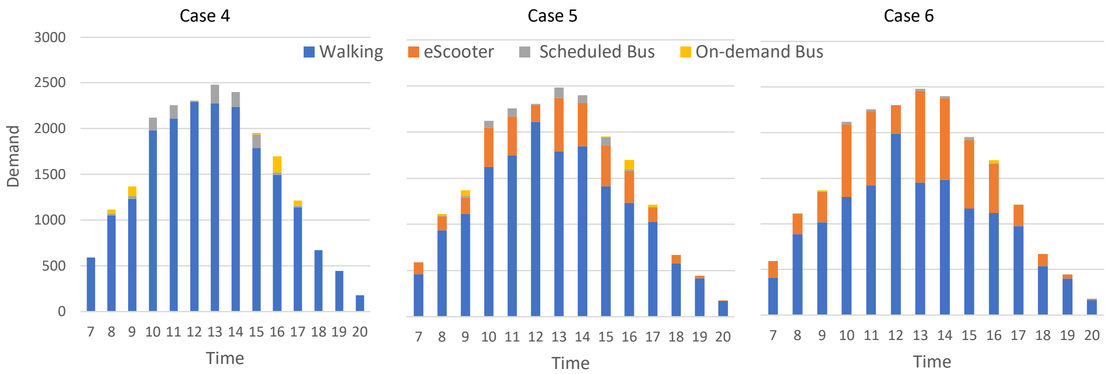

Figure 4. Selected transportation mode in Case4-6

5. Conclusion

The case study shows that the *MP* could be used to effectively evaluate multiple mobility services. First, we simulated and visualized the current situation using the *MP*. Second, we ran several simulations to look for improvement measures. And finally, we decided the direction of improvement, in the context of the additional on-demand bus service.

References

1) Shared Mobility Simulations for Lyon. In International Transport Forum Policy Papers. OECD Publishing, https://www.itf-oecd.org/sites/default/files/docs/shared-mobility-simulations-lyon.pdf

2) MaaS Blender, https://github.com/maasblender, Accessed January 23, 2025.