Introduction of a license number authentication system and utilization of collected data to promote regional tourism

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Abstract

In times when the birth rate is dropping, the population is aging rapidly, and the number of residents and local government employees is decreasing at critical rates, evidence-based policy making (EBPM) is becoming pivotal in order to utilize limited resources effectively. In this study, for the purpose of promoting data utilization using ICT in local governments, a license number authentication system was installed in a Hida City parking lot in Gifu, and license plate data of cars using the parking lot was collected. Tourist activity analysis using the collected data reduced workload for employees and revealed that useful data that previously were not available manually, such as tourists' durations of stay, could be obtained. In addition, visualization tools were developed so that local government employees themselves can analyze tourist activity and utilize them in tourism strategies to attract tourists and revitalize the local community.

Keywords

local governments, data utilization, EBPM, license number authentication system, visualization

1. Introduction

At a time when regional issues and needs are becoming increasingly diversified and the number of residents and local government employees is decreasing due to the acceleration of the declining birthrate and aging population, it is becoming more important than ever to promote the utilization of local government data and to formulate policies based on such data (EBPM: Evidence-based Policy Making) [Cabinet Secretariat, 2019]. In particular, regional tourism is anticipated to gain new financial resources and attract the rapidly increasing number of international visitors in Japan, and local governments are being expected to strengthen their data utilization efforts in order to effectively utilize their limited human resources. In data utilization, it is important to utilize not only the data existing within local government offices, but also other various types of data such as open data and private sector data. However, the fact that data are scattered and difficult to collect, together with the lack of human resources and know-how to utilize the data, have evolved into major challenges for local governments [Ogawa et al., 2016].

To this, in an effort to promote regional tourism, this study will construct a system designed to continuously collect valuable tourism data through usage of ICT. In addition, by developing visualization tools for local government employees, the employees themselves will be able to analyze tourist activity and utilize them in their tourism strategies that will attract tourists and revitalize the local community.

2. Fieldwork location

2.1 Hida, Gifu

This study targeted regions where it is necessary to work on tourism in order to attract consumption from outside the city, as consumption and its scale of economy are shrinking due to its dwindling population.

Hida, Gifu, the city in which fieldwork was conducted in this study, is located at the northernmost tip of the prefecture of Gifu, with a population of 23,793 and an aging rate of 38.83%, experiencing a shrinking and aging population and low birth rate. Hida positions tourism promotion as its top priority in its community development.

However, Hida's main industry is manufacturing, and not tourism. Furthermore, its neighboring cities of Takayama and Gero place tourism as their main industries and are already famous, lowering Hida's recognition as 'Hida City.' The challenge would be to attract tourists who visit "Hida Takayama" to "Hida."

The mayor of Hida holds lecture meetings to explain his policies to the public, and all 10 of those are uploaded on YouTube [Hida City Secretarial Public Relations Section, 2019]. In the 7th meeting, under the theme of "Tourism and Community Development," the mayor emphasized that tourism is an extremely important industry in Hida where the population and birth rate are declining together with the population aging, and presented the following 3 perspectives behind his reasoning:

- Amid the declining population in which the economy will scale down if nothing is done, tourism is a key industry that will draw in consumption from outside the city.
- Having local resources seen and enjoyed by many will build pride among locals toward their hometown and vitalize the

community, which will have more residents staying, encourage people originally from the area and now living in urban areas to return, attract people from non-urban areas and have more people migrate to Hida.

- Tourism is an industry in which all residents can become involved, and working on regional development will lead to community development for Hida.

The mayor of Hida explained the above perspectives by presenting many data on tourism, and emphasized the importance of using data to learn more about tourist activity.

2.2 Current conditions in Hida

Hida's Tourism Section has been working on various efforts to promote tourism, but its line of operations has been diversifying as it responds to the growing interest of society towards tourism and change of circumstances. For example, the main line of operations of the Tourism Section previously was to plan and manage events, participate in tourism exhibitions, and manage and operate sightseeing facilities. Now, however, in addition to these, the section also engages in operations based on marketing such as gaining recognition, attracting visitors, identifying and branding resources, preparing to accept visitors and developing human resources.

Hida conducted a questionnaire survey in 2017 in order to understand tourist activity. Table 1 shows an outline of the questionnaire survey.

