GISUP 2025, International

The 27th International Conference on

Geospatial Information Science and Urban Planning

November 14, 2025

Venue:

NUTIC (Nagasaki University Technology Innovation Campus)

7-1 Saiwai-machi, Stadium City North, 4F, Nagasaki City

Organized by:

Organizing Committee of GISUP 2025, International

School of Information and Data Sciences, Nagasaki University

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Welcome to GISUP 2025

Welcome to GISUP2025 in Nagasaki, Japan

Dear colleagues and friends from Korea and Japan, It is my great pleasure and honor to welcome you to the 2025 GISUP International Conference. I am delighted to meet you in Nagasaki, Japan, in the autumn season of harvest, having safely endured a summer that was hotter than any other year.

The 2025 GISUP International Conference is a international academic exchange platform exploring a sustainable urban future through the convergence of Geospatial Information Science (GIS) and Urban Planning. More importantly, this year's conference, focusing on GeoAI(Geo-Artificial Intelligence), big data, and GIS, aims to share new insights into solving urban problems and utilizing spatial data in the era of the Fourth Industrial Revolution. These transformative technologies are not only reshaping how we understand and manage urban environments but are also opening new frontiers for interdisciplinary collaboration and innovation.

This conference co-hosted by the department of Geospatial Big Data, Inha technical college, Republic of Korea and the school of information and data sciences, Nagasaki university, Japan. This conference is a truly meaningful opportunity to strengthen academic and technological cooperation between Korea and Japan and to expand global knowledge networks. Beyond academic exchange, we hope this conference serves as a platform for meaningful dialogue, innovative ideas, and enduring partnerships across borders and disciplines.

Thank you once again for your participation. I wish this conference will be a fruitful and inspiring experience fo all.

Sincerely,

Conference Chair, Dr. Prof. Dae young Kim

Professor, Department of Geospatial Big Data
Inha Technical College, Korea

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GISUP 2025, International Detailed Program

The 27th International Conference on
Geospatial Information Science and Urban Planning
(GISUP 2025, International)

Time and Dates:
November 14, 2025 (Offline Meeting)

Venue:
School of Information and Data Sciences
NUTIC (Nagasaki University Technology Innovation Campus)
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School of Information and Data Sciences, Nagasaki University

Conference Program Contents:
This conference consists of all information for Geospatial Information Science and Urban Planning (GISUP2025, International) papers. It's for scientific session on various GIS and urban planning methods and systems.

Schedule:

- Registration (9:00-9:25)
- Opening Address (9:30-9:40) *by Conference Chair, Prof. Dr. Dea Young KIM*
- Scientific Session-1 (9:40-10:40)
  (with 5 presenters, each present will be 10 minutes)
- Coffee Break (10:40-10:50)
- Scientific Session-2 (10:50-11:40)
  (with 4 presenters, each present will be 10 minutes)
- Final Comments and Discussion (11:50-12:00)
- Closing Address (11:50-12:00) *by Conference Vice Chair, Prof. Dr. Rieko Nakao*

Catalog

Scientific Session-1

Scientific Session-2

Scientific Session - 1

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GISUP 2025 (International), No. 27, pp. 1-3, November 14, 2025

A GeoAI Framework for Fire Risk Assessment and Spatial Simulation in Electric Vehicle Charging Infrastructure

YuJin Lee* • ByeongJun Ko** • YongJin Joo***

ABSTRACT: Many electric vehicle fires in recent years have occurred during charging or parking. However, institutional and technological management systems for ensuring fire safety at charging stations remain inadequate. This study provides a simulation tool capable of spatial analysis by calculating an AI-based fire safety rating for electric vehicle charging stations. To reflect the structural and spatial characteristics of electric vehicle charging stations, variables such as facility location, charging method, battery type, and maintenance status were designed. External factors such as fire accessibility, building use, and population density were also incorporated. The collected data was applied to a LightGBM prediction model to calculate the probability of fire occurrence at each charging station, and SHAP analysis was used to identify key influencing factors. The prediction results were visualized using the ol-Cesium map library, which enables 3D spatial simulation, to express building-level fire risk. Property damage estimates and service area analysis were used to identify priority management areas and response routes. This study quantifies the fire risk of electric vehicle charging stations through safety ratings and, based on visualization, is expected to contribute to establishing an AI-based smart fire response framework.
Keywords: electric vehicle charging stations; fire safety ratings; LightGBM; artificial intelligence

1. Introduction

A significant number of electric vehicle fires in recent years have occurred during charging or parking. Institutional and technical management systems for ensuring fire safety at charging stations remain inadequate. Many countries, including the US, UK, and China, operate systems to assess the fire safety of electric vehicle charging stations. This rating system quantifies risk by reflecting various factors such as battery capacity, charger type, charging station location, and surrounding building density, and uses this as a policy management indicator. Through this, a management system is being established that can identify potential fire risks at each charging station in advance and establish prevention and response strategies according to the level.

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In contrast, South Korea only has guidelines at the level of an electric vehicle fire safety manual, and there is no formal rating system or evaluation index to quantitatively assess the safety of charging stations. This indicates that charging station management remains largely reactive, highlighting the urgent need for the introduction of a systematic evaluation system. Therefore, this study aims to calculate fire safety indicators for electric vehicle charging stations through artificial intelligence-based urban spatial information analysis, and to convert these indicators into a predictable management system by grading them.

To achieve this, multidimensional spatial data, including the location of electric vehicle charging stations, charger specifications, battery characteristics, surrounding building density, and accessibility to fire infrastructure, were integrated. The LightGBM prediction algorithm was then applied to calculate the fire risk rating for each charging station. The results were then visualized in a 3D simulation environment, and a GIS-based tool was developed to intuitively compare and analyze fire risk ratings. The electric vehicle charging station safety rating provides a basis for quantitatively comparing and assessing fire risk and allows for a visual understanding of the risk level at each charging station location. Furthermore, the risk-based rating results will enable efficient management priority setting and prevention-focused safety management.

2. Methodology

This study constructed a composite dataset combining charging station characteristics and fire occurrence-related variables to predict fire risks at electric vehicle charging stations. This dataset was then applied to the LightGBM (Gradient Boosting Machine) algorithm to predict fire safety ratings for each charging station. To predict fire occurrence at electric vehicle charging stations, data on electric vehicle charging station characteristics were incorporated as independent variables. The simulation procedure of EV charging station factors are as shown in Figure 1 below.

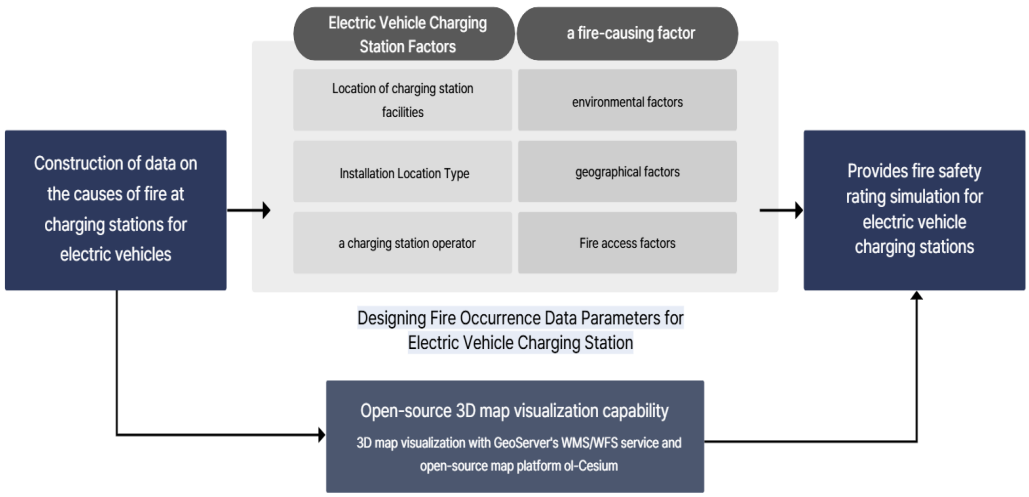

Figure 1. Simulation procedure of EV charging station factors

To reflect the facility structure and operational characteristics of electric vehicle charging stations, key variables included facility location, installation type (indoor/outdoor), operator, battery type, charging method and specifications, and operation/inspection status. These variables were converted to categorical and numerical formats and used as model inputs, with weights applied to reflect risk

differences across each characteristic. External environmental factors at charging stations also directly impact fire spread and response efficiency. Therefore, additional variables were designed to include firefighting accessibility, demographic characteristics, geographic factors, and environmental factors. Numerical variables, such as distance, usage, and accessibility, were included, while categorical variables, such as building use and materials, were included External environmental factors were combined with EV charging station characteristics to create a composite prediction model that integrated both internal and external factors.

The integrated dataset was then input into the LightGBM prediction model to calculate the fire occurrence probability for each charging station**.** During the model training phase, training and validation data were split at an 8:2 ratio, and F1-score was used as a performance evaluation metric. Furthermore, Shapley Additive Explanations (SHAP) analysis was used to determine and visually interpret the key impact of EV charging station equipment structure, location, and surrounding environment on fire risk.

3. Results and Discussion

The predicted fire risk and safety rating prediction results are integrated with an open-source map platform via GeoServer's WMS/WFS service. The ol-Cesium map library displays building-level risk by color and height. Then, to provide pre- and post-fire response strategies, property damage was calculated during the pre-fire phase. The fire damage estimation standards provided by the National Fire Agency were referenced, and the expected damage classification criteria were used to divide the loss rate into four levels and calculate it for each building. Grid-based spatial analysis was used to identify risk areas requiring priority management. Service area analysis provides a service that optimizes firefighting resource deployment and response routes by considering the structural and operational characteristics of electric vehicle charging stations in the event of a fire.

4. Conclusion

This study comprehensively reflects the structural and spatial characteristics of charging stations and surrounding environmental factors, presenting fire safety assessment indicators comprised of battery type, charging method, fire access, and building use. This indicator was then trained using an AI predictive model to quantify the risk level for each charging station and generate a fire safety rating. This provides a standard for objectively comparing and assessing the fire risk of electric vehicle charging stations, enabling a visual understanding of the risk level at each charging station location. The safety ratings for electric vehicle charging stations can be calculated, and AI-based analysis based on risk visualization can be used to implement a smart firefighting system. By applying a customized fire dispatch system, this indicator can be utilized as a simulation tool for pre-event and post-event analysis.

