Verification of the possibility of transportation conversion through the introduction of MaaS at the University of the Ryukyus

Y. Kikuchi[a, *1], H. Sugawara[a], A. Ishii[a], D. Kamiya[b], A. Uechi[c]

[a] *Yachiyo Engineering CO., LTD., Research Institute for Infrastructure Paradigm Shift*

[*1] *CS Tower, 5-20-8, Asakusabashi, Taito-ku, Tokyo 111-8648, Japan, ys-kikuchi@yachiyo-eng.co.jp*

[b] *University of the Ryukyus, Faculty of Engineering*

[c] *University of the Ryukyus, Graduate School of Engineering and Science*

Abstract

At the University of the Ryukyus, located in Okinawa Prefecture, Japan, many students commute to school by vehicle, causing traffic congestion and accidents in the surrounding area. Thus, universities encourage students to use public transportation to get to school. As a measure to improve transportation convenience, the concept of mobility-as-a-service, or MaaS, has been introduced, combining various transportation services into a single service. In this study, we propose a "campus MaaS" that specializes in the concept of MaaS as a means of commuting to and from school on university campuses. We report the results of a campus MaaS trial experiment in December 2022 and discuss future issues to verify the possibility of converting the means of commuting.

Keywords：*MaaS, Blockchain, Economic model, Transportation Demand Management*

Introduction

The share of public transportation in Japan has been declining in recent years as more people use private vehicles as their primary mode of transportation, especially in regional metropolitan areas (Ministry of Land, Infrastructure, Transport and Tourism, 2017). If private vehicle use exceeds parking capacity, traffic congestion caused by waiting for parking will reduce the convenience of public transportation, triggering further decline in the number of public transportation users. Specifically, in Okinawa Prefecture –the target of this study– public transportation is limited to one railroad line, the monorail, and buses. Buses have been identified as having problems, such as "few services" and "late arrivals," resulting in low levels of public transportation convenience and use awareness (Ishii et al., 2019). Japan's public transportation policy is based on a maximum fare approval system subject to price-cap regulations, thus it is not sufficiently flexible for fare changes due to legal restrictions. Therefore, service improvements that actively utilize public transportation, such as park-and-ride and school bus systems to ease traffic congestion in urban areas, have not progressed as well as expected. Furthermore, many students who travel to their part-time jobs after classes commute to the university using their own vehicles because of the travel time of public transportation and lack of a regular schedule. There is concern that the influx of students commuting to universities using private vehicles will cause traffic accidents on campus and traffic congestion in the surrounding area, as well as increase greenhouse gas emissions from private vehicles. Therefore, the challenge is to provide such students with multiple means of transportation other than their own vehicles and to change their attitudes, so that they will use alternative means of transportation is required.

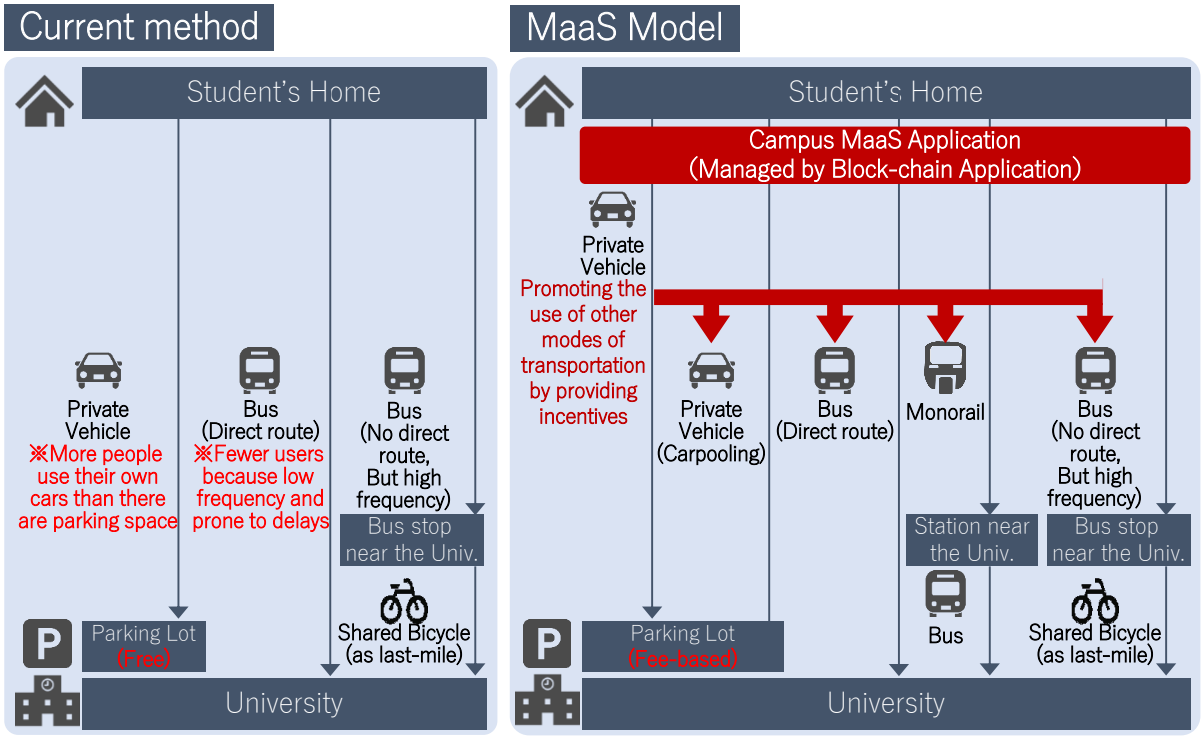
A new mobility service concept called mobility-as-a-service (MaaS) was launched in Finland in 2014, aiming to increase the convenience of mobility by combining various mobility services for door-to-door travel. The idea is to increase the convenience of mobility by combining various mobility services, such as bicycles, car sharing, and on-demand bus services, as well as public transportation, such as railways, subways, street cars/trams, and buses. Currently, the MaaS model is mainly operating in Europe, while in Japan, various MaaS models, including those of transportation operators, have been verified for introduction and considered for implementation since 2018. Most MaaS models being tested are specialized for transportation in sightseeing areas or for completing reservations for demand transportation in depopulated areas via mobile apps, among others. However, few aim to maintain public transportation as a means of transportation in the community.

