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An Analysis of Bicycle Utilization for Reducing Vehicle Registration

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Abstract - Korea has tried to solve many problems that cars have by providing odd-numbered driving systems and eco-friendly electric vehicles to solve problems caused by increased car registration. However, the number of cars continues to rise and there are many problems such as air pollution problems, noise pollution problems, and traffic accidents. I thought that if there was a transport alternative, it could be solved and that it could be solved by increasing the utilization rate of eco-friendly bicycles among transport vehicles. Therefore, using R, a tool for big data analysis, this paper tries to analyze the correlation between bike-related facilities and the utilization rate of bicycles in the Seoul area and suggest ways to improve the bicycle environment to increase the bicycle utilization rate.

Index Terms - Big Data, R, Vehicle, Reduction, Bicycle, Environment.

INTRODUCTION

As the economy per household improves compared to the past, people's psychological desire to pursue convenience increases. To address that need, people began purchasing cars in line with the era of mass production technology, and as a result, in 2018, it surpassed 23 million units, with one car per 2.2 people in South Korea[1]. This is causing serious traffic problems such as traffic congestion, traffic accidents, increased logistics costs and parking difficulties, noise pollution, and environmental pollution.

The country encourages two-part, ten-part, and public transportation to solve these problems, but with rising prices every year, public transportation costs are rising and most traffic solutions are only recommendations, and there are still many serious traffic problems. Therefore, some developed countries are actively encouraging the use of bicycles, a green mode of transportation, to address these transportation problems and promote citizenship related to transportation and the environment[2].

The country provides bicycle-related convenience facilities such as bicycle parking lots, bicycle rental stations, and bicycle roads to settle bicycles as real-life transportation, but most people do not use bicycle convenience facilities because they only provide them. To overcome this, it is necessary to comprehensively review various bicycle use activation policies and apply them according to urban characteristics[3]. This study reviews the problems of related systems and policies, identifies the current status of bicycle use in Seoul, and presents measures and connections to activate bicycle use to reduce the registration rate of cars in the future.

RELATED WORKS

I. Big Data Processing Technology

Big data refers to data of a size that exceeds the acceptable limits of commonly used data collection, management and processing software. Big data is largely divided into stages of collection, storage, processing, analysis, and visualization, and the common characteristics of big data can be described as 3V. 3V refers to the volume of data, the velocity of data generation, and the diversity of form. Additionally, Veracity, Variability, and Visualization were added[4,5].

II. R language

R and its libraries implement a variety of statistical and graphical techniques, including linear and nonlinear modeling, classical statistical testing, time series analysis, classification, and clustering. R is easily scalable through functionality and expansion, and the R community is known for its active contributions to the package. Many of the standard functions of R are written in R itself, making it easy for users to use the algorithm. For computational tasks, C, C++, and Fortran codes can be linked and called at runtime. R objects can be written directly in C, C++, Java, NET, or Python code. R shares packages made by many people, making them highly scalable in certain functions or fields of research. Due to the tradition of S, R provides stronger object-oriented programming capabilities than most statistical computing languages. Another advantage of R is static graphics that can produce high-quality graphs, including mathematical graphics. Dynamic and interactive graphics are also available in additional packages. R has its own document format, Rd, similar to LaTeX, which is used to provide comprehensive documents online and in hard copies[6].

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III. A Study on the Development of Integrated Management system for Registration of Bicycles

The study, conducted by the Ministry of Public Administration and Security, writes about the bicycle registration system to increase bicycle utilization. The bicycle registration system, a system that systematically manages bicycles like cars, reduces long-term neglect of bicycles and prevents bicycle theft, thereby helping to establish various policies. Japan and the Netherlands have these bicycle registration systems, which are mandatory in Japan (no compulsion). In the Netherlands, the biggest operating method is self-regulation. They have something in common that bicycle-related work will be carried out nationwide through police inspections and identification of registered bicycle recognition stickers (DPC), and it is one of the most necessary points when carrying out a bicycle registration system[7].

IV. A Study on the Improvement of the System for the Promotion of Bicycle Use

The study examines the status of overseas bicycle-related systems and policies, and current bicycle-related laws, systems, and policy issues to address better bicycle-related laws and policies. Although the data written in 2007 were old, the reasons why people did not use bicycles at that time were cited as the lack of public awareness, low legal status of bicycles, and policy. This means that even if there are bicycles, they are not often used due to the image of low-level transportation, social dignity, and poor management of bicycle roads.

Therefore, the study argues that, from a macro perspective, the state needs to step up to prevent environmental pollution and energy overconsumption and improve bicycle-related projects and policies, including removal of obstacles that harm bicycle demonstration cities, subsidies, and facilities[8].

