Future Road Traffic Accident Safety Measures Based on Risk Assessments of Pedestrian Accidents

Aiming for More Effective Measures Utilizing the Location Information of Pedestrian Accidents

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1. Summary

The causes that give rise to traffic accidents can be largely divided up into three major categories. These are: (1) Factors related to the road traffic environment, such as the weather and geographical conditions, road structure, road traffic conditions, and differences in land use along roads; (2) Human factors such as the driver's driving skill, mental state and physical condition, and pedestrians or cyclists suddenly darting out; and (3) Vehicle-related factors such as the vehicle's inspection / maintenance status and inclusion of safety devices. But in many cases, individual traffic accidents occur as a result of a combination of these factors. In addition, when you look at the number of traffic accidents that occur at the level of individual areas or road sections over a single year, you see that the numbers themselves are not that large, and in many cases they fluctuate significantly from year to year. Therefore, detailed examinations for each individual location are necessary in order to accurately determine the risk of traffic accidents at individual areas or road sections, identify the major factors causing them, and link these with traffic safety measures. For this reason, there are strong demands to assess the risk of traffic accidents at the level of individual areas or for each road section and establish assessment models that elucidate the major risk factors behind accidents, and thereby improve the efficiency of examinations of traffic safety measures.

At the same time, starting from 2012 latitudinal and longitudinal information began to be included in traffic accident ledgers, which made it possible to perform accident analyses by pinpointing the sites where accidents occur for not only traffic accidents on major roadways, but also those occurring on community roads as well. As such, its use is being expanded out to traffic safety measures, such as by using this information to pinpoint areas where accidents frequently occur, provide efficient traffic safety education, and for use in enforcement.

The figure on the right displays traffic accidents that occurred around Shinjuku Station between 2012 and 2015 by pedestrian accidents, accidents involving cyclists, and accidents involving vehicles other than bicycles (single vehicle accidents and vehicle-vehicle accidents). Fig. 1 reveals that whereas the majority of accidents involving vehicles occur along major roadways (the purple lines in the figure are major roadways where road traffic censuses are performed), pedestrian accidents and those involving cyclists often occur on community roads that are not major roadways. The fact that progress has been made in installing sidewalks and other facilities along most major roadways is thought to be a factor behind why few pedestrian accidents or cyclists occur along major roadways. In addition, as shown in Fig. 2, more than half of all pedestrian accidents or cyclists occur within a range of 1km or less from home indicating that these sorts of accidents are of a type featuring strong regional characteristics.

The extent to which such traffic accidents occur is largely consistent throughout all of Japan. Therefore, for pedestrian accidents and those involving cyclists we can see that accident analyses at the level of individual areas are more suitable than accident analyses that focus on particular roads. Therefore, in the past fiscal year ITARDA has been working to establish a model for assessing the risk of pedestrian accidents at the level of meshes of 500m×500m by focusing on six representative prefectures. This study will report on the measures to establish an assessment model at the national level and to harness this for future traffic safety measures.

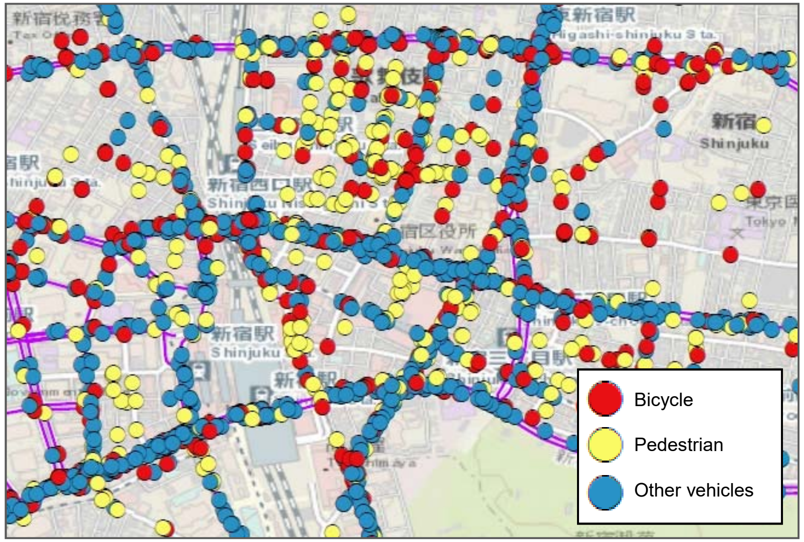

Fig. 1. Image of traffic accidents that occurred around Shinjuku Station (total from 2012 through 2015)

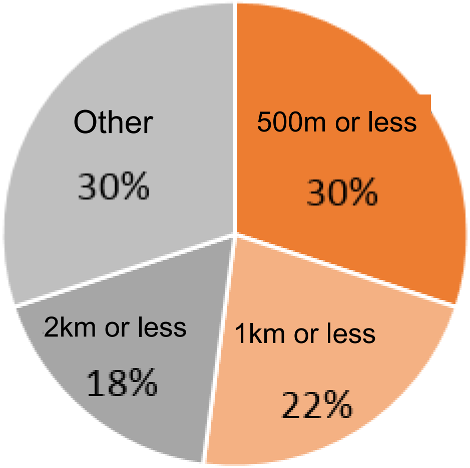

Fig. 2. Composition ratio for the number of pedestrian accidents / cyclists by distance from home (2017)

2. Background to and objectives of the study

Starting from 2012, latitudinal and longitudinal information began to be included in traffic accident ledgers, which made it possible to perform accident analyses by pinpointing the sites where accidents occur for not only traffic accidents on major roadways, but also those occurring on community roads as well. As such, its use is being expanded out to traffic safety measures, such as by using this information to pinpoint areas where accidents frequently occur, provide efficient traffic safety education, and for use in enforcement. The expectation is that efficient traffic safety measures will be promoted through the use of such accident location information in order to achieve the target from the Tenth Traffic Safety Basic Plan of reducing the number of fatalities from traffic accidents to 2,500 or fewer by the year 2020.
However, the number of traffic accidents that occur at individual intersections, road sections, and areas often tend to fluctuate significantly from year to year, as indicated in the following example. For this reason, fluctuations in the number of accidents that occur will be efficiently represented by using accident location information in order to conduct accident analyses for each intersection, road section, or area to pinpoint the major factors behind accidents and continue examining countermeasures for these. Ideally, the latent risk of traffic accidents should be assessed for each individual intersection, road section, and area; an accident risk assessment model that denotes the major factors behind the risk of accidents should be established; and this should be put to use for efficient accident analyses and considerations of traffic safety measures.

<Examples of fluctuations in the number of accidents for each individual intersection, road section, or area>
Trends in the number of accidents at the Ohara Intersection in Suginami Ward, Tokyo
2014: 12 2015: 9 2016: 14 2017: 9
Trends in the number of accidents between the Omotesando Intersection along National Highway No. 246 and the Minami-Aoyama 3-chome Intersection
2014: 7 2015: 3 2016: 4 2017: 9
Trends in the number of pedestrian accidents in Moriyama City, Shiga Prefecture
2014: 36 2015: 25 2016: 38 2017: 26
Trends in accidents involving cyclists in Koka City, Shiga Prefecture
2014: 37 2015: 23 2016: 27 2017: 34

As was mentioned above, whereas the majority of accidents involving vehicles other than bicycles occur along major roadways, pedestrian accidents and those involving cyclists often occur on community roads that are not major roadways. In addition, the accident types and accident factors for accidents involving vehicles at non-intersections and intersections along major roadways vary significantly. Therefore, the decision was made to adopt the following two points as basic policies to serve as premises for systematically establishing a model for assessing the risk of traffic accidents. In this study, major roadways refer to roads targeted for surveys in road traffic censuses.

