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Identification of locations where accidents frequently occur using data on accidents involving property damage data and analysis of accident patterns

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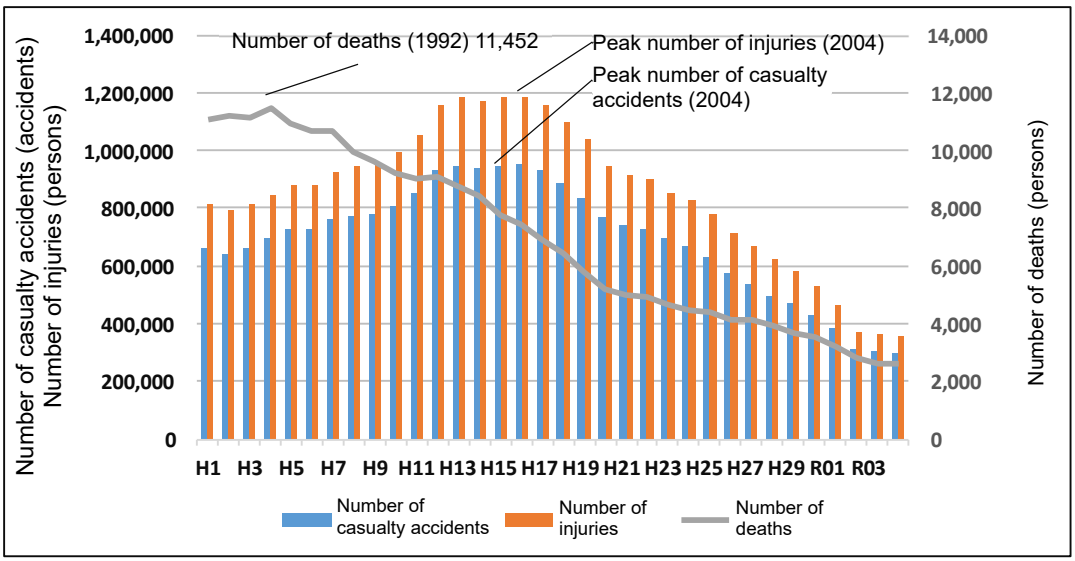
1. Introduction

The number of fatal accidents nationwide in Japan peaked in 2004 level at 952,720. Subsequently, as a result of traffic safety measures taken by organizations, such as those involved in public safety, road construction, and automobile manufacturing, the number of casualty accidents has been on a downward trend, decreasing to 300,839 as of 2022, or approximately 30% of the 2004 peak (see Fig. 1).



Despite this nationwide decrease in casualty accidents, a traffic white paper issued by the Ibaraki Prefectural Police has shown that accidents involving property damage had been on an upward trend until 2018 (see Fi g. 2).

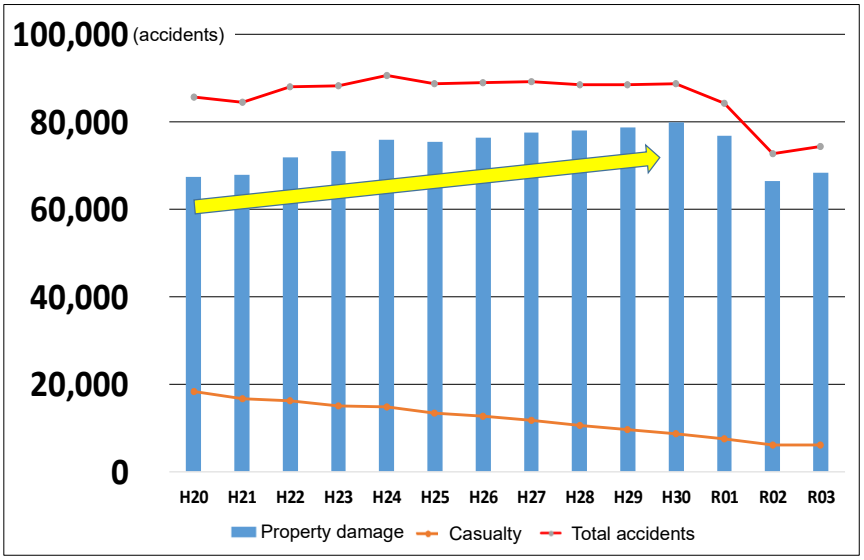


Fig. 2 - Trends in casualty accidents and accidents involving property damage in Ibaraki Prefecture