ANALYSIS

The purpose of this paper is to analyze the environment and utilization of bicycles and find ways to improve the bicycle environment so that the use rate of bicycles can be increased as an alternative to reducing car registration. First, we simply overlapped the two graphs to see if there was a correlation between the increase in the number of car registrations and the utilization of bicycles.

The data are based on Seoul's car registration status and Seoul's bicycle usage data provided by the Seoul Open Data Square and visualized the number of car registration and bicycle utilization rate from 2012 to 2018 in the form of a twisted line graph using the ggplot function provided by the ggplot2 library.

The y-axis on the left is the figure for car registration and the y-axis on the right is the ratio for bicycle use. In Fig. 1, the number of car registrations has been steadily increasing from 2,969,184 in 2012 to 3,124,651 in 2018, with the bicycle utilization rate generally decreasing from 28% in 2012 to 20.8% in 2018. The reason why the two graphs are not exactly proportional is that not all uses of bicycles are used as means of transport. Fig. 2 shows the percentage of cases where bicycles are used as a means of transport, from 4.6 percent to 5.5 percent over the past six years, maintaining a margin of error within 1 percent.

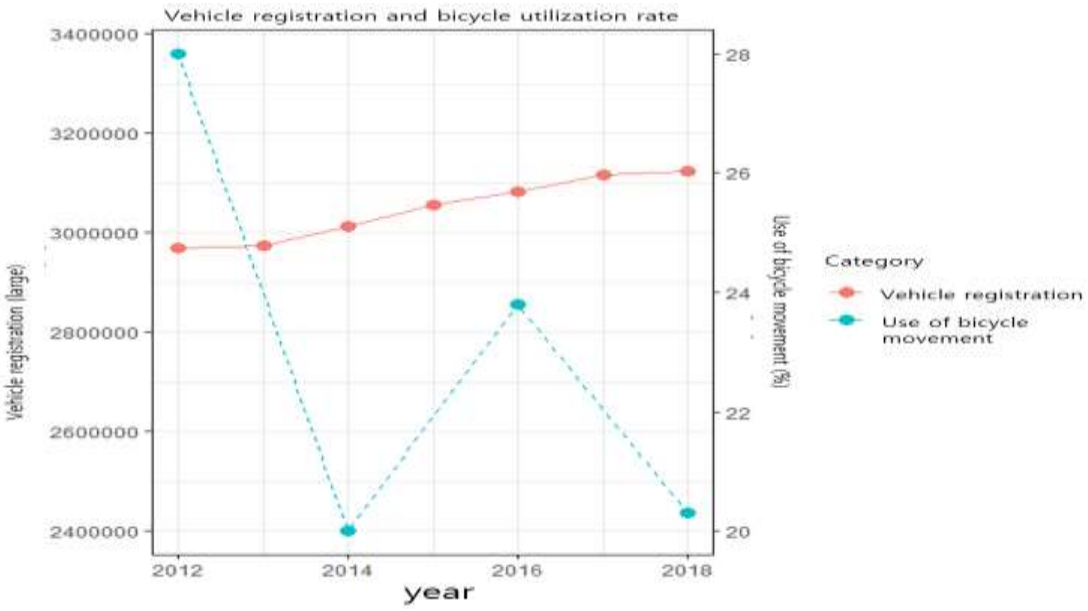

Fig.1. Vehicle Registration Statistics and Bicycle Utilization Rate Visualization by Year