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Estimation of Exposure Doses at Futaba Kosei Hospital after the Accident at the Fukushima Daiichi Nuclear Power Station

Maho Takeshita[*] •Hitomi Matsunaga[**] • Noboru Takamura[***] • Masao Ueki[*****] • Byungdug Jun[*****]

ABSTRACT: The accident at the Fukushima Daiichi Nuclear Power Station in 2011 led to large-scale evacuations, during which many disaster-related deaths occurred, particularly among hospitalized and medically vulnerable individuals. Although evacuation is generally considered a primary protective measure, the risks associated with urgent relocation have not yet been fully examined. This study evaluates the potential reduction in disaster-related deaths through sheltering indoors during the acute phase of the accident. Our focus was on Futaba Kosei Hospital, which recorded the highest number of disaster-related deaths. As there was no monitoring station located near the hospital, we used nonlinear robust regression to reconstruct missing measurements at Yamada, incorporating the physical half-lives of major radionuclides. We then estimated dose rates at Shinzan by combining the reconstructed Yamada data with later Shinzan observations and adjusting them using an optimal scaling factor validated with mean absolute error. Based on the estimated dose curves, we simulated cumulative external exposure in various scenarios considering building shielding, time spent indoors and transportation. All scenarios showed a substantial reduction in the cumulative dose when individuals remained inside reinforced concrete structures. These results imply that sheltering indoors may be a safer alternative to immediate evacuation for high-risk populations.
Keywords: Fukushima Daiichi accident; Nuclear accident; Disaster-related deaths; Evacuation; Indoor sheltering; Radiation dose estimation; Monitoring data; External exposure simulation

1.Introduction

Following the accident at the Fukushima Daiichi Nuclear Power Station (FDNPS) in March 2011, large-scale evacuation orders were issued to surrounding municipalities, forcing many residents to relocate within a short period of time. It is important to note that a significant number of disaster-related fatalities occurred during this process, particularly among hospitalized patients, older adults,

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and medically fragile individuals. These deaths were largely attributable not to the disaster itself, but to indirect factors such as interruption of medical care, physical strain during transportation and inadequate support systems. A previous study by Takeshita et al. (2025) estimated the external radiation exposure experienced by medical workers and hospitalized patients using dose rate data from the Yamada monitoring post.[1] However, three major hospitals were located 2–3 km away from the monitoring post. Consequently, it was challenging to assess the radiation conditions directly in the vicinity of each hospital.

In this study, we focus on Futaba Kosei Hospital, where several disaster-related deaths were reported. Its proximity to the Shinzan monitoring post, makes dose estimation around the hospital geographically feasible. We have reconstructed missing dose rate data at Yamada and estimated early-phase dose rates for Shinzan. We then compared cumulative external doses under multiple evacuation and indoor sheltering scenarios. Our aim is to evaluate whether indoor sheltering could serve as an effective protective measure for vulnerable populations during the acute phase of a nuclear accident.

2. Experimental Section

2.1 Materials and Methods

This study used three types of publicly available data to estimate ambient dose equivalent rates around Futaba Kosei Hospital.[2] The primary dataset comprised H*(10) measurements from monitoring posts in Fukushima Prefecture, which provided continuous observations during the first year after the accident. To verify the consistency of these measurements, we also referred to the Airborne Monitoring Survey conducted by the Ministry of Education, Culture, Sports, Science and Technology (MEXT), as well as to the air dose data collected by TEPCO within the 20 km zone surrounding the FDNPS. Previous studies have used the Yamada monitoring post, located roughly midway between three major hospitals, as the representative early-phase dose rate during the first month, when the risk of disaster-related deaths is highest (see Figure 1(a)).

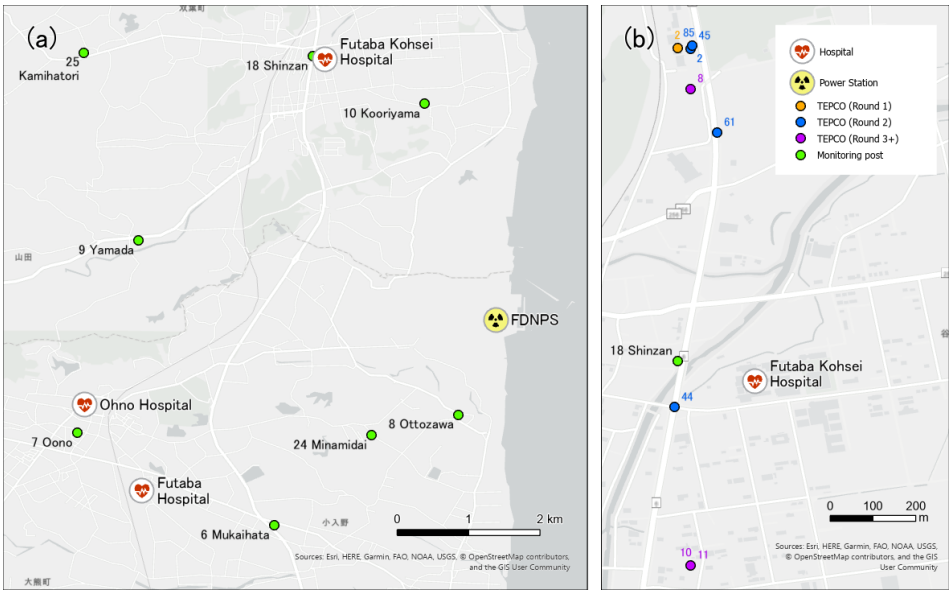

Figure 1. (a) Location of Fukushima Prefecture monitoring posts and major hospitals
(b) Monitoring points around Futaba Kosei Hospital

In the present study, we extend this approach by incorporating Shinzan data, for which measurements began in early September. We estimated Shinzan's dose rates for the first month after

the accident (March–April) and used the estimated curve to conduct exposure simulations for Futaba Kosei Hospital. The consistency of the estimated dose rates was further checked using TEPCO measurements collected around the hospital.

2.2 Reconstruction of Missing Data at Yamada Monitoring Post

There is a long period of missing data at the Yamada post from mid-April to early September 2011 (see Figure 2). To address this issue, we used Robust Fitting of Nonlinear Regression Models (NLROB), incorporating the physical half-lives of the primary radionuclides (I-131, Cs-134 and Cs-137), to reconstruct the dose rate curve for the missing period.

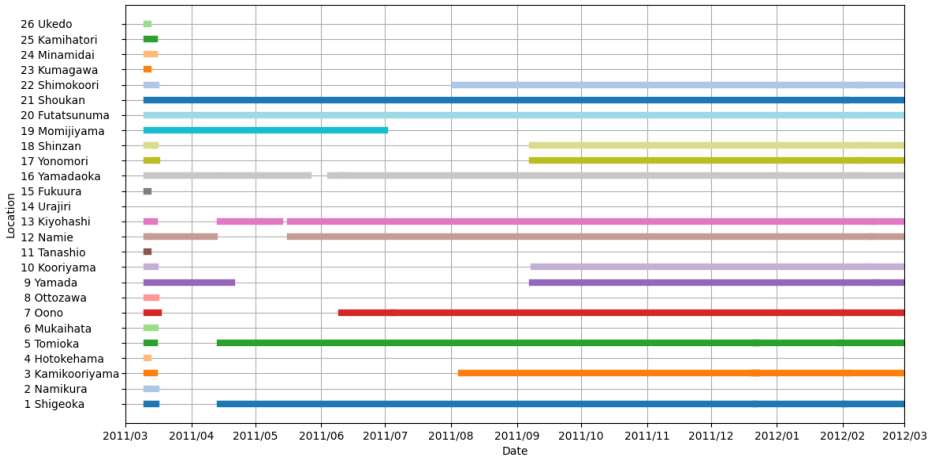

Figure 2. Measurement periods of Fukushima Prefecture monitoring posts in FY2011

2.3 Estimation of Dose Rates in the Shinzan Area

Airborne monitoring survey results revealed elevated dose rates in the north-west direction from FDNPS, indicating the influence of the radioactive plume. The Yamada monitoring post is located near this high-dose region and recorded the highest value among Fukushima Prefecture's monitoring posts. As Yamada and Shinzan are situated roughly perpendicular to the main plume direction, we assumed that their dose rates are proportional. Based on this assumption, Shinzan's early-phase dose rates (March–April) were estimated using Equation (1).

$$\text{Yamada}(t) \approx n \times \text{Shinzan}(t) \tag{1}$$

The optimal scaling coefficient (n) was determined as 0.1899 by minimizing the mean absolute error (MAE) between the reconstructed Yamada data and the Shinzan post-September measurements. The plausibility of n was then validated using TEPCO measurement data in the vicinity of Futaba Kosei Hospital.

2.4 Simulation of External Radiation Exposure

To evaluate the influence of evacuation behavior and building characteristics on cumulative external exposure, we constructed multiple simulation models differing in structural type, time spent indoors, evacuation timing and duration of outdoor movement. Each scenario incorporated ambient dose rates

estimated for the Shinzan area, applying shielding coefficients based on specific building types and sizes. Building sizes were derived using ArcGIS by analyzing the floor areas of Futaba Kosei Hospital and typical wooden residential houses, with the resulting values assigned to the simulation models. For this study, we applied shielding coefficients of 0.12 for Futaba Kosei Hospital, 0.28 for standard reinforced concrete (RC) buildings and 0.63 for wooden houses.[3] As this analysis deals with emergency conditions, we assumed that 1 Gy is equivalent to 1 Sv when calculating external radiation doses.[4]

Table 1. Conditions for each simulation model.

Model	Subjects	Times in hospital	Commuting and outdoor durations	Times in houses	
0	-	-	24 hours	-	-
1_a	Medical personnel	9 hours	2 hours	13 hours	Wooden
1_b					RC
1_c			-	15 hours	Wooden
1_d					RC
2_a		11 hours	2 hours	11 hours	Wooden
2_b					RC
2_c			-	13 hours	Wooden
2_d					RC
3	Hospitalized patients	24 hours	-	-	-

3. Results and Discussion

3.1 Monitoring Data and Reconstruction

As illustrated in Figure 3, the reconstructed Yamada data exhibited a decay pattern that was consistent with the physical half-lives of the primary radionuclides. The estimated Shinzan dose rates (see Figure 4) were consistent with TEPCO's measurements, thereby confirming the validity of the estimation method. Figure 1(b) shows the spatial relationship between Shinzan, Futaba Kosei Hospital, and the surrounding monitoring locations.

