Report of Research Results

A. Title:

An Analysis of the Risk Level of Scooter Rider's Behavior Applied to Couriers' Fragmented Usage-Based Insurance

B. Primary Researcher:

Primary Researcher：Hai-Wei Chang, Affiliation National Cheng Kung University

C. Co-researcher:

Wei-Hsun Lee, Tsai-Chen Wu, Yu-Chen Yang, Affiliation National Cheng Kung University

D. Summary:

The burgeoning demand for food delivery services in Taiwan has led to a substantial surge in motorcycle couriers, consequently leading to various traffic disorder issues. As the number of orders is the primary factor impacting their compensation, couriers may resort to aggressive driving tactics to maximize the volume of their orders within the shortest time. This method of calculating compensation based on the number of orders might serve as an economic incentive for delivery personnel, but it could potentially have adverse impacts on overall road safety. In order to address this prevailing phenomenon, how to delve into the behavioral patterns of motorcycle couriers and evaluate their potential risks to other road users is a significant challenge. This study introduces a risk assessment model for motorcycle couriers.

The model utilizes the properties of semi-supervised generative adversarial networks for precise recognition of riding maneuvers and for addressing issues related to data imbalance. It then combines five driving behaviors with seven risk factors, which include four aggressive behaviors and normal behavior, to calculate risk scores and assess the risk level of each delivery trip. The proposed model captures courier driving behavior and risk level effectively, providing a foundation for self-management frameworks among couriers, as well as reward mechanisms for delivery platforms. The gathered information can also help insurance providers create innovative UBI policies with premium reductions for safe couriers. These measures could potentially improve poor driving habits and boost overall road safety.

E. Aim of Research:

Taiwan has witnessed a significant rise in food delivery services, thanks to mobile commerce technologies. These services enable consumers to order via mobile apps, connecting them to nearby motorcycle couriers through a cloud system. Couriers respond in real time, collect meals, and deliver them within set timeframes. However, issues arise as couriers, paid per order, sometimes compromise traffic rules for speed,

leading to accidents, including fatalities. Without effective intervention from government agencies, this trend might escalate, threatening road safety.

Addressing these challenges requires shared responsibility among merchants, delivery platforms, couriers, and consumers. Traffic accidents result from intricate interactions between individual driving factors and road conditions. Current safety research mainly analyzes environmental factors and basic accident data, lacking in-depth insight into driving behavior. The complexity of motorcycle movement, distinct from cars, hampers the application of existing risk prediction models. Defining and assessing dangerous driving behavior specifically for motorcycles remains underexplored, complicating the development of effective interventions. Naturalistic driving research provides more realistic data but suffers from low volumes, hindering accurate modeling of rare dangerous behaviors.

This study proposes a method for assess risk score based on dangerous driving behavior. The purpose of this study are summarized as follows:

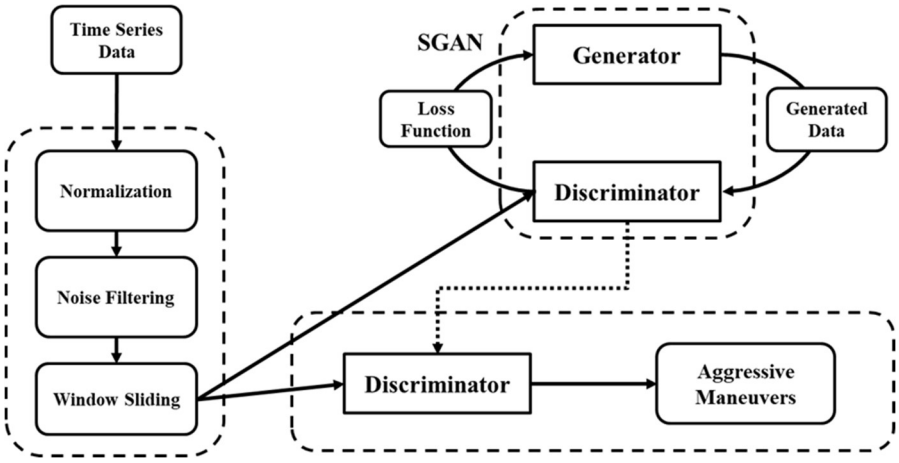
- Propose a risk level definition suitable for motorcycle couriers.
- Propose a risk level definition based on driving behavior.
- Propose a motorcycle dangerous riding maneuver recognition model.
- Propose a virtuous interactive framework for self-management of motorcycle couriers.

