Analysis of Factors Affecting Traffic Accidents and Introduction to Korea's Traffic Safety Policies

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Traffic Safety & Traffic Accidents

1. Traffic Safety & Traffic Accidents

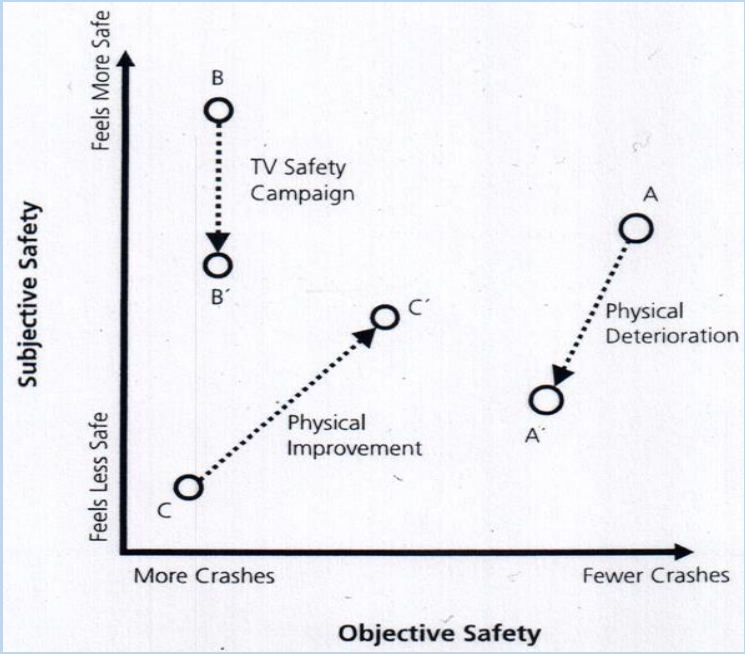
Objective and Subjective Safety

- The HSM focuses on how to estimate and evaluate the crash frequency and crash severity for a particular roadway network, facility, or site, in a given period, and hence the focus is on "objective" safety. Objective safety refers to use of a quantitative measure that is independent of the observer.

- In contrast, "subjective" safety concerns the perception of how safe a person feels on the transportation system. Assessment of subjective safety for the same site will vary between observers.

Objective and Subjective Safety

- The change between Points A to A´ represents a clear-cut deterioration in both objective and subjective safety.
- The change between Points B to B´ represents a reduction in the perception of safety on a transportation network
- The change from Point C to C´ represents a physical improvement to the roadway (such as the addition of left-turn lanes) that results in both a reduction in crashes and an increase in the subjective safety.