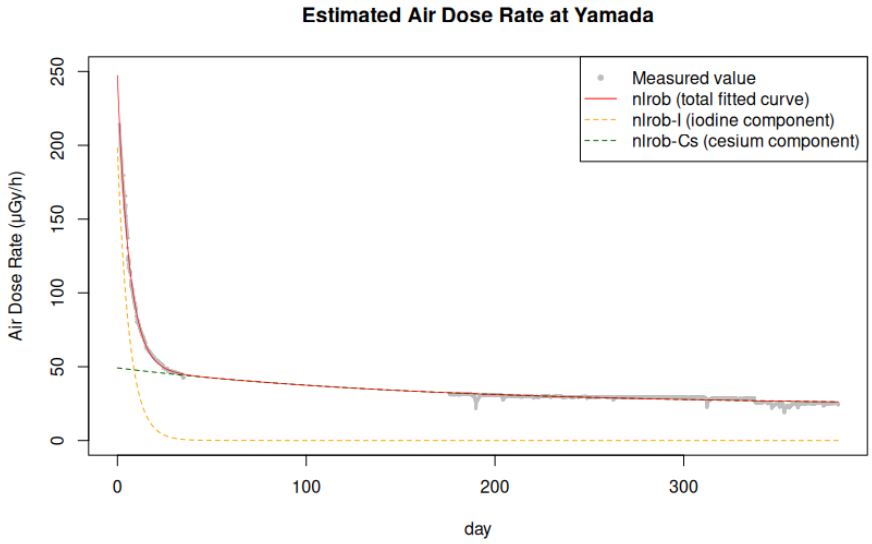

Figure 3. Estimated H*(10) at the Yamada monitoring post for one year after the hydrogen explosion on 15 March 2011.

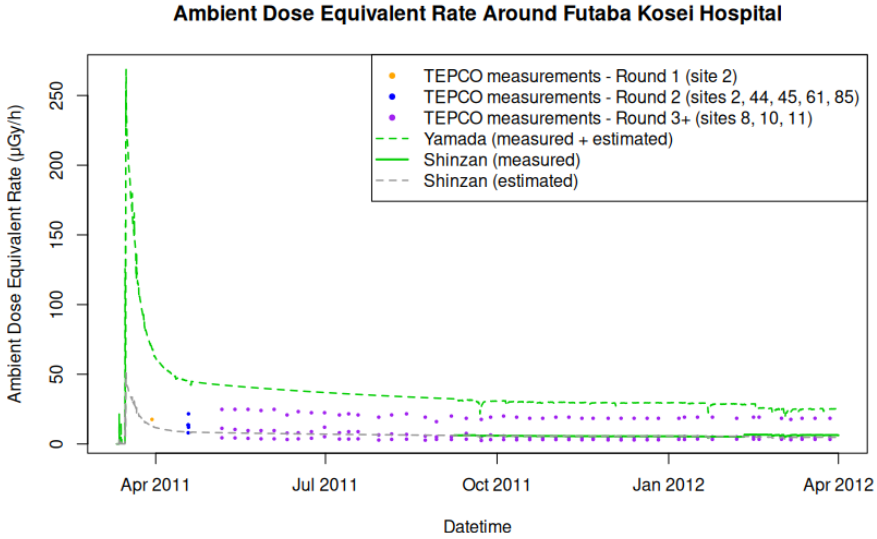

Figure 4. Estimated H*(10) at the Shinzan monitoring post, with TEPCO measurements from three survey rounds (1–3+) are shown as dots.

3.2 Simulation Outcomes

Figure 5 shows the cumulative external doses for all simulation models. Across all scenarios, sheltering indoors in RC buildings resulted in the lowest radiation exposure. Although wooden houses also provided a measurable degree of dose reduction, the shielding effect of these structures was notably lower than that of RC. In contrast, evacuation scenarios involving prolonged outdoor movement produced higher cumulative doses, indicating that time spent outdoors during plume passage significantly increases exposure.

These findings demonstrate that the choice of protective action, whether immediate evacuation or indoor sheltering, strongly influences cumulative external dose. They suggest that staying indoors

in an RC building may be a more protective option for medically vulnerable individuals than urgent evacuation during the early phase of a nuclear accident.

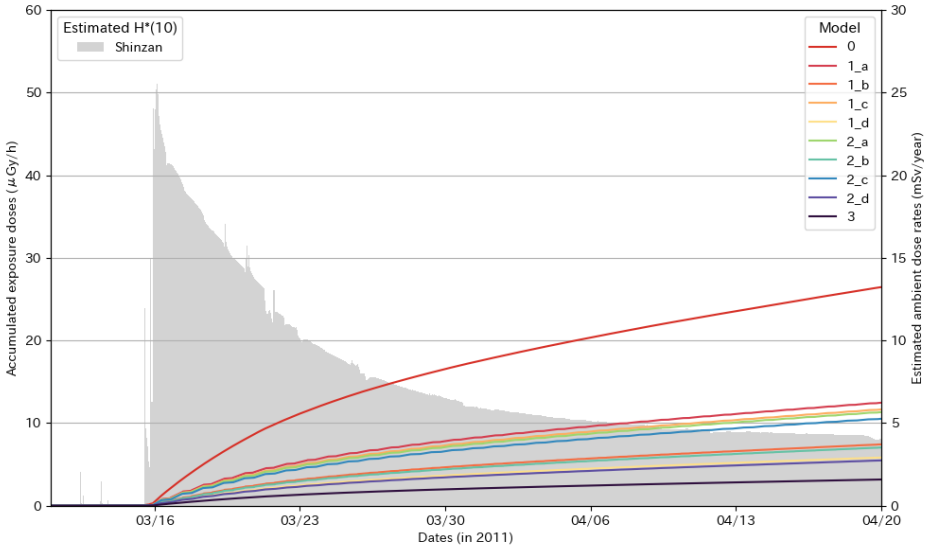

Figure 5. Cumulative external dose simulated for each model.

3.3 Discussion

Our results suggest that immediate evacuation may not always be the safest protective action for medically fragile individuals. In the early plume phase, indoor sheltering can limit dose intake more effectively than urgent evacuation, which may involve prolonged exposure outdoors and interruption of essential medical care.

4. Conclusion

These findings support a more flexible decision-making framework for nuclear emergencies, emphasizing localized dose estimation and patient-specific risk assessments. This study reconstructed missing monitoring data, estimated air dose rates around Futaba Kosei Hospital, and simulated external exposure under multiple scenarios. Indoor sheltering, particularly in reinforced-concrete buildings, significantly reduced cumulative external doses in all models.

These results highlight the importance of considering sheltering as a viable protective option during the early phase of nuclear emergencies, especially for high-risk populations. Future work will involve extending dose estimation methods to additional hospitals and evaluating protective actions for essential workers.

Acknowledgement

I would like to thank my supervisor and laboratory colleagues for their valuable guidance throughout this study. I also acknowledge Fukushima Prefecture, the Ministry of Education, Culture, Sports, Science and Technology (MEXT), and the Tokyo Electric Power Company (TEPCO) for providing access to radiation monitoring datasets. This work was supported by JST SPRING, Japan Grant Number JPMJSP2172.

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A Study on GeoLLM-Driven Real Estate Sale Recommendation using Post-Occupancy Evaluation and Location Preference Analysis

ByeongHyeok Im * • HoJun Lee** • YuJin Lee** • YongJin Joo***

ABSTRACT：Post Occupancy Evaluation (POE) is an evaluation system that allows public housing agencies, construction companies, and design firms to verify and diagnose environmental performance through resident feedback during the user phase. The Korea Land and Housing Corporation (LH) incorporates location factors such as accessibility to improve the residential environment and establish a basis for customized policies. Therefore, the purpose of this study is to propose a real estate listing recommendation service that reflects preferred location factors based on POE scores. First, listing data, residential environment data, and resident review data were collected and preprocessed. Second, review data was analyzed for preferred location factors through attribute-based sentiment analysis, attributes were categorized into topics, and a POE score for each topic was calculated. Third, property information relevant to user queries was visualized on a 3D map using the ChatGPT API and natural language processing techniques. The results of this study suggest a novel online real estate listing recommendation service that integrates AI and spatial information to reflect individual preferences, which is expected to enhance the convenience of property search and the delivery of information.

Keywords: POE, preferred location factors, real estate, real property for sale, chatbot

1. Introduction

Post Occupancy Evaluation (POE) is an evaluation system that allows public housing agencies, construction companies, and design firms to verify and diagnose environmental performance through feedback from residents during the occupancy phase. The Korea Land and Housing Corporation (LH) incorporates location factors such as accessibility to improve residential environments and establish a basis for customized policies. Previous studies on other residential environment preferences have shown that location and price are the top priorities when selecting a residential location, followed by building factors in third place. Location preferences vary across age groups. Current real estate platforms rely on search criteria centered on building properties and do not reflect age-specific preferences. This limits their ability to reflect residential environment preferences such as amenities and public transportation, as well as individual preferences. The purpose of this study is to propose a real estate sale recommendation service that reflects location preferences based on POE scores.

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To achieve this, we first collect and preprocess sale data, residential environment data, and resident review data.Second, we analyzed review data using attribute-based sentiment analysis to identify preferred location factors. We then categorized these attributes into topics and calculated a POE score for each topic. Third, we visualized sale information relevant to user queries on a 3D map using the ChatGPT API and natural language processing techniques. Through this, we propose a personalized sale recommendation method that reflects individual location preferences, going beyond conventional search methods.

2. Methodology

To implement personalized property recommendations, this study first collected and preprocessed sale data, residential environment data, and review data (Figure 1). The sale data included information such as sale price, area, and floor number, while the residential environment data included infrastructure information such as public transportation, educational facilities, and medical facilities. The review data included resident reviews and ratings, reflecting user preferences. During the preprocessing process, the sale and residential environment data were geocoded using the same coordinate system to derive the actual distance between the sale and preferred facilities. The review data was categorized by age group, and simple stopword processing and tokenization were performed.

