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Research on Methods for Identifying Accident-Prone Areas with an Urgent Need for "Zone Measures" on Residential Roads

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1. Introduction

(1) Background and purpose of this research

Approximately half of all road traffic accidents involving fatalities (limited to casualty accidents, the same applies hereinafter in this research) occur while walking or riding a bicycle. Additionally, approximately half of these occur within 500 meters of the victim's home.(1)

To address such accident occurrences, “zone measures” for residential roads have been promoted nationwide since the “Community Zone Formation Project” was started by Japan’s Ministry of Land, Infrastructure, Transport and Tourism (MLIT) in 1996, which aim to create traffic environments where local residential roads can be used safely and securely.[a] Since 2021, safety measures that combine traffic regulations with physical devices have also been promoted by MLIT under the name “Zone 30 Plus”.(2)

In considering “zone measures”, technical knowledge is accumulated regarding investigation and analysis methods for issues faced by the area in question (such as accidents and their causes, and traffic conditions) as well as methods for formulating measures. Furthermore, technical standards including “Technical Standards for Installing Raised Sections, Narrowed Sections, and Curved Sections” (MLIT)(3) and manuals such as the “Revised “zone measures” Manual for Residential Roads” (Japan Society of Traffic Engineers (JSTE))(4) have been implemented and published. However, although identifying and prioritizing dangerous areas in urgent need of measures using quantitative indicators is important for the effective and efficient implementation of “zone measures”, the methods for doing so have not yet been fully established.

The goal of this research is to formulate and verify methods of identifying areas with an urgent need for “zone measures” by determining what types of aggregated data and indicators are most suitable for that purpose.

(2) Current issues and alternatives

As a useful tool for identifying areas with an urgent need for “zone measures”, the Institute for Traffic Accident Research and Data Analysis (ITARDA) has published a "Residential Road Accident Mesh Map," which visualizes the number of accidents on municipal roads, etc.,[b] by 4th-level mesh. However, since 4th-level mesh data mechanically divides areas without considering factors such as terrain, areas with frequent accidents may not necessarily align with those that have an urgent need for “zone measures”, presenting a challenge in

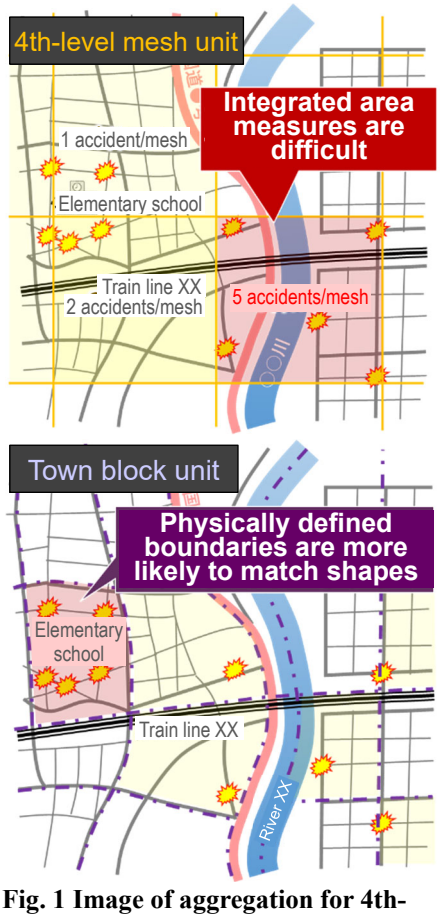

Fig. 1 Image of aggregation for 4th-level mesh units and town block units

[a] These measures are implemented in urban areas and similar locations within zones defined by wide arterial roads, rivers, or other physical boundaries, and are aimed at ensuring safety across the entire area. Physical devices (such as speed humps and narrowed lanes) are installed within the area and at boundary points. These, together with traffic regulations, are designed to make drivers aware of the differences in traffic and roadside environments between the area roads and arterial roads. They also aim to alert drivers, reduce driving speeds, and restrict through traffic.