Table 1: Outline of the questionnaire survey on tourist activity

Term	1/1/2017-12/31/2017
Number of responses	560
Distribution method	Sightseeing facilities, accommodation facilities and tourist information centers in Hida
Survey items	Primary destination and purpose of the trip, means of transportation, travel companion type, length of stay, spending during travel, first-time or repeating visit, main places visited, other opinions

The results of the survey were useful in understanding tourist activity, as well as raising awareness towards the importance of utilizing data. However, it was unclear whether the results of the survey adequately reflect the trends of all tourists, and it was possible that only a limited number of tourists cooperated to answer the survey. In addition, since the questionnaire survey asks for a great level of cooperation from tourists, a system that continuously obtains data without placing a burden on tourists was needed. It is also necessary to grasp day-to-day tourist activity in more detail, such as the daily number of tourists. The results of the survey are useful for understanding the trends of tourists, but it does not indicate the daily tourist activity in detail.

The questionnaire survey on tourist activity also revealed that 70 % of tourists who visited drove to Hida. There are two parking lots in the city: Shiyakusho-mae Parking Lot and Wakamiya Parking Lot. Many tourists park at these two parking lots that are available free of charge and located at the center of Hida's sightseeing area. Hida considered it important to understand what was going on at these two parking lots when studying tourist activity, and have been surveying the parking lots. Once a day, Tourism Section employees visited the two parking lots, wrote down license plate information of parked cars, and distributed the tabulated results to lodging businesses in the vicinity.

2.3 Hida's challenges

The challenge Hida had was the lack of quantitative data that can continuously track the trends of tourists. Although the questionnaire survey mentioned in 2.2 enabled understanding of tourist attributes and the main purposes of their visits, continuing the survey requires significant effort and furthermore, the survey cannot cover all tourists. In addition, there are statistics on lodging that enable local governments to grasp tourist activity, but there are only a few accommodation facilities in Hida and most of the tourists visit for a day trip or many stay overnight in nearby tourist destinations such as Takayama or Gero. For these reasons, it is difficult to understand tourist activity in Hida through statistics on lodging.

Furthermore, the surveying of parking lots described in 2.2 had two issues. The first issue was the significant workload added to employees. The surveying of parking lots required employees to visit the two lots once a day and copy license plate information of parked cars. This task takes about an hour daily, which adds significant workload to employees. The second issue was the quality of the data. The surveying of parking lots has been conducted on weekdays, but on weekends and when there are many tourists, the surveying did not take place because the city hall is closed. In addition, the surveying conducted once daily only represents the conditions when employees have been to the parking lots. The aggregated results were also used to compile tourism statistics, but in doing so, the numbers were adjusted through multiplying by a fixed multiple. As such, the data itself contains many defective aspects, and is thus not sufficiently accurate.

3. Obtaining data
3.1 License number authentication system

There were two issues associated in obtaining data through the conventional surveying of parking lots: Workload on employees and data quality. Therefore, through industry-government-university collaboration, this study worked on automatically acquiring data by using the license number authentication system.

The license number authentication system consists of a PC and camera. The information on the car license plate photographed is scanned as an image, and the system in the PC extracts only the license plate from the image to read the license
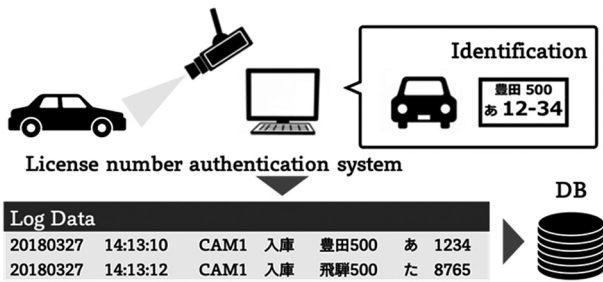
Figure 1: Outline of the license number authentication system

plate information. The information read is stored in the database together with the camera name and the time the information was read (Figure 1).

The license number authentication system was provided by NEC Solution Innovators, Ltd. during the demonstration experiment period. In addition, starting in April 2019, after the demonstration experiment, data on license numbers has continued to be collected as an industry-government-university collaboration project.

3.2 Demonstration experiment

In order to confirm the effectiveness of the introduction of the license number authentication system, a demonstration experiment was conducted for 39 days from July 24 to August 30, 2018. The license number authentication system was installed in a cabin at the entrance of the Shiyakusho-mae Parking Lot

Figure 2: Installed license number authentication system

to obtain license plate information from cars. There were two sets prepared for the system to recognize license plates of cars entering the parking lot and another to recognize cars exiting the parking lot (Figure 2).

