# Constructing a Risk Assessment Model for AI Transportation Systems from the Viewpoint of Antifragility

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## 1. Summary

Intelligent transportation system is an important application field of artificial intelligence technology in transportation systems. Although AI technology can improve the safety of transportation, AI technology itself also has a certain degree of risk. AI may need to have moral judgment, because in some cases, human morality may be wrong, and in some situations, humans will be unable to respond immediately due to unexpected events. As more and more AI services are applied to the transportation system, the risk issues related to the application of AI technology in the transportation system become necessary and urgent. This project will introduce the viewpoints of vulnerability, resilience, and antifragility to construct the risk assessment framework of the intelligent transportation system constructed by AI technology through the fuzzy cognitive map. An important reference for security policies.

Keywords：antifragility, artificial intelligence, transportation, risk assessment

## 2. Aim of Research

As AI technology enters our daily lives at an ever-increasing rate, there is an increasing need for AI systems to work in conjunction with humans, which requires AI systems to exhibit behaviors that humans can interpret. Synthesizing such behaviors requires AI systems to reason based on the mental models of human collaborators. AI workers need to pay attention to two important aspects: "legal regulations" and "cultivating the ethical behavior of AI users and future R&D personnel" Building an ethical self-driving decision-making system is undoubtedly the most difficult challenge for AI applications in transportation systems One of the main challenges in constructing a machine moral model of moral decision-making is the bias in human moral decision-making.

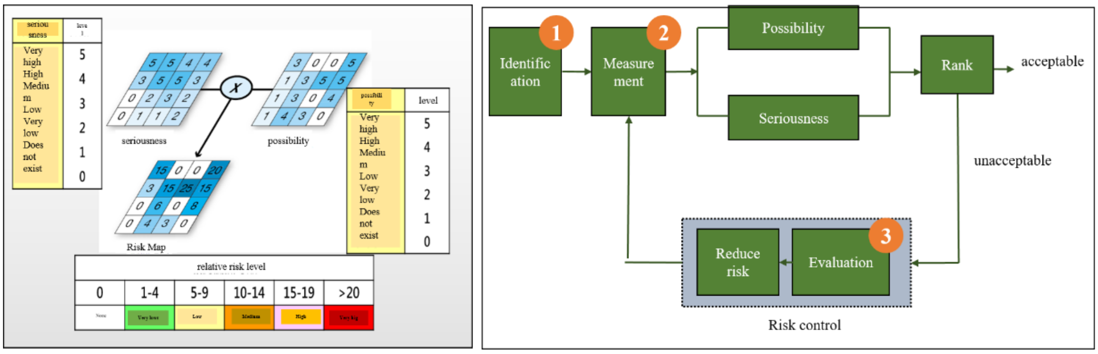
How intelligent transportation systems use data and software, rather than human intuition, to calculate the best response when faced with a major disaster situation. Is this decision a universal value? Or do you need to adapt to local conditions? Whose point of view should this decision be optimized for? Is it the owner of the car or another affected passerby? From the perspective of the insurance company or the perspective of the traffic management unit? AI applications in the field of transportation are inevitably related to issues related to transportation decision-making behaviors such as ethics or moral norms. Whether it is Japan (2019 AI White Paper) or the United States (United States Department of Transportation), relevant processes or regulations have been proposed. For example, the US Department of Transportation stipulates 15 safety checklists for self-driving cars on the road, one of which is the need to respond to self-driving cars when faced with ethical dilemmas, and Japan plans to complete the legal specification of AI ethics by 2030. These countries The approach to ethical issues arising from the application of AI also shows that any industry or country that wants to apply AI technology cannot ignore the risk issues inherent in AI technology itself. Figure 3 is the research structure of this study, and the project is expected to accomplish the following three points:

1. Risk identification: In-depth interviews and literature reviews are used to illustrate the types

of risks in the application of AI technology to intelligent transportation systems.

2. Risk measurement: Use expert questionnaires to collect and analyze data to draw a risk map of the application of AI technology in the transportation system, and find out the risk types with higher risk levels when AI technology is applied to the transportation system through the risk map.

3. Scheme evaluation: Through the fuzzy cognitive map, analyze the variables with higher risk types. In addition to analyzing the structural relationship between the variables that affect this type of risk, and based on the results of the analysis to build the management strategy proposed to reduce the AI risk of application of AI technology in transportation




Picture 1 Research architecture

## 3. Method of Research & Progression

Fuzzy Cognitive Maps (FCM) is to expand the application field of cognitive maps. The characteristic of fuzzy cognitive maps is that they can deal with variable relationships that are not easily defined in the original cognitive maps. The fuzzy approximate relationship between the variables can be used, and the degree of the relationship between the variables can be expressed by a rational number in the {-1, 1} interval to express the degree of influence between the two variables. The structure of fuzzy cognitive map is a network structure formed by the interactive relationship between variables; the construction step of fuzzy cognitive map first presents the overall situation of events with different types of variables and their connections and then represents each other with their correlation patterns. The degree of correlation attached to the causal edge is represented by positive and negative signs, and the degree of ambiguity of the causal relationship is represented by a value between {-1, 1}. The values of the variables in the fuzzy cognitive map do not necessarily need to be dealt with by fuzzy theory. The "fuzziness" of the fuzzy cognitive map means that the relationship between the variables and the variables in the cognitive map has a certain degree of ambiguity. Obfuscation of non-exponential variables themselves.

