**Prediction of Road Safety Using Road/Traffic Big Data**

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**ABSTRACT**

In reflection of road expansion and increasing use rates, interest has increased in securing road safety. In addition, as natural disasters and calamities in cities are occurring more frequently than before, the necessity of systems and technologies to predict traffic information for safety is also emphasized. Accordingly, this study aims to investigate the technology of road safety prediction based on road big data. This study examines actual cases of road management systems and road safety analysis technologies, Korea and other countries. The types and usability of road information collected through a road management system are analyzed. Based on the result, the limitations of existing technologies and road management systems are analyzed. A number of related technologies and road management systems were examined using based on basic physical information such as distance, speed, etc. and past event information, and they do not reflect various specific factors and real-time data. Accordingly, it is necessary to develop technology for road/traffic information service that utilizes various real-time data sets such as traffic information, climate information, and road condition information as well as analyzes multiple data sets comprehensively. In This study, the utilization of real-time data derived from Korea road management system were investigated and a direction for road safety analysis and traffic information service is also suggested. It will be possible to develop more reliable road safety analysis and management systems and technologies using road data derived from various type of Korea road management systems.

**KEYWORDS**

Road/Traffic data, Driving environment, Road Safety, Road management system

**1 INTRODUCTION**

As expressways are advanced, the scale of roads has been expanded and use rates have greatly increased. Therefore, the securing safety of drivers has become a significant issue. According to one statistical analysis in Korea, the number of traffic accidents has somewhat decreased as the level of consciousness became higher. However, the number of accidents on the road due to natural disasters and calamities in cities has recently increased.

Specifically, the number of slope collapses due to natural disasters such as typhoons and earthquakes and porthole/ sinkhole incidents in cities has continued increasing (Figure 1). The number of slope collapses on domestic expressways and national roads in 2012 was 196, four times more than 51 in 2008 (Figure 2). The number of road collapses also has continued increasing: It is estimated that the number in 2014 is 1,200, about twice more than 660 in 2010. (Figure 3).

As road safety is threatened by natural disasters and calamities in cities, it is necessary to come up with effective measures and to develop a systematic mechanism of road safety analysis. This study examines road safety analysis technologies, Korea and other countries, and actual cases of road management systems with the aim to improve the level of road safety. Based on the result, limitations of existing technologies road management systems are analyzed. Presented also is a direction for ways to secure road safety in utilization of Korean road management systems.

A case study was conducted to grasp road safety analysis technologies in major advanced countries as well as the level of technology advancement of road management systems. Based on the result, limitations of existing road safety analysis technologies are analyzed, and a direction for road safety analysis and traffic information service is presented.
In the U.S., an integrated road management system has been operated since 1990 to enhance safety in road management. To prevent road slope collapses, a landslide monitoring system is being operated in utilization of LHP (Landslide Hazard Program) technology. Applying the road pavement management system in the U.S. has been an obligation specified by the land transportation laws over all states since 1993. To prevent calamities in cities, potential risks of disaster occurrence are predicted and preventive measures are taken accordingly in utilization of the DIN (Disaster Information Network).

In Japan, MICHI (Ministry of Construction Highway Information database system), a comprehensive road management system, is operated at each local construction bureau. In 1965, the world-first road pavement investigation equipment was developed and has been applied to the road pavement management system. As for road slope collapses, optical fiber sensors have been utilized since the beginning of 2000 to monitor safety of road slopes and to take preventive measures. Traffic volume control facilities include CCTV's, broadcasting facilities, emergency calls, remote monitoring control facilities, and road information display facilities for efficient operation of a disaster preventive system.

In Europe, a system to prevent and monitor bridge fire incidents is being operated. It is obligatory to operate systems to deliver climate information including fogs, weather, and temperature as well as to maintain standpipe systems. In addition, the concepts of bridge management system and road pavement management system were introduced in the 1980s and have been applied to DISK (the Netherlands), DANBRO (Denmark), BRUTUS (Norway), etc.

2.2 Limitations of Existing Technologies and a Direction for Development

A number of related technologies and road management systems were examined in the technology trend analysis of this study. These are road safety analysis using based on basic physical information such as distance, speed, etc. and past event information, and they do not reflect various specific factors and real-time data. Besides, such existing systems and technologies have limitations in that they analyze current data of traffic accidents.
only and do not include sections that are of potential risks but have involved no traffic accidents during the analysis period.

Accordingly, it is necessary to develop technology for road/traffic information service that utilizes various real-time data sets such as traffic information, climate information, and road condition information as well as analyzes multiple data sets comprehensively. Besides, demands among users are to be reflected in technology development in order to develop highly reliable real-time road management system in connection with traffic information. In this study, the utilization of real-time data derived from Korea road management system were investigated.

3 KOREAN ROAD MANAGEMENT SYSTEMS AND SUGGESTIONS FOR UTILIZATION

3.1 Current Condition of Korean Road Management Systems

The Ministry of Land, Infrastructure, and Transport have developed since the 1990s and operated various road-related systems stated below in order to maintain bridges and road facilities as well as prevent and cope with road slope collapses and traffic congestions: ROAS (Road Occupation Access System), BMS (Bridge Management System), PMS (Pavement Management System), CSMS (Cut Slope Management System), and TMS (Traffic Management System). The configuration of systems is illustrated in Figure 4.

