A Study on Traffic Safety Culture by Introducing a Reciprocal Safety Culture Model in Motorcyclist Safe Driving

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Introduction

According to the World Health Organization (WHO), motor vehicle traffic accidents will be a global issue in 2020 due to road fatalities and injuries that have increased significantly worldwide since 2004 (Ward, Watson, Fleming-Vogl, 2019). As a result, the American Automobile Association (AAA) foundation of traffic safety introduced the idea of Traffic Safety Culture (TSC) first time in 2007 (AAA, 2007) to approach traffic safety issues. In line with that idea, several researchers suggested an organizational safety culture (OSC) concept to study a traffic safety culture (TSC) (Wiegmann, von Thaden, and Gibbons, 2007; Nævestad & Bjørnskau, 2012; Edward, Freeman, Soole, Watson, 2014; Ward et al., 2019). In addition, the Australian Government demonstrated the TSC approach to intervening in motorcyclists' drinking and speeding behavior (Edward et al., 2014). However, from those studies, the methodology to investigate the TSC related to a specific problem context has not been described clearly. Edward and colleagues (2014) claimed the OSC concept is similar to the TSC. Hence, the TSC issues supposedly could be approached using the OSC methodology. From this perspective, studying a TSC needs to overview of how the road traffic organization develops a safety culture, how drivers apply it to their daily driving, and how road users perceive safety. Several models developed by researchers are available to approach the safety culture issue in the organization (Reason, 1998; Guldenmund, 2000; Cooper, 2000). The reciprocal safety culture (RSC) model developed by Cooper (2000) could explain the transformation process of prevailing culture in the road traffic as described by Ward (2019). Therefore, in this research we applied a RSC model as a framework to investigate what the organization has (situational aspects), what people do (behavioral aspects) and how

people think (psychological aspects) in developing the TSC.

The current study of road traffic safety reported by the WHO (2018) claimed the traffic accident involving motorcyclists were found in the several Southeast Asian countries such as Thailand, Indonesia, and Cambodia. Previous study on motorcyclists' safe driving behavior claimed Indonesia face traffic issues with motorcyclists in several provincial capitals, such as Denpasar City - Bali Province (Wedagama, 2015), Surabaya City - East of Java Province, Yogyakarta City (a particular area), and Bandung City (West of Java Province) (Susilo, Joewono, Vandebona, 2015). The Bandung Road Safety Annual Report 2017 (2018) claimed 68% traffic crashed involving motorcyclists. Moreover, a significant number of traffic violations committed by motorcyclists recorded in the RTO database (Andrijanto and Pangaribuan, 2016). Therefore, the traffic situation in Bandung City was suitable for studying a safety culture in the road traffic domain. The purpose of this study is to reveal the safety culture construction in developing motorcyclists safe driving by introducing the application of the reciprocal of safety culture model on the road traffic organization.

Method

The RSC model developed by Cooper (2000; 2016) consists of three aspects of safety culture, as shown in Fig. 1. (1) Situational aspects represent the organization's policies, operating procedures, management systems, control systems, communication-flows, and workflow systems. (2) Behavioral aspects describe the people's behaviors related to the organization's effort to develop workplace occupational safety. (3) Psychological aspects are people's beliefs, values, attitudes, and perceptions along various dimensions of safety

thought. In this research, the RSC model covered macro and micro applications in investigating the TSC as a whole and each aspect of safety culture. Thus, the general framework for studying the TSC using the RSC model can be seen in Fig 2. We conducted the investigation respectively by answering questions (1) for situational aspects, (2) for behavioral aspects, and (3) for psychological aspects. Furthermore, the application of the RSC model for investigating each aspect is explained case by case.
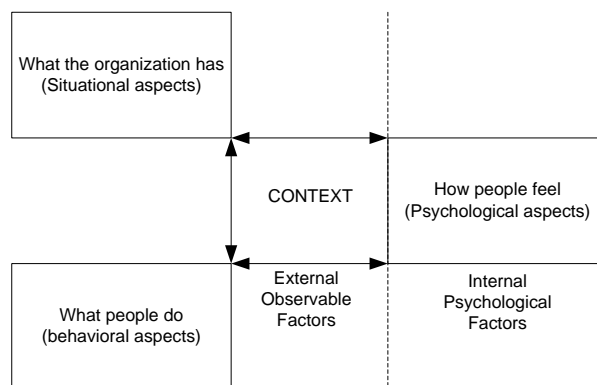