The Shiyakusho-mae Parking Lot is located in the center of the sightseeing area and is adjacent to Hida City Hall and Hida City Library. Thus, the parking lot may also be used by people visiting the city hall and library as well as city employees, in addition to tourists. The demonstration experiment thus also focused on whether information obtained from license plates can be used to distinguish between tourists and non-tourists.

As a result of the demonstration experiment, it was confirmed that accurate data could be obtained to an extent. The items of the collected data included the car passing date and time (year/month/day/ hour/minute/second), camera name, Land Transport Bureau, car model number, purpose, and sequence number. The collected data can be output in CSV format from the database of the license number authentication system.

3.3 Real-time data acquisition

With the introduction of the license number authentication system, license plate information of visiting vehicles could now be obtained automatically. However, the retrieval of the data became a problem. In the demonstration experiment, employees output data into CSV file from the license number authentication system every month for analysis when utilizing the collected data. Thus, in this study, an environment in which collected data can be utilized in real-time was considered as a means for data utilization.

Once the parking lot data can be utilized in real-time, useful services can be developed for local governments as well as local commerce and industry associations and visitors. In addition, real-time congestion levels of the parking lot can also be estimated. Arrival information, such as of sightseeing buses, is useful information for lodging businesses and tourism-related businesses in the area.

Therefore, to obtain data real-time, a cloud environment was developed. The save location of the data obtained from number authentication was changed to a folder synchronized with the
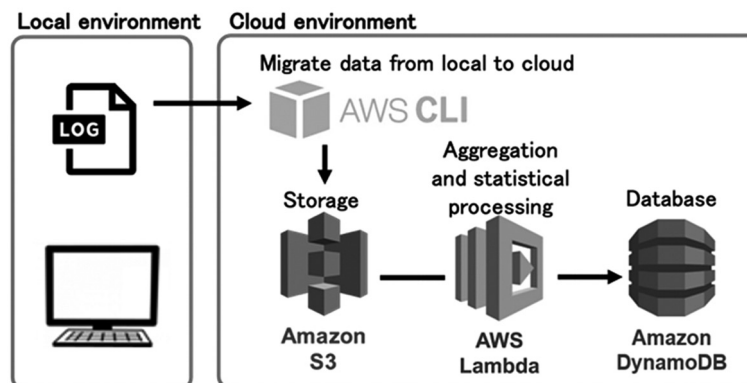

Figure 3: Overview of the real-time processing environment

cloud environment so the data obtained from number authentication can be aggregated on the cloud. AWS cloud service was used in this study. An abbreviation of Amazon Web Service, AWS is a collective term for Amazon's cloud computing services [Amazon Web Services, 2020]. AWS makes it relatively easy and affordable to build real-time data processing capability and a scalable environment.

The AWS services used in this study were AWS CLI for operating AWS from a local environment, S3 for cloud storage, Lambda for aggregation and DynamoDB for databasing. Using AWS, the study worked to automate the processes of uploading collected data from the local environment to cloud storage (S3), automatically aggregating (Lambda) the uploaded data, and then storing the data in a database (DynamoDB) (Figure 3).

4. Data analysis

4.1 Analytical data

Tourist activity analysis that combined data collected by the license number authentication system and relevant open data was conducted. These types of tourist activity analysis are particularly prone to be limited to only one data source, and rarely combine multiple data. The study also considered what kind of analysis can be run from each data source, as well as what kind of analysis would be effective.

4.1.1 License number data

The vehicle license number data used for data analysis were obtained by the license number authentication system described earlier in 3.1. In addition to the data items obtained by the system, fields required for the analysis were also added. The items of the original data were divided by class to facilitate analysis. For example, while there are more than 100 types of license numbers in the original data registered in the Land Transport Bureau, the study added an item to classify between "Hida license number" and "Other license numbers." Items that could be derived without processing the original data were also added. For example, the length of stay cannot be calculated by viewing the recorded data individually, but can be calculated from the difference in recording time when there is a pair of identical license numbers entering and exiting in a day. In addition, data such as appearance frequency can also be calculated through aggregation. Items considered effective for analysis were calculated and added.