Because accidents involving property damage could potentially turn into casualty accidents depending on the circumstances, any increase in such accidents is undesirable, and it is extremely important to identify accident-prone areas using data on accidents involving property and conducting accident analysis.

Therefore, in this study, I utilized database of accidents involving property damage (approx. 300,000 accidents from 2015 to 2018) provided by the Ibaraki Prefectural Police in order to conduct the following:

(1) Macro analysis aimed at assessing the characteristics of accidents involving property damage by

comparing them with casualty accidents

(2) Identification of locations where accidents involving property damage frequently occur using a Geographic Information System (GIS)

(3) Accident pattern analysis of locations where accidents involving property damage frequently occur

2. Macro analysis

Macro analysis was performed by comparing the details of accidents involving property damage with casualty accidents in terms of road type, road shape, accident type, and time of occurrence.

2-1. Road type

When comparing the percentages of accidents that occurred on expressways, national highways, major prefectural roads, and prefectural roads (hereinafter collectively referred to as "trunk roads") with those that occurred on local municipal roads (hereinafter referred to "community roads"), I found that most casualty accidents occurred on trunk roads (trunk roads: 57%, community roads: 38%), while accidents involving property damage occurred almost equally on both types of roads (trunk roads: 38%, community roads: 34%). Furthermore, I found that 24% of accidents involving property damage took place in locations such as parking lots (referred to as "location of general traffic" in accident reports), indicating that more accidents involving property damage occur on community roads and parking lots than do casualty accidents.

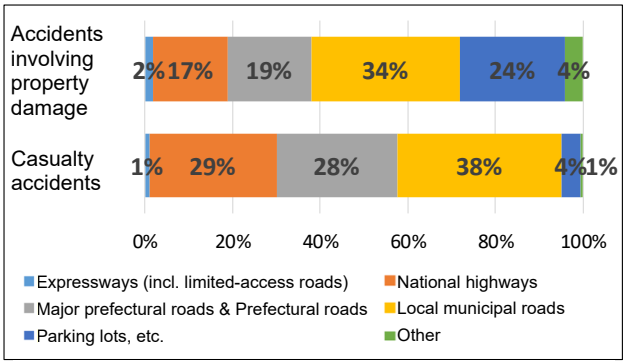


Fig. 3 - Percentages by Road Type (2015 to 2018)

2-2. Road shape

When comparing the percentages of accidents involving property damage and casualty accidents that occurred at intersections or near intersections (hereinafter referred to "intersections, etc.") with those that occurred at non-intersections, I found that 52% of casualty accidents occurred at intersections, etc. and 43% occurred at non-intersections, while 38% of accidents involving property damage occurred at intersections, etc. and 31% at non-intersections. On the other hand, when comparing the percentages of accidents that occurred at intersections with those that occurred near intersections, I found that 35% of casualty accidents occurred at intersections while 17% occurred near intersections for a ratio of nearly 2:1. In the case of accidents involving property damage, I found that 22% occurred at intersections while 16% occurred near intersections for a ratio of nearly 2:1.5, indicating that accidents involving property damage occur more frequently near intersections.