[b] Roads excluding national roads, major prefectural roads, general prefectural roads, and expressways.

identifying such areas.

Therefore, in this research, a method for aggregating the fatal and injury accident density by town block unit will be formulated as an alternative.

Since town block boundaries are more likely to align in shape with physical boundaries such as arterial roads and rivers than 4th-level mesh boundaries, it is considered advantageous for identifying areas with an urgent need for integrated area-based measures (エラー! 参照元が見つかりません。). Unlike with 4th-level mesh, because town blocks vary in size, the number of accidents is divided by the area of each town block to normalize it as the 'accident count per unit area (fatal and injury accident density)', which will be used as the indicator.

2. Research Method

(1) Research procedure

The procedure used in this research is as follows.

1) The accident data (accidents occurring between FY2018 and FY2022) and the town block and village boundary data (from the R2 national census town block and village boundary data, Japan's Ministry of Internal Affairs and Communications (MIC)) are overlaid in a GIS (Geographic Information System), with the number of accidents (limited to accidents on municipal roads, the same applies hereafter in this research) being aggregated by town block unit.
2) Fatal and injury accident densities for each town block are aggregated using the following indicators.
   [Indicators to be verified]
   I. $\frac{\text{Total number of accidents [per 5 years]}}{\text{Town block area [km2]}}$
   II. $\frac{\text{Number of accidents on roads with a lane width of less than 5.5 meters [per 5 years]}}{\text{Town block area [km2]}}$
   III. $\frac{\text{Number of pedestrian and bicycle accidents within 500 meters of the victim's home [per 5 years]}}{\text{Town block area [km2]}}$
3) For each indicator, we will examine which town blocks rank highest in fatal and injury accident density, check aerial photographs of the top-ranking town blocks, and review the accident occurrence situation, which will help in identifying the characteristics and issues associated with each indicator.

(2) Targeted regions

Analysis will focus on Hokkaido, Tokyo, Chiba, and Kagawa prefectures, as these regions are characterized by distinctive land use and town block composition.

3. Research results

Verification results for the characteristics and issues of each indicator are shown below.

Indicator I:

$$\frac{\text{Total number of accidents [per 5 years]}}{\text{Town block area [km2]}}$$

The simplest indicator uses the total number of accidents within a town block as the numerator. Fig. 2 Example 1 of top-ranking town blocks for Indicator I and Fig. 3 Example 2 of top-ranking town blocks for Indicator I show the locations of accidents with distinctive accident patterns as in identified top-ranked town blocks.

In the town block shown in Fig. 3 Example 2 of top-ranking town blocks for Indicator I, accidents occur in various locations across the area's roads, indicating an urgent need for overall improvements safety. It can therefore be said that “zone measures” are suitable for this town block. However, the accidents in the town block shown in Fig. 2 Example 1 of top-ranking town blocks for Indicator I are concentrated on arterial roads, while large swaths within the same area have no accidents, indicating a low need to enhance safety across the entire town block and making “zone measures” unsuitable. Instead, section-specific measures to improve safety on the specific roads or segments with frequent accidents would be more suitable.

Using Indicator I resulted in the identification of more town blocks where “zone measures” are unsuitable, such as in Fig. 2 Example 1 of top-ranking town blocks for Indicator I, than in the identification of town blocks where “zone measures” are suitable, such as in Fig. 3 Example 2 of top-ranking town blocks for Indicator I. It is therefore considered undesirable to use Indicator I for identifying areas with an urgent need for “zone measures”.

