

EMPLOYER-BASED BEHAVIORAL SAFETY PROGRAMS FOR COMMERCIAL MOTOR
VEHICLE DRIVERS: EXAMINING THE ROLE OF INDIVIDUAL, ORGANIZATIONAL,
AND METHODOLOGICAL FACTORS ON THEIR EFFECTIVENESS

A Thesis

by

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ABSTRACT

An understanding of the prevalence of theory within employer-based behavioral traffic safety programs is lacking in both the literature and workplace. The dangerous nature of workplace driving is understood far more than how to change driver behavior. The objective of this paper is to evaluate the existence of ten different behavioral change theories and models within articles that contain populations of professional drivers. The ten theories are presented based on their focus on individual differences between drivers or organizational factors. A review of the prevalence of these theories within behavior-based safety programs and an examination of their effectiveness through the lens of individual, organizational, and methodological factors is also presented. Results indicate that behavioral-change theories are helpful frameworks in crafting effective employer-based driver safety programs. The paper concludes by offering recommendations to employers for the creation and sustainment of theory-based driver safety programs based on current evidence in the literature.

CONTRIBUTORS AND FUNDING SOURCES

Contributors

This work was supervised by the student's thesis committee chair, Professor Winfred Arthur, Jr., with Professor Olabisi Atoba of the Department of Psychological and Brain Sciences, and Professor Wendy Boswell of the May's Business School as committee members. It also reflects feedback from Professor Stephanie C. Payne.

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1. INTRODUCTION

Employer awareness of the cost of commercial motor vehicle (CMV) crashes involving their employees is critical, and it is increasingly clear that protecting their employees from vehicle crashes is not only good for employee well-being, but also a profitable business investment. The Network of Employers for Traffic Safety (2016) reported that crash injuries on and off the job can cost employers as much as \$47.4 billion annually. Aside from the monetary concerns of employee crashes, the disproportional involvement of large trucks in fatal vehicle collisions compared to passenger vehicles points to a need for employer-based traffic safety initiatives. In 2003, 11% of all fatal crashes involved large trucks and accounted for 4,986 fatalities (Knipling, 2007). The disproportional number of miles driven by truck drivers compared to passenger vehicles and the prevalence of fatalities in large truck crashes make them a population more likely to benefit from employer-based driver safety program countermeasures and for them to be cost-effective in the long-run (Maccubbin, Staples, & Mercer, 2003). CMV safety is a complex issue and when asked about the most important safety items, both fleet safety managers and subject matter experts (SMEs) cited risky driving behaviors, such as speeding and tailgating, to be in the top three most critical aspects of driver safety (Knipling, Hickman, & Bergoffen, 2003). Although multi-faceted, it is clear that a large piece of CMV driver safety involves driver behavior. Thus, behavior-based safety programs may prove to be effective initiatives for organizations to implement at their workplaces.

Behavioral change theories have the potential to offer guidance on the development and implementation of behavior-based safety programs. Identification of these theories could explain why employer interventions are effective and provide a framework for other employers to follow during the creation of their own driver safety programs. There are several behavioral change

theories that are widely discussed in the behavioral change literature. For the purposes of this paper, ten behavioral change theories or models are initially examined, although additional theories and models found during the examination of the literature are discussed in subsequent sections. It is recognized that “theories” and “models” are not synonymous and that the literature oftentimes distinguishes between the two (Kezar, 2001). Theories and models will be referred to using the labels that the authors’ used in their articles.

The behavioral change literature was examined for both theories and models within organizational driver safety programs to determine the prevalence of behavioral change theories. Several electronic databases comprised the scope of the analysis, including PsycINFO, EBSCO, TRID, Web of Science, SAGE, and SCOPUS. A web search was conducted on the websites of various transportation organizations such as Network of Employers for Traffic Safety, American Transportation Research Institute, and The National Institute for Occupational Safety and Health. A list of all the search terms included in the review of literature can be found in Appendix A.

In some cases, behavioral change theories were not explicitly stated, but there were theoretical components of the safety program or study, and their theoretical components will be discussed. Brief descriptions of the behavioral change theories that were examined in the literature provide an overview of how organizational programs contain essential components of each theory. The theories chosen for this paper are not an exhaustive list of behavioral change theories. These theories were chosen for their likelihood of being present in the professional driver literature based on a preliminary review of the literature for relevant behavioral change theories, however, it is recognized that additional theories were present as well and theories not mentioned here will be discussed in subsequent sections.

Banks, Freeman, and Davey (2016) recognize that there is an overall lack of association between crash causation and behavioral change theory. In turn, what is recognized as effective is not always scientifically grounded and oftentimes fails in its desired goals. Examining the literature for the ten behavioral change theories or models within the professional driver population will reveal the degree of effectiveness associated with empirical evidence and commercial driver safety programs. The theories and models initially examined are (1) Health Belief Model, (2) Nudge Theory, (3) Social Cognitive Theory, (4) Social-Ecological Model, (5) Theory of Planned Behavior, (6) Transtheoretical Model of Change, and (7) Workplace Health Model, and (8) Diffusion of Innovation Theory, (9) Kotter's 8-Step Change Model, (10) Lewin's Three-Step Change Theory.

Theories and models were organized into two categories; theories that considered individual factors and theories that considered organizational factors. Six theories or models were classified into the group of theories that consider individual factors, and they are discussed first. Four theories predominantly considered organizational factors and do not take individual differences into consideration, which are discussed afterward. Individual and organizational factors are subsequently discussed. Table 1 shows the categorization of theories into the two groups that consider individual and organizational factors.