Therefore, this study proposes a transportation demand management (TDM) approach that aims to shift university commuting from private cars to public transportation, and to maintain public transportation in the region. To do so, we propose a campus MaaS model that introduces shared bicycle services, carpooling to and from schools, and a parking lot use system. Campus MaaS is built on a blockchain-based platform, and a demonstration experiment was conducted using a mobile app that implements some of the proposed functions, targeting students and faculty members at the University of the Ryukyus in Okinawa Prefecture, Japan, where many students commute to school by private vehicles.

Methodology

Figure 1a shows the current commuting method to the University of the Ryukyus. Most students commute to the University of the Ryukyus via private vehicles, partly because parking on campus is free. Other means of commuting to the university include direct route buses and a combination of buses running on the main road, approximately 2 km from the university, and shared bicycles as a last-mile service. However, direct buses to the university are infrequent and can be delayed by 10 minutes or more on some days, causing students to be late for class (Ishii et al., 2019). In addition, reservations for the use of shared bicycles in Japan can only be made 30 minutes before use, and it is not clear whether bicycles will actually be available until just before using them, which does not ensure a reliable means of daily commuting to school.

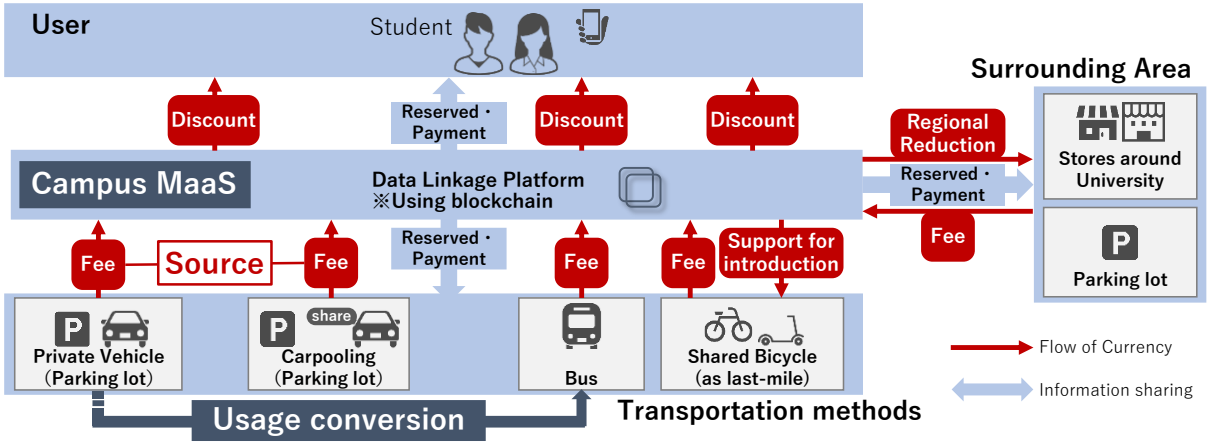
Figure 1a. (Left) Current method for university commuting,
Figure 1b. (Right) Example of MaaS model for university commuting



Source: Prepared by the authors

To solve this problem, our proposed campus MaaS model provides "parking lot sharing", "advance shared bicycle reservation", and "reservation and payment integration" for parking and each means of transportation, as shown on Figure 1b. This model aims to optimize the use of parking spaces, promote the use of public transportation, and improve services. Specifically, for the campus MaaS model shown in Figure 1b, we propose an economic model that integrates transportation behavior and incentivization in a TDM measure to promote public transportation use. Currently, parking at the University of the Ryukyus is free; however, this model aims to reduce the use of private cars by charging parking fees. The parking fees can then be used as a source of funds, redistributed to students and faculty members who discourage the use of private cars and as a last-mile measure to encourage shifting to the use of public transportation. Figure 2 illustrates the economic model of campus MaaS.