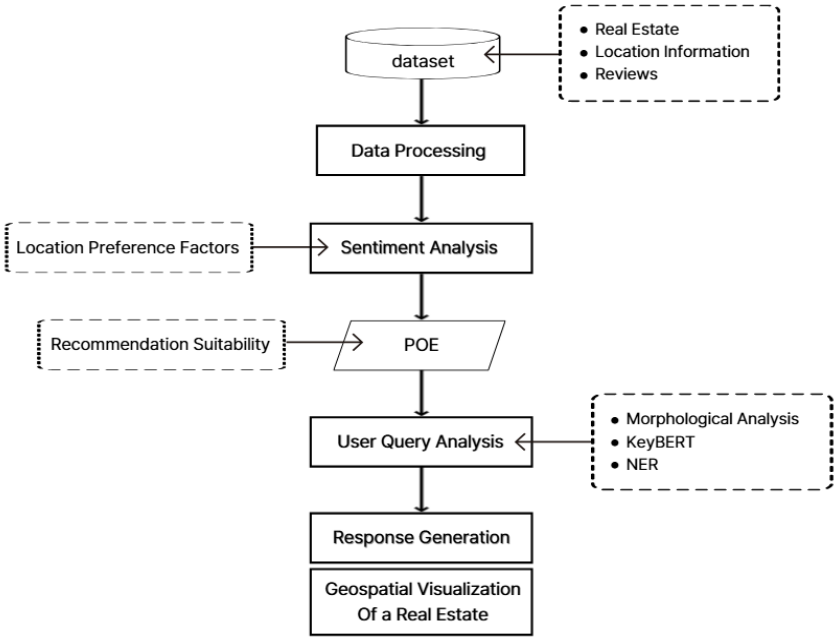

Figure 1. Study procedure

Second, the preprocessed review data was subjected to attribute-based sentiment analysis using attribute-based sentiment analysis (ABSA) with LLM as the extractor. Among the extracted positive attributes, LLM was used to group similarly semantically derived topics (POE). The preference score was calculated based on the positive and negative scores of the topic. Using the Weighted Suitability Index (WSI), the POE score for each sale was calculated by considering the facility preference score, the actual distance between the sale and the facility, and the satisfaction level of

the facility. This allows for sale recommendations that reflect preferred location factors based on the POE score, a distinction that differentiates the search from existing sale searches.

Third, KoNLPy's OKT, KeyBERT, and NER techniques were used to perform morphological analysis on user queries, extracting core keywords and location names for use in sale search. As a result, the ChatGPT API generates responses tailored to user requirements and provides sale information via a 3D map. Through this process, users receive sale recommendations based on their personal location preferences and receive optimized information based on the POE that underpins the recommendations.

3. Results and Discussion

Location and accessibility factors were classified using Point of Interest (POE) items, which were constructed by topicalizing positive and negative attributes derived from ABSA. The preference score calculated from the positive/negative ratio was combined with the actual distance between the property and the facility, and the distance of facility satisfaction. Based on the Weighted Suitability Index (WSI), location accessibility preferences were differentiated by age group, resulting in a numerical POE score that served as the basis for property recommendations. User queries were extracted using KoNLPy OKT, KeyBERT, and NER to extract key keywords and area names for property search. The ChatGPT API provided corresponding responses and property information. Property information was visualized on a 3D map, allowing users to intuitively understand the relationship with surrounding facilities. Through this process, a POE score was obtained for each property by age group, which was then provided along with the property information to provide users with a better understanding of the suitability of the property recommendation.

4. Conclusion

This study proposed a method for implementing a user-tailored real estate property recommendation service that reflects individual location preferences using ChatGPT, a large-scale language model. To achieve this, we conducted attribute-based sentiment analysis, identified preferred location factors, and built an unstructured database. The results of this study suggest a novel online real estate listing recommendation service that integrates AI and spatial information to reflect individual preferences, which is expected to enhance the convenience of property search and the delivery of information.

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Estimating Physical Damage Caused by the Hiroshima Atomic Bomb with DSM Analysis

Atsushi Koyanagi* ・Byungdug Jun**

ABSTRACT: A map summarizing the physical damage caused by the atomic bomb dropped on Hiroshima City on August 6, 1945, has been created. This paper uses a Digital Surface Model (DSM) to estimate the physical damage to buildings caused by the atomic bomb and compares it with the map. As a result, quantifying the damage caused by the atomic bomb enables a more detailed depiction of its spatial and structural impact, as well as the actual extent of the damage.
Keywords: Atomic Bomb, Hiroshima, DSM

1. Introduction

On August 6, 1945, the U.S. military detonated the first uranium bomb in human history over Hiroshima City. According to the U.S. Strategic Bombing Survey report, a total of 70,000 people died instantly in Hiroshima City, with 60,000 deaths by November and 70,000 deaths by 1950[1)]. The U.S. military photographed Hiroshima from aircraft both before and after the atomic bombing. Visualization of the atomic bomb damage in Hiroshima has been conducted, and maps depicting the damage to buildings and human casualties caused by the bombing were created[2), 3)].

These maps show the collapse status of buildings before and after the bombing. Using a DSM generated from aerial photographs allows for quantitative confirmation of building survival status before and after the bombing. This paper aims to quantitatively identify buildings destroyed by the atomic bomb by referencing maps depicting structural damage and the DSM.

2. Experimental Section

2.1 Using Data and tools

This paper references the map depicting the percentage of building damage by town block from the publication “Preparation of Photographic Maps as Visualized Examples of Damage Conditions in the Hiroshima Atomic Bombing,” authored by Mr. Takezaki and published in September 2019 by the Hiroshima Peace Memorial Museum Materials Research Group. This map illustrates the physical damage to buildings in Hiroshima caused by the atomic bomb. Below is a portion of the map referenced in Figure 1.

DSM creation utilized the Ortho mapping feature of ArcGIS Pro, software provided by Esri. The data analyzed consists of scanned aerial photographs taken over Hiroshima City, comprising two

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types. The first set consists of 28 aerial photographs taken on July 25, 1945, at an altitude of 24,600 feet. The second set comprises 33 aerial photographs taken on August 11, 1945, at an altitude of 28,000 feet. The Ortho mapping function requires a file containing the external calibration information for the photos, a file used for camera calibration, and a file containing the ground control points (GCPs) used for block adjustment to match the map coordinate values. The scanning data used in this study does not include the coordinate values of fiducial marks required for camera calibration or the latitude and longitude of the aerial photographs themselves. Therefore. We estimated the latitude and longitude for each aerial photograph using pixel value extraction in Photoshop and the georeferencing function in ArcGIS Pro.

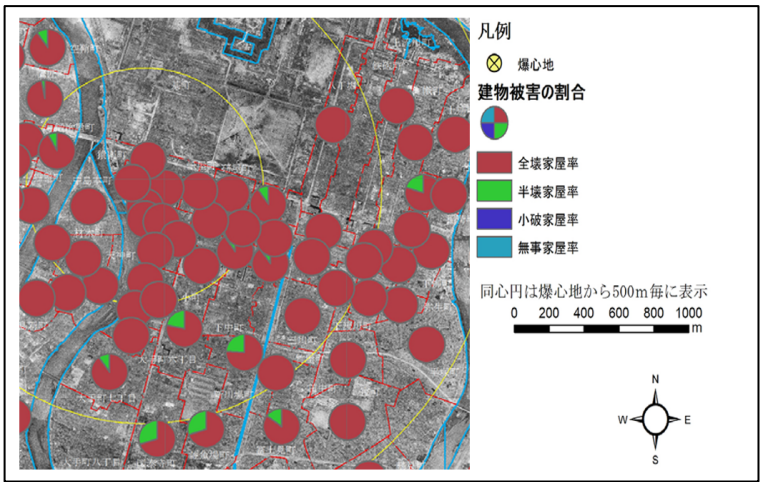

figure 1. Partial diagram showing the percentage of building damage by town block

2.2 Method

The aerial photographs used in this study contain numerous mountains and rivers, which contribute to a large range between the maximum and minimum values of DSM. Therefore, for DSM generation, we used the minimum number of images necessary to cover the target area while still enabling ortho mapping. The target area consists of the residential zone containing the hypocenter, where the rate of completely destroyed houses is 100%, as shown in Figure 1, and the residential zone corresponding to the present-day Fujimi Town, located at least 500 meters from the hypocenter and exhibiting a rate of partially destroyed houses. The area of the former region is approximately 30,000 m², while the area of the latter region is approximately 45,000 m². Figures 2 and 3 below show the target areas. The black frames in Figures 2 and 3 indicate the target areas, and the tip of the red diagram in Figure 2 indicates the hypocenter. The aerial photographs used for DSM extraction on July 25 are Nos. 26, 27, 28, 50, and 51, with 5 ground control points (GCPs) used and 2 verification points. In contrast, the aerial photographs for August 11th are Nos. 8, 9, 28, 29, and 30, with 8 GCPs used and 3 verification points. For DSM extraction, the common settings in ArcGIS Pro were: cell

size set to 0.2m, matching method set to semi-global matching, and smoothing disabled to clearly define the boundary between land and rivers.

figure 2. Target area including the hypocenter

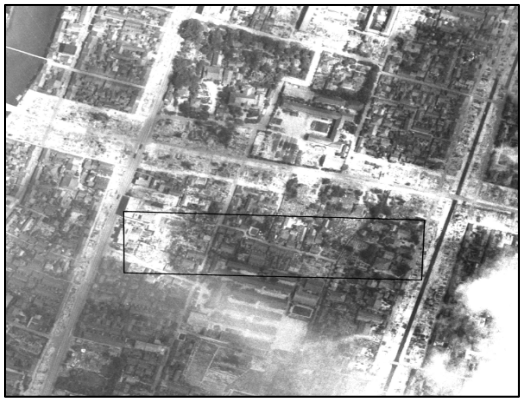

figure 3. Target area near Fujimi-mach

3. Results and Discussion

The results are shown in Table 2 and Figures 4, 5, 6, and 7 below.