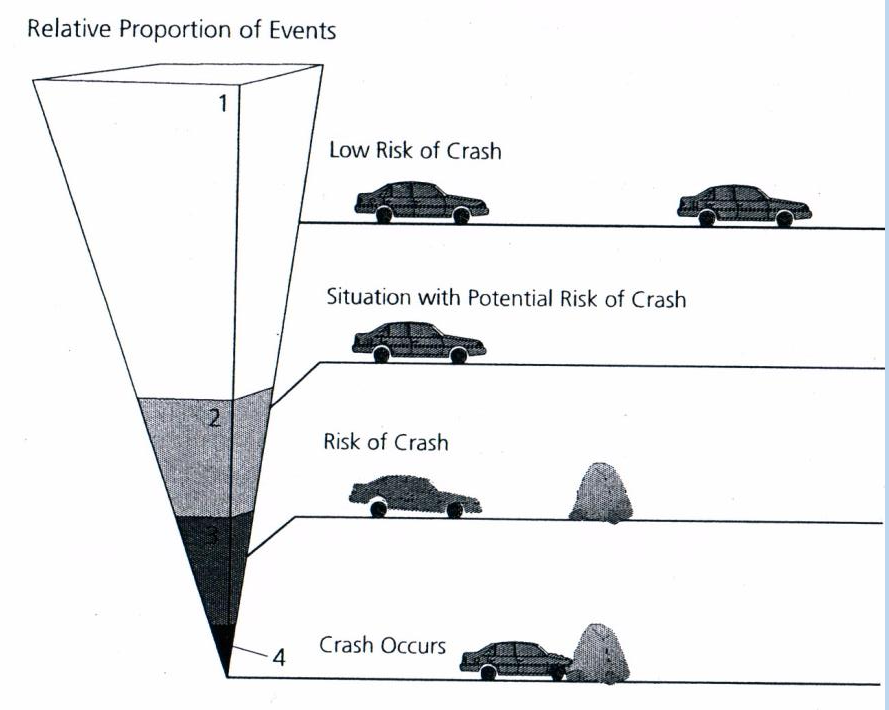


Crashes are rare and random events

- Crashes are rare and random events.
- By rare, it is implied that crashes represent only a very small proportion of the total number of events that occur on the transportation system.
- Random means that crashes occur as a function of a set of events influenced by several factors, which are partly deterministic (they can be controlled) and partly stochastic (random and unpredictable).
- For example, for a crash to occur, two vehicles must arrive at the same point in space at the same time. However, arrival at the same time does not necessarily mean that a crash will occur. The drivers and vehicles have different properties (reaction times, braking efficiencies, visual capabilities, attentiveness, speed choice), that will determine whether or not a crash occurs

Crashes are rare and random events

- For the vast majority of in the transportation system, events occur with low risk of a crash.
- In a smaller number of events, the potential risk of a crash occurring increases.
- In even fewer events, the risk of a crash occurring increases even more.
- Finally, in only a very few events, a crash occurs.



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Cause of Traffic Accident

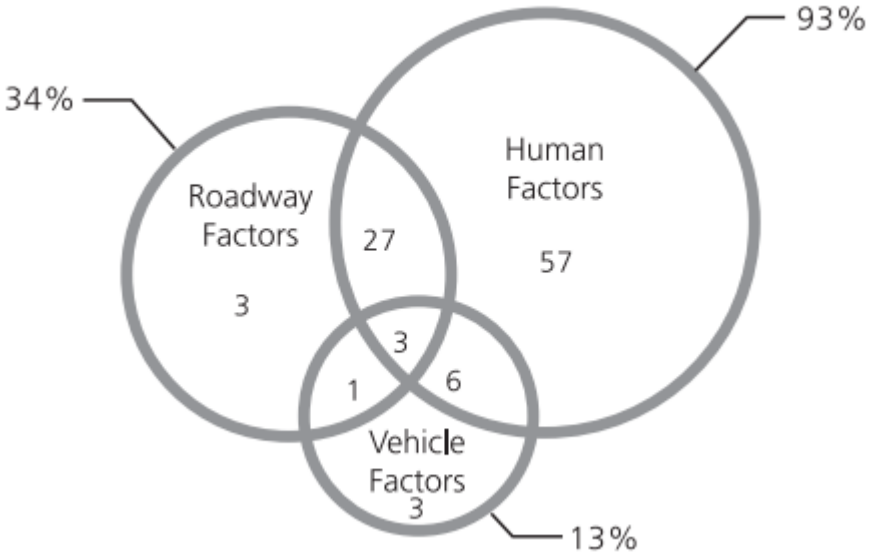
2. Cause of Traffic Accidents

Contributing Factors to Vehicle Crashes

- While it is common to refer to the “cause” of a crash, in reality, most crashes cannot be related to a singular causal event.
- Instead, crashes are the result of a convergence of a series of events that are influenced by a number of contributing factors.
- These contributing factors influence the sequence of events before, during, and after a crash.
- Before-crash events reveal factors that contributed to the risk of a crash occurring, and how the crash may have been prevented.
- During-crash events reveal factors that contributed to the crash severity and how engineering solutions or technological changes could reduce crash severity.
- After-crash events reveal factors influencing the outcome of the crash and how damage and injury may have been reduced by improvements in emergency response and medical treatment.

2. Cause of Traffic Accidents

Contributing Factors to Vehicle Crashes



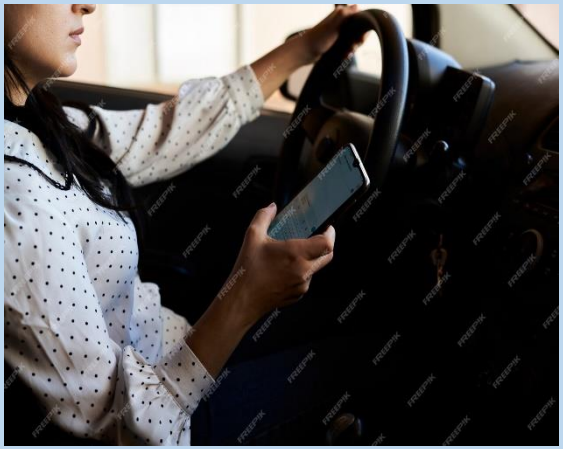
Source : Treat, J. R., (1979)
Tri-level Study of the Causes of Traffic Crashes: Final report—Executive Summary.
Report No. DOT-HS-034-3-535-79-TAC(S). Institute for Research in Public Safety, Bloomington, IN,

