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# Identifying the Components of Artificial Intelligence in Improving Safety, Reducing Traffic Crashes and Costs with Content Analysis

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## Abstract

**Purpose:** Artificial intelligence systems in urban transportation can utilize various tools and methods to enhance safety. The current study was undertaken to investigate the utilization of artificial intelligence in improving urban transportation safety, reducing traffic crashes, and cutting costs, using a qualitative approach and expert opinions in the field of transportation.

**Method:** Seven experts in the field of urban transportation in Tehran were selected as the sample. The interview responses, structured around 10 questions, were collected and analyzed using MaxQDA software and content analysis methodology. In this type of analysis, the content is examined to identify patterns, themes, ideas, and implicit or underlying messages.

**Findings:** From the conducted interviews, four main contents were extracted, including decision support systems (with five sub contents), data analysis systems (five sub contents), accident prevention systems (four sub contents), and alerting systems (four sub contents).

**Conclusion:** Given the advanced technologies in the field of artificial intelligence, intelligent systems in urban transportation will be of greater importance. These systems include traffic prediction and management, driver detection and alerting, smart vehicle systems, and data analysis. The role of these systems in improving urban transportation safety, reducing crashes, cutting costs, and enhancing system efficiency is crucial. These systems are capable of identifying warning signs and providing safety solutions. Through the use of these systems, city managers can identify problems and offer appropriate solutions to improve urban transportation, thereby enhancing the living conditions of citizens.

**Keywords:** Safety, Content Analysis, Traffic Crashes, Urban Transportation, Artificial Intelligence

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## Introduction

Intelligent transportation systems utilizing artificial intelligence (AI) can significantly improve the safety and efficiency of urban transportation networks. The primary objectives include enhancing road safety, optimizing transportation efficiency and speed, reducing costs, and improving the quality of life for citizens. AI enables the design of algorithms and smart systems for data analysis, learning, and decision-making. This can lead to remarkable advancements in the safety and efficiency of urban transportation.

In the future, intelligent and autonomous vehicles powered by AI will continue to evolve, with the ability to perceive and predict their own performance and the surrounding environment. Additionally, smart traffic management systems can improve traffic flow and prevent accidents.

AI also plays a crucial role in enhancing public transportation management and the utilization of intelligent communication networks like 5G.

Overall, AI has a key part to play in improving the safety, efficiency, and cost-effectiveness of urban transportation. This technology encompasses:

1. Rapid detection and response algorithms for accident prevention (Yang & Qi, 2021)
2. Intelligent traffic management systems to address traffic issues and enhance quality of life (Li et al., 2023)
3. Imputation of missing data in transportation systems to improve analytical accuracy (Cheong et al., 2023)
4. Smart transportation management for traffic reduction and increased efficiency (Xue, 2023)

From the perspective of future studies, AI plays a significant role in improving road safety. The key components include:

1. Accident prediction and early warning systems (Karim et al., 2022):
   AI models can predict accidents with 94% accuracy and 4.5 seconds before occurrence.
   The use of interpretable techniques like Grad-CAM enables increased user trust.
2. Intelligent traffic management (Priya S & K. G, 2023):
   AI algorithms can optimize traffic congestion, traffic light timing, and routing, leading to improved traffic safety and sustainability.
3. Driver drowsiness detection (Purohit et al., 2023):
   AI-based systems can detect and warn or intervene in driver drowsiness.
4. Predictive accident modeling (Siswanto et al., 2023):
   AI models can analyze accident, road, and weather data to forecast the probability and severity of future accidents.

## Methodology

The purpose of this research is qualitative, using content analysis with an exploratory approach. The sampling method combines purposive judgment and snowball sampling from transportation experts in Tehran in 1402 (2023-2024). Structured

interviews were conducted with 7 experts until theoretical saturation was reached. The data analysis followed Braun and Clarke's (2013) process: repeated reading, extracting semantic units, coding, categorizing codes, identifying and categorizing themes, and reviewing the coding. To ensure validity, participant feedback and expert opinions were obtained. For reliability, measures included presenting responses to professors, review by participants, peer review, and calculating the Holsti coefficient (>0.7). MAXQDA, a leading qualitative data analysis software, was used. Its features include multi-language support, effective interface, coding of diverse data types, reporting, and graphical modeling. In summary, this qualitative study used content analysis with a systematic, iterative approach to identify key themes from expert interviews on transportation in Tehran. Robust measures were taken to ensure validity and reliability of the findings.

## Results

The sample of experts who responded to the interviews consisted of 7 experts in the field of urban transportation, of whom 4 had doctoral-level education and 3 had master's-level education. In terms of age, the average age of the experts was 31.428 years with a standard deviation of 5.126, and in terms of gender, 6 were male and 1 was female. In total, four main themes were identified from the conducted interviews, including:

1. decision support systems with five sub-themes: route, interaction with people, driver training, communication systems, and AI algorithms.
2. Data analysis systems with five sub-themes: data collection, data processing, data analysis, forecasting and solution presentation.
3. Accident prevention systems have four sub-themes: sensors and data collection devices, artificial intelligence algorithms, Alert systems, and automated systems.
4. Warning systems with four sub-themes: detection, hazard prediction, warning drivers, traffic control and driver support, were extracted, which can be observed in Figure (1).

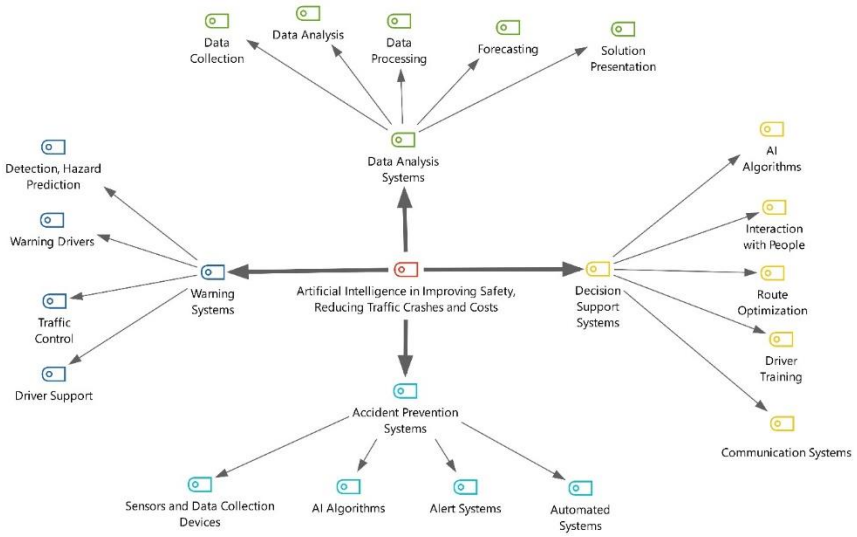


**Figure 1. General diagram of main and sub-themes identified**

## Conclusions

A detailed analysis of the key components of artificial intelligence in the field of intelligent transportation can lead to the identification of effective solutions to increase safety, reduce accidents, and optimize costs. This information is used as a guide for the purposeful application of artificial intelligence in intelligent transportation. Content and thematic analysis can help better understand how the components of artificial intelligence interact, leading to the better and more integrated design of intelligent transportation systems.

Suitable topics for future studies include identifying gaps and challenges in the field of intelligent transportation, applications of artificial intelligence in predicting dangerous driver behaviors, vehicle safety, design of automated warning and intervention systems, reducing transportation costs and optimizing routing, and ethical and legal challenges.

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