## 4. Results of Research

This research primarily focuses on smart transportation systems constructed using AI technology. The results of risk identification and risk calculation analysis will further help us understand how to mitigate the risks associated with AI technology in transportation systems. The relevant variables in the constructed model can also assist government regulatory agencies in understanding the factors influencing AI risk management in smart transportation system frameworks.

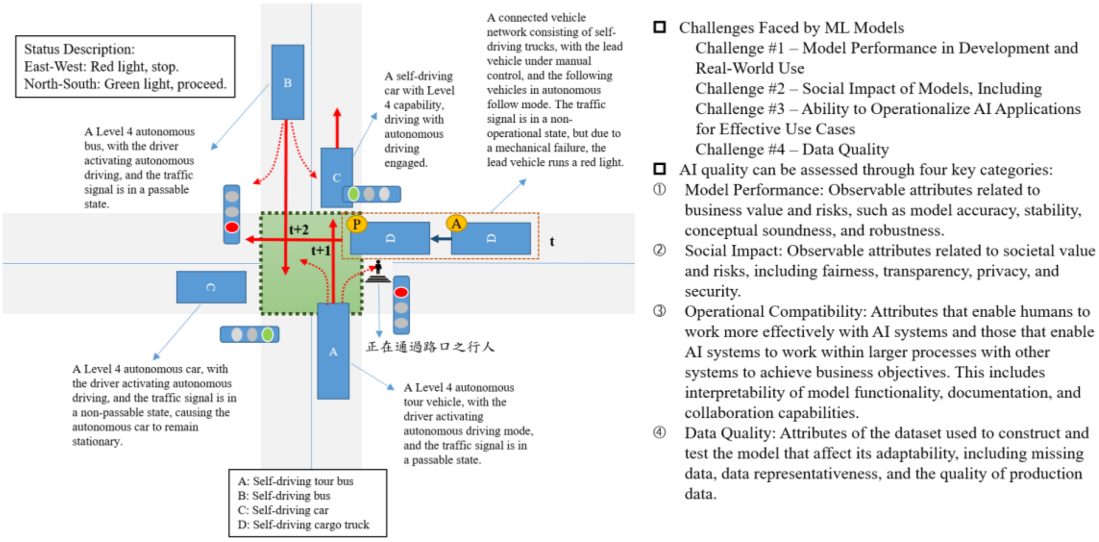
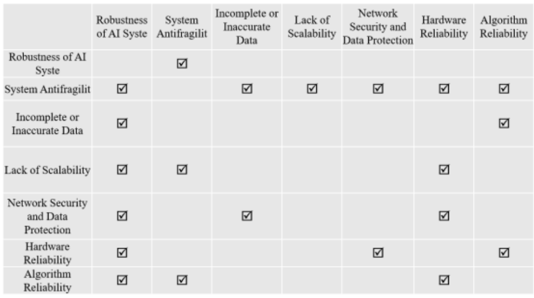



Figure 1: Schematic Representation of Research and Analysis Scenarios

By systematically analyzing these three components (Probability, Risk, and Consequence), the PRN framework allows for a more robust understanding of risk scenarios, enabling informed decision-making and prioritization of risk mitigation efforts. Data collection took place from April to May 2023, and the interviewed experts included 5 from academia, 3 from bus operators, 3 from the public sector, and 3 from the logistics industry, totaling 11 experts from relevant academic or practical fields. The model was used to select scores for each expert's assessment dimension. Table 3 and Figure 6 illustrate the results of the PRN risk analysis for AI transportation systems. Based on the results of the PRN risk analysis, the risk levels are categorized as follows:(1) High Risk: (S1) Robustness, (H3) Hardware Integration Capability, (L1) Human Supervision and Accountability, (L2) Human-Machine Collaboration; (2) Medium Risk: (S2) Interpretability, (S3) Data Quality, (H2) Hardware Performance; (3)Low Risk: (H1) Hardware Manufacturing Country, (E1) Ethical Compliance, (E2) Relevant Legal Regulations, (E3) Network Connection Security, (L3) Human Psychology.

In AI transportation systems, scalability is a critical factor that directly impacts the system's adaptability and long-term availability. When a system lacks scalability, it may be affected in the following ways: (1) Difficulty in Expansion: Systems lacking scalability may struggle to adapt to growing demands or changing circumstances. This can result in a performance decline and limit the system's capacity for expansion; (2) Technological Lag: Inability to seamlessly integrate new technologies or features into the system can lead to obsolescence, making it challenging to remain competitive against rivals; (3) Rising Costs: Poor system scalability can increase maintenance and upgrade expenses, as the system cannot be efficiently expanded or upgraded; (4) Increased Risk: In a rapidly changing environment, poor system scalability can make it more susceptible to security vulnerabilities or threats, thereby increasing overall risk.