Table 1. RMSE of the verification point

RMSE deviation / Shooting date	dX（m）	dY（m）	dZ（m）
July 25, 1945	27.000	43.314	11.629
August 11, 1945	5.607	8.134	2.700

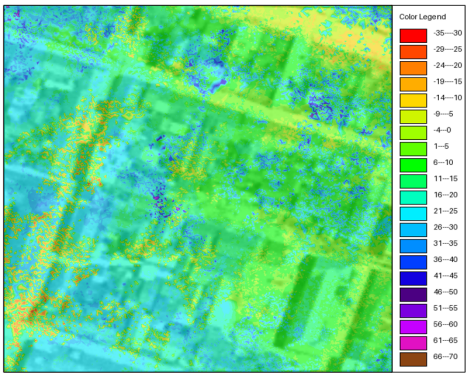

figure 4. DSM near the epicenter on Jul. 25

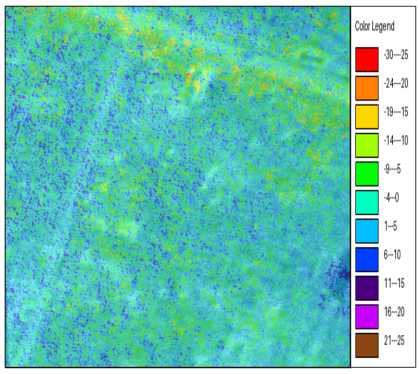

figure 5. DSM near the epicenter on Aug. 25

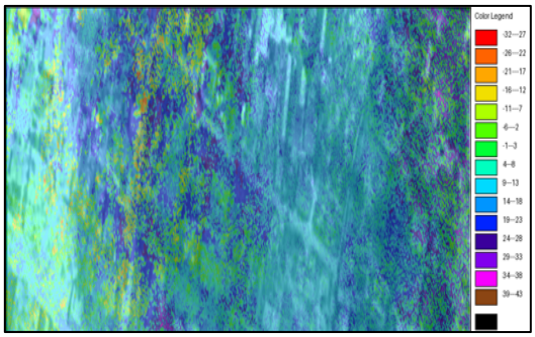

figure 6. DSM near Fujimi town on Jul. 25

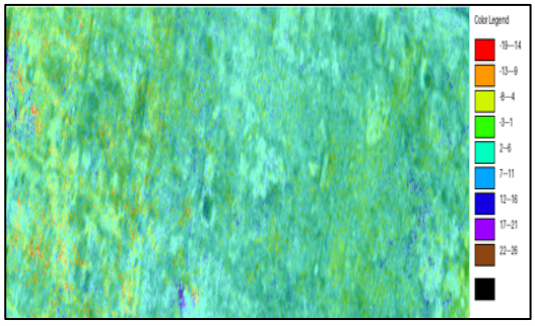

figure 7. DSM near Fujimicho on Aug. 25

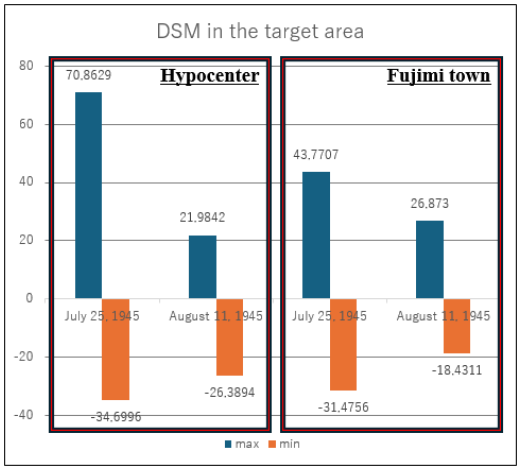

figure 8. DSM range in the target area

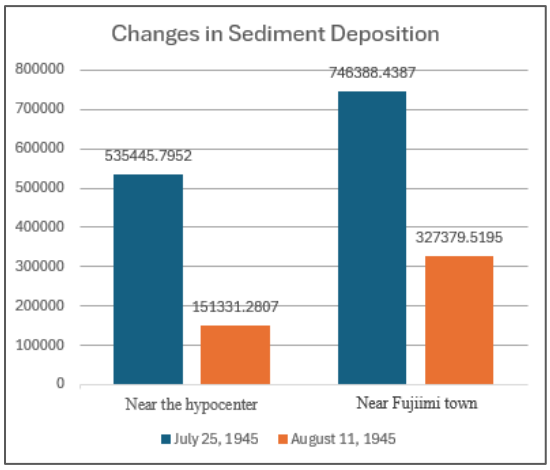

figure 9. Sediment Deposition Graph

Before and after the atomic bombings, the range between the maximum and minimum DSM values was larger before the bombings and smaller after. Regarding the vicinity of the hypocenter, Figure 4 shows roads and buildings can be roughly distinguished, and the DSM clearly indicates the absence of buildings after the bombing. Figure 5 shows that the color coding indicates greater variation in the DSM data before the bombing, while after the bombing, the variation in the DSM data is noticeably smaller. Regarding the area near Fujimi-cho, Figure 6 reveals that the difference in DSM values is greater in areas with varying brightness due to cloud cover. Figure 7 shows roads and buildings are roughly distinguishable, but it is difficult to determine the difference between completely destroyed and partially destroyed structures. Referring to Figure 1, the post-bombing building conditions show that houses in the target areas near ground zero and Fujimi-cho are completely destroyed. However, it is difficult to confirm the partially destroyed buildings in the target area near Fujimi-cho. Figure 8 indicates that the DSM error obtained in this study is large, negatively impacting the accuracy of the DSM for the target area.

Differential calculations of DSM before and after the atomic bombings were performed to estimate the total volume of buildings. Figure 9 shows the results. In the target area near the

hypocenter, the volumes were 535,445.7952 m³ on July 25, 1945, and 151,331.2807 m³ on August 11, 1945. In the target area near Fujimi-cho, the volumes were 746,388.4387 m³ and 327,379.5195 m³. The differential calculation results showed 384,114.5145 m³ and 419,008.9192 m³. Although there are concerns regarding accuracy due to significant DSM errors in the obtained sedimentation volume, the similarity in the difference results across the target area suggests the method is effective. Based on these results, comparing the building damage reference map with the DSM confirmed that while total building destruction could be verified using the DSM, verifying partial destruction proved difficult.

4. Conclusion

This study quantified the damage to buildings before and after the atomic bomb explosion dropped on Hiroshima during the war using DSM and compared it with the “Map of Building Damage Rates by Neighborhood” created by Mr. Takezaki. The accuracy of the DSM created in this study cannot be considered very high, as indicated by the large error in the verification points. However, it was possible to distinguish roads and buildings from the DSM. Furthermore, while this remains strictly within the scope of estimation, the distribution of sediment accumulation aligns with the target area and building collapse rates. Therefore, for future prospects, we aim to measure sediment accumulation using DSM with verification point accuracy below 5 meters, and to examine the relationship between distance from the hypocenter and estimated physical damage to buildings.

Acknowledgments

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A Study on Analysis of the Spatial Correlation Between Urban Physical Environments and Personal Mobility Device Accidents

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ABSTRACT: This study aims to develop a model for predicting the potential accident risk of personal mobility devices (PMs) through a "Geo-Mashup service," which combines machine learning and GIS technologies. Targeting Gangnam District in Seoul, we collected traffic accident data and complex urban spatial elements, including buildings, road networks, and population. We applied space syntax for the hierarchical characteristics (integration and selectivity) of the road network and analyzed the spatial patterns of accident-prone areas using DBSCAN clustering. Finally, we used the XGBoost algorithm to predict PM accident risk and SHAP analysis to identify key influencing factors. This model can provide empirically validated data for data-driven urban planning and policymaking for PM safety management.

Keywords: Machine learning, Space syntax, Personal mobility, DBSCAN Geo-Mashup service

1. Introduction

In recent years, the use of personal mobility (PM) for short-distance travel within cities has rapidly increased, and related traffic accidents have also emerged as a serious social problem. To address these urban challenges, efforts are actively being made to combine geographic information systems (GIS) and machine learning to predict risks within complex spatial phenomena. However, many previous studies have often focused on analyzing simple correlations between accident history data or specific static environmental factors (e.g., commercial density, road width). Notably, despite the fact that PM accidents occur through interactions between pedestrians and vehicles, these studies have failed to reflect urban structural characteristics that represent actual "flow" or "mobility." This study aims to overcome these limitations and achieve more sophisticated PM accident risk prediction. To this end, we introduce space syntax, a core methodology that analyzes how the physical form of a city influences human mobility patterns.

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Spatial syntax goes beyond simply assessing the physical properties of roads. It can quantify the accessibility (integrity) and mobility potential (selectivity) of each road from the perspective of the entire road network, making it a powerful proxy variable for traffic flow. This study, targeting Gangnam District in Seoul, used DBSCAN to identify spatial clustering characteristics of PM accidents. It then integrated spatial syntax variables with urban environmental variables to train an XGBoost machine learning model. Ultimately, the goal is to implement these analysis results as a map-based "Geo-Mashup" service, presenting a predictive model that can be applied to practical traffic safety policies.

2. Methodology

This study was conducted using the analysis procedure shown in Figure 1. It consisted of four stages: data collection, data processing, modeling, and map visualization.

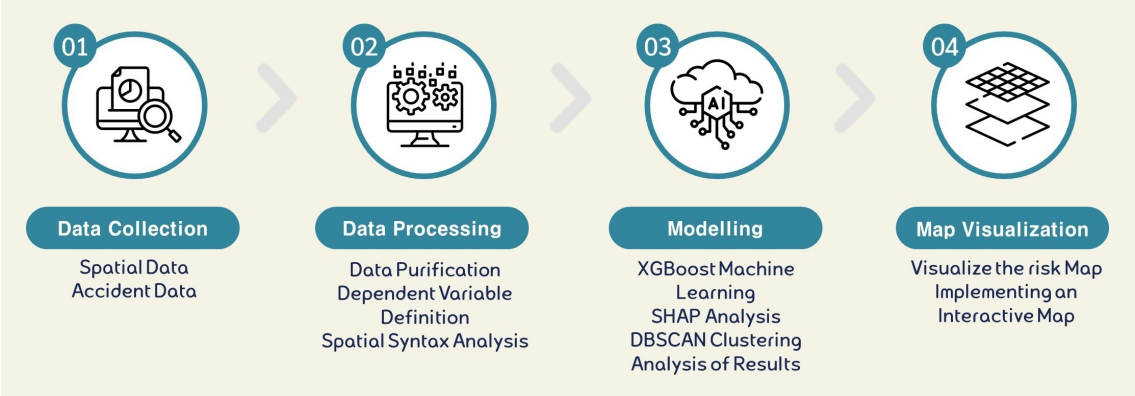

Figure 1. Research procedure

First, the study site was selected as Gangnam-gu, Seoul, a district with a high PM traffic volume and accident rate. PM accident data was collected from the Road Traffic Authority (TAAS). To accurately reflect the risk level of accidents, the dependent variable was defined as an "integrated accident index," which reflects accident severity (fatal, serious, and minor injuries) rather than the simple number of accidents. The independent variables were constructed multidimensionally to represent complex urban spatial environmental factors expected to influence PM accidents.