2. Cause of Traffic Accidents

Contributing Factors to Vehicle Crashes

- Human : age, judgement, driver skill, attention, fatigue, experience and sobriety
- Vehicle : design, manufacture, maintenance, regular vehicle inspection, overloading
- Roadway/Environment : geometric alignment, cross-section, traffic control devices, surface friction, grade, signage, weather, visibility

[Human]



[Vehicle]

[Roadway]

2. Cause of Traffic Accidents

Haddon Matrix

- A framework for relating the series of events in a crash to the categories of crash-contributing factors is the Haddon Matrix.
- The Haddon Matrix helps create order when determining which contributing factors influence a crash and which period of the crash the factors influence.

Period	Human Factors	Vehicle Factors	Roadway/Environment Factors
Before Crash Factors contributing to increased risk of crash	distraction, fatigue, inattention, poor judgment, age, cell phone use, deficient driving habits	worn tires, worn brakes	wet pavement, polished aggregate, steep downgrade, poorly coordinated signal system
During Crash Factors contributing to crash severity	vulnerability to injury, age, failure to wear a seat belt, driving speed, sobriety	bumper heights and energy adsorption, headrest design, airbag operations	pavement friction, grade, roadside environment
After Crash Factors contributing to crash outcome	age, gender	ease of removal of injured passengers	the time and quality of the emergency response, subsequent medical treatment

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Traffic Accident Data

3. Traffic Accident Data

Data Needed for Crash Analysis

- Accurate, detailed crash data, roadway or intersection inventory data, and traffic volume data are essential to undertake meaningful and statistically sound analyses.

Type	Needed Data
Crash data	Crash location, date, time, severity, collision type, basic information about the roadway, vehicles, and people involved.
Facility data	Roadway– classification, number of lanes, length, presence of medians and shoulder width, Intersection–road names, area type, traffic control, and lane configurations.
Traffic Volume data	AADT(Annual Average Daily Traffic), If AADT data are unavailable ADT(Average Daily Traffic), Intersection total entering vehicles(TEV), vehicle–miles traveled(VMT) on a roadway segment, Pedestrian crossing counts, turning movement volumes.

3. Traffic Accident Data

Limitation of Observed Crash Data Accuracy

- The limitations exist to recording, reporting, and measuring crash data with accuracy and consistency.
- These issues can introduce bias and affect crash estimation reliability in ways that are not easily addressed.
- These limitations are not specific to a particular crash analysis methodology and their implications require consideration regardless of the particular crash analysis methodology used.

- (limitation 1) Data quality and accuracy
- (limitation 2) Crash reporting thresholds and the frequency-severity indeterminacy
- (limitation 3) Differences in data collection methods and definitions used by jurisdictions

3. Traffic Accident Data

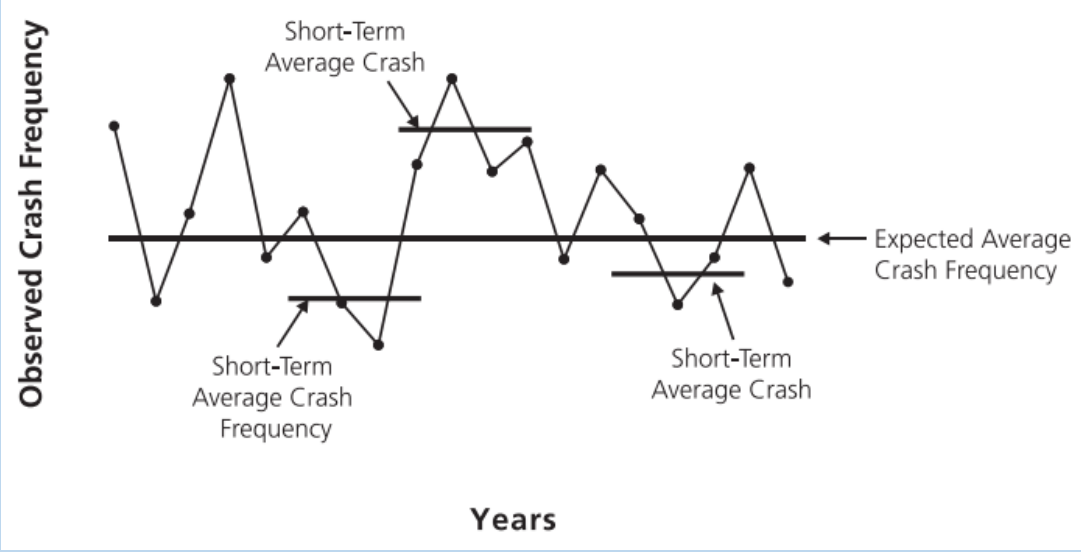
Limitation of Observed Crash Data Accuracy

- A more detailed examination of the limitations of the data is provided in the table below.