Basic policy (1): Establish a risk assessment model for pedestrian accidents, accidents involving cyclists, and accidents involving vehicles other than bicycles on community roads at the level of meshes of 500m×500m
Basic policy (2): Establish risk assessment models for accidents involving vehicles other than bicycles on major roadways for both non-intersections and intersections. Since risk assessment results for pedestrian accidents and those involving cyclists must be provided in conjunction with the provision of risk assessment results for traffic accidents on major roadways, risk assessment models for pedestrian accidents and those involving cyclists will be established in conjunction with this for both non-intersections and intersections

Based on these two basic policies, this study will establish accident risk assessment models for the national level when it comes to pedestrian accidents and report on policies to use this for future traffic safety measures. This is due to the concerns that the risk of pedestrian accidents (which account for nearly 40% of fatal traffic accidents) will grow as a result of the rising share of fatal accidents involving elderly pedestrians accompanying the aging of society and the increased demand for walking and running as a result of increasing health consciousness.

Contents of the Presentation

1. Background to and objectives of the study
2. Proposal for a risk assessment model for pedestrian accidents
3. Estimates of parameters and assessment results via the risk assessment model for pedestrian accidents
4. Results of analyzing factors behind the divergences for meshes where there were significant divergences between the actual values and the assessment results
5. Improvements for the assessment models and risk assessment results from the models following the improvements
6. Future applications and challenges for further improvements to the model

1. Background and objectives : Need to determine the risk of traffic accidents by area

○ Latitudinal and longitudinal information was added to accident ledgers starting from 2012

→ This made it possible to determine the occurrence status more accurately by area and location for not only major roadways, but community roads as well

→ Expectation that this will be used for effective traffic safety measures

○ The number of accidents that occur in each individual location fluctuate significantly from year to year

<Examples>

Trends in the number of accidents at the Ohara Intersection in Suginami Ward, Tokyo
2014: 12 2015: 9 2016: 14 2017: 9

Trends in the number of accidents between the Omotesando Intersection along National Highway No. 246 and the Minami-Aoyama 3-chome Intersection
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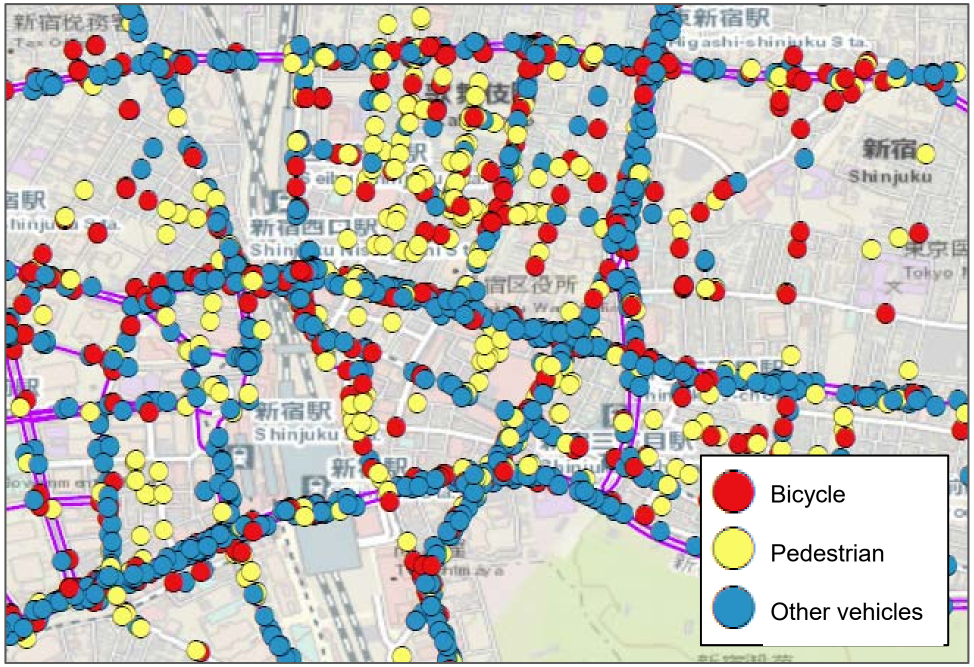
Trends in the number of pedestrian accidents in Moriyama City, Shiga Prefecture
2014: 36 2015: 25 2016: 38 2017: 26

Trends in accidents involving cyclists in Koka City, Shiga Prefecture
2014: 37 2015: 23 2016: 27 2017: 34

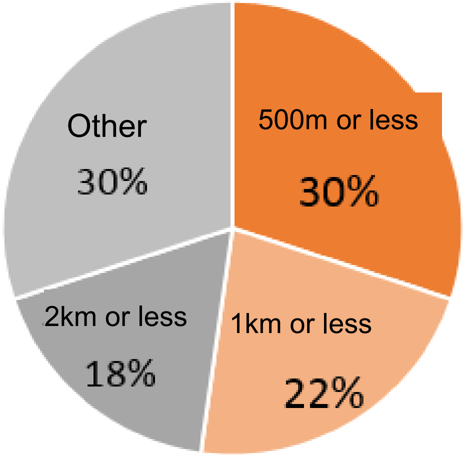
→ In addition to determining the number of accidents, **accident risk assessments models must be established to indicate the latent risk of traffic accidents occurring at each individual location and the major factors behind these**

1. Background and objectives : Basic policies for establishing the models

○ **Pedestrian accidents and accidents involving cyclists tend to occur in a distributed manner over the entire area**
Single vehicle and vehicle-vehicle accidents (not including bicycles) are concentrated along major roadways



Composition rate of pedestrian accidents / cyclists by distance from home (2017)



* **In cases where the primary party is driving a vehicle and the secondary party is a pedestrian or cyclist, the composition rate of accidents by distance from the home of the secondary party**

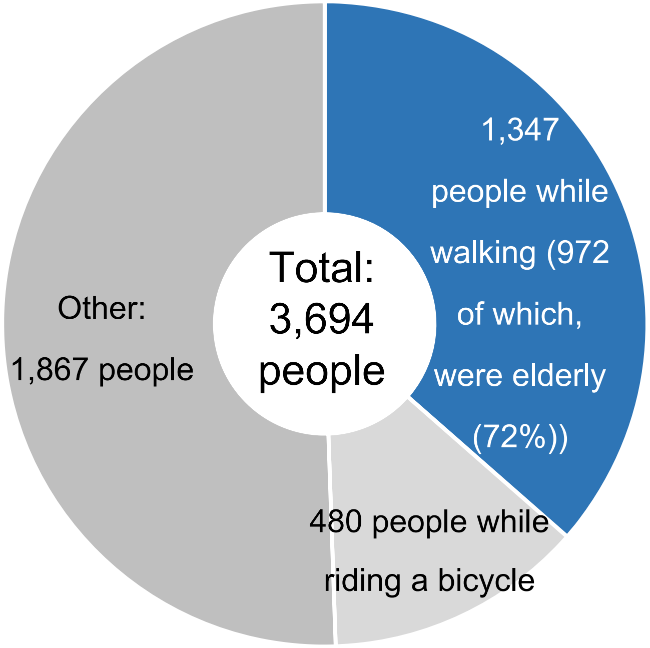
Policy (1) **Establish a risk assessment model for pedestrian accidents, accidents involving cyclists, and accidents involving vehicles other than bicycles on community roads at the level of meshes of 500m×500m**

Policy (2) Establish risk assessment models for accidents involving vehicles other than bicycles on major roadways for both non-intersections and intersections, and provide risk assessment models for pedestrian accidents and those involving cyclists in conjunction with this when the evaluation results are provided