Data collected through the public data portal and the Seoul Open Data Plaza were broadly categorized into (1) building use and density characteristics, (2) physical and structural characteristics of the road network, and (3) spatial-syntactic characteristics representing traffic and floating population. As an analysis methodology, first, DBSCAN (Density-Based Spatial Clustering of Applications with Noise) was utilized to identify the spatial density characteristics of PM accident data. Unlike K-Means, DBSCAN does not require a pre-specified number of clusters and is suitable for identifying irregularly shaped clusters, making it suitable for identifying accident hotspots.

Second, space syntax, a key differentiator of this study, was applied. This technique quantifies the hierarchical importance of each road within the context of the entire city road network. "Integration" represents the accessibility of a specific road, while "Choice" represents the frequency with which a road is included in the shortest path within the network. These were utilized as key proxy variables for floating population and traffic flow.

Third, XGBoost (Extreme Gradient Boosting) was selected as the final prediction model. PM accidents are non-linear phenomena characterized by the complex interaction of multiple factors.

Therefore, ensemble techniques, which effectively learn complex relationships and demonstrate high predictive performance, are suitable.Furthermore, SHAP (SHapley Additive exPlanations) analysis was conducted to address the model's "black box" problem and derive policy implications.

3. Results and Discussion

Model training results showed that the developed XGBoost model exhibited very high fitness for the training data and effectively controlled overfitting. Notably, the model also demonstrated statistically significant and robust predictive performance in explaining real-world accident risk on the test set, which evaluates its performance in predicting new data. This suggests that the model was not over-optimized for the training data alone and exhibited stable generalization performance even on unknown data (e.g., different time zones or similar urban environments). To identify key influencing factors, SHAP analysis was performed, revealing that "building-related factors" and "space syntax-based factors" significantly contributed to accident risk. Specifically, areas with high building density and mixed-use characteristics indicate a high concentration of commercial and business activities, suggesting frequent PM traffic and structural conflicts with pedestrians. Furthermore, roads with high "selectivity" variables in spatial syntax indicate a potential for high traffic volume (vehicles and PM) even if they are not the destination. This suggests increased exposure and thus a higher accident risk. The final prediction results were visualized as a risk map at the administrative district level using GIS. The visualized map showed high spatial consistency with actual accident-prone areas analyzed using DBSCAN, demonstrating that this model effectively reflects actual risk patterns.

4. Conclusion

This study proposes a geo-mashup model that predicts PM accident risk in Gangnam-gu, Seoul, by integrating GIS, machine learning (XGBoost), and urban spatial analysis techniques (DBSCAN, space syntax). To differentiate itself from existing studies, we introduce space syntax variables that reflect the hierarchical nature of the road network. SHAP analysis empirically demonstrates that building density and road width are key factors in accident risk. The predictive model and risk map developed in this study can serve as valuable scientific evidence for establishing data-driven, proactive traffic safety policies, such as establishing geofence-based speed limit zones, expanding safety infrastructure, and strengthening enforcement of illegal parking to ensure the safety of PM users. Future research plans to enhance the model by incorporating additional data on weather, day of the week, time of day, and PM user behavior.

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Differences in health self-management behaviors among care recipients between remote islands with different degree of isolation from the mainland

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ABSTRACT:
The Japanese classification of remote islands often distinguishes between primary remote islands (PRIs) and secondary remote islands (SRIs). This study explored differences in health self-management behaviors of island residents with illness by the degree of isolation. We conducted a questionnaire survey in clinics in four remote islands in Goto City, Nagasaki Prefecture, Japan. Sixty-five individuals participated in one PRI and sixty-four in three SRIs. Regarding preventive health behavior, we found poorer attendance of lung cancer and colorectal cancer screenings in SRIs, possibly attributable to the availability and accessibility of screenings. For illness coping behaviors among residents in SRIs, the proportions of those who search for relevant information themselves before deciding whether to go to hospital/clinic, and those who decide their treatment plan with their doctor were lower, while the proportion of those who do not care even when feeling unwell was higher. Health self-management behaviors among residents on SRIs seemed less active than those in SRIs, possibly due to limited availability of heath care services and closer relationships with medical workers. These results indicate that isolation from the mainland can affect island residents' health self-management behaviors.

Keywords: health self-management behaviors; preventive health behavior; illness coping behavior; remote islands

1. Introduction

Japan has 14,120 remote islands. In particular, Nagasaki Prefecture has the most with 1,479 remote islands. The Japanese classification of remote islands often distinguishes between primary remote islands and secondary remote islands. Primary remote island, or PRI hereafter, have direct public transportation access to the mainland. On the other hand, secondary remote island, or SRI, requires transit via a PRI. This means that an SRI is accessible from mainland Japan only via PRI.

Table 1 shows the characteristics of four remote islands in Goto City, Nagasaki Prefecture. All of them have a significant population decline and a high aging rate. Also, transportation options are limited especially on SRIs, where there are only a few regular ferries to the mainland. In addition, these SRIs have no hospitals and just one or two clinics. Thus, in remote islands, health emergency

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Table 1. Characteristics of the four islands

	PRI	SRIs		
	Fukuejima Island	Hisakajima Island	Kabashima Island	Saganonshima Island
Population				
Total population in 2020	31,945	257	95	79
Change from 2000	−26.4%	−55.0%	−65.8%	−66.8%
Population aged≧65 years in 2020	39.6%	56.1%	64.2%	39.2%
Transportation				
Regular ferry to Fukuejima Island	-	5 round trips	3 round trips	4 round trips
Public transportation within island	Bus, Taxi	Taxi, Rental cars	None	None
Healthcare environment				
No. of hospitals and clinics	4 Hospitals, 27 Clinics	1 Clinic	2 Clinics	1 Clinic
No. of medical workers	605	3	8	4
Cancer screening (lung & colorectal)	○	×	△	×

response and management of chronic disease are crucial. Therefore, residents with illness are expected to maintain their health so that their health condition would not worsen.

Because available transportation and healthcare resources are different, and such environmental factors can affect residents' health-related behaviors, we hypothesized that the residents' health self-management behaviors can differ between in PRI and SRIs. Therefore, we aimed to explore differences in health self-management behaviors between residents with illness on PRI and SRIs.

2. Methods

The study areas were Fukuejima Islands as a PRI and Hisakajima, Kabashima, and Saganoshima Islands as SRIs in Goto City, Nagasaki Prefecture, Japan. To focus on island residents with illness, a questionnaire survey was conducted for medical care recipients who visited clinics. We visited all clinics in the SRIs, and the two clinics in the PRI and distributed self-administered questionnaires to all patients aged ≥18 years.

The questionnaire consisted of participants' basic information and health self-management behaviors (preventive health behavior and illness coping behavior). As for preventive health behavior, we asked about the frequency of general health check-ups and cancer screenings. The Japanese government recommends that people of all ages receive a general health check-up annually and that those aged 40 and over receive lung cancer and colorectal cancer annually. The question items on daily lifestyle were adopted from an earlier study conducted in Japan (Hoshi & Morimoto, 1991). Question items about illness coping behavior consisted of 13 questions, of which, five were about actions when they felt unwell, four were about decisions on hospital/clinic visits, and four were about decisions on treatment plans. Among them, 12 were adopted from the previous study mentioned above (Tamura & Miyazaki, 2023), and the other was designed for this survey, which asked about medical treatment outside the islands.

The chi-square test was used to compare the proportion of answers between PRI and SRIs, excluding those who did not provide answers. The significance level was set at $p<0.05$. IBM SPSS Statistics ver.30 was used for statistical analysis.

3. Results and Discussion

Sixty-five respondents completed the survey for PRI, while sixty-four completed it for SRIs. Table 2 shows their basic characteristics. There were significant differences in age ($p=0.014$), educational attainment ($p=0.001$), car ownership ($p<0.001$). The SRIs showed a higher proportion of those aged 80 years or older, and lower proportions of people with a higher educational level and people who owned private cars.

Table 2. Basic characteristics of the participants (N=129, n (%))

		PRI (n=65)		SRIs (n=64)	
Age*	<40y	3	(4.6)	2	(3.1)
	40-49y	4	(6.2)	1	(1.6)
	50-59y	12	(18.5)	1	(1.6)
	60-69y	15	(23.1)	19	(29.7)
	70-79y	21	(32.3)	20	(31.3)
	80-89y	8	(12.3)	15	(23.4)
	90y≤	2	(3.1)	6	(9.4)
Sex	Female	38	(58.5)	31	(48.4)
Living alone		16	(24.6)	18	(28.1)
Education*	Junior high school or lower	15	(23.1)	35	(54.7)
	High school	19	(29.2)	17	(26.6)
	Junior College/ Vocational School	15	(23.1)	3	(4.7)
	University	8	(12.3)	3	(4.7)
	No answer	8	(12.3)	6	(9.4)
Car ownership*	Yes	56	(86.2)	25	(39.1)
	No	5	(7.7)	38	(59.4)
	No answer	4	(6.2)	1	(1.6)

*$p<0.05$ by chi-square test excluding “no answer”.

There was no significant difference in daily lifestyle or the frequency of general health check-ups. Table 3 shows the results of the cancer screenings. Compared to the PRI, fewer respondents in the SRIs received annual lung and colorectal cancer screenings ($p=0.035$ for lung and $p<0.001$ for colorectal cancer screening). A national survey in 2022 reported that, among those aged ≥40 years, the proportion of those who attended cancer screening within a year was 45.0% for lung cancer and 41.5% for colorectal cancer (Ministry of Health, Labor and Welfare, 2023). Compared to these figures, the screening rates for PRI and SRIs are low. The difference between the PRI and SRIs is attributable to the availability of these screenings, as the availability of the screenings is highly limited in the SRIs.