Type	Description
Data quality and accuracy	Typographic errors, the use of general terms to describe a location, entry of road names, road surface, vehicle types, etc.
Crash reporting thresholds	In most states, crashes must be reported to police when damage is above a minimum dollar value threshold.
Crash reporting and the frequency-severity indeterminacy	Some studies indicate that crashes with greater severity are reported more reliably than crashes of lower severity.
Differences between crash reporting criteria of jurisdictions	Crash reporting thresholds, definition of terms and criteria relating to crashes, traffic and geometric data, crash severity categories

Natural Variability in Crash Frequency

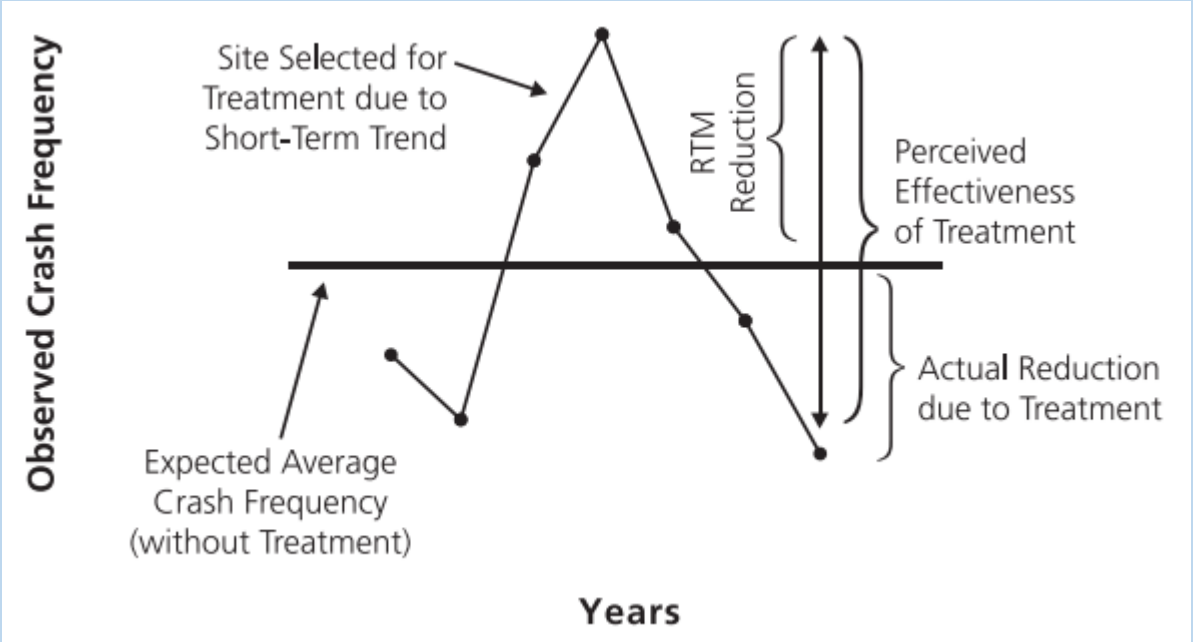
- Because crashes are random events, crash frequencies naturally fluctuate over time at any given site.
- The randomness of crash occurrence indicates that short-term crash frequencies alone are not a reliable estimator of long-term crash frequency.



3. Traffic Accident Data

Regression-to-the-mean bias

- Regression-to-the-mean : When a period with a comparatively high crash frequency is observed, it is statistically probable that the following period will be followed by a comparatively low crash frequency.