This study focuses on intelligent transportation systems constructed using AI technology. The analysis of risk identification and calculation in AI transportation systems reveals that the robustness of AI systems is the most significant risk type. The FCM (Fuzzy Cognitive Mapping) model constructed in this study, which influences the robustness of AI systems, includes dimensions such as "system anti-fragility," "incomplete or inaccurate data," "lack of system scalability," "network security and data protection," "hardware reliability," and "algorithm reliability." The results of FCM analysis highlight that the lack of system scalability and system anti-fragility are the two main variables related to the risks in AI transportation systems. The findings of this research can further assist us in understanding how to reduce the risks associated with AI technology in transportation systems and provide a deeper insight into how humans can mitigate these risks. The variables in the constructed model can also help government authorities comprehend the selection of key factors influencing AI risk management and the formulation of risk management strategies within the framework of intelligent transportation systems.



| | Robustness of AI Syste | System Antifragilit | Incomplete or Inaccurate Data | Lack of Scalability | Network Security and Data Protection | Hardware Reliability | Algorithm Reliability |
|---|---|---|---|---|---|---|---|
| Robustness of AI Syste | | ☑ | | | | | |
| System Antifragilit | ☑ | | ☑ | ☑ | ☑ | ☑ | ☑ |
| Incomplete or Inaccurate Data | ☑ | | | | | | ☑ |
| Lack of Scalability | ☑ | ☑ | | | | ☑ | |
| Network Security and Data Protection | ☑ | | ☑ | | | ☑ | |
| Hardware Reliability | ☑ | | | | ☑ | | ☑ |
| Algorithm Reliability | ☑ | ☑ | | | | ☑ | |

Figure 2: Relationship Matrix Among Dimensions of the FCM Model

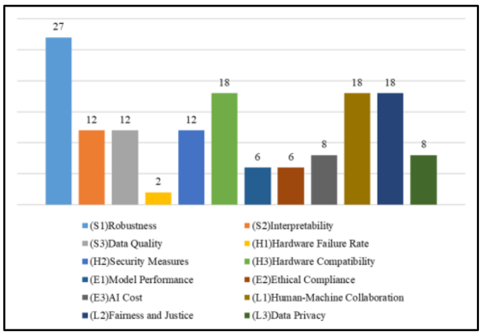



Figure 4: Bar Chart of Risk Types in AI Transportation Systems

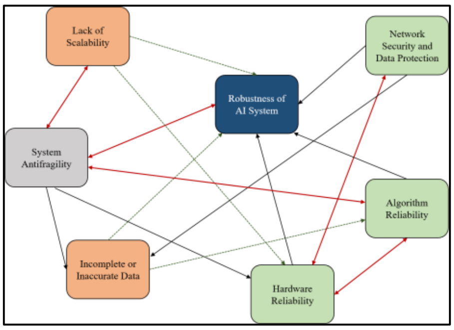



Figure 3: FCM Model Architecture

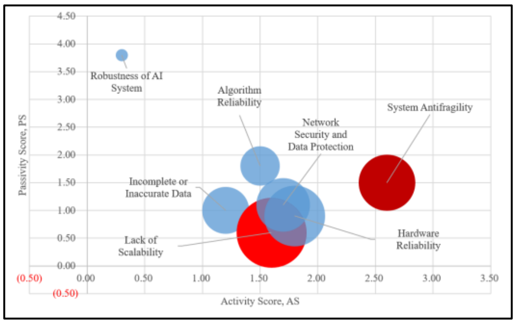



Figure 5: AS-PS Analysis Results

## 5. Future Areas to Take Note of, and Going Forward

The Intelligent Transportation System (ITS) is a significant application domain of artificial intelligence technology in the field of transportation. The application of AI technology is expected to enhance the efficiency and safety of transportation systems. However, it is crucial to further investigate the risks associated with AI technology itself. Therefore, exploring the types of risks that AI technology may introduce into transportation systems and formulating corresponding strategies are essential topics in transportation safety research. FCM (Fuzzy Cognitive Mapping) analysis techniques can assist managers in identifying critical factors that affect risks. Furthermore, FCM analysis allows transportation managers to gain insights into the "edge management" issues between different entities. Therefore, it is necessary to further deepen the research of the FCM model.

## 6. Means of Official Announcement of Research Results

The research content of this project has been published in the following journals:

(1) Yu-Kai Huang, “Constructing a Risk Assessment Model for AI Transportation Systems from the Viewpoint of Antifragility,” *Journal of the Chinese Institute of Transportation*, submitted. (TSSCI)

(2) 黃昱凱 (2023)，耐破壊性の観点から見たスマートロジスティクスシステムのリスク評価モデルの構築，第 56 回(令和 5 年度)生産工学部学術講演会。(日本東京)