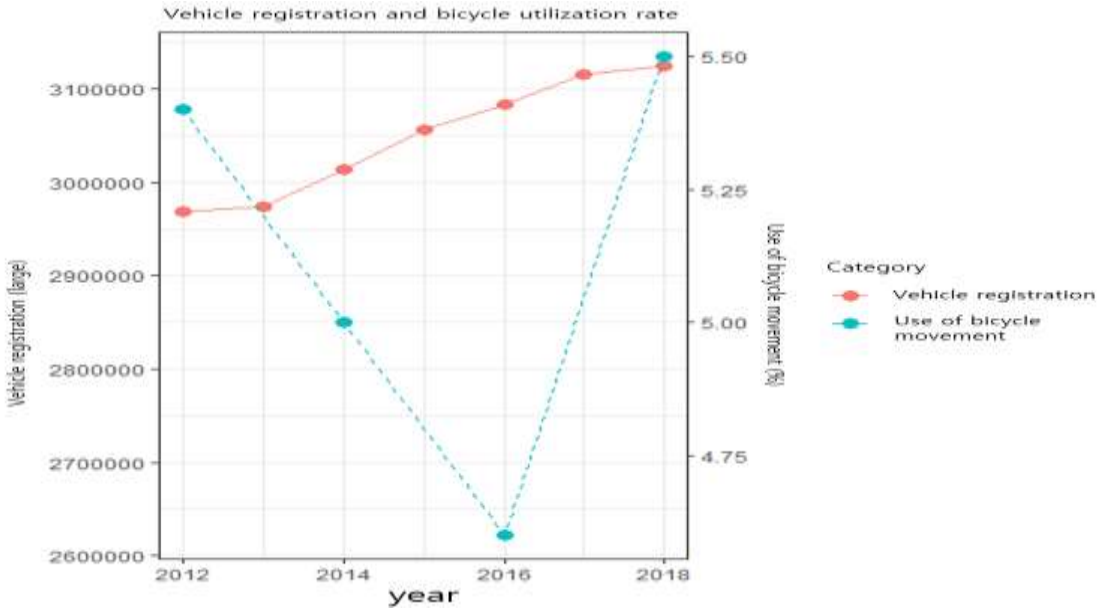

Fig.2. Vehicle Registration Statistics and Bicycle Utilization Rate or Transportation Visualization by Year

To make it easier to see the ratio of the bicycle's means of transportation and exercise, the ggplot function is used to visualize the bicycle as a bar graph for each purpose of using it, as shown in Fig. 3.

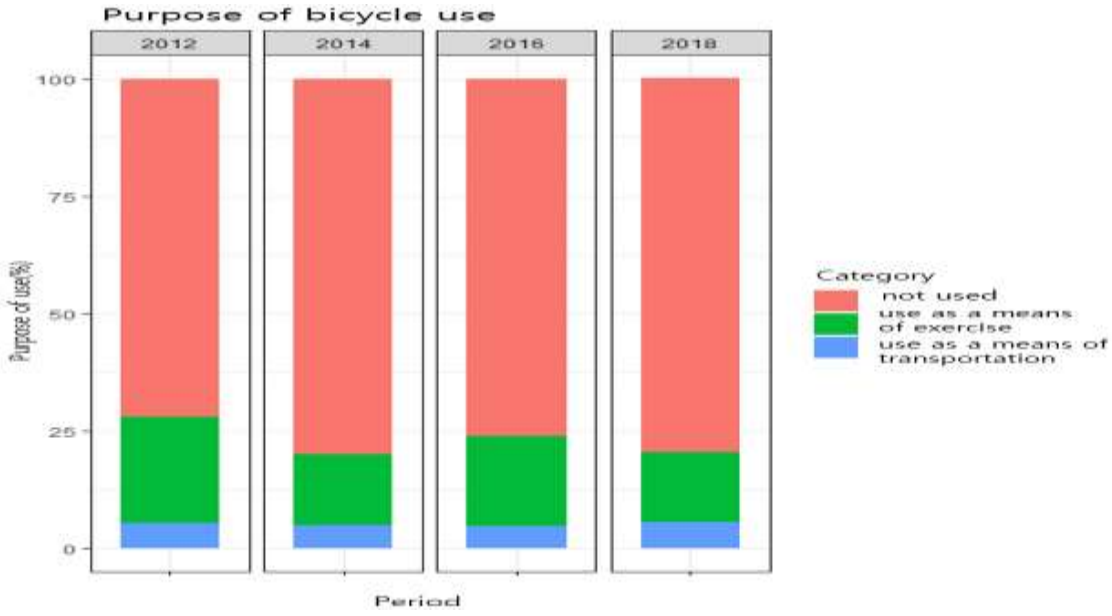

Fig.3. Visualization of the Purpose of Biking by Year

In Fig. 3, only 23 to 27 percent of cyclists use bicycles, and most of them use them as a means of exercise. The proportion of people who use bicycles as a means of transportation is only about 20% of those who use bicycles less than about 5%.

The period variables in Table 1 refer to the utilization of each means of commuting/commuting between 2012 and 2018. Since the purpose of transportation used for commuting and commuting is all used as a means of transportation, it is possible to compare the ratio of transportation used as a means of transportation and bicycle use. Using the ggplot function, numerical data for each means of transportation used to commute/ commute are visualized and shown through a line graph.

Table 1. Statistical Data of Transportation for Commuting

Data Structure
'Commute_brf': 7 obs. of 9 variables:
$ Period: int 2012 2013 2014 2015 2016 2017 2018
$ Walking: num 15.3 15.8 17.4 13 12.3 16.1 16.5
$ Bicycle: num 3.1 2.7 2.8 2.2 1.6 2.1 2.7
$ Motorcycle: num 0.3 0.6 0.7 0.4 0.4 0.5 0.7
$ Bus: num 20.9 21.9 24.6 27.7 32.6 25.6 24.8
$ Subway: num 14.6 11.1 10.5 13.1 9.9 12.2 10.7
$ Bus+Subway: num 22.4 24.3 19.4 18.8 19.6 ...
$ Taxi: num 0.1 0.3 0.2 0.5 0.3 0.1 0.2
$ A car: num 21.1 22.1 22.2 22.4 21.3 22.6 22.2

In Fig. 4, the number of people commuting by car from 2012 to 2018 remained steady at around 22 percent, from 21.1 percent to 22.6 percent, and about 2.5 percent, from 1.6 percent to 3.1 percent, respectively. The highest percentage of commuter/school transportation was public transportation, which accounted for about 55 percent, such as subways and buses. However, public transportation has too many people to use, making it inconvenient to use commuting time and increasing fares.