License number data were collected from 7/24/2018 to 8/30/2018 when the demonstration experiment took place, and between 4/16/2019 and 11/30/2019 after the collection of license number data officially started. Data from 232 days were used, excluding the data when the system stopped due to an unknown cause.

4.1.2 Weather data

Weather data was used by downloading the weather data for Takayama from the "Download past data" link on the Japan Meteorological Agency website. Data was downloaded for the same period as when license plate data was collected. The information on the Japan Meteorological Agency website conforms to CC BY (Creative Commons Attribution 4.0 International), and it states that anyone can freely use the information, including reproduction, public transmission, translation and transformation, and can also be used commercially [Japan Meteorological Agency, 2020]. As for weather data, items for calculating the weather from the rain level and weather number were added.

4.1.3 Event data

Hida's event calendar data was used as event data after obtaining approval from the city.

4.2 Analysis results

Data were analyzed using Tableau. Tableau is business intelligence (BI) tool specializing in analysis from Software, an American developer, and helps users make quick, high-quality decisions by visualizing and analyzing various forms of data [Tableau, 2020].

Using Tableau, in addition to analysis using "area visited (by Land Transport Bureau, by prefecture)," analyses on "average number of visits," "average length of stay," "analysis by vehicle type and purpose," "analysis by time of visit," "analysis on weekends and holidays," "analysis by visit frequency," "analysis combined with weather data," and "analysis combined with event data" were conducted.

Figure 4 shows "analysis on weekends and holidays." This is an example of trend analysis on the average number of visits and the average length of stay by holiday and weekday. As for the number of visits on holidays and weekdays, Hida license numbers recorded 1.5 times more on average during weekdays than on holidays. Meanwhile, license numbers other than from Hida recorded 2 times more visits during holidays compared to weekdays. From this, it can be identified that the means of using the parking lot and visitor types differ greatly between Hida license numbers and the other license numbers. For the length of stay, Hida license numbers stay about 1.5 times longer on holidays compared to weekdays, and considering there are no city hall users on holidays, it can be speculated the drivers are library users or tourists. On average, license numbers other than from Hida stay about 10 minutes longer on holidays.

Analyzing the data collected by the license number authentication system grasped tourist activity in more detail. The results of the analysis were consistent with previous experience, with some confirming the past results and some revealing new findings. For example, it was a new discovery that tourists and non-tourists could be classified by information obtained from license plates. Owned cars that are compact passenger cars or normal-sized passenger cars that do not have Hida license numbers were considered to be tourists. It was made clear that applying this condition enabled an extraction of tourists from outside the prefecture and conducting analysis that focused only on tourist data. In addition, analysis revealed the
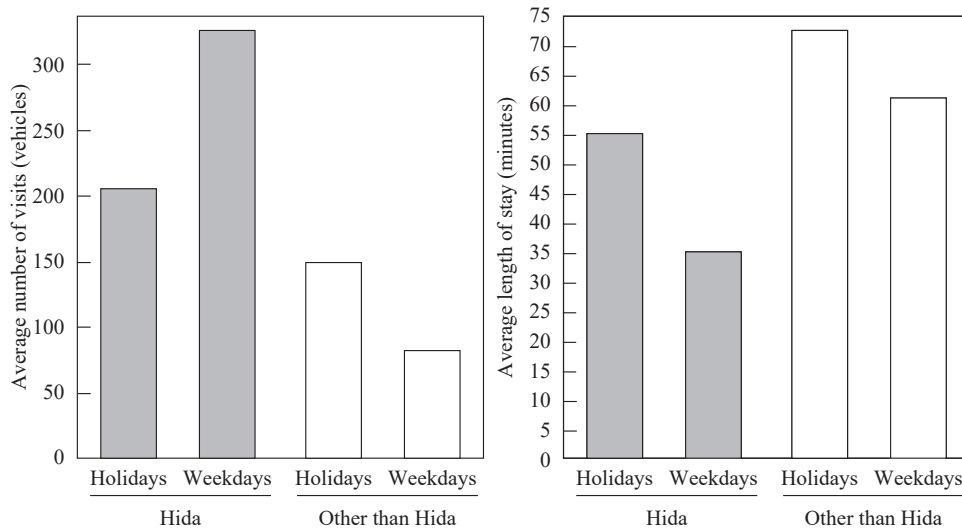
Figure 4: Number of visits and length of stay on holidays and weekdays