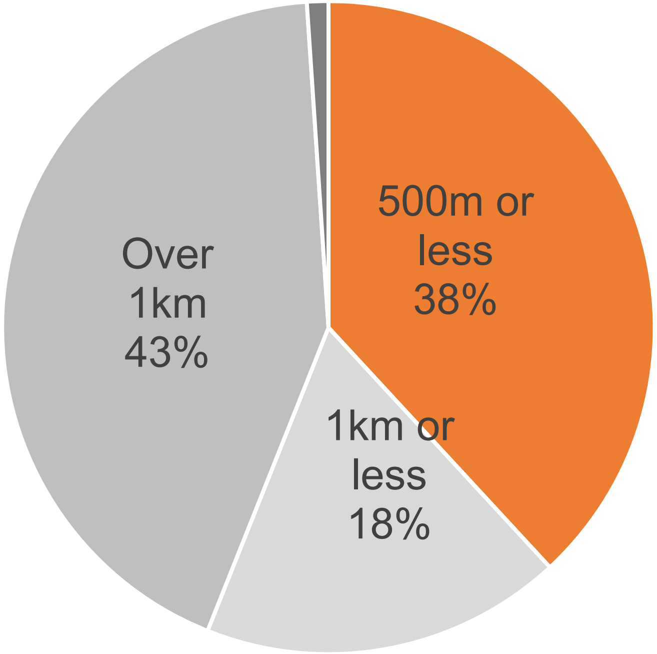
1. Background and objectives: Need for risk assessments of pedestrian accidents

- ○ The number of fatalities from pedestrian accidents accounts for over 30% of all traffic accidents (the worst number of fatalities per capita among developed countries)
- ○ Roughly 40% occur within 500m of home, and they often occur on community roads
- ○ There is a rising share of fatal accidents involving elderly pedestrians and an increase in pedestrians as a result of rising health consciousness
  - → As the aging of society advances, strengthening countermeasures against pedestrian accidents poses a pressing challenge
  - → **Examinations will be performed by giving priority to establishing models that can accurately assess the risk of pedestrian accidents with a view towards adopting effective countermeasures against such accidents**

No. of fatalities from traffic accidents by accident type (2017)



Composition rate of pedestrian accidents by distance from home (2017)



2. Proposal for a risk assessment model for pedestrian accidents

Hypothesis (1):

The occurrence probability for the number of accidents (Y_k) that occur in mesh k over a three-year period **follow a Poisson distribution** (generally employed for traffic accident analysis models; **Parameter λk = Expected value for the number of accidents and is set as the risk assessment value**)

$P(Yk) = \lambda k^{Yk} \cdot e^{-\lambda k} / Yk\,!$ (P(Yk): Occurrence probability)

Hypothesis (2):

Explanatory variables will be established using data that can be collected for each mesh measuring 500m×500m, and explanatory variable candidates will be selected via a decision tree analysis

Hypothesis (3):

The relational expression between parameter λk and the explanatory variables can be defined for Log λk via a linear function, and all factors that are difficult to index will be added as random effects → **Generalized Linear Mixed Model** (GLMM: where the “mixed” refers to the addition of random effects)

Hypothesis (4):

The **parameters will be estimated via Bayesian inference** based on Bayesian statistics **for each prefecture (10 districts in Hokkaido)** in light of differences in weather / geographical conditions, the development status of road networks, differences in land use, differences in the use of public transportation, differences in driver disposition, and other differences in factors that cause accidents specific to each prefecture

2. Proposal for a risk assessment model for pedestrian accidents

~ Selecting explanatory variable candidates via a decision tree analysis ~

○ Assessment models were established by using data on pedestrian accidents from 2013 – 2015 by **focusing on 31 prefectures** with highly accurate latitudinal and longitudinal information (Hokkaido, with its expansive area, was divided up into 10 districts)

○ Explanatory variable candidates: **15 items for which data can be obtained for each mesh**

(1) Number of convenience stores
(2) Area of building sites (km^2)
(3) Area of commercial districts (km^2)
(4) Road extensions (km)
(5) Area of residential districts (km^2)
(6) Area of industrial districts (km^2)
(7) Number of department stores
(8) Number of hospitals
(9) Number of fast food restaurants
(10) Number of banks
(11) Number of gas stations
(12) Number of middle / high schools
(13) Distance from train station (km)
(14) Number of intersections
(15) Total population (nighttime population)

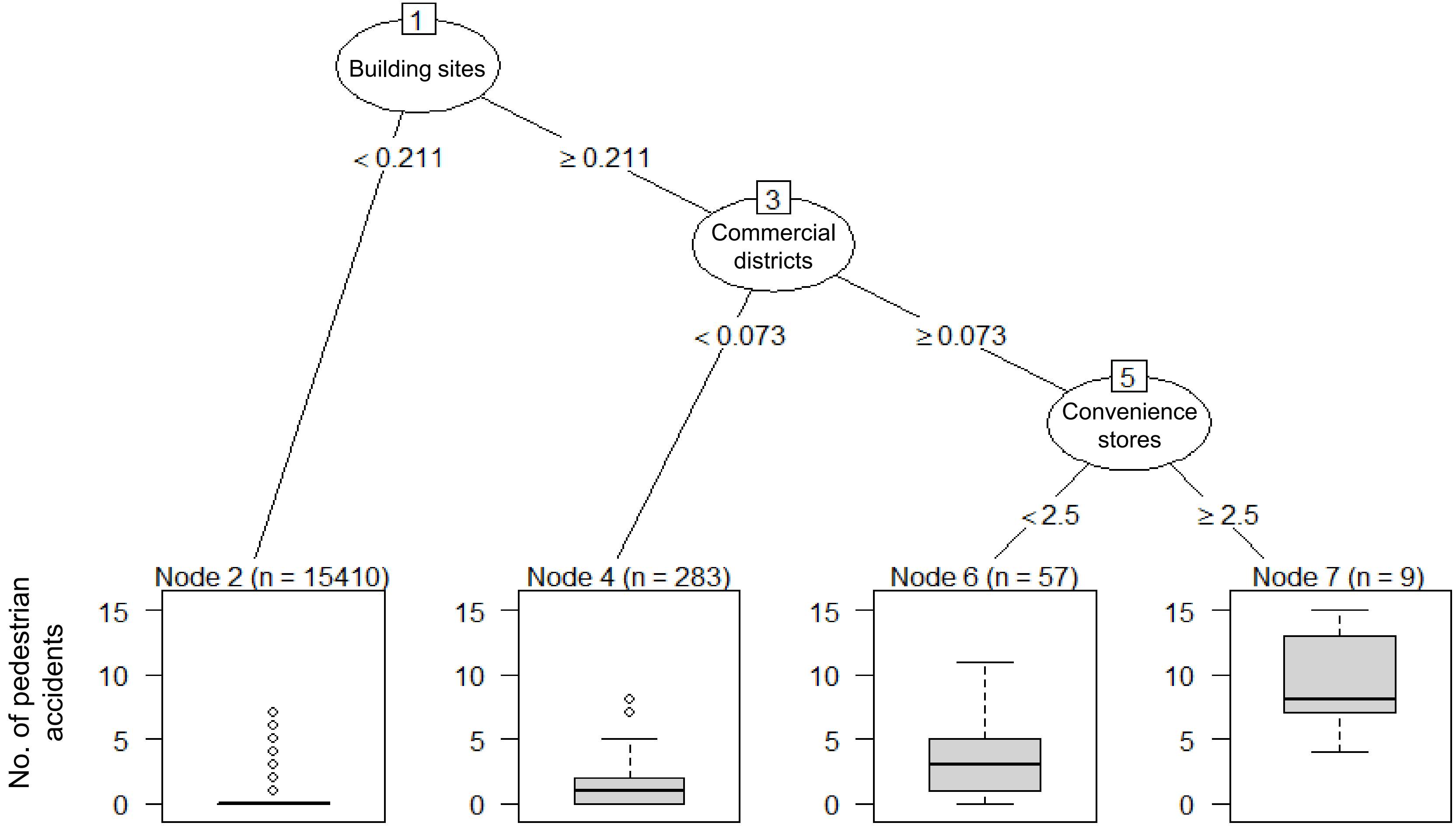
○ Results of the decision tree analysis: **The focus for candidates was narrowed down to (1) Number of convenience stores, (2) Area of building sites, and (3) Area of commercial districts**