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Traffic Accident Prediction Method

4. Traffic Accident Prediction Mothod

Observed Crash Frequency and Crash Rate

- Crash frequency and crash rates are often used for crash estimation and evaluation of treatment effectiveness.

$$\text{Crash Rate} = \frac{\text{Average Crash Frequency in a Period}}{\text{Exposure in Same Period}}$$

- Observed crash frequency and crash rates are often used as a tool to identify and prioritize sites in need of modifications and for evaluation of the effectiveness of treatments. Typically, those sites with the highest crash rate or perhaps with rates higher than a certain threshold are analyzed in detail to identify potential modifications to reduce crashes

4. Traffic Accident Prediction Method

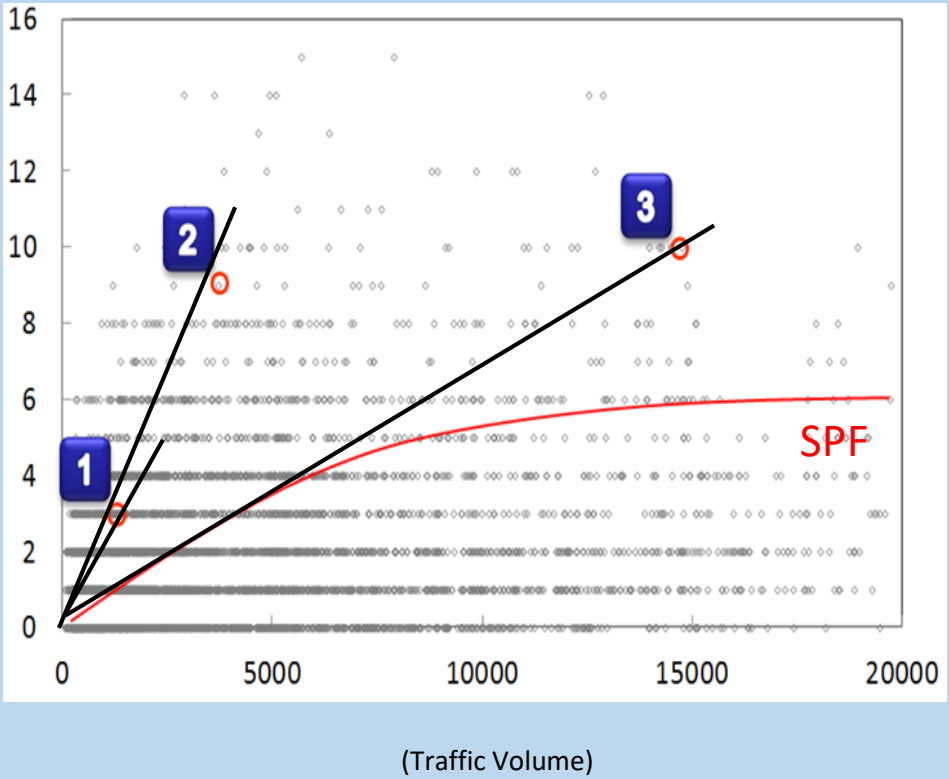
Crash Estimation Using Statistical Methods

- Statistical models using regression analysis have been developed which address some of the limitations of other methods identified above. These models address RTM bias and also provide the ability to reliably estimate expected average crash frequency for not only existing roadway conditions, but also changes to existing conditions or a new roadway design prior to its construction and use.
- As with all statistical methods used to make estimation, the reliability of the model is partially a function of how well the model fits the original data and partially a function of how well the model has been calibrated to local data.
- In addition to statistical models based on crash data from a range of similar sites, the reliability of crash estimation is improved when historic crash data for a specific site can be incorporated into the results of the model estimation.

4. Traffic Accident Prediction Method

HSM Method

- The HSM method was developed in the United States and is widely used worldwide as a traffic accident prediction method.
- HSM was developed to improve the limitations of crash prediction methods that rely solely on crash counts and crash rates and to establish a standardized and quantitative approach for crash prediction and evaluation.



4. Traffic Accident Prediction Method

HSM Method

- The HSM method requires three key components :
- **(1) Safety Performance Function (SPF)** – A model equation that predicts the average crash frequency for an ideal roadway segment.
- **(2) Crash Modification Factor (CMF)** – A factor that accounts for changes in crash frequency due to geometric design and safety features.
- **(2) Calibration Factor (C)** – A coefficient that adjusts for local conditions and characteristics.
- The crash frequency is estimated by multiplying these three functions together.

$$N_{predicted} = N_{SPFx}(CMF_{1x} \times CMF_{2x} \times CMF_{3x} \times \cdots \times CMF_{yx}) \times C_x$$

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Korea's Traffic Safety Policies