number of visits and length of stay decreased on rainy days among tourists while the number of visits and length of stay increased among visitors who were not tourists. Analysis also could measure the impact of the events through the number of visitors and length of stay. In this way, by analyzing weather data and event data in addition to the collected data, changes in the trends of tourists according to weather conditions and the effects of attracting tourists per event could be estimated. For Hida license numbers thought to be owned by local residents, new insights were gained, including the fact that the number of visits on weekends and holidays drastically drops and that the number of visitors increases at 9 a.m. when the city hall starts operations and 1 p.m. when lunch recess ends. The analysis indicated the tourist activity trends as well as the activity of local residents, and also revealed potential ways of utilization other than in the tourism realm.

5. Data utilization
5.1 Visualization tool

In order to promote tourism, it is important not only to collect and analyze data, but also to create examples of the use of such data. In this study, a visualization tool for local government employees to conduct data analysis was created using a BI (Business Intelligence) tool called Google Data Portal [Google, 2020]. Google Data Portal is a platform from Google for big data analysis and a tool that allows users to create graphs that visually present analysis results according to various data formats and can be viewed on browsers. Since it supports various
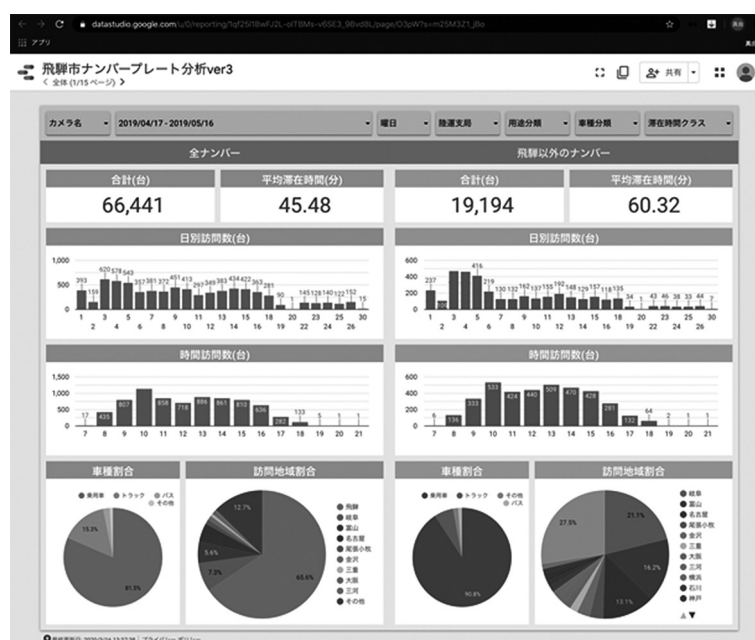

Figure 5: Display screen of visualization tool

data formats, the analysis screen can be flexibly designed and the visualized results can be shared through URL, this study used Google Data Portal to create the tool. The visualization tool enables the user to see the total number of visitors, the number of visitors per day, the number of visitors per hour, the percentage of visitors per area, congestion levels per hour, the average length of stay and other data. In addition, users can select and specify conditions such as the time period, entries and/or exits, type of car and other conditions so that only the results of the customized conditions can be displayed, which will enable conducting analysis according to purpose, such as analyzing segments considered to be tourists.

This study asked four Hida Tourism Section employees to use the visualization tool and followed up with a questionnaire survey. As positive feedback on the tool, the employees commented, "Data can be compared with the statistical data already obtained by the Tourism Section," "The graphs make it easier to visually compare," and "I like how you only need to open the URL to see the results." On the other hand, an employee pointed out, "In order to open the visualization tool to the public, we need to assume a situation where data could not be obtained successfully due to equipment failure or other issues. And, if we can control the timing of opening the visualization tool to the public, there would be no problem for residents to utilize the data."

5.2 Smart speaker application

Smartphone or PC operations were required to view the visualization tool described in 5.1. This study decided to also develop an application for smart speakers, considering that smart speakers are suitable for stores and residents in Hida, where its population is aging, to obtain tourism data more easily.

A smart speaker is a speaker that can incorporate with data AI assistants compatible with interactive voice operations. Smart speakers can be operated by speaking to them, which allows for children and the elderly who are not familiar with smartphones and PCs to use them with ease. This study used Amazon Alexa, one of the best-known smart speakers that possess high affinity with AWS [Amazon Alexa, 2020].