2. Proposal for a risk assessment model for pedestrian accidents

~ Selecting explanatory variable candidates via a decision tree analysis ~

A combination of the area of commercial districts, number of convenience stores, and area of building sites allows for the absolute best mesh demarcations

Example) Shiga Prefecture



2. Proposal for a risk assessment model for pedestrian accidents

Generalized Linear Mixed Model (GLMM)

For the occurrence probability for the number of pedestrian accidents by mesh over a three-year period, when a Poisson distribution is followed parameter λ_k (=expected value, risk assessment value) for a Poisson distribution for hypothetical mesh k is expressed by the following equation

β2 represents the number of convenience stores, β3 represents the area of building sites (km^2), and β4 represents the impact (magnification factor) that the area of commercial districts (km^2) has on the occurrence of accidents (β1- β4 are common values for all meshes within a prefecture, and are estimated for each prefecture)

λ_k = exp(β1 + β2 x Number of convenience stores + β3 x Area of building sites + β4 x Area of commercial districts + log(road extensions)(offset items) + random effects)

These are offset variable items, and logarithmic values for road extensions (km) within a mesh (λ is assumed in proportion to road extensions, and the parameter is fixed at 1)

Expression of the impact that environmental factors that cannot be expressed in β1 – β4 have on the occurrence of accidents by factoring in their spatial autocorrelation (calculated for each mesh)

Spatial autocorrelation image

Refers to the fact that locations that are nearby in a spatial sense have similar trends regarding the occurrence of accidents

2. Proposal for a risk assessment model for pedestrian accidents

$Y_k|\lambda_k \sim \mathrm{Poisson}(\lambda_k), \quad k = 1, \ldots, K$ (K is the number of meshes)

$$\boldsymbol{x}_k = (1, x_{k1}, \ldots, x_{k3})$$

$$\boldsymbol{\beta} = (\beta_1, \ldots, \beta_4)$$

$$\log(\lambda_k) = \boldsymbol{x}_k^\top \boldsymbol{\beta} + O_k + \phi_k,$$

$\boldsymbol{\beta} \sim \mathcal{N}(\boldsymbol{\mu}_{\boldsymbol{\beta}}, \Sigma_{\boldsymbol{\beta}})$ (Multivariate normal distribution: Prior distribution for β)

(The prior distribution for β is a regular distribution with an average value of 0 and a dispersal of 1,000 (non-informative prior distribution))

O_k : Offset item (Logarithmic value for the road extensions (km) in mesh k)

ϕ_k : Random effects for mesh k
Expressed by the following equation (Conditional autoregressive (CAR) model proposed by Leroux et al. in 2000)

$$\phi_k|\phi_{-k}, W, \tau^2, \rho \sim \mathcal{N}\left(\frac{\rho\sum_{i=1}^K w_{ki}\phi_i}{\rho\sum_{i=1}^K w_{ki} + 1 - \rho}, \frac{\tau^2}{\rho\sum_{i=1}^K w_{ki} + 1 - \rho}\right),$$

(Prior distribution for ϕ_k)

$$\phi_{-k} = (\phi_1, \ldots, \phi_{k-1}, \phi_{k+1}, \ldots, \phi_K),$$

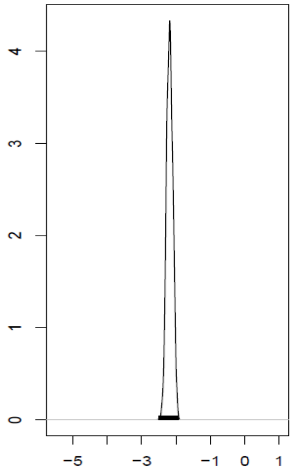
$\tau^2 \sim \text{Inverse-Gamma}(1, 0.01),$ (Prior distribution for τ^2)

For weighing matrix W, if mesh k and mesh i share a border then corresponding factor w_{ki} is defined as equaling 1, but if this is not the case w_{ki} is defined as being equal to 0.

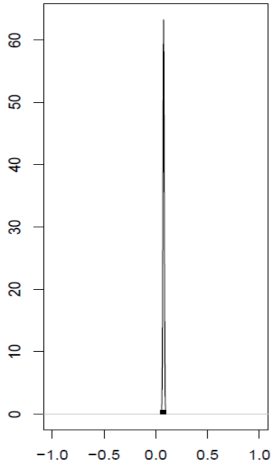
3. Analyses of the results of estimating parameters and assessment results via the risk assessment model for pedestrian accidents

- ○ Parameter estimates via Bayesian inference: Excellent estimated results in all 31 prefectures
  <Example: Tokyo> *The median values for the posterior distribution were set for the estimated parameter values

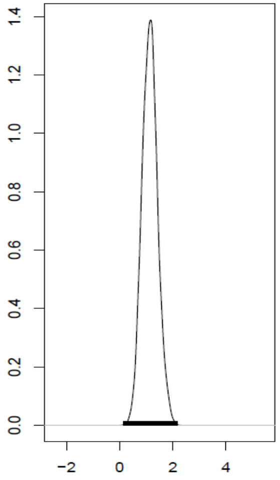
β1
(Intercept)



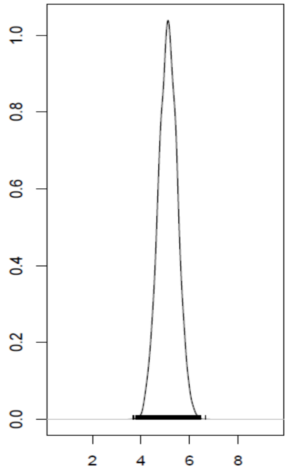
β2
(Number of
convenience stores)



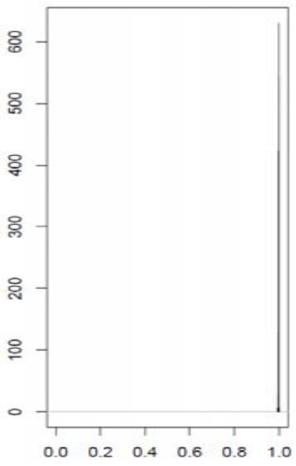
β3
(Area of building
sites)



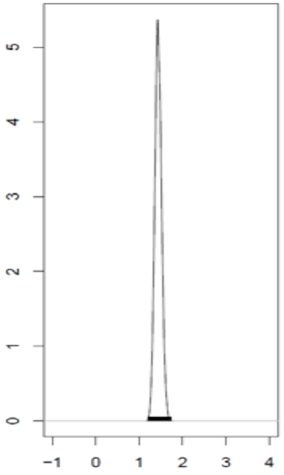
β4
(Area of commercial
districts)