Fig. 1 Reciprocal safety culture model (Cooper, 2000)
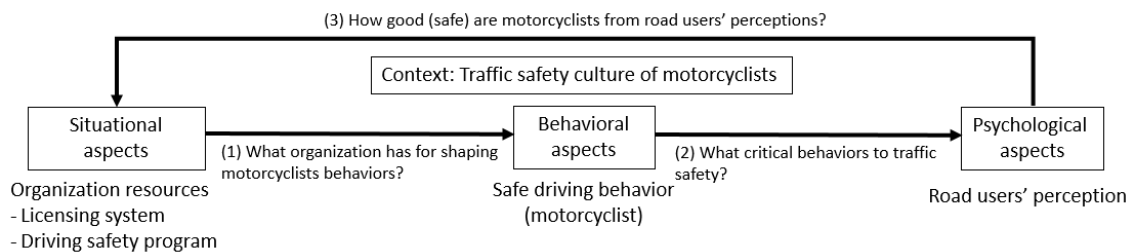
Fig. 2 General framework for studying TSC

The study on situational aspects applied the macroergonomic analysis and design (MEAD) method (Hendrick and Kleiner, 2002) to investigate "what the RTO has." The macroergonomic has been used by Kleiner (1999) to develop a safety culture in the nuclear plant domain. Therefore, this study aims to investigate discrepancies between the RTO expectations of motorcyclists' behaviors and the current situation. We expected to reveal safety culture weaknesses embedded within the licensing system. For this purpose,

we conducted four steps of MEAD in the RSC model, as shown in Fig.2. The MEAD step 4 integrates MEAD step 1, 2, and 3 to compare the organization's expectations (Step 1) with current situations obtained from the quality of the licensing system in producing a licensed motorcyclist (Step 2) and the procedure for obtaining a driving license (Step 3).
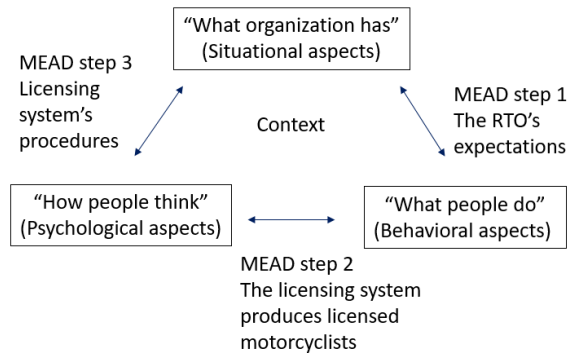

Fig. 3 Application MEAD in the RSC model

MEAD step 1 is a system and environment scan. MEAD step 2 is a production system type and setting performance expectations. MEAD step 3 investigates unit operations and work process. Finally, MEAD step 4 integrates steps 1, 2, and 3 for identifying variances.

The behavioral aspects investigated motorcyclists' behavior by applying six steps of the Behavior-based safety (BBS) program developed by the Health and Safety Authority (2013). In this study, we used the RSC model to develop a conceptual framework using a BBS program to identify motorcyclists' behaviors critical to traffic safety. Fig. 3 shows a conceptual framework for this study. This study aims to reveal motorcyclists' behavior critical to traffic safety by answering these two research questions: "how often do motorcyclists behave safely according to the driving safely criteria?" and "how are motorcyclists' performance perceived in terms of the driving safety programs?" In BBS step 1, we created the BBS team, which consisted of the RTO's sub-organization, motorcyclist representatives, and researchers. We correlated the answers of H1 and H2 by using multiple linear regression. BBS step 2 studied six safety

Reciprocal safety culture model

Situational aspects
(What the RTO has?)
Driving safety program
(DSP)

shaping

perceiving

Context
Motorcyclists
Traffic safety issue

Behavioral aspects
(What drivers did?)
Safe/unsafe behaviors

strengthen
/weaken

Psychological aspects
(What drivers think?)
I am good/bad

Hypotheses

(H1)
How often do motorcyclists behave
safely according to safety program?