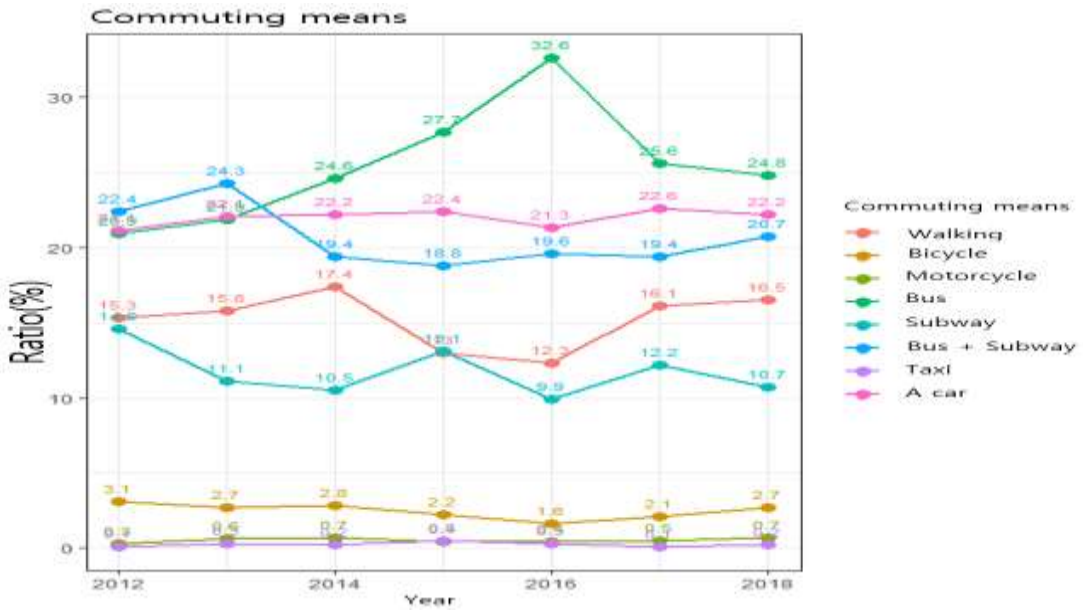

Fig.4. Visualization of Statistical Data of Transportation for Commuting by Year

Table 2 shows the statistical data of bicycle satisfaction by year in Seoul. In order to convert a bicycle into a means of transportation, we looked into how satisfaction with the bicycle use environment is changing and some causes of dissatisfaction were found.

Table 2. Statistical Data on Bicycle Satisfaction in Seoul

	2012	2014	2016	2018
Very satisfied	2.5	8.8	9.4	10.2
Slightly satisfied	67.6	50.8	50.1	45.1
usually	23.2	29.9	30.3	32.7
a little dissatisfied	5	8.6	7.3	10.7
Very dissatisfied	1.7	1.9	2.9	1.3
Average	6.62	6.4	6.4	6.3

In Fig. 5, using the ggplot function, we visualized the distribution of satisfaction over time as a bar graph.