Regarding Illness coping behavior, we found significant differences between the participants in the PRI and SRIs in three question items: those who search the relevant information themselves before they decide whether to visit or contact a hospital/clinic were found less frequently in the SRIs ($p<0.001$), those who decide their treatment plan in consultation with the doctor were found less frequently in the SRIs ($p=0.027$), while those who do not really care even when they feel unwell were found more frequently in SRIs ($p=0.026$). This seemingly inactivity of participants in the SRIs’ illness

Tables 3. Cancer screenings of the participants (N=124, n (%))

		PRI (n=62)		SRI (n=62)	
Lung cancer screening*	Every year	22	(35.5)	11	(17.7)
	Once in several years	10	(16.1)	6	(9.7)
	Less frequently	8	(12.9)	8	(12.9)
	Never	21	(33.9)	36	(58.1)
	No answer	1	(1.6)	1	(1.6)
Colorectal cancer screening*	Every year	24	(38.7)	7	(11.3)
	Once in several years	21	(33.9)	9	(14.5)
	Less frequently	6	(9.7)	10	(16.1)
	Never	11	(17.7)	35	(56.5)
	No answer	0	(0.0)	1	(1.6)

Excluding those under 40 years. *$p<0.05$ by chi-square test excluding “no answer”.

coping behaviors should be attributable to the fact that doctors and nurses in the SRIs often live on the same island, and therefore, have closer relationships with residents than in PRI. The number of hospital/clinics per capita and the number of medical workers per capita are much higher in the SRIs, which supports the idea. Indeed, in our survey, doctors and nurses in the SRIs clinics were frequently contacted by the residents about minor things. Such relationships have two aspects: having a face-to-face relationship between residents and healthcare providers, and on becoming dependent on medical institutions. It may increase the healthcare burden.

4. Conclusion

Health self-management behaviors among residents on SRIs seemed less active than those on PRI, possibly due to limited availability of health care services and closer relationships with medical workers.

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A Study on Predicting Illegal Parking of Shared Personal Mobility Devices Using an LSTM-Based Spatiotemporal Analysis

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ABSTRACT: Personal mobility (PMO) devices (PVs) are electric-powered personal transportation devices, such as electric scooters and electric bicycles. The increasing use of shared PMOs and the resulting increase in illegal parking are leading to increased towing budgets and human resource consumption. Therefore, the purpose of this study was to predict illegal parking for shared PMOs using LSTM(long-short-term memory) models, thereby analyzing the areas and spatial characteristics of illegal parking. First, we collected towing data for shared PMOs and public transportation usage data. Second, we analyzed the areas and regional characteristics of illegal parking using spatial clusters. Finally, we used an LSTM time-series model to predict illegal parking zones for shared PMOs and visualized these zones on a map. The results of this study suggest that analyzing the areas of illegal parking for shared PMOs can lead to the feasibility of installing dedicated parking lots for shared PMOs and minimizing the costs of illegal parking enforcement.
Keywords: Personal mobility, Illegal parking, LSTM (Long-Short-Term Memory)

1. Introduction

Personal mobility (PMO) refers to personal transportation devices that use electricity, such as electric scooters or electric bicycles. The growing use of shared PMOs is driven by a number of factors, including growing interest in and demand for eco-friendly transportation, a rise in short-distance neighborhood trips, and the convenience of shared services. Furthermore, the reasons for using PMOs include "traveling to areas lacking public transportation," 55% of respondents said, "for leisure activities," 28% said, "to avoid public transportation congestion," 22% said, and "for commuting to school or work." For these reasons, PMOs are deeply ingrained in our lives. However, complaints about illegal parking of shared PMOs in Seoul increased from approximately 31,000 cases in 2021 to approximately 111,000 cases in 2024. Furthermore, the budget for towing illegally parked shared personal mobility vehicles (PMs) is increasing every year, with a total budget of over 8 billion won spent on towing costs over the four years from 2021 to August 2024.

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This means that cracking down on illegal parking is continuously draining both the towing budget and human resources, necessitating an efficient method for analyzing spatiotemporal patterns of illegal parking in PMs. Therefore, the purpose of this study was to predict illegal parking of shared personal mobility vehicles using long-short-term memory (LSTM) and analyze the dense areas of illegal parking and their spatial characteristics. To this end, we first collected towing data for shared personal mobility vehicles and public transportation usage data. Second, we analyzed the dense areas of illegal parking and their regional characteristics using spatial clustering. Finally, we used an LSTM time-series model to predict illegal parking zones for shared personal mobility vehicles and visualize them on a map.

2. Methodology

This study utilized various urban data to predict illegal parking areas for shared personal mobility vehicles (PMs) in Seoul. The figure 1 below shows the research procedure.

Figure 1. Research procedures

First, we collected and integrated data on shared PM towing history and public transportation usage in Seoul to establish an analysis foundation. Kernel density estimation was then applied to identify the spatial distribution of illegal parking. K-means clustering was used to categorize Seoul's legal dongs into residential, commercial, educational, residential, tourism, cultural, and mixed-use areas. Furthermore, the DBSCAN (Density-Based Spatial Clustering of Applications with Noise) algorithm, which automatically forms clusters based on data density, was utilized to derive regional patterns of illegal parking density.

Finally, a Long Short-Term Memory (LSTM)-based time-series prediction model was developed to predict areas prone to illegal parking for shared PMs. The predicted results were visualized using the Kepler map visualization library, which displays towing density, reasons for towing, and illegal parking distribution by day of the week and short-term periods, facilitating intuitive analysis of spatial patterns.

3. Results and Discussion

An analysis of illegal parking for shared personal mobility devices in Seoul revealed that illegal parking is concentrated in mixed commercial and residential areas, near subway stations and bus

stops, and around universities. Using K-means analysis, we classified neighborhood characteristics into six categories—living, commercial, residential, tourism, culture, and mixed-use—and found that illegal parking rates were particularly high at night in commercial areas and during rush hour in residential areas. The DBSCAN algorithm, applied to the analysis, identified additional small, high-density clusters of illegal parking, unlike existing administrative districts.

These results provide a basis for further refinement of enforcement zones. LSTM time-series predictions revealed a cyclical pattern, with illegal parking concentrated primarily on Friday and Saturday nights. The predicted results matched the actual towing areas by over 80%, and the prediction accuracy was also higher than that of existing statistical models. Kepler-based map visualization enabled us to identify areas with high concentrations of illegal parking at a glance. These analysis results are expected to be effectively utilized in practical decision-making, such as efficient deployment of enforcement personnel, designation of PM-only parking areas, and establishment of illegal parking regulation policies.

4. Conclusion

This study identified areas with high concentrations of illegal parking for shared personal mobility vehicles (PVs) and their spatial characteristics in each region of Seoul using kernel density estimation and K-means clustering. Based on this, LSTM and DBSCAN algorithms were applied to predict areas prone to illegal parking. The results demonstrated that effectively identifying high concentrations of illegal parking for shared PVs validates the feasibility of installing dedicated parking lots for PVs and contributes to reducing enforcement and towing costs. Furthermore, the results suggest practical administrative and policy applications, including the introduction of QR code-based parking authentication systems, the establishment of regional parking regulations, and promotional strategies to promote a healthy parking culture. These findings can serve as a foundation for developing customized illegal parking management systems tailored to regional characteristics.

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Burden on caregivers of people with dementia who use Alzheimer's Cafés

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ABSTRACT: The present study aim is to investigate the factors related to burden on caregivers of people with dementia. A self-administered questionnaire was conducted on caregivers of older people with dementia at community-based Alzheimer's Cafés in Nagasaki Prefecture. Caregiver burden was evaluated using a visual analog scale (VAS) and the caregiver's mental health status was measured with Geriatric Depression Scale-15 (GDS-15). Total 46 caregivers (male8, female36, mean age 72.6 ± 12.8) were respondent. The caregivers' mental health showed 14 (30.4%) to have depressive tendencies or states. Regarding the relationship between caregiver burden and mental health, a higher proportion of depressive tendencies were observed among those with a heavy caregiving burden (Chi-square test, $p = 0.065$). These findings indicate the need to develop systems that can provide more appropriate care for older people with dementia and support the mental health of their caregivers.

1. INTRODUCTION

Japan is a rapidly aging society, with older adults aged ≥ 65 years accounting for 29.1% of the total population in 2025. In addition, the aging of the population is expected to continue. As the population ages, the number of older people with dementia is also expected to increase. Dementia is the leading cause of care needs among older people and a serious social health issue in Japan. Caring for an older person with dementia is more burdensome than caring for an older person without dementia. Furthermore, previous studies have suggested that the severity of dementia is associated with higher caregiver burden among family caregivers. It has been reported that caregivers strongly harbored anxieties about continuing care due to concerns regarding their own condition and that of the care recipient. Therefore, the burden on family caregivers of older people with dementia is significant. However, the actual situation of family caregivers remains somewhat unclear.

In Japan, Alzheimer's Cafés, which provide a place and time for persons with dementia, their caregivers, their family members and professional to exchange ideas, information, and experiences, have been opened in local communities. Alzheimer's Cafés, which began in the Netherlands in 1997, are being increasingly adopted in Japan, which aims to establish such Cafés in every local community across the country. At the time of this writing, 8182 Alzheimer Cafés had been opened in Japan, with an installation rate of 89.8%.

In the present study, we conducted a questionnaire survey on caregivers of older people with dementia at Alzheimer Cafés with the aim of clarifying the burden on family caregivers of people

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with dementia who use such Cafés, as well as the association between caregiver mental health and the caregiving burden.

2. METHODS

A self-administered questionnaire was conducted on caregivers of older people with dementia at community-based Alzheimer's Cafés in Nagasaki Prefecture. The questionnaire was composed of items on sociodemographic characteristics (age, sex, family structure, education, and self-rated financial status), caregiver burden, and the caregiver's mental health status (Geriatric Depression Scale-15 [GDS-15]). Caregiver burden was evaluated using a visual analog scale (VAS), in which scores are recorded by making a mark on a 10-cm line. The GDS-15 is a mental health indicator in which the tendency to experience depressive symptoms worsens as the total score increases. The score range of the GDS-15 is from 0 to 15, with scores ≤ 4 considered normal and scores ≥ 5 considered to indicate a tendency toward depression.