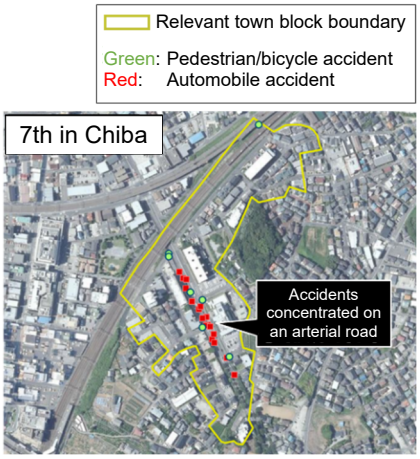

Fig. 2 Example 1 of top-ranking town blocks for Indicator I

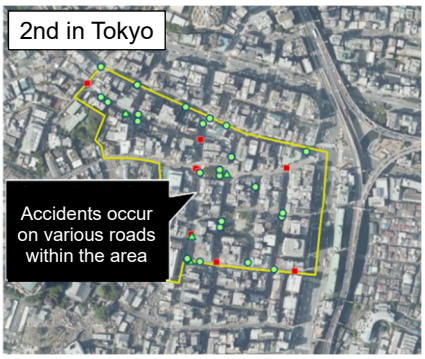

Fig. 3 Example 2 of top-ranking town blocks for Indicator I

Indicator II:

$$\frac{\text{Number of accidents on roads with a lane width of less than 5.5 meters [per 5 years]}}{\text{Town block area [km2]}}$$

This indicator—which focuses on road width—uses the number of accidents on roads with a lane width of less than 5.5 meters as the numerator. As an example of identifying top-ranked town blocks, Fig. 4 Example of top-ranking town blocks for Indicator II shows accident locations in the three top-ranking town blocks in Tokyo.

In the top-ranked town blocks, accidents occur in various locations across the area's roads, making it possible to identify many town blocks where “zone measures” are suitable. Indicator II is therefore considered is suitable for identifying areas with an urgent need for “zone measures”.

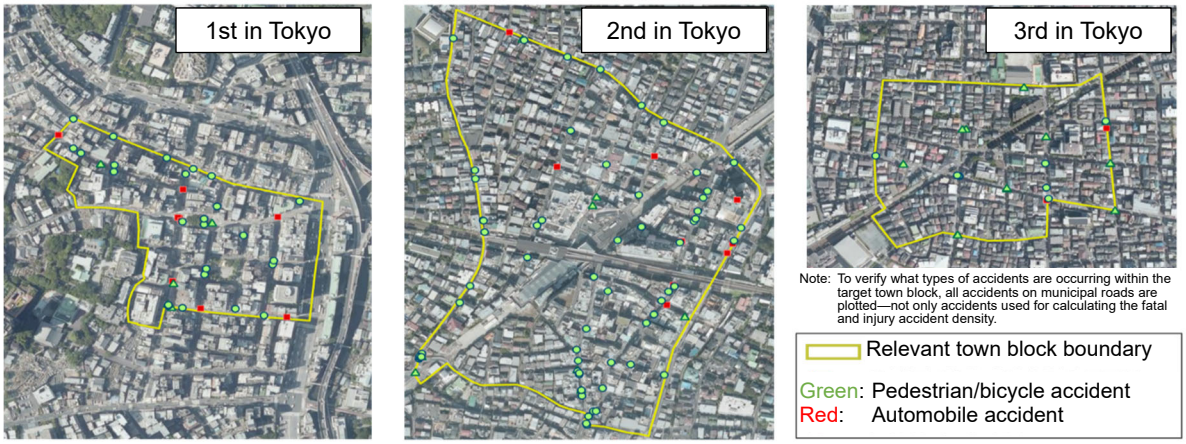

Fig. 4 Example of top-ranking town blocks for Indicator II

Indicator III:

Number of pedestrian and bicycle accidents within 500 meters of the victim's home [per 5 years]
Town block area [km2]

Considering the circumstances regarding fatal accident occurrences as shown in (1), this indicator uses the number of pedestrian and bicycle accidents within 500 meters of a victim's home as the numerator. Fig. 5 Example of top-ranking town blocks for Indicator III shows one of the top-ranked town blocks. Even among the top-ranked town blocks, there were many cases where such accidents are not as frequent on the area's roads, as shown in Fig. 5 Example of top-ranking town blocks for Indicator III.