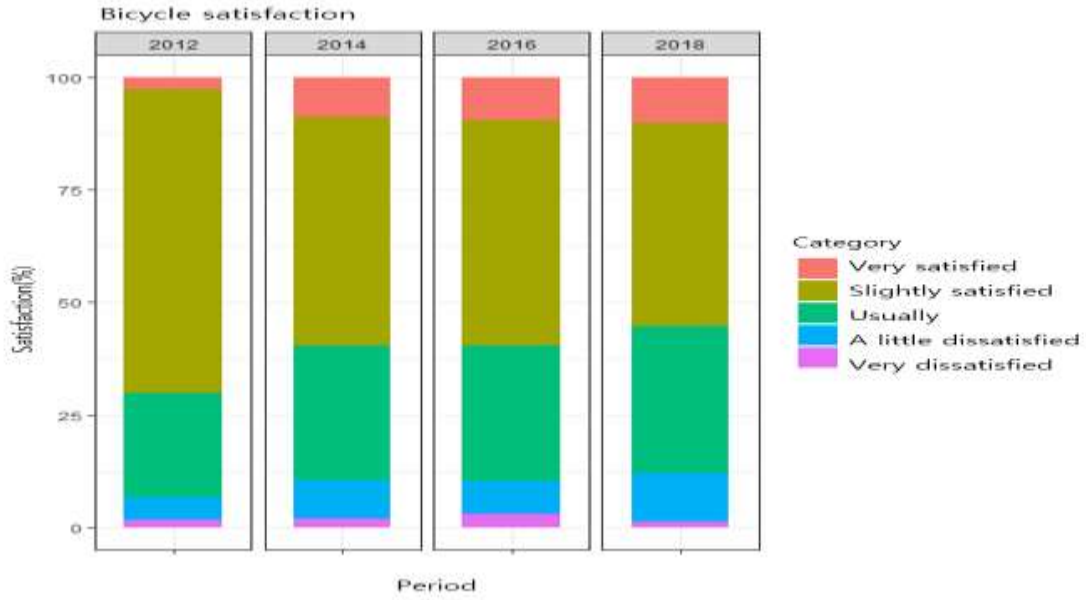

Fig.5. Bicycle Satisfaction Visualization for Year

In Fig. 6, the main causes of dissatisfaction were the risk of bicycles, lack of space to ride, lack of bicycle facilities, and no bicycles. Among these various problems, the solutions that can be directly solved are safety problems, space problems, and facility problems[9].

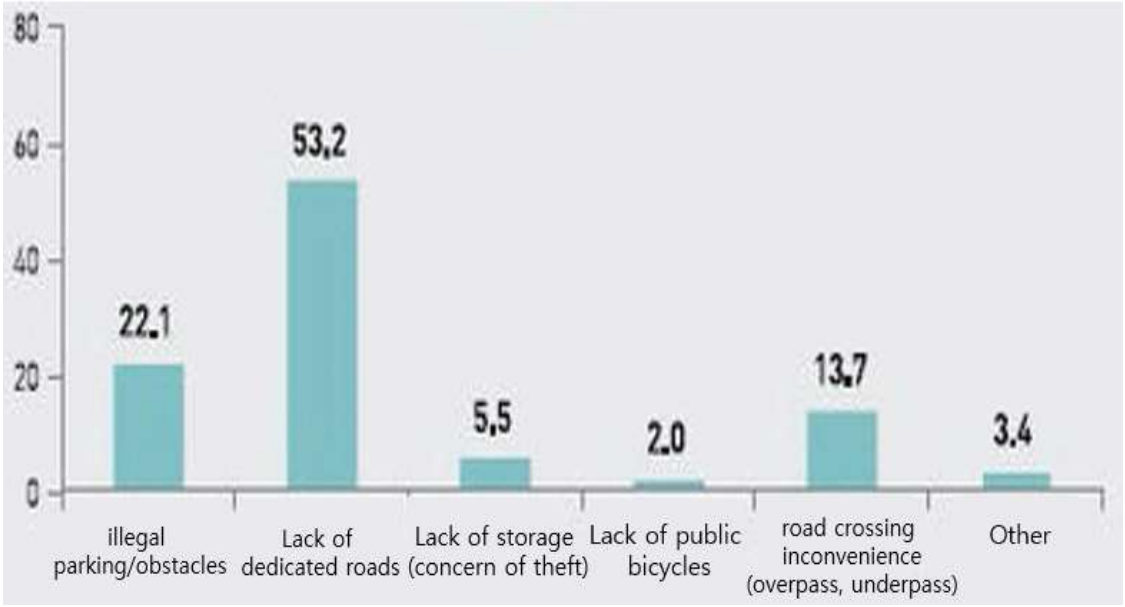

Fig.6. Reasons for Bicycle Dissatisfaction

Table 3 is the data collected on the number of bicycle traffic accidents in order to check whether there is any relation with the safety issues and the extension status of bicycle roads, which are deeply involved in space and facility problems.

Using the ggplot function, the correlation was investigated by superimposing the graph of the section and length of the bicycle road with the graph of the total number of bicycle accidents, the number of injuries, and the number of deaths.

In Fig. 7, the number of bicycle paths is steadily increasing from 421 sections and 666 km in 2012 to 562 sections and 916 km in 2018. On the other hand, the number of bicycle accidents is decreasing from a total of 3,225 cases in 2012 (3342 injured, 29 deaths) to a total of 2680 cases (2796 injured, 28 deaths) in 2018. In this regard, it can be seen that the increase in bicycle lanes also affects the safety of bicycles.