ρ



$\tau^{(2)}$

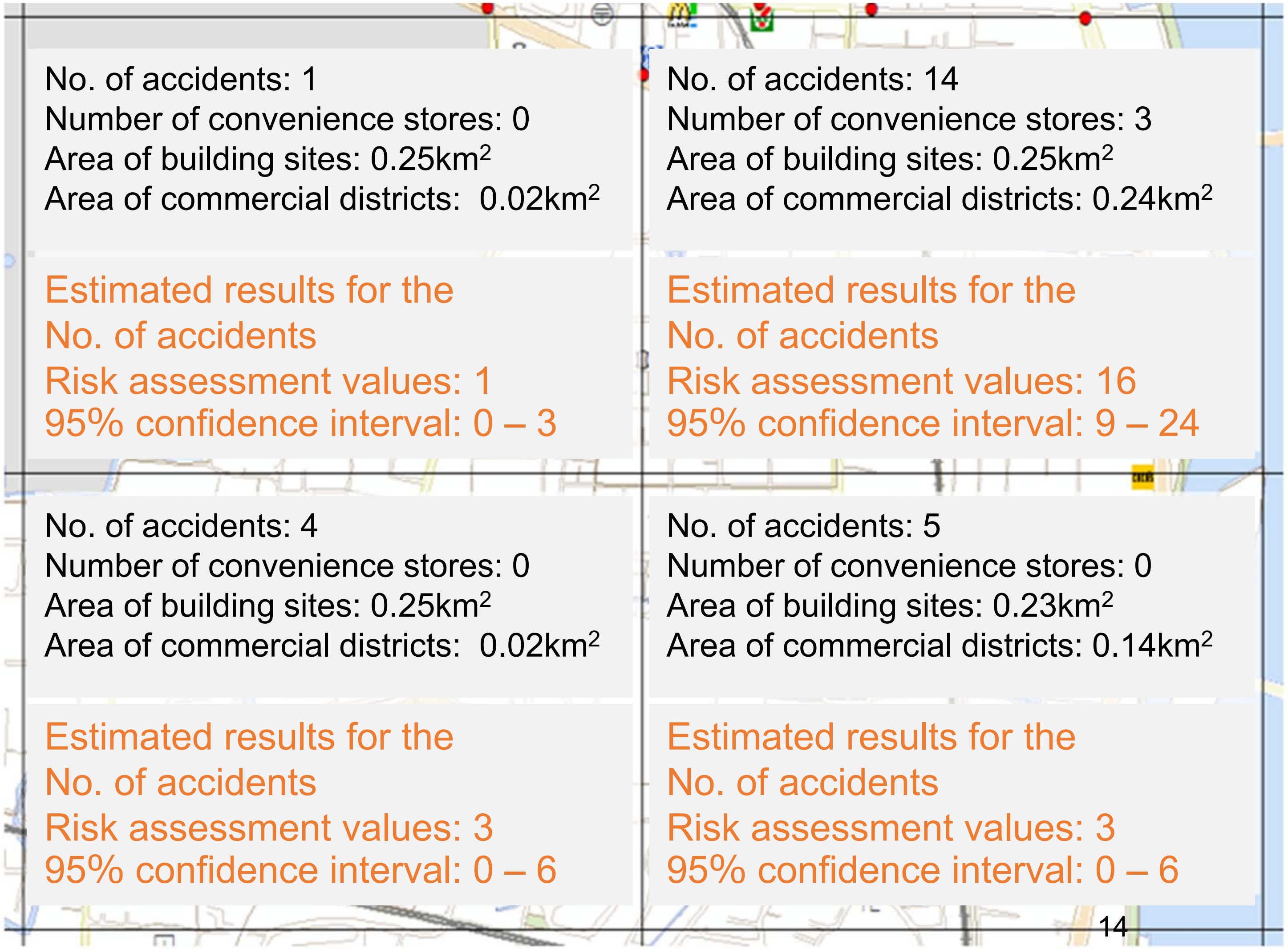


- ○ More than 90% of the meshes fall within the risk assessment value (λk) range of ±2 in all prefectures; More than 99% of the meshes fall within a 95% confidence interval

	Share of meshes that fall within assessment value of ±1	Share of meshes that fall within assessment value of ±2	Share of meshes that fall within a 95% confidence interval
Tokyo	73.0%	91.5%	99.7%
Shiga Prefecture	97.5%	99.4%	99.5%

3. Analyses of the results of estimating parameters and assessment results via the assessment model for pedestrians (examples from certain districts in Shiga Prefecture)

Example) Four meshes located in Shiga Prefecture (numbers in the risk assessment values after the decimal point were rounded up)



No. of accidents: 1
Number of convenience stores: 0
Area of building sites: 0.25km^2
Area of commercial districts: 0.02km^2

Estimated results for the No. of accidents
Risk assessment values: 1
95% confidence interval: 0 – 3

No. of accidents: 14
Number of convenience stores: 3
Area of building sites: 0.25km^2
Area of commercial districts: 0.24km^2

Estimated results for the No. of accidents
Risk assessment values: 16
95% confidence interval: 9 – 24

No. of accidents: 4
Number of convenience stores: 0
Area of building sites: 0.25km^2
Area of commercial districts: 0.02km^2

Estimated results for the No. of accidents
Risk assessment values: 3
95% confidence interval: 0 – 6

No. of accidents: 5
Number of convenience stores: 0
Area of building sites: 0.23km^2
Area of commercial districts: 0.14km^2

Estimated results for the No. of accidents
Risk assessment values: 3
95% confidence interval: 0 – 6

● Accident sites

3. Analyses of the results of estimating parameters and assessment results via the assessment model for pedestrians

○ Risk assessments results: The risk assessment values for pedestrian accidents by mesh are accurate enough that they can be used onsite (specified as having a 95% confidence interval when provided)

○ Factors giving rise to risk: In addition to (1) Number of convenience stores, (2) Area of building sites, (3) Area of commercial districts, and (4) Road extensions set via the explanatory variables and offset items, **the random effects must also be analyzed**

<Analysis results for the random effects>

(1) The larger a metropolitan region the stronger its spatial autocorrelation, with the number of accidents being similar in adjoining meshes (adjacency effect). The ρ parameter, which expresses how strong the spatial autocorrelation is, is 1.0 for all of the prefectures with major metropolitan regions

(2) The risk assessment values (λk) for each mesh differ to some degree for each prefecture, but when the fluctuations in the random effects are averaged the fluctuations are between 0.6 – 1.7-fold within a range of ±σ (σ is the standard deviation for the random effects)