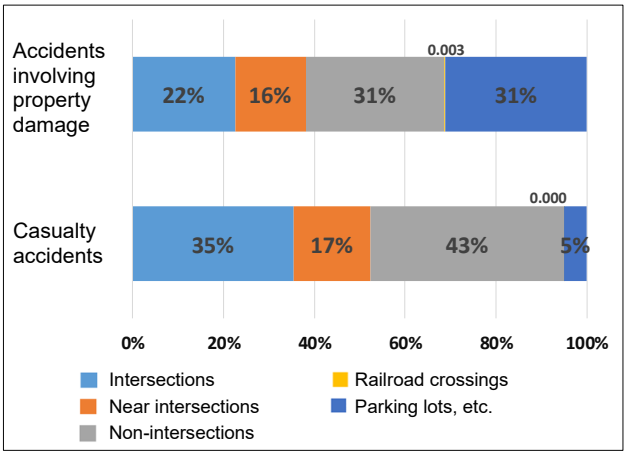


Fig. 4 - Percentages by Road Shape (2015 to 2018)

2-3. Accident type

Although rear-end collisions accounted for nearly 40% of casualty accidents, in the case of accidents involving property damage, I found that rear-end collisions, crossing collisions, and vehicle-vehicle accidents, etc., each accounted for roughly 20% of all accidents. I also observed that single-vehicle accidents accounted for the largest proportion of accidents involving property damage at 33%. It can be assumed that the high number of single-vehicle accidents is due to any collision with a parked vehicle in a parking lot being considered a single-vehicle accident.

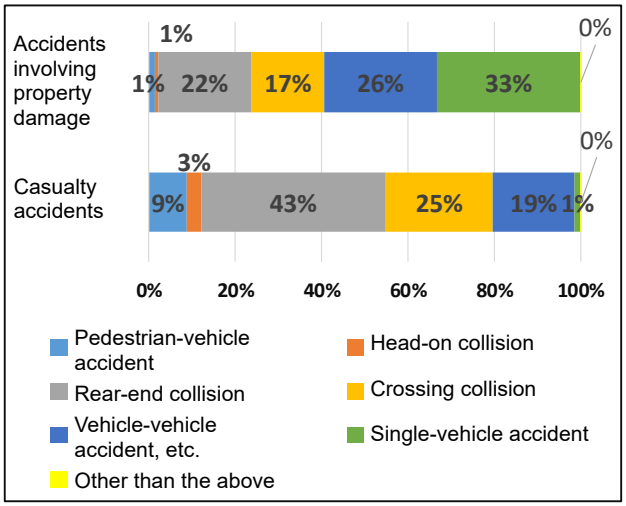


Fig. 5 - Percentages by Accident Type (2015 to 2018)

2-4. Time of occurrence

In the case of both casualty accidents and accidents involving property damage, the same trend has been observed in which most such accidents occur during work and school commuting hours in the morning and evening.

During work and school commuting hours, the percentage of casualty accidents is slightly higher than that of accidents involving property damage, while during mid-day hours, the percentage of accidents involving property damage is higher than that of casualty accidents.

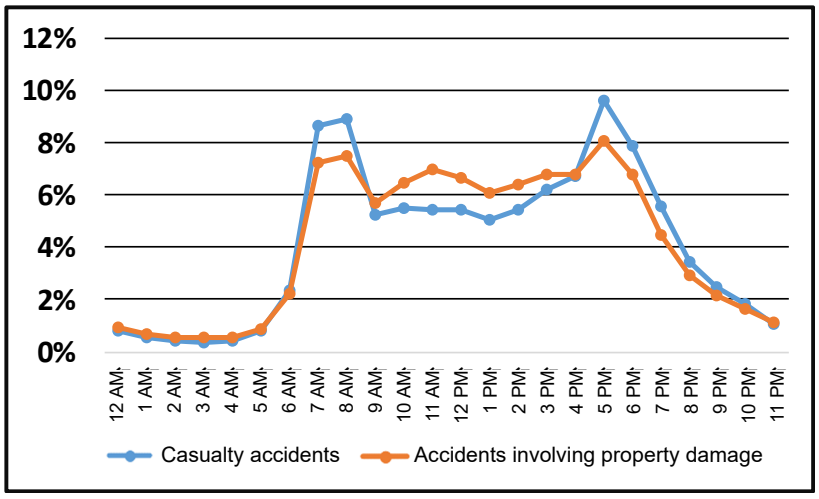


Fig. 6 - Percentages by Time of Occurrence

3. Identifying locations where accidents involving property damage frequently occur

During this research, I worked to identify intersections where accidents involving property damage frequently occur by using the coordinate data from the database for accidents involving property damage together with GIS.