The goal is to establish a self-management mechanism for motorcycle courier, establish a positive cycle, and ultimately improve the corporate image of the delivery platform. For insurers, the risk analysis system provides the risk rating of delivery personnel to insurers, allowing insurers to establish a new type of fragmented UBI vehicle insurance, implement premium reductions for delivery personnel with excellent driving behavior performance, and ultimately improve the adverse selection problem caused by asymmetric information in traditional vehicle insurance. The delivery personnel themselves also receive appropriate protection, achieving a win-win situation.

F. Method of Research:

The motorcycle riding maneuver recognition in this research will be conducted through the following process: utilizing the built-in accelerometer of a smartphone to collect three-axis acceleration data from the motorcycle and collecting three-axis angular velocity data using a gyroscope. This data will be used to establish a time-series dataset of motorcycle driving behaviors. Subsequently, a deep learning model will be employed to recognize various hazardous driving behaviors. Upon completion of training, this model can be applied to identify the driving behaviors of real motorcycle couriers using their time-series data, which can then be combined with multiple risk

indicators for risk analysis.



G. Results of Research:

1. Results of Recognizing Aggressive Riding Maneuver

- SGAN model demonstrates robust convergence in training: Loss < 0.05, Accuracy > 0.9.
- SGAN showcases superior recognition capability for various motorcycle maneuvers compared to other models.
- "Over Leaning" recognized at an 80% rate, while "Normal Maneuver" achieves a flawless 100% accuracy.
- "Sudden Braking" misclassified as "Sudden Lane Changing" at a rate of 33.33%.
- SGAN's exceptional accuracy in sparse data surpasses that of the CNN model.
- SGAN maintains an average 0.23 performance gap superiority over the CNN model.
- Comparative analysis between the "Five-class" and "Binary then four-class" classification methodologies.
- Enhanced classification accuracy is observed using the "Binary then four-class" approach.
- SGAN excels in recognizing aggressive maneuvers within the chosen classification approach, validating its suitability for subsequent risk assessments and experimentation.

2. Results of Driving Risk Assessment

- Excluding top three high-frequency pedestrian-vehicle interactions, 23 trips formed the experiment's ground truth.
- Model Three (risk assessment model proposed in this study), using a risk

level threshold at 0.5σ and behavior weight of 3, achieved a conformity rate of 60%, surpassing Models One and Two.

- Model One and Model Two, employing different risk level thresholds, exhibited a 36% conformity rate with expert risk levels.
- The study's risk assessment model closely aligns with expert subjective evaluations, validating its accuracy over prior research.
- Results demonstrate that Model Three's approach better mirrors expert subjective risk assessments compared to the other models tested.

3. Application on Couriers' Fragmented Usage-Based Insurance

The risk assessment model forged in this study becomes a potent tool for delivery platforms, empowering them to oversee driving behavior, bolster corporate reputation, and enhance customer satisfaction. Through driving behavior scrutiny and trip risk evaluation, drivers are motivated to abide by safety regulations, steering clear of infractions. Establishing a scoring system based on driver performance allows platforms to offer rewards, fostering motivation and service excellence. These measures solidify customer trust in service quality and safety, elevating satisfaction and loyalty. Effective control of driver conduct augments the platform's corporate image, culminating in a mutually beneficial scenario for both drivers and the platform.

To make it more convenient for customers or stakeholders to use the risk assessment method established in this study, the risk score of the trip is divided into three risk levels. The threshold values for dividing risk levels are experimented with k times the standard deviation, specifically 0.5 times the standard deviation, 1 times the standard deviation, and 1.5 times the standard deviation. The threshold value can be choose by stakeholder, like insurance companies. The concept of UBI insurance price as shown below (Bian et al., 2018).

$$InsurancePrice = C_0 + Risk_p * w_p * M$$

H. Future Works:

Future research aligned with this study could explore the following directions:

- Investigate the interdependency of different aggressive maneuvers.
- Expand the repertoire of recognized aggressive maneuvers.
- Enhance methodologies for expert assessments.

I. Means of Official Announcement of Research Results

Proposed as a dissertation of master's degree of graduate program of transportation science, Department of Transportation and Communication Management Science, National Cheng Kung University.