↓

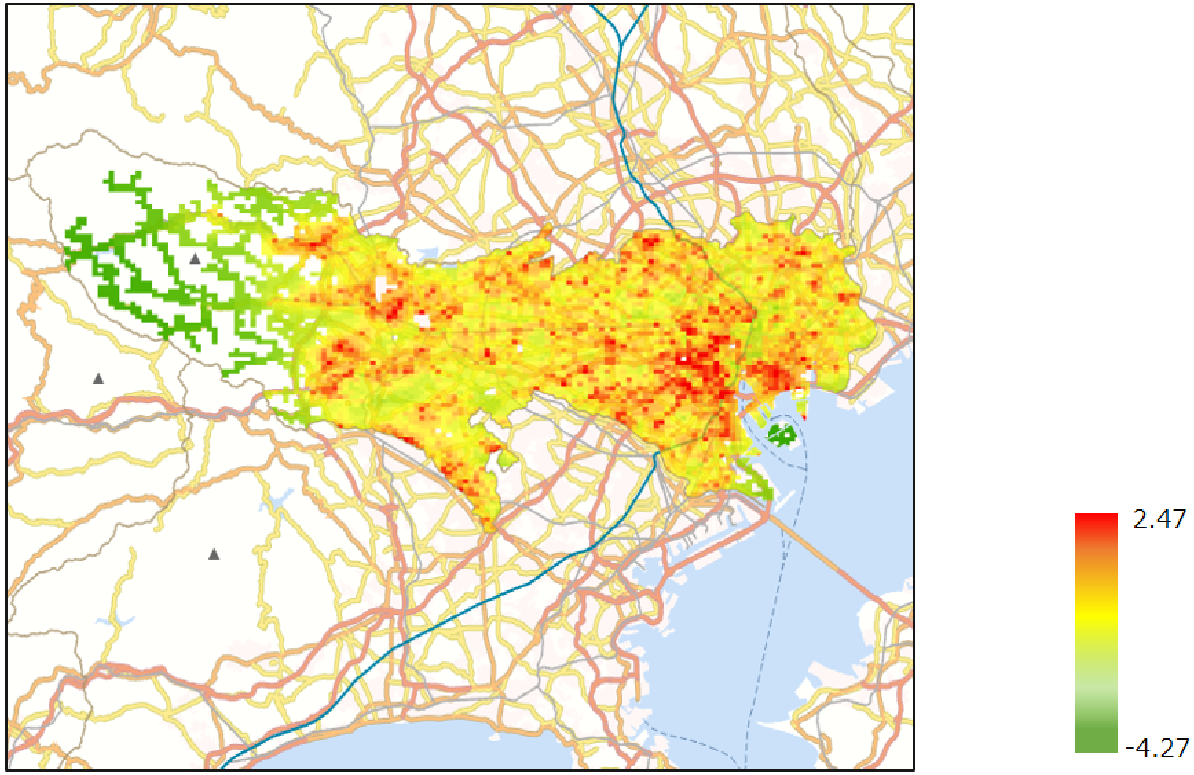
This reveals a dispersion of the risk assessment values for each mesh due to the three explanatory variables, road extensions, and factors other than the adjacency effect

A factor analysis was performed on the fluctuation in the random effects by analyzing those meshes in which there were extreme discrepancies between the risk assessment values from the assessment model and the actual values

3. Analyses of the results of estimating parameters and assessment results via the assessment model for pedestrians

Distribution of random effects
(districts with a strong spatial autocorrelation: ρ＝1.0)

<Example: Tokyo>

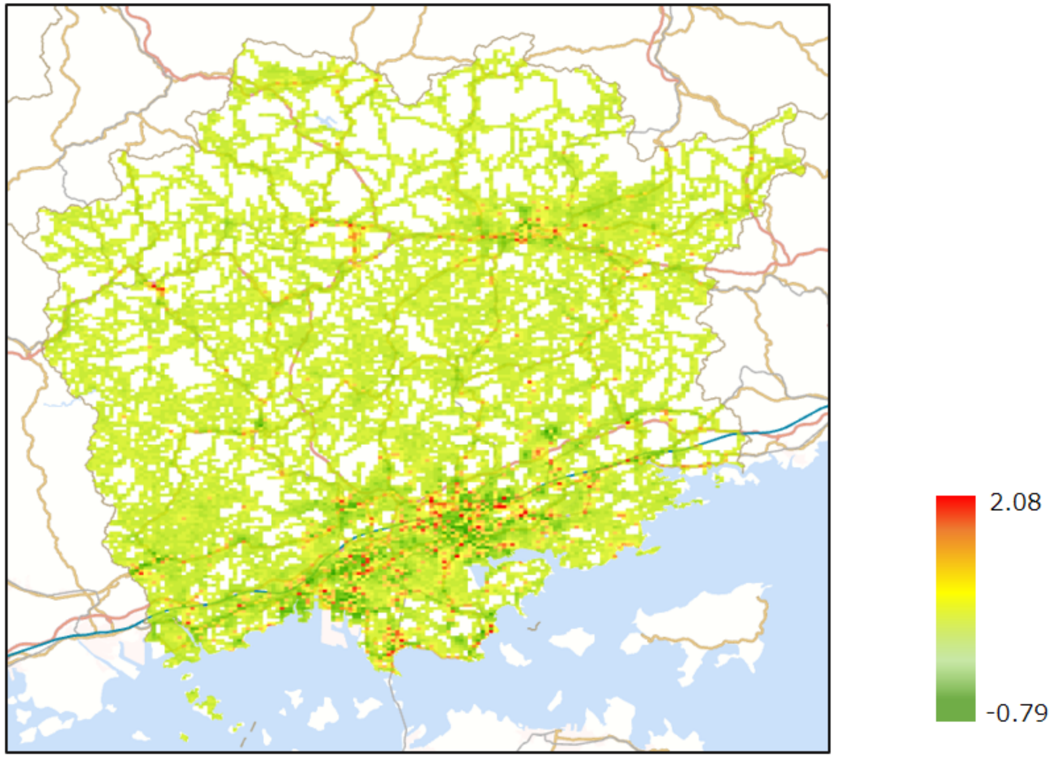


Since the spatial autocorrelation is strong and the random effects for adjacent meshes are similar to one another, gradation has been applied

3. Analyses of the results of estimating parameters and assessment results via the assessment model for pedestrians

Distribution of random effects
(districts with a weak spatial autocorrelation: $\rho=0.1$)

<Example: Okayama Prefecture>



The spatial autocorrelation is weak and the random effects are dispersed, even for adjacent meshes

4. Analysis of meshes with a significant divergences between the assessment results from the assessment model (risk assessment values) and the actual values

<Divergences tended to be larger in meshes with four or more accidents>

- The random effects were considerably larger than the average value with the spatial autocorrelation factored in

<Divergences tended to be smaller in meshes with three or fewer accidents>

- The random effects were considerably smaller than the average value with the spatial autocorrelation factored in

- **For meshes with a significant discrepancy between their risk assessment values and actual values, factors giving rise to this discrepancy were specifically identified, as were the factors behind the fluctuation in the random effects**

<Reference> Equation expressing the prior distribution of random effects (reprinted)

Fluctuation due to external variables that are difficult to index
↓

$$\phi_k|\phi_{-k}, W, \tau^2, \rho \sim \mathcal{N}\left(\frac{\rho\sum_{i=1}^{K} w_{ki}\phi_i}{\rho\sum_{i=1}^{K} w_{ki}+1-\rho}, \frac{\tau^2}{\rho\sum_{i=1}^{K} w_{ki}+1-\rho}\right),$$

↑
Average value with the spatial autocorrelation factored in (adjacency effects)

$$\phi_{-k} = (\phi_1, \ldots, \phi_{k-1}, \phi_{k+1}, \ldots, \phi_K),$$

For weighing matrix W, if mesh k and mesh i share a border then corresponding factor w_{ki} is defined as equaling 1, but if this is not the case w_{ki} is defined as being equal to 0.

4. Analysis of meshes with a significant divergences between the assessment results from the assessment model (risk assessment values) and the actual values

＜Selecting meshes to be analyzed＞

○ Meshes where numerous (four or more) accidents occurred than the risk assessment values (136 meshes: Approximately 0.03% of the total)

○ Meshes where fewer (three or less) accidents occurred than the risk assessment values (54 meshes: Approximately 0.01% of the total)

<Analysis results>

○ **Major factors producing larger divergences**

- **Insufficient traffic safety measures**, such as lack of intersection improvements and lack of sidewalk development for major roadway development: 135 locations (99%) (Problems with intersections: 119 locations (88%); Problems with major roadway development: 39 locations (29%))
- **Underestimations resulting from large parks, river areas, and so forth** despite the large volume of traffic and numerous pedestrians in meshes in the downtown areas of metropolitan regions: 45 locations (33%)
- Abnormal increases in the volumes of both automobile and pedestrian traffic due to the **installation of shopping centers not included in the area of commercial districts**: 25 locations (18%)
- Abnormal increases in the volume of pedestrian traffic on a temporary basis due to **well-known tourist attractions and large-scale convention centers and sports facilities**: 11 locations (8%), etc.