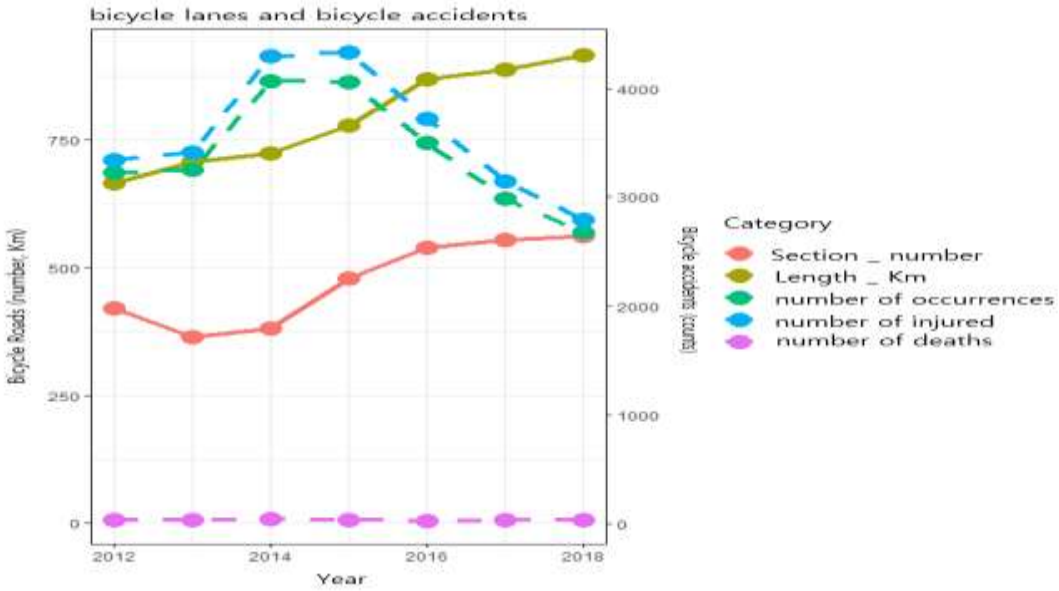

Fig.7. Visualization of Statistical Data on Bicycle Road and Accident

Using the ggplot function, the number of bike paths and bicycle utilization by autonomous region is shown, the average ratio of the two components by autonomous region is calculated and sorted accordingly to the difference to facilitate identification of the unsuitable autonomous region.

In Fig. 8, the upper y-axis represents the bicycle usage rate by autonomous district and is indicated by blue circles and lines on the graph. The y-axis at the bottom represents the length of bicycle paths for each autonomous district and is indicated by green circles and lines. In the graph, the upper autonomous districts have less bicycle use than the bicycle road, Songpa-gu, Gangnam-gu, and Gangdong-gu, and the lower autonomous districts have more bicycle use than the bicycle road, and there are Yangcheon-gu, Seongbuk-gu, and Dongdaemun-gu.

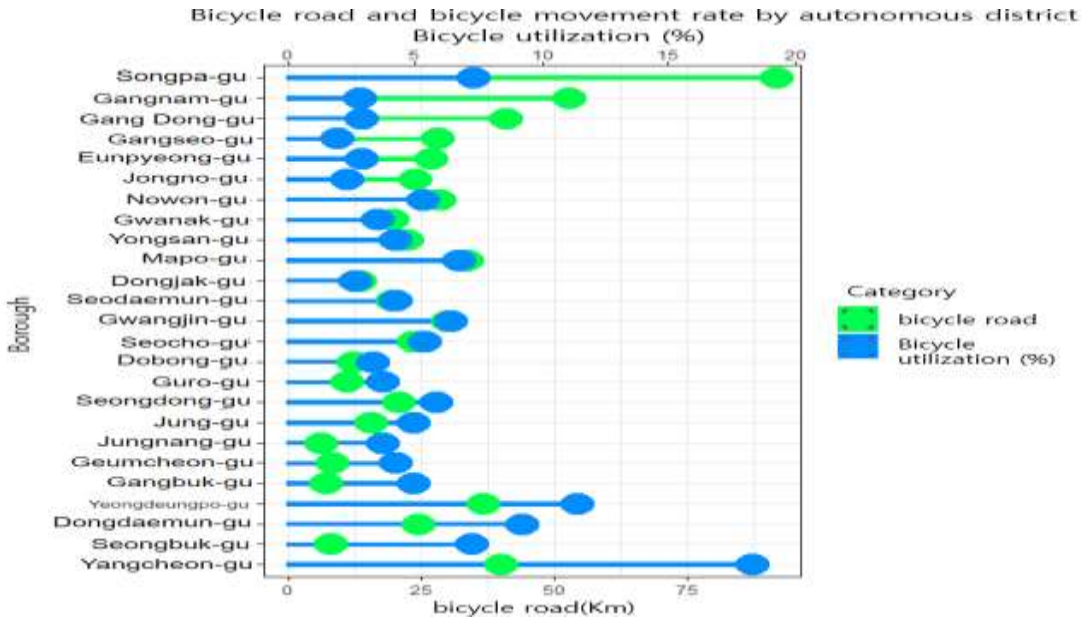

Fig.8. Visualization of Statistical Data on Bicycle Road and Bicycle Utilization Rate for Transportation by Administrative District in Seoul

In order to find out why there is an imbalance between bicycle paths and bicycle usage rates, the details of bicycle paths, exclusive roads, and public roads, were analyzed.