(H2)
How are motorcyclists' performance
perceived in terms of the driving safety
programs?

Behavioral-based safety program

(1) Creating BBS team
RTO's sub-organization, motorcyclist representatives, and academic institution
(researchers)

(2) Targeting behaviors (ABC model)

Antecedent (A)
The six criteria of
DSP expectation for
safe behavior.

Target Behaviors (B)
What the drivers did?

Consequence (C)
Traffic events recorded in
the database: accident, near
misses, incidents, etc.

(3) Developing checklist
Sixty three target behaviors approved by RTO's sub-organization

(4) Measurement systems

H1

H2

Checklist:
sixty three
behaviors

+

Four point
Likert
scale

Driving-safety score

0   100

Bad   Good

Good

Safety score

Bad

unsafe   safe
behaviors

Correlation between behavioral (H1) and
psychological (H2) aspects
Dependent variable (y): driving-safety score
Independent variable (xi): drivers' behaviors

Multiple linear regression
Correlation hypothesis: H_0: drivers' behavior will
not influence the driving-safety score.
Rejected H_0 if alpha score was < 0.05

(5) Observation
- Driving safety questionnaire (DSQ) consists (1) motorcyclist basic information (name, gender, etc.), (2) a driving-safety score, (3) driver behaviors
- Number of sample: Cochran formula for a large population, 95% confidence level, 50% proportion, and 10% tolerable error.
- Purposive sampling: 97 licensed motorcyclists, vehicle plate code corresponding to the urban area, and engage daily driving on the main road