The developed smart speaker application provides users with tourism data also linked with weather and Hida's event calendar in addition to the license number data obtained by the license number authentication system (Figure 6).

Figure 6: Screen after the application is started

Past and present conditions can be seen by speaking into and touching the screen through utilizing the data from the AWS database described in 3.2. The application works with both voice and touchscreen controls, allowing users to see license number information, including the total number of cars parked on a given date, the number of buses and rental cars and the number of cars visiting per key area, as well as the weather, temperature and events held in Hida that day.

The application (skill) is started by saying, "Alexa, open the parking report." After starting the application, a menu selection screen is displayed, where users select either "Check current parking status" or "Check past parking data." An example of the results screen is shown in Figure 7. In the weather and temperature field, users can see the weather and temperature at 6 a.m., 12 p.m. and 6 p.m. In the event information field, events of the day can be confirmed. In the field for the number of cars visiting, the total number of cars visiting is shown. The number of rental cars and the number of buses are both shown in fields for that day. As for the number of visits by area according to results of analyses, the number of license plates from 9 regions with the largest number of visits can be viewed. By scanning

Figure 7: A screenshot of the application

the QR code at the bottom right, users can access the online visualization tool, which allowed for more detailed analysis.

Four Hida Tourism Section employees used the smart speaker application and answered a questionnaire survey. As positive feedback on the smart speaker app, the employees commented, "This app is very convenient because I won't need to use a PC. It gives me access to data instantly when I need to," and "The elderly can also use this app because entering information is easy." In addition, they indicated how they would be willing to use the application in the future as well, such as by commenting, "This app may be useful to provide information to residents," and "If the app can be available in multiple languages, it can be used as a tourism guide for international tourists." Meanwhile, there were some opinions that implied how there is room for improvement, such as "It may be embarrassing to use the app when there are others around me," and "The app cannot respond to dialects."

6. Discussion

Through its introduction of the license number authentication system, this study succeeded in collecting more valuable data than Hida had previously collected in its parking lot surveys. The license number authentication system improved the quantity and quality of data as well. Instead of once-a-day surveys, the city now collects data while the system is running, including on weekends and holidays, which previously were not surveyed. This increased the collection of data and in turn enabled the collection of accurate statistics. In addition, the previous survey method investigated the prefecture and number of cars coming from outside the prefecture from license plates, but with the introduction of the license number authentication system, more detailed data can be obtained. For example, it is now possible to classify purposes between rental cars, buses, personally owned cars and commercial vehicles from the data. In addition, data such as the entry and exit times were also data that previously could not be obtained from the once-a-day surveys. The information is important because the length of time a tourist stays can be calculated, thereby enabling estimations for tourist satisfaction levels and spending. It can be said that the introduction of the license number authentication system had a significant effect on being able to identify how long tourists stayed. The study also developed a cloud environment and considered building a system that collects data in real time. With this system, data collection can be automated so the latest data will always be available. In this way, this study contributed to the continuous collection of data, which will serve as a foundation for data utilization in Hida.

This research also developed visualization tools and smart speaker applications for data utilization. As for the visualization tool, a tool that is easy to use for the local employees was developed by continuing to improve the display method through repeated discussions with Hida employees. For the smart speaker application, an application that enables users to visualize and confirm analysis results and other data using

Amazon Alexa was developed. The fact that PC operation is not needed and it is user-friendly for anyone was highly evaluated, and indicated potential for further expansion as a means for information dissemination to residents.

7. Conclusion

To promote regional tourism, this study enabled local government employees to analyze tourist activity developing a visualization tool by building a mechanism to continuously collect valuable tourism data using ICT. In addition, by developing a smart speaker application and showing an example of data utilization, this study consistently conducted data acquisition, analysis, and utilization activities, and clarified their respective results and challenges through feedback from the local government.

Going forward, this study would like to expand its efforts on the license number authentication system so that information can be obtained at other locations. Combining information from other locations would gain a more detailed understanding of tourist activity, and if similar efforts can be made outside of Hida, a better understanding of tourist activity can be gained on a wider span.

Although the collected analysis results are useful for local governments, data utilization can potentially be expandable by making them accessible to the public. Therefore, this study plans to disclose the statistically processed data as open data to promote data utilization and facilitate coordination with other organizations.

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