Figure 2. Campus MaaS Economic Model



Source: Prepared by the authors

To create a sustainable autonomous economic model, blockchain technology was used to provide a data collaboration platform. In applying blockchain technology, we evaluated it based on the indicators of necessity in the "Blockchain Technology Overview" flowchart provided by the U.S. National Institute of Standards and Technology (Dylan et al., 2018). The results, it was determined that the application of blockchain was desirable given the need to provide multiple pieces of information for this demonstration experiment (publicizing the reservation status of parking, carpooling, and shared mobility), preventing falsification of reservation status, and eliminating the need to appoint an administrator for continuous and efficient management.

The demonstration experiment was conducted over 10 weekdays, from December 5 (Monday) to December 16 (Friday) 2022, at the University of the Ryukyus, in Nishihara Town, Okinawa Prefecture, Japan, and targeted the commuting behaviors of 25 people (16 students and 9 faculty members). At the University of the Ryukyus, approximately 1.5 times as many students (approximately 5,000) commute by vehicle as the number of parking spaces available (Kikuchi et al., 2022) and problems, such as "traffic congestion caused by waiting to enter parking lots," have become apparent. Since there was concern that students who did not commute to school using private vehicles would be reluctant to use public transportation due to the increased time and cost burden (bus fares, etc.), we considered those who chose a means that led to public transportation use as contributing to "reducing traffic congestion" and "maintaining regional public transportation." Therefore, we rewarded them with points as an incentive for choosing public transportation instead of private vehicles. To verify the effectiveness of the shift in transportation mode, we implemented the following two functions, which are part of the proposed model, on a blockchain platform:

1. Shared bicycle as last-mile service (registration can be made one week in advance).

   Shared bicycles were introduced as a means of access (last-mile) to the university from bus stops in the vicinity that are operated by high-frequency buses, thereby increasing the university transportation options.

2. Carpooling assist system

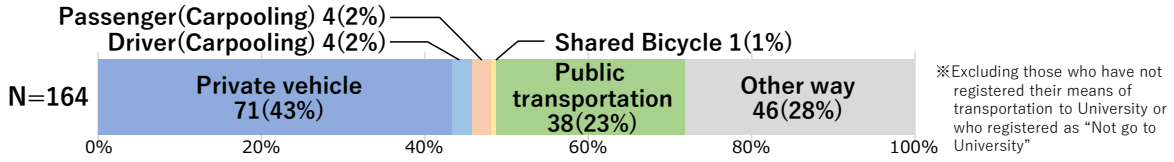
   To reduce the number of private vehicles commuting to the university, a carpooling system was established in which several people ride together to the university. Carpool matching was implemented by issuing and acquiring tickets through blockchain-based smart contracts.

Results

Based on the analysis of the data posted on the platform, Figure 3 shows the results of the reservations and registrations for means of commuting during the experimental period. Overall, the largest number of participants used private vehicles (alone) at 71 (43%), while 38 (23%) used public transportation. There were four (2%) carpool drivers and passengers, and one (1%) shared bicycle user. In follow-up interviews regarding the reasons for the low use of carpooling, participants cited "resistance to riding in someone else's car" and "resistance to the increased time required" as reasons for the low use of carpooling. Thus, it is necessary to consider changes to the use system in the future.

Regarding why only a few participants used the shared bicycle, some respondents stated that "the roads around the university are narrow and dangerous for bicycles," "the university is located on hilly terrain, making it difficult to use bicycles", and 23 of the 25 participants in the experiment did not consider using the shared bicycle because they could take the bus that goes directly to the university. Therefore, it is necessary to consider changing the shared bicycle use system in the future, as well as expanding the range of participants' residences in subsequent experiments. Regarding mode of transportation, 46 participants (28%) chose "other;" however, according to the interviews, they chose "walking" as their mode of transportation. It should be noted that some of the participants in the experiment are students who may be willing to use public transportation, and the results confirm that the redistribution of parking fees to public transportation users may convert approximately 20% of participants from private cars to public transportation. Though used infrequently, we were also able to establish the use of carpooling systems and shared bicycle, thus confirming the possibility that these can be used as a means of commuting to the university.

Figure 3. Reservations and registrations of means of transportation (experimental period)



Source: authors' elaborations

Conclusion

By introducing an advanced last-mile reservation system, a carpooling support system, and incentives when using public transportation, we were able to confirm the possibility of shifting from private vehicles to public transportation when commuting to the university. However, most of the participants in this experiment live in locations with high accessibility to the university. In future studies, the relationship between student residences, the required commute time, and the number of public transportation connections from their residences to the university must be analyzed to identify measures to optimize the commuting method. Moreover, when the number of people shifting away from private vehicles increases, the current public transportation infrastructure and other services may not be sufficient to handle the increase. Therefore, it is necessary to consider the scale of use conversion through the amount of incentives and other measures. Finally, because the platform constructed for the current experiment has not yet been linked to the data owned by each transportation administrator, a technical verification of the blockchain system must be conducted and rules for data linkages established in the future.

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