(6) Feedback
- The critical safety-related behaviors, obtained from independent variables with a significant MLR output value of < 0.05
- Driving behavior scale, showing contribution of motorcyclist behavior to the traffic safety according to a driving-safety score obtained from MLR equation.
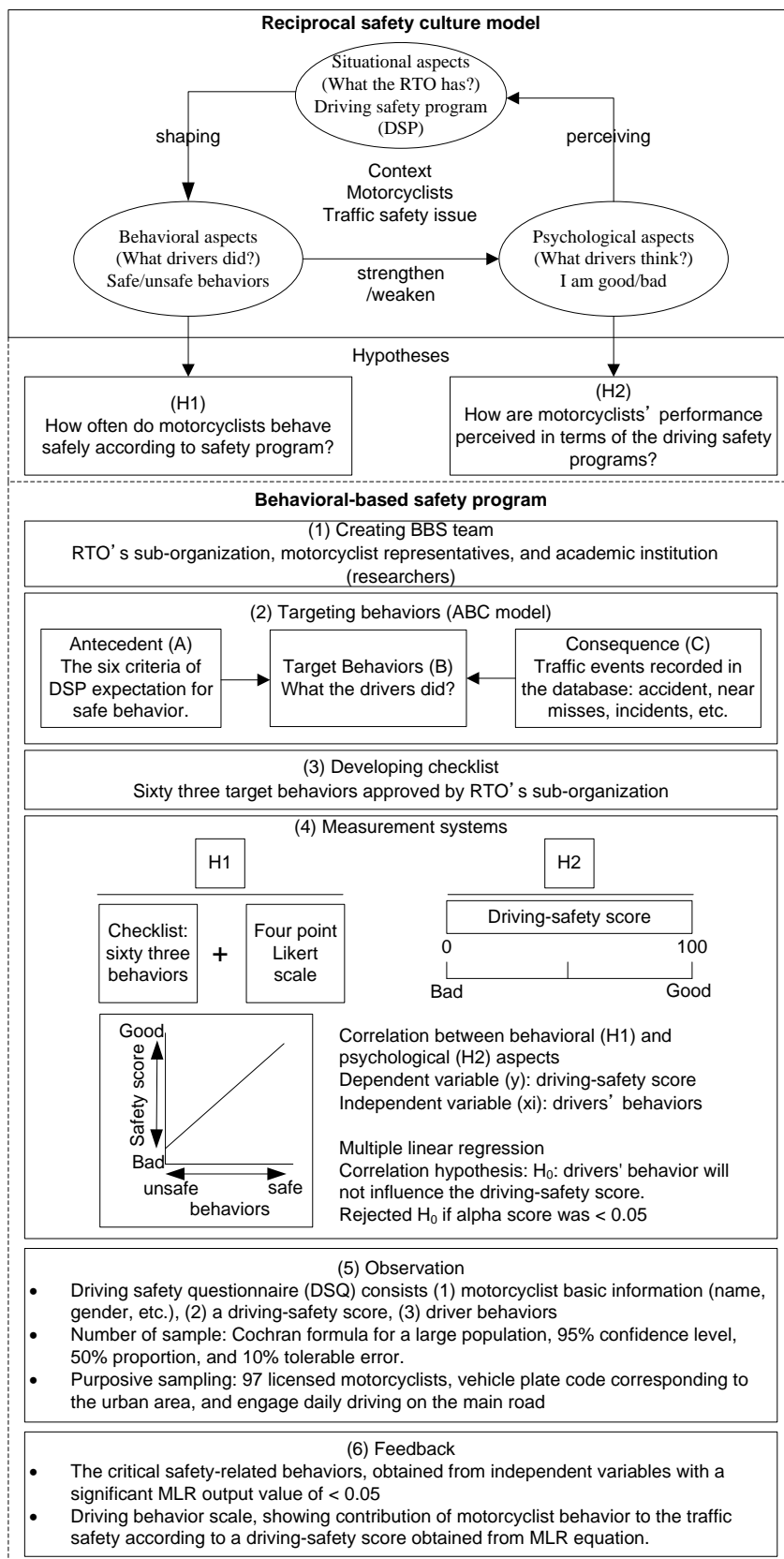
Fig. 4 Conceptual framework of behavioral aspects' study

driving criteria related to the traffic events recorded in the RTO's database (e.g., traffic accidents, near-misses' incidents) using the antecedent-behavior-consequence (ABC) model. This study aims to reveal target behaviors related to the program. BBS step 3 developed a checklist for observing motorcyclists' behavior. BBS step 4 correlates the answers to research questions using multiple linear regression and optimized using stepwise regression to reveal the critical behaviors. In step 5, we developed the driving safety questionnaire (DSQ) by modifying the driving safety questionnaire (DSQ) developed by Reason (1999). The questionnaire was distributed to 97 motorcyclists with a vehicle plate corresponding to Bandung City. The feedback (step 6) described the critical safety behaviors and the driving behavior scale that reflected the motorcyclists' perception of their unsafe-safe driving performance in road traffic.

The psychological aspects focused on road users' perceptions of motorcyclists' behavior. This study aims to describe road traffic situations by answering these two research questions "How often do motorcyclists behave safely according to other road users' safety?" and "How do motorcyclists perform safe driving?" We conducted a similar method with the behavioral aspects investigation. However, we analyzed the target behavior from the study of behavioral aspects by considering the interaction of motorcyclists with car drivers and pedestrians. The DSQ investigating motorcyclists' behavior is developed for studying car drivers' and pedestrians' perceptions. The questionnaire was distributed to 97 car drivers and 97 pedestrians purposively with criteria commuting on the urban road daily. Car drivers were private car drivers or taxi drivers and pedestrians were students or office employees walking on pedestrian sidewalks.