I visualized the ratio of the exclusive road with a bar graph using the ggplot function. Fig. 9 is a graph sorted based on the value obtained by dividing the length of the combined section of the bicycle road with the exclusive road on the sidewalk and the road

on the road by the total length of the bicycle road. If you look for Songpa-gu, Gangnam-gu, and Gangdong-gu, where the bicycle use rate was not good even though there are many bicycle roads mentioned in Fig. 8, you can see that the ratio of exclusive roads among the total roads is low. If you look for the good Yangcheon-gu, Seongbuk-gu, and Dongdaemun-gu, you can see that the ratio of exclusive roads among all roads is high.

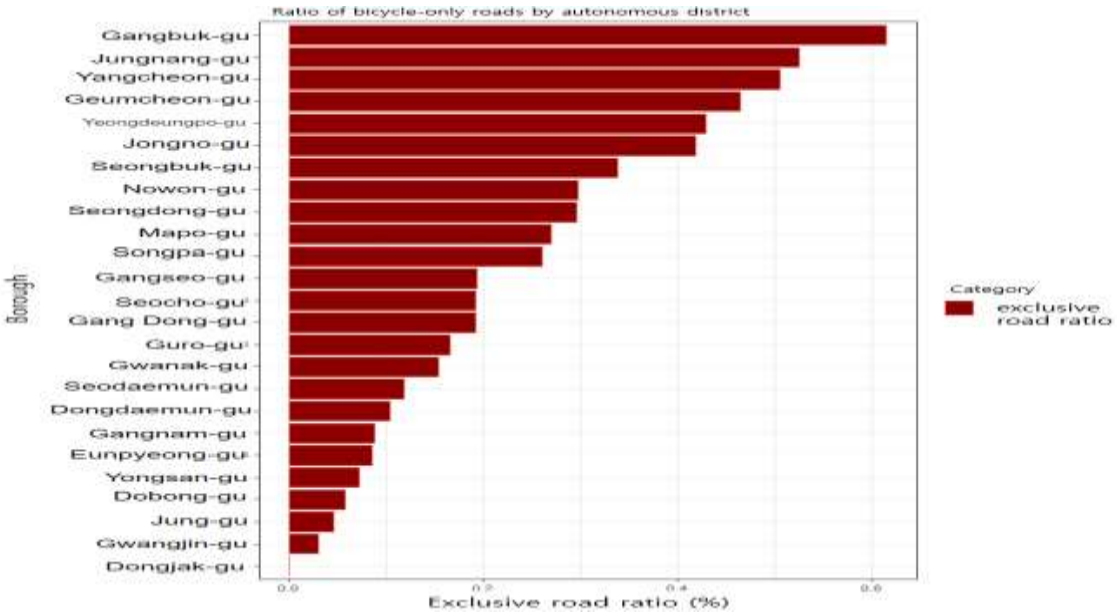

Fig.9. Visualization of Percentage of Bike-only Roads to All Bike Roads by Administrative District in Seoul

In addition to bicycle paths, we also analyzed the Seoul public bicycle Seoul Public Bikes, which can solve the cause of dissatisfaction with bicycles.

The ggplot function was used to indicate the number of Seoul Public Bikes by each autonomous district and the amount of Seoul Public Bikes consumption, and the average ratio of the two factors were obtained for each autonomous district and sorted according to the difference to make it easier to identify unsuitable autonomous districts.

In Fig. 10, the upper y-axis represents the amount of Seoul Public Bikes consumption by autonomous district and is indicated by blue circles and lines on the graph. The y-axis at the bottom indicates the number of Seoul Public Bikes installations by autonomous district and is indicated by yellow circles and lines. In the graph, the upper autonomous districts have less Seoul Public Bikes usage compared to the number of Seoul Public Bikes, Gangnam-gu, Seocho-gu, and Geumcheon-gu.

It can be seen that this is also related to the ratio of bike lanes shown in Fig. 9. In Gangnam-gu, Seocho-gu, and Geumcheon-gu, where the use of Seoul Public Bikes was not good despite the large number of Seoul Public Bikes mentioned in Fig. 10, it can be seen that the ratio of exclusive roads among all roads is low. If you look for the good Mapo-gu, Yeongdeungpo-gu, and Gwangjin-gu, you can see that the ratio of exclusive roads among all roads is high.