Our general concepts regarding this identification method are:

(1) If within the circle of an arbitrary radius centered on the location of a given accident (referred to as the "frequent occurrence criteria"), a certain number of accidents involving property damage have occurred nearby (referred to as the "concentration criteria"), that circle is set aside for further investigation. (see Fig. 7)

(2) The same process is performed for all accidents involving property damage. (see Fig. 7)

(3) If any of the circles set aside for further investigations overlap, the outer circumference of each circle shall be in the same location. (see Fig. 8)

By examining combinations of concentration criteria (radius of circle) and frequent occurrence criteria (number of accidents involving property damage within the circle), the concentration criteria (radius) suitable for identifying intersections was 10 m while the frequent occurrence criteria was 30 accidents.

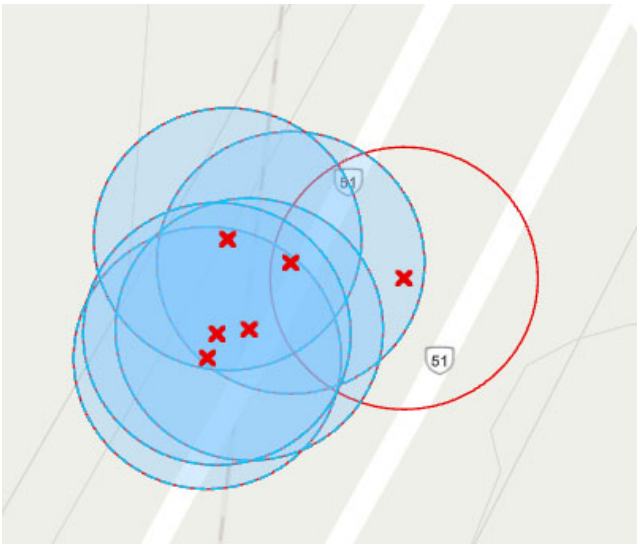


Fig. 7 - Image of circles (blue) set aside for further investigation

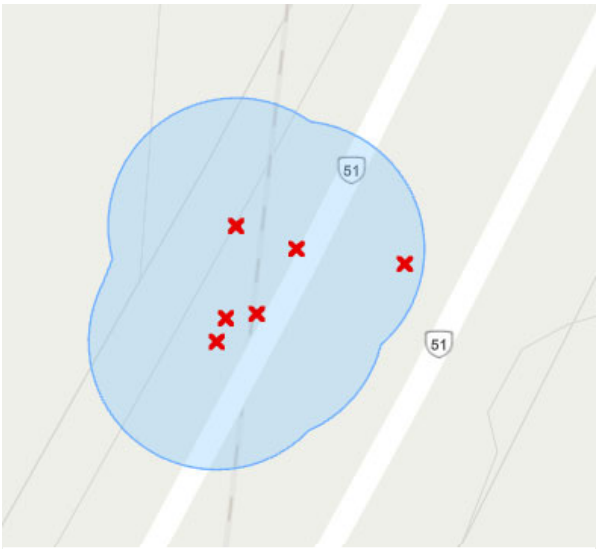


Fig. 8 - Image of locations identified as having frequent accidents involving property damage

Using these identification criteria (concentration criteria: 10 m radius, frequent occurrence criteria: 30 accidents), I were able to identify a total of 29 locations, including 16 intersections and 13 parking lots.

Accident pattern analysis was then conducted on these identified intersections where accidents frequently occur (16 intersections).