4. Analysis of meshes with a significant divergences between the assessment results from the assessment model (risk assessment values) and the actual values

○ **Major factors producing smaller divergences**

- **Proper implementation of traffic safety measures on community roads**: 51 locations (94%)
- **Improvements completed for intersections along major roadways**: 36 locations (67%)
- **Community roads developed in a grid format / structures making it difficult for through-traffic to enter**: 30 locations (56%)
- **Lower risk of pedestrian accidents in proportion to the area of commercial districts that only contain small facilities that attract customers**: 19 locations (35%), etc.

<Summary of the analysis results>

(1) **Major factors behind the fluctuations in the random effects include differences in the traffic safety measures and road development status for each mesh**
→ Difficult to index, must be surveyed individually

(2) **Consideration must be given to explanatory indicators to replace the area of commercial districts**

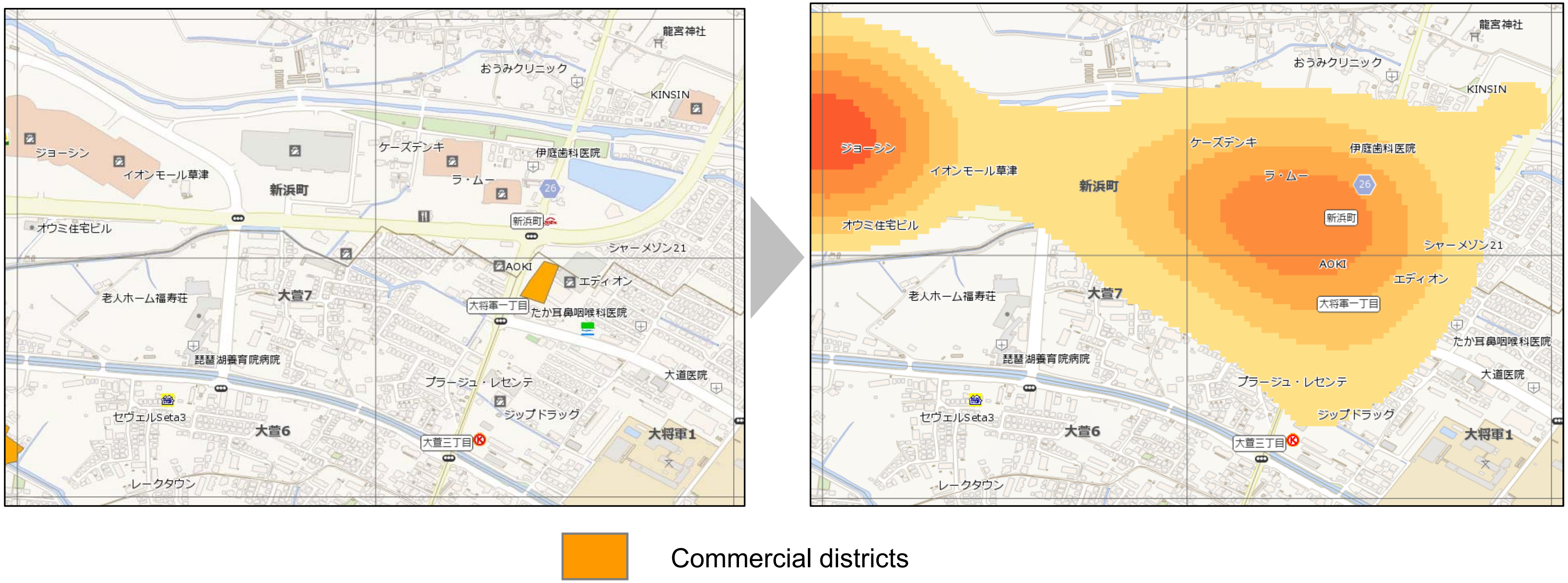
(3) Impact from well-known tourist attractions, large convention centers and sports facilities, etc.
→ Difficult to index, countermeasures must be reviewed individually

(4) Out of consideration for the impact from river areas in the downtown areas of metropolitan regions, **offset items are to be updated from road extensions to kilometers travelled**
→ Difficult to index given current conditions, consider the "Number of signalized intersections," which is believed to be correlated with kilometers travelled, as a new explanatory variable

5. Improvements for the assessment models and risk assessment results from the models following the improvements

Improvement (1):

Shopping centers (big box commercial facilities) were added in place of the area of commercial districts; kernel density was estimated using the positional coordinates of department stores, supermarkets, cafes, family restaurants, fast food restaurants, banks, lodging facilities, and rest and leisure facilities; and the **"Area impacted by facilities that attract customers" was made an explanatory variable**