ROAS is a system to secure policy support for effective operation of a road occupation approval system and to provide integrated information of road occupation; BMS is to provide data related to bridge maintenance and to establish short-term and long-term maintenance strategies and plans for bridges; PMS is to manage road pavement systematically and efficiently by investigating and evaluating the status of road pavement based on the database of pavement construction and maintenance records; CSMS is to manage road slope safety through thorough and constant investigations on slope safety in relation to climate changes and weathering; and TMS is to provide efficient road planning service in reference to the basic data collected through regular and constant surveys. For the linkage among various road-related systems and efficient implementation of road maintenance, HMS (Highway Management System) has been established and operated.

3.2 Road Safety Analysis Based on Road Information

This section is to analyze the types and usability of road information collected through a road management system. A direction for road safety analysis and traffic information service is also suggested.

The types and usability of road data collected through a road management system are presented in Table 1. ROAS provides data sets such as road occupation spots, areas, goals, and periods. It is expected that this system makes it possible to analyze road risks according to goals of road use and events. BMS collects safety-related data such as bridge load and structural information as well as basic information such as bridge length, width, and types. Based on the collected data, it will be possible to analyze bridge movements and risks as well as to control the volume of traffic. PMS collects various data sets such as pavement and maintenance records, crack rates, and grades of pavement status. In utilization of this database, it is possible to analyze the grade of pavement cracks in relation to the volume of traffic and road importance. CSMS utilizes slope detailed investigation data, constant measurement data, and maintenance status data, based on which, it is possible to predict risks of slope collapse and operate a disaster prevention system efficiently.
Table 1. Road Information of Road Management Systems

<table>
<thead>
<tr>
<th>category</th>
<th>Road Info.</th>
<th>Ways of Info. Utilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROAS</td>
<td>Occupation spot, area, goal, and period</td>
<td>Analysis of risks depending on the occurrence of events</td>
</tr>
<tr>
<td>BMS</td>
<td>Bridge type, load, design loading, year of completion, length, width, and structural info.</td>
<td>Analysis of risks depending on the occurrence of events</td>
</tr>
<tr>
<td>PMS</td>
<td>Bridge type, load, design loading, year of completion, length, width, and structural info.</td>
<td>Traffic volume control based on the analysis of bridge risks</td>
</tr>
<tr>
<td>CSMS</td>
<td>Detailed investigation info., constant measurement info., maintenance status</td>
<td>Annual average volume of traffic, traffic volume of each vehicle type, traffic volume in each road section</td>
</tr>
<tr>
<td>TMS</td>
<td>Prediction of risks of road slope collapse</td>
<td>Analysis of traffic congestion in combination of various road data sets</td>
</tr>
</tbody>
</table>

TMS utilizes various types of traffic volume data. It is expected that the combination of various road data sets will contribute significantly to the analysis of traffic congestion.

Road-related data continues to be accumulated in application of various road management systems, and accordingly, it is necessary to develop road/traffic information service and data collection/processing platforms in utilization of collected road data for road safety improvement and 'smart road' realization. The road management systems and traffic/road information service based on road information that are suggested in this study are summarized in Figure 5.

The integrated analysis of road information and certain semi-structured data collected through various road management systems will make it possible to provide more reliable road traffic information for safe driving.

### 3.3 Expected Effects

The suggested way of securing road safety utilizes various types of road information for more reliable prediction of road/traffic conditions. As preventive measures for traffic accidents and natural disasters are also taken into account, the traffic information service will help drivers drive safely on the road and realize smart road use.

In addition, the real-time information sharing between infrastructure systems and vehicles will enhance the quality of driving conditions, which will increase the level of satisfaction among road users as a result.

Drivers are provided with traffic information according to their specific needs, which will save time on the road and pleasant, satisfactory use of roads to the destination.

Besides, it is expected that traffic congestion will be alleviated and environmental pollution also will be reduced accordingly.

![Figure 5. Analysis of Road Safety in Utilization of Road Information](image)

![Figure 6. Effects of the prediction of road safety using big-data](image)

### 4 CONCLUSION & DISCUSSION

#### 4.1 Conclusion

This study includes an investigation on road safety analysis technologies and systems, home and
abroad, to improve the level of road safety. Limitations of existing systems and technologies are also analyzed. Based on the results, presented is a direction for road safety analysis technologies in utilization of domestic road management systems.

The frequent occurrences of natural disasters and calamities in cities around the globe threaten road safety, and it is necessary to come up with preventive measures accordingly.

Existing road safety analysis technologies and road management systems, home and abroad, are based on information of basic physical properties and past events. These analysis technologies cannot reflect various types of specific data sets and real-time data. Hence, it is necessary to develop road/traffic information technology in utilization of various real-time data sets.

Existing domestic road management systems include ROAS, BMS, PMS, CSMS, and TMS, and the road data continues to be accumulated.

4.2 Discussion

It is expected that the integrated analysis of spatial information and certain types of semi-structured data based on road data sets accumulated by multiple systems will make it possible to develop road/traffic status prediction technology.

It will be possible to develop more reliable road safety analysis and management systems and technologies in utilization of various types of road information, which also will realize safe and smart use of road infrastructures.

REFERENCES