4. Accident pattern analysis of locations where accidents involving property damage frequently occur

4-1. Overview of locations where accidents frequently occur

When classifying these sixteen intersections by road type, nine intersections were located on trunk roads, while the remaining seven were located on community roads. When further classified by whether these intersections had a traffic signal or not, I found that two of the intersections had traffic signals, while the remaining 14 intersections did not (of these, two of them had only single-light traffic signals). (see Table 1)

	No. of intersections	Presence of traffic signal
Trunk road Trunk × Trunk Trunk × Community	9 locations	No traffic signal (7 locations) Traffic signal (2 locations)
Community road Community × Community	7 locations	No traffic signal (7 locations)

Table 1. Intersections where accidents involving property damage frequently occur (16 intersections)

I also used GIS to identify casualty accidents that had occurred at the identified locations where accidents frequently occur, which enabled me to collate the numbers of casualty accidents and accidents involving property damage. (see Fig. 9)

Because the number of casualty accidents that occur at intersections on community roads tends to be lower, they are considered potential locations for so-called latent casualty accidents. Conversely, when looking at the numbers of casualty accidents that occur at intersections on trunk roads, it can be seen that these are locations where both accidents involving property damage and casualty accidents frequently occur.

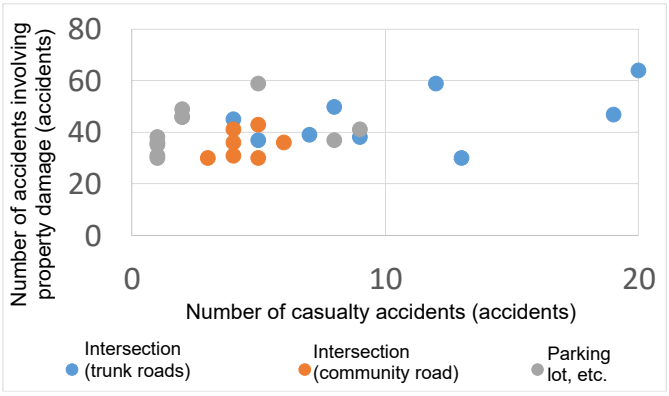


Fig. 9 - Numbers of casualty accidents and accidents involving property damage at the identified 29 locations

4-2. Accident pattern analysis

When conducting accident pattern analysis on intersections located on community roads, I analyzed intersections without traffic signals at which 36 accidents involving property damage and three casualty accidents had occurred. When analyzed by accident type, crossing collisions accounted for roughly the same amount of casualty accidents and accidents involving property damage. However, all of the casualty accidents involved a bicycle as the secondary party, while only seven of the 36 accidents involving property damage involved a bicycle. This leads me to feel that measures aimed at preventing bicycle-related accidents at these same locations are necessary.

When conducting accident pattern analysis on intersections located on trunk roads, I analyzed intersections without traffic signals at which 59 accidents involving property damage and 12 casualty accidents had occurred. When analyzing these intersections by accident type, I found that all casualty accidents had occurred due to rear-end collisions near the intersections. And, although a large number of the accidents involving property damage at these intersections were also due to rear-end collisions, crossing collisions were also responsible for three of these accidents, indicating that accidents involving property damage occurred within intersections at a different frequency than casualty accidents.

This leads me to feel that measures aimed at preventing accidents caused by crossing collisions at these same locations are necessary.

5. Summary

This research using data on accidents involving property damage enabled the following results to be obtained:

- I was able to use macro analysis to organize the characteristics of accidents involving property damage by comparing them with casualty accidents.
- I was able to construct methods of identifying intersections where accidents frequently occur by using coordinate data for accidents involving property damage together with GIS.
- Through accident pattern analysis performed on intersections where accidents involving property damage frequently occur, I was able to understand how these accidents occur in a different manner than casualty accidents, enabling me to identify possibly useful countermeasures.

<Acknowledgment>

This research was carried out using the database of accidents involving property damage provided by the Ibaraki Prefectural Police Headquarters. For this, I would like to express our sincere gratitude.

<Source>

Ibaraki Prefectural Police Headquarters Traffic White Paper (2021 Edition)
https://www.pref.ibaraki.jp/kenkei/a02_traffic/archives/white_paper/white_paper_r03.html