5. Korea's Traffic Safety Policies

Strategies to influence the above and reduce crash

- We have previously examined the factors that influence traffic accidents.
- Reducing risk factors in three areas—humans, roads, and vehicles—can help decrease traffic accidents.
- Traffic safety policies generally follow four internationally standardized strategic areas.
- These four strategies are naturally focused on **safe users, safe roads, safe vehicles, and post-crash response**

5. Korea's Traffic Safety Policies

VISION

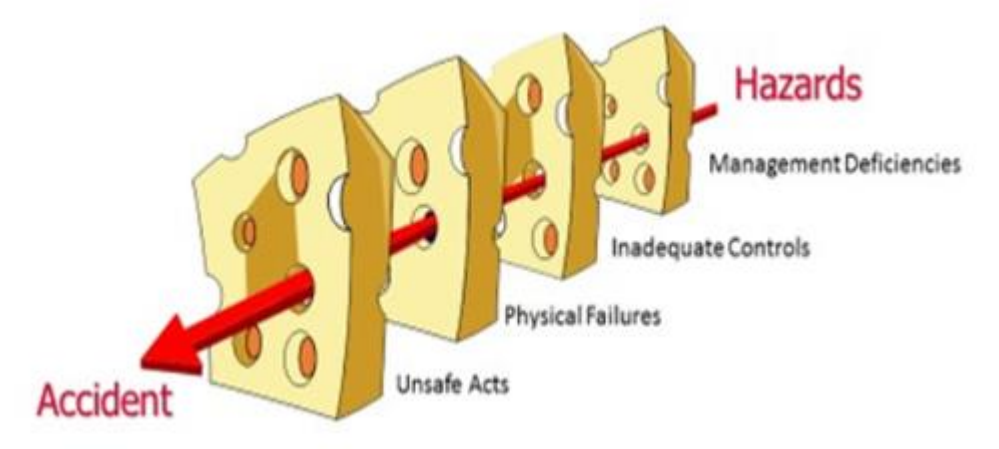
- After Sweden first declared Vision Zero in 1997, the concept of eliminating road traffic fatalities spread across Europe until the early 2000s. As a result, international organizations such as the UN, OECD, and EU all announced their goal of achieving zero road fatalities by 2050.
- In response, in 2021, these organizations recommended that each country reduce road fatalities by 50% over the next 10 years (by 2030).
- The adoption of Vision Zero has since expanded beyond Europe (Sweden, Spain, etc.) to North America (United States, Canada) and Asia (Australia, Japan), reinforcing global commitment to road safety.

5. Korea's Traffic Safety Policies

Safety System

➢ OECD 회원국 중 15개 국가에서 도입

- The **Safe System** approach is designed to prevent serious and fatal crashes by implementing a comprehensive accident prevention system that addresses various risk factors, similar to the **Swiss Cheese Model** theory.
- The philosophy of the **Safe System** is based on the recognition that **humans are prone to making mistakes on the road**, and therefore, the environment should be designed to **accommodate these errors safely**.
- Additionally, it shifts the perspective away from blaming individuals for traffic accidents and instead considers them **failures of the road traffic system**, emphasizing the responsibility of **road designers and operators** in ensuring safety.



5. Korea's Traffic Safety Policies

Policy directions & strategies

Building a road traffic system for accident prevention through a systematic approach

Traffic System : Establishing a traffic system with pedestrian-priority speed management and enforcement

① Creating a pedestrian-priority traffic environmnet

② Strengthening speed control and restrictions for accident prevention

③ Improving customized legal systems for different groups

④ Enhancing the operation of protected zones for vulnerable road users

Road Safety : Expanding preventive safety infrastructure

① Expanding pedestrian-centerd road facilities

② Improving roads with high accident risks

③ Expanding major accident prevention facilities on arterial roads

④ Building customized infrastructure for vulnerable road users

5. Korea's Traffic Safety Policies

Vehicle Safety: Innovation in vehicle standards for safe driving

① Expanding the installation of advanced safety devices

② Strengthening vehicle safety standards

③ Establishing a safety management system for future vehicles

Human(road users) : Establishing education, promotion, and inspection systems

① Expanding and implementing the 'Toward Zero' safety system

② Promoting awareness campaigns targeting general road users

③ Strengthening inspection education for commercial vehicles

Post-Crash Response : Rapid Emergency response & support for victim

① Establishing local emergency response systems

② Strengthening accident investigation and analysis capabilities

③ Expanding support for traffic accident victims

Thank you