Result

A comprehensive study on situational aspects of safety culture using the MEAD method identified five elements of weak safety culture embedded in the licensing system (Andrijanto, Itoh, Pangaribuan, 2020). First, a lack of education had led the motorcyclists to obtain an improper understanding of traffic regulations. Second, the motorcyclists had a weak comprehension of the daily implementation of the traffic regulations. Third, the system could not assess the driver's competency correctly; the motorcyclists poorly appraise the risk by violating the traffic signs. Forth, the omission of the driving ability certificate led the candidate to ignore the lessons learned process. Finally, the RTO in the licensing system had applied inadequate quality procedures by allowing the candidates to obtain a driving license with a non-procedure process.

The behavioral aspects investigation confirmed the influence of motorcyclist behavior on the driving safety perception using the multiple linear regression, optimized by the stepwise regression (Andrijanto, Itoh, Sianipar, 2022). The regression model was significant with $F_{(8, 88)} = 7.716$, $p < 0.05$, eight independent variables have significant $p < 0.05$ with VIF value < 2.0. The regression model identified the critical behaviors as follows: (1) suddenly merging into other lanes without signaling, (2) following police instruction during an incident, (3) avoiding chain-reaction collisions, (4) checking wing mirrors intensively when changing lanes, (5) turning off the indicator after turning, (6) having driving licenses and vehicle documentation with the driver when driving, (7) wearing a standard helmet (following regulations), and (8) using the pedestrian sidewalk to drive when there are traffic jams. The motorcyclist's perception of driving safety scored 76.4 from the stepwise regression and 76.9 from the survey. This result reflected

motorcyclists' high perception of their driving safety performance.

The study on psychological aspects resulted in both regression models being significant. The regression model of car drivers significant with $F_{(17, 78)} = 4.144$, $p < 0.05$, identified three significant independent variables. As well as the pedestrian's perspective significant with $F_{(11, 85)} = 7.116$, $p < 0.05$, and identified three significant independent variables. Those behaviors were (1) using a noisy exhaust, (2) clearing the lane for special vehicles (ambulance and fire trucks), (3) using the correct indicator to turn according to the direction, (4) following police instructions, (5) zigzagging on the busy road, and (6) slowing down near zebra crossing and railroads. The driving safety score of both road users indicated the motorcyclists have a medium safety driving performance. This result shows car drivers and pedestrians felt uncomfortable when interacting with motorcyclists on the road.

Conclusion

The construction of the TSC in the motorcyclist's safe driving revealed five weak elements of safety culture embedded in the licensing system supervised by the RTO's sub-organization (situational aspects). Thirteen critical behaviors related to the safety culture weaknesses (behavioral aspects) have been identified. The road users perceived uncomfortable when interacting with motorcyclists. Furthermore, each critical behavior associated with the driving safety criteria has a relationship with the safety culture weaknesses and the assessment in the licensing system.

We introduced the application of the RSC model for studying the TSC of motorcyclists' safe driving in this research. Three aspects of the RSC model (situational,

behavioral, and psychological) identified the prevailing safety culture related to motorcyclists' safety behavior in urban road traffic. We could reveal related issues behind each aspect by correlating some aspects. For example, the correlation between situational and behavioral aspects could identify the safe behavior expected by the RTO (situational aspects - the organization' expectation). In another case, the correlation between behavioral and psychological aspects could reveal driving behavior critical to traffic safety (behavioral aspects - what drivers do). Furthermore, we identified several weak elements of safety culture embedded in the RTO that weakened motorcyclists' understanding to practice traffic regulation correctly. Identified motorcyclists' behaviors and the traffic violation record committed by motorcyclists reflected those weaknesses. In addition, the poor quality of a licensing system has mistakenly led motorcyclists to develop their skills for using brakes, signals, and checking side mirrors.

Therefore, further research is needed to determine motorcyclists' behavior in performing those basic skills to anticipate some hazardous situations on the road. Furthermore, the TSC condition in several cities in Indonesia related to motorcyclists' behavior issues, e.g., Denpasar City (Wedagama, 2015), Surabaya City, and Yogyakarta City (Susilo et al., 2015), need to be studied. From this study, we expect to reveal other issues related to the development of the TSC by the RTO in their region.

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