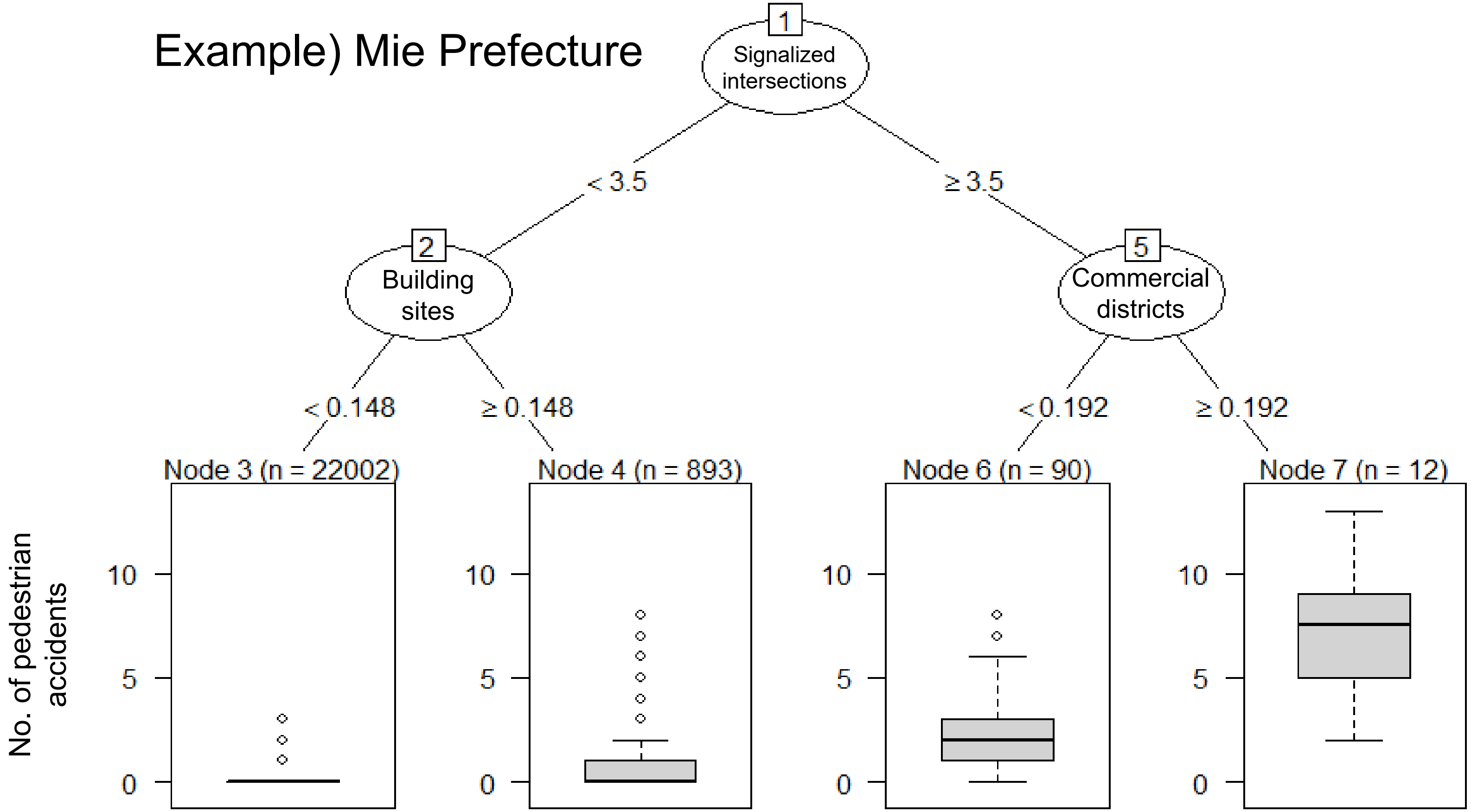


5. Improvements for the assessment models and risk assessment results from the models following the improvements

Improvements (2):

Instead of the “Number of intersections,” add in the “Number of signalized intersections,” which has a strong correlation to the kilometers travelled in each mesh, in its place to perform the decision tree analysis. Clearly establish that the **“Number of signalized intersections” newly serves as an explanatory indicator candidate**

Example) Mie Prefecture



5. Improvements for the assessment models and risk assessment results from the models following the improvements

Improvement (3):

When the correlation coefficient between explanatory variables is 0.7 or greater, **only one explanatory indicator is to be adopted based on whichever one had the lower widely applicable information criterion (WAIC) for indicators, which evaluates the degree of incompatibility of the GLMM** (to avoid multiple collinearity resulting from having four explanatory variables). However, if the correlation coefficient for the number of convenience stores and the area affected by facilities that attract customers is 0.7 or greater, **then the area affected by facilities that attract customers, including convenience stores, is to be newly established for this**

< Summary of the assessment results from the assessment model following the improvements >

○ Excellent estimated results regarding the parameters
○ More than 99% of meshes fell within a 95% confidence interval for all districts
○ The WAIC resulted in improvements across all prefectures except for Shizuoka Prefecture, and the degree to which this worsened in Shizuoka Prefecture was negligible (14,037 → 14,050) ⇒ **Changed to a more highly relevant assessment model**

	Share of meshes that fall within assessment value of ±1		Share of meshes that fall within assessment value of ±2		Share of meshes that fall within a 95% confidence interval		WAIC	
	Before improvements	After improvements	Before improvements	After improvements	Before improvements	After improvements	Before improvements	After improvements
Tokyo	73.0%	84.3%	91.5%	95.2%	99.7%	99.8%	17,978	17,947
Shiga Prefecture	97.5%	98.4%	99.4%	99.5%	99.5%	99.4%	4,412	4,291

5. Improvements for the assessment models and risk assessment results from the models following the improvements

< Summary of the assessment results from the assessment model following the improvements (continued) >

○ Standard deviation for the random effects from meshes surrounded by eight other meshes
⇒ Improved from 0.53 to 0.48 as an average of 31 prefectures. **In order to dramatically improve this, consideration must be given to using traffic safety measures and the development status of roads as indicators at the individual mesh level**

○ Replace the area of commercial districts with the area affected by facilities that attract customers
⇒ Using the area of commercial districts that resulted in underestimates, improvements were achieved for 24 of the 25 meshes underestimated by the risk assessment values, and for 18 of the 19 meshes that were overestimated (no improvement was seen with the remaining two meshes) ⇒ **Improved by and large**

○ 45 meshes for which the risk assessment values resulted in underestimates due to river areas and the like in meshes for the downtown areas of metropolitan regions
⇒ The “Number of signalized intersections” will be used as an explanatory variable, and while improvements were seen in 32 meshes, there were no improvements in 13 meshes
⇒ **Consideration must be given to using kilometers travelled as an offset item**

6. Future applications and challenges for further improvements to the model

<Future applications>

Initiatives to reduce pedestrian accidents will be carried out in a continuous manner via safety measures for school routes, establishing “Zone 30,” registering “Safe Pedestrian Areas,” and through the PDCA cycle. In addition, the following countermeasures will be proposed through the use of the risk assessment model for pedestrian accidents, and consideration will be given to accidents to which children and the elderly fall victim along school routes and in zones of daily life

Proposal (1):

Identify meshes in which roughly five or more pedestrian accidents occur over three years where the upper values for the 95% confidence interval are exceeded (meshes for which there is a strong possibility that countermeasures against pedestrian accidents have been insufficient) ⇒ Closely scrutinize factors that cause pedestrian accidents individually and consider countermeasures against pedestrian accidents at the district level, including the applicable meshes, as needed

(88 meshes (0.02%))

Proposal (2):

Identify meshes other than those in Proposal (1) in which roughly 20 or more accidents occurred in prefecture with major metropolitan regions or in which roughly 10 or more accidents occurred in other prefectures over three years. Closely scrutinize factors that cause pedestrian accidents individually and consider countermeasures against pedestrian accidents at the district level, including the applicable meshes, as needed

(270 meshes with 20 accidents or more (0.05): 6.1% accident occurrence)

*** 243 meshes (90%) in Tokyo, Kanagawa, Chiba, Saitama, Aichi, Osaka, Kyoto, Hyogo, and Fukuoka**

(1,618 meshes with 10 or more accidents (0.3%): 19.6% accident occurrence * Including 9 meshes for Proposal (1)

6. Future applications and challenges for further improvements to the model

<Future plans>

○ This fiscal year, a risk assessment model for accidents involving cyclists will be developed

○ Both pedestrian accidents and those involving cyclists are accidents that frequently occur near zones of daily life
⇒ Ideally, countermeasures should be addressed at the same time at the district level

○ **There are plans to provide assessment results on the risk of pedestrian accidents and the risk of those involving cyclists for each mesh sometime in FY2019 by using traffic accident data from 2016 – 2018 with a focus on 36 prefectures (this will also be provided for the remaining prefectures in sequence after its accuracy has been confirmed)**

○ **A Manual on Using the Results of Risk Assessments on Traffic Accidents (Draft) will be prepared in aiming to offer it simultaneously so as to promote its use onsite**

<Six challenges for improving the model>

Challenge (1):	Improve the accuracy of latitudinal and longitudinal information on traffic accidents
Challenge (2):	Research on differences in the risk of accidents by prefecture
Challenge (3):	Research on factors causing the different spatial autocorrelation from region to region
Challenge (4):	Use indicators expressing the implementation status of countermeasures against pedestrian accidents, such as extensions of undeveloped sidewalks along major roadways, as explanatory indicators
Challenges (5):	Use kilometers traveled by mesh as an offset item
Challenges (6):	Improve the accuracy of the area affected by facilities that attract customers by weighting said facilities

Thank you for your kind attention

This study was compiled together based on advice from the Review Committee for the Advancement of Risk Assessment Models for Traffic Accidents (Chaired by Professor Hirokazu Akahane of the Chiba Institute of Technology) that was established in ITARDA. Moreover, the major results of the study were compiled based on the guidance of the director of the Road Bureau in the FY2017 Review Work for Traffic Safety Measures via Traffic Accident Analyses and Risk Assessments for Business Vehicles commissioned by the Road Bureau of the Ministry of Land, Infrastructure, Transport and Tourism.