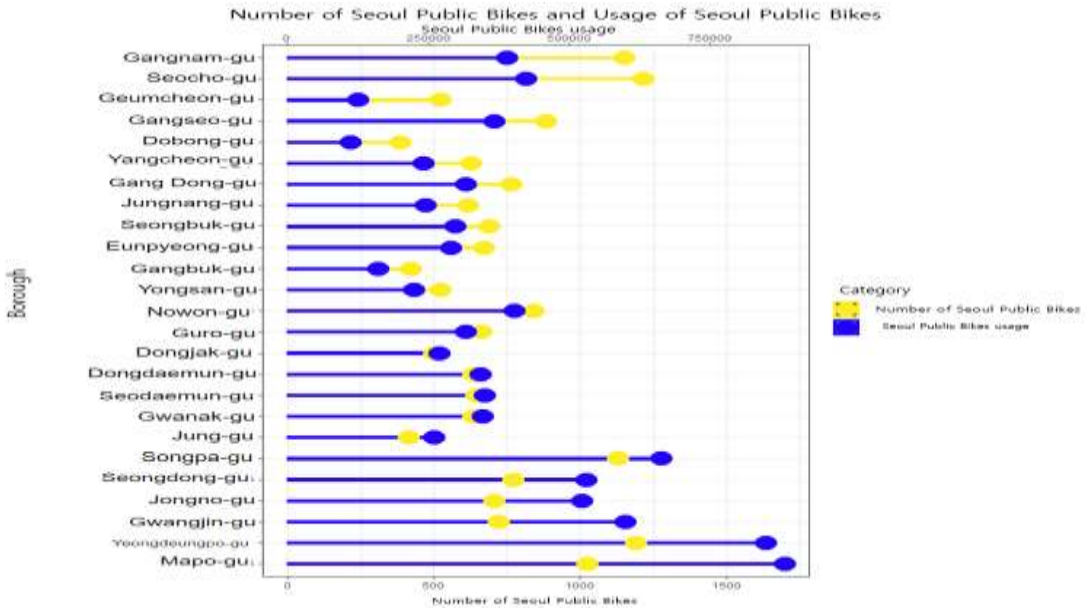

Fig.9. Visualization of the Number of Seoul Public Bike and the Usage of the Seoul Public Bike by Administrative District in Seoul

ANALYSIS RESULTS

I. Direction for turning a bicycle into a means of transportation

Fig. 3 in this study shows that the use rate of bicycles is about 25%, but the use rate of bicycles is about 5%, which is only about 20%, so it is urgent for cyclists to use bicycles as a means of transport rather than improving them. In order to change the bicycle into a means of transportation, satisfaction with the bicycle use environment was examined as shown in Fig. 6, and it can be seen that the number of very satisfied people is increasing, but the overall satisfaction is decreasing. From these results, it can be inferred that the satisfaction of those who used bicycles in the past increased as the facilities was improved, but the overall satisfaction decreased because those who did not use the bicycle did not give any special opinions. When looking at the causes of dissatisfaction in Fig. 6, it is important to improve the perception of bicycles as a means of transportation by securing roads for bicycles, safety regulations for bicycles, and increasing bicycle convenience facilities.

II. The new direction of bicycle convenience facilities

First, looking at Fig. 8, 9, and 10 of this study, it was confirmed that there were unsuitable boroughs when sorted according to the difference between the bicycle usage and the convenience facility installation ratio for each borough. Fig. 8, which visualizes bicycle roads and bicycle utilization, suggests that bicycle roads need to be built in Yangcheon-gu, Seongbuk-gu, and Dongdaemun-gu, which are not enough compared to the utilization rate. /In addition, when comparing the number of bikes, bicycle utilization, and the usage of bikes through Fig. 10, Yangcheon-gu, Yeongdeungpo-gu, and Mapo-gu require the construction of a new bike because the number of bikes is relatively low compared to the utilization rate. Furthermore, as shown in Fig. 8 and 10, the number of amenities and improvement in the bicycle use environment are not proportional. Fig. 9 shows that psychological anxiety from pedestrians or cars is inevitable when using public bike paths. Therefore, in order to increase the use of bicycles, it is desirable to expand facilities such as bicycle-only roads where cyclists can be safe and psychologically sound.

CONCLUSION

In this paper, measures such as air pollution, noise pollution, environment-friendly electric vehicles or vehicle sipping systems in response to safety accidents, and installation of soundproof walls between roads, etc. are showing poor effects, and the direction of reducing car registration itself will be more effective. To reduce car registration, we investigated bicycle-related data provided by the Seoul Open Data Square portal and decided that it is desirable to use bicycles as alternative means of transportation for cars. To this end, first, we studied whether the installation rate of bicycle paths and Seoul Public Bikes was appropriate user data on the bicycle road installation status and bicycle usage rate by the autonomous district. Through this process, we could see which autonomous districts particularly needed amenities. In addition, we learned that it is not only important for bicycle convenience facilities to be large or small, but to improve the environment in consideration of the user's psychological factors, such as whether there is a dedicated road or not. If more data are available, it is possible to derive various measures to improve the bicycle use environment based on the data, which is expected to lead to a decrease in vehicle registration rate, which is expected to benefit greatly in environmental and safety issues.

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