The inclusion criteria were caregivers currently providing care to older people with dementia and/or caregivers who had cared for older people with dementia for at least 1 year in the past. This survey was conducted at Alzheimer's Cafés in five purposefully selected districts within Nagasaki Prefecture. The investigation period was from July to September 2025. This study was approved by the Ethical Committees of Nagasaki University Graduate School of Biomedical Sciences (authorization No.: 25021305).

3. RESULTS

In total, 87 questionnaires were distributed through the Alzheimer's Cafés in the survey areas, among which, responses were received from 48 individuals (response rate: 55.2%). After excluding two individuals with < 1 year of caregiving experience, 46 cases were analyzed (valid response rate: 52.9%).

A total of 46 caregivers (8 males, 36 females; mean age ± standard deviation, 72.6 ± 12.8 years; range, 37–91 years) responded to the questionnaire. Table 1 shows the respondents' sociodemographic characteristics. In total, 78.3% of the caregivers and 67.4% of the older persons with dementia were female, with an average age of 85 ± 8.2 years. In addition, the caregivers were caring for family members such as a spouse or parent; 28.3% of older persons with dementia were not utilizing care insurance.

The median VAS score indicating the respondents' perceived caregiving burden was 4 (25th percentile: 3, 75th percentile: 7). Those with a VAS score ≤ 4 were classified into a low caregiver burden group, while those with a VAS score ≥ 5 were classified into a heavy caregiver burden group. The caregivers' mental health was assessed using the GDS-15, with scores < 5 indicating normal mental health, 5–9 indicating depressive tendencies, and ≥ 10 indicating a depressive state. In this study, 14 (30.4%) respondents were considered to have depressive tendencies or states. Regarding the relationship between caregiver burden and mental health, a higher proportion of depressive tendencies was observed among those with a heavy caregiving burden (chi-square test, $p = 0.065$).

4. DISCUSSION AND CONCLUSION

In the present study, a self-administered questionnaire survey was conducted on caregivers of older people with dementia at Alzheimer's Cafés in various areas of Nagasaki Prefecture. The findings indicated that women were more likely than men to provide care, and that older family

members were caring for even older people with dementia. The caregivers felt that caring for an older person with dementia was a heavy burden. Approximately 30% of the caregivers were assessed as having depressive tendencies or states. An analysis of the relationship between the burden of caring for older people with dementia and the mental health of the caregivers revealed that caregivers who felt a heavy burden caring for older people with dementia were more likely to experience depressive tendencies. These findings indicate the need to develop systems that can provide more appropriate care for older people with dementia and support the mental health of caregivers.

Table 1. Sociodemographic characteristics of the respondents (N = 46)

Caregiver				**Older person with dementia**			
		n	(%)			n	(%)
Sex	Male	8	(17.4)	Sex	Male	14	(30.4)
	Female	36	(78.3)		Female	31	(67.4)
Age (years)	Mean ± SD	72.6 ± 12.8		Age (years)	Mean ± SD	85.0 ± 18.2	
Education level	High school or below	26	(56.5)	Relatives	Spouse	19	(41.3)
	University degree or above	19	(41.3)		Parents or others	26	(56.5)
Self-rated financial status	Sufficient	36	(78.3)	Care insurance	Receive support	31	(67.4)
	Poor	9	(19.6)		Do not receive support	13	(28.3)

Non-responses were excluded from the analysis. SD, standard deviation.

Table 2. Relationship between caregiver burden and mental health

	Low caregiver burden group	Heavy caregiver burden group	P-value
Normal	19 (79.2%)	10 (52.6%)	0.065
Depression or depressive tendencies	5 (20.8%)	9 (47.4%)	

The chi-square test was performed.

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A Study on Real-time Enforcement of Illegal Parking of Personal Mobility Devices by Using Deep Learning and Cloud Services

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ABSTRACT: Currently, reporting PMs (Personal Mobility Devices) requires reporters to manually input the reported location, take photos of the scene, and select the type of illegal parking and service provider. The current enforcement system can be improved by utilizing CCTV footage for citizen reports, automatic classification of objective judgments based on legal grounds, automatic acquisition of location information, and real-time cloud-based management of enforcement information. The purpose of this study is to detect illegal parking of personal mobility devices using CCTV footage and to investigate a cloud-based real-time enforcement method. The results of this study demonstrate the potential of cloud computing technology in monitoring illegal parking and managing enforcement by creating a real-time map of illegal parking situations. Furthermore, analyzing data on the location and regional distribution of illegal parking over time can contribute to the selection and analysis of priority enforcement areas, the handling of citizen complaints, and traffic improvement.

Keywords：PM electric scooter, YOLO, GCP, location information, AWS

1. Introduction

Personal mobility devices (PMs) are electric-powered transportation devices used by individuals, including electric scooters, electric bicycles, and electric wheels. The use of PMs has recently increased, and a survey revealed that the most common reason was "to travel in areas with poor public transportation access." According to Seoul City's e-scooter complaints and budget expenditures, approximately 370,000 complaints were received and a budget of 7.9 billion won was spent from 2021 to August 2024. There are five types of illegal parking for PM personal mobility devices: on separate roads and bicycle paths, on tactile paving and traffic islands, within 3 meters of crosswalks, within 5 meters of subway exits, and within 5 meters of bus stops. Because illegal parking is reported based on citizen reports, roads and sidewalks remain unsafe until such time.

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Currently, PM reporting requires the reporter to manually enter the location of the reported incident, take photos of the incident, and select the type of illegal parking and service provider. The current enforcement system can be improved by detecting citizen reports through CCTV footage, automatically classifying objective judgments based on legal grounds, automatically acquiring location information, and managing enforcement information in real time using the cloud.

The purpose of this study was to detect illegal parking of personal mobility devices using CCTV footage and to study a cloud-based, real-time enforcement method. To achieve this, CCTV footage was collected from parts of Seoul and Ilsan. A YOLO model was trained using the image dataset and detection areas were selected. GCP representative points were selected, PM electric scooters were detected within the footage, and their types of illegal parking were classified. The absolute coordinate location information of the detected PM electric scooters was calculated. Next, an EC2 instance was created using an AWS web server and connected to RDS. The calculated PM information (time, type, address, etc.) was stored and managed in RDS. Using the map API, illegal parking status information was mashed up to provide a service to analyze areas with high rates of illegal parking and identify priority areas for enforcement.

2. Methodology

The study's procedure is as shown figure 1. For detection, CCTV footage from parts of Seoul and Ilsan, publicly available on AIHub, was collected. To train a model for electric scooter detection, a YOLO model was trained using Roboflow's image dataset. Next, a Transformer was used to automatically select a detection area.

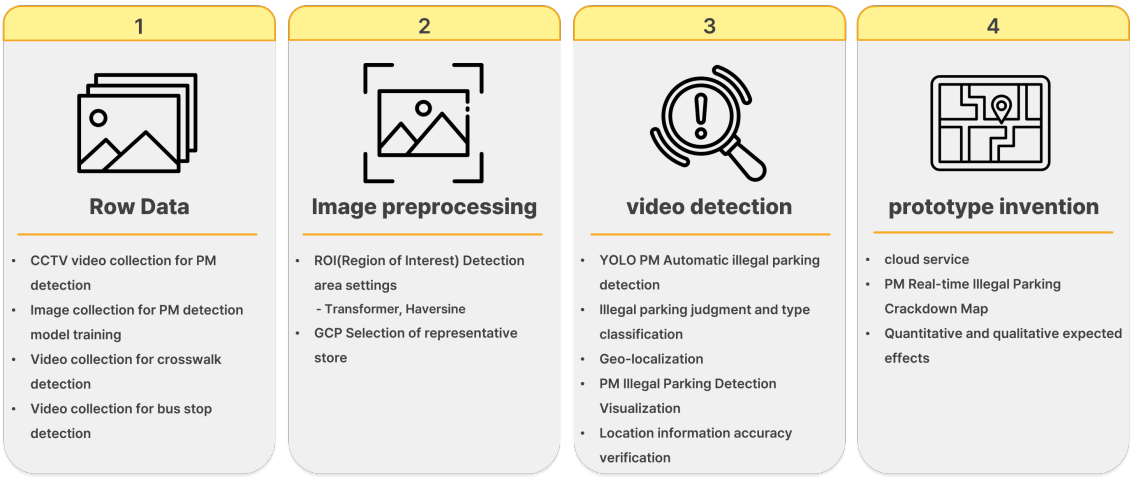

Figure 1. Research procedures

Next, ground control point (GCP) representative points were selected within the footage. These GCP representative points were selected by matching pixel coordinates with absolute coordinates.

The selected GCP representative points were used to convert image relative coordinates to absolute coordinates and to increase coordinate accuracy. Next, PM electric scooters were detected within the footage. After detection, the type of illegal parking was classified using a Transformer and the Haversine formula.

This classification allowed for legal enforcement decisions regarding illegal parking. The relative coordinates of the detected PM electric scooters were converted to absolute coordinates using a homography matrix transformation in OpenCV. To evaluate the accuracy of the generated location information, MAE and RMSE (Root Mean Square Error) were evaluated. Next, we created an EC2 instance using the AWS web server and connected it to RDS. We stored and managed the generated PM information (time, type, address, etc.) in RDS. We visualized the illegal parking location information stored in RDS on a map, and through mapping and hotspot analysis, we identified information and distribution maps of illegal parking of PM electric scooters.

3. Results and Discussion

The location information for detected illegal parking is linked to RDS on AWS EC2 instances and displayed using a map library, based on PMs that have completed enforcement and PMs in the process of enforcement. Detected PM information allows users to check detection time, date, service provider, coordinates, and address. This service also provides a priority enforcement area selection decision-making service that allows users to check the current enforcement progress by PM.

4. Conclusion

This study used AWS and YOLO to detect illegal parking in public parking areas through real-time object detection and image segmentation of CCTV images. Furthermore, by converting this data into actual illegal parking location information, a map service was implemented using Amazon AWS to enable real-time analysis of illegal parking conditions based on cloud computing. The results of this study demonstrate the potential of cloud computing technology for illegal parking status monitoring and enforcement management, as the PM illegal parking status map is created using real-time data. Furthermore, analyzing data on illegal parking locations and their regional distribution over time can contribute to the selection and analysis of priority enforcement areas, the handling of citizen complaints, and traffic improvement.

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