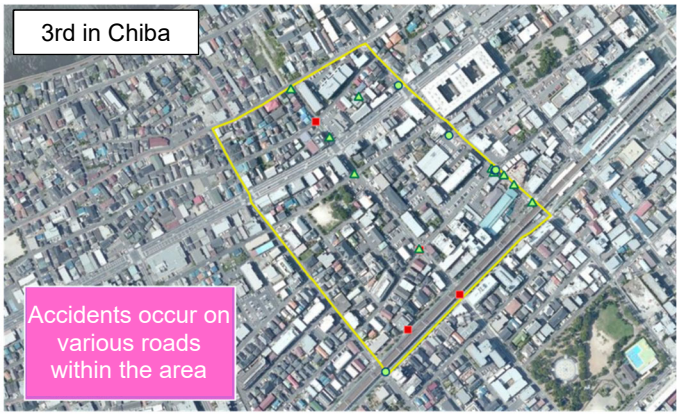

Fig. 5 Example of top-ranking town blocks for Indicator III

Because the "number of pedestrian and bicycle accidents within 500 meters of a victim's home" does not necessarily reflect the number of accidents on an area's roads, it is considered undesirable to directly use Indicator III for identifying areas with an urgent need for "zone measures". However, when considering priorities, it may be possible to use this as a secondary indicator for further refinement after identifying such areas using Indicator II.

4. Conclusion and Future Issues for Research

(1) Research results

In this research, a method for identifying accident-prone areas with an urgent need for "zone measures" at the "town block" level was developed, and the suitability of different indicators was examined. As a result, a method

of using fatal and injury accident density—calculated by dividing 'the number of accidents on municipal roads within the town block having a lane width of less than 5.5 meters' by the 'town block area'—as an indicator was found to be suitable for identifying areas with an urgent need for "zone measures".

(2) Future issues for research

In this research, a method for identifying areas at the town block level was examined, but because the areas and shapes of town blocks are highly diverse, the areas where "zone measures" should be implemented do not necessarily align with town block boundaries. Therefore, it is necessary to consider methods for setting the boundaries of areas requiring "zone measures".

Additionally, although this research examined an indicator normalized by "number accidents per unit area (fatal and injury accident density)", this indicator does not take the effects of population density differences into account, causing town blocks with higher population densities to rank higher. In response to this, it is considered important to examine methods for identifying accident-prone areas that take such population densities into account.

[References/Sources]

(1) Ministry of Land, Infrastructure, Transport and Tourism (MLIT), "Situation of traffic accidents – Ministry of Land, Infrastructure, Transport and Tourism", Ministry of Land, Infrastructure, Transport and Tourism website, https://www.mlit.go.jp/road/road/traffic/sesaku/jiko_anzentaisaku.html, (referenced September 9, 2024)

(2) Ministry of Land, Infrastructure, Transport and Tourism (MLIT), "History of Measures for Residential Roads", Ministry of Land, Infrastructure, Transport and Tourism website, https://www.mlit.go.jp/road/ir/ir-council/life_road/pdf01/5.pdf, (referenced September 9, 2024)

(3) Ministry of Land, Infrastructure, Transport and Tourism (MLIT), "Technical Standards for Installing Raised Sections, Narrowed Sections, and Curved Sections (Urban Bureau and Road Bureau Director's Notification, March 31, 2016)", Ministry of Land, Infrastructure, Transport and Tourism website, https://www.mlit.go.jp/road/sign/kijyun/pdf/20160331totubukyousakukukkyoku.pdf, (referenced September 9, 2024)

(4) Japan Society of Traffic Engineers (JSTE), 2017, "Revised 'Zone Measures' Manual for Residential Roads", Maruzen Publishing Co., Ltd.

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