Table 1 *Categorization of theories on the basis of their focus on individual versus organizational factors*

Theories with Individual Factors	Theories with Organizational Factors
The Health Belief Model	The Workplace Health Model
Nudge Theory	The Diffusion of Innovation Theory
Social Cognitive Theory	Kotter’s 8-Step Change Model
The Social-Ecological Model	Lewin’s Three-Step Change Theory
Theory of Planned Behavior	
The Transtheoretical Model of Change	

1.1 Theories and Models with Individual Factors

The *Health Belief Model* is a psychological health behavior change model that seeks to advance the understanding of a person’s likelihood of engaging in healthy behavior (Rosenstock, 1966). The model consists of a person’s (1) perceived susceptibility to the problem, (2) perceived severity of the problem, (3) perceived benefits of a given behavior, (4) perceived barriers to behavior change, (5) cues to action that lead to behavior acceptance, and (6) perceived self-efficacy to change behavior.

Nudge Theory seeks to change behavior without imposing regulations that individuals perceive as an infringement on their rights. It takes a rational approach in that it recognizes areas where individuals are susceptible to biases, such as a person’s biases towards governmental interventions, legislation, and enforcement and therefore refrains from implementing interventions through these means. Instead, nudges are non-monetary and non-regulatory interventions that gently direct individuals towards a particular behavior without taking away the

individual's ability to choose (Alemanno & Sibony, 2015; Halpern, 2015). Typically, a nudge is a cost-effective change to a person's environment that increases the likelihood of that person automatically behaving in a certain manner.

Social Cognitive Theory seeks to explain people's regulation of their behavior through control and reinforcement in order to achieve goal-directed and long-term behavior change (Bandura, 1991). The model consists of (1) reciprocal determinism that describes a person's behavior both influences and is influenced by their environment, (2) behavioral capability, or ability to perform a behavior, (3) observational learning, (4) reinforcements that effect the likelihood of re-engagement of behavior, (5) expectations or consequences of behavior, and (6) self-efficacy to perform behavior.

The *Social-Ecological Model* seeks to aid in understanding how five personal and environmental factors interact and influence a person's behavior (McLeroy, Steckler, & Bibeau, 1988). These five factors begin at an individual level and progress to domains covering large groups of people. The five factors are: (1) intrapersonal factors including knowledge, attitudes, and developmental history, (2) intrapersonal processes and primary groups such as family and work groups, (3) institutional factors such as a social institution's rules and regulations, (4) community factors such as the cultural values and norms within an organization, and (5) public policy from local, state, or national laws or policies.

Theory of Planned Behavior describes a person's motivation and ability to succeed at an intended behavior (Ajzen, 1985). The model consists of a person's (1) attitudes towards the behavior, (2) behavioral intention or motivation level to perform, (3) subjective norms such as others' beliefs about a behavior that influences a person's likelihood of engaging in the behavior, (4) social norms such as the customary codes of a culture, (5) perceived power, determined by a

person's perceived presence of impeding or facilitating factors, and (6) perceived behavioral control, determined by a person's perceived ability to perform the behavior. Figure 2 provides the main components of the Theory of Planned Behavior.

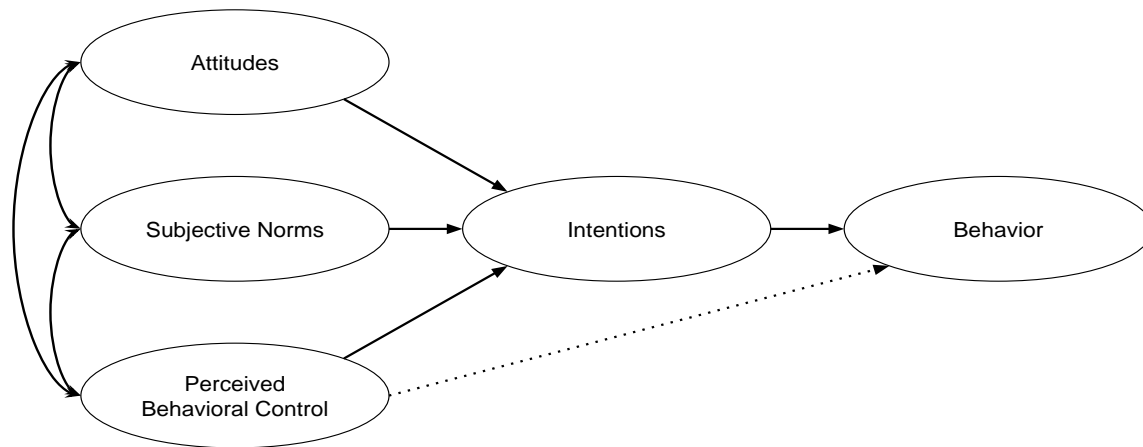


Figure 2. Theory of Planned Behavior. Adapted from “From intentions to actions: A theory of planned behavior” by Icek Ajzen (1985).

The *Transtheoretical Model of Change* is a theory with proven effectiveness (Prochaska & DiClemente, 1983) that incorporates aspects of social and biological theories in order to instill change (Prochaska et al., 1992). The linear steps are as follows: (1) precontemplation, (2) contemplation, (3) preparation, (4) action, (5) maintenance, and (6) termination.

1.2 Theories and Models with Organizational Factors

The *Workplace Health Model* is the practice of implementing policies and interventions at various levels of an organization in order to minimize different risk factors (Center for Disease Control and Intervention, 2016). The model consists of a (1) workplace health assessment to

understand organizational structure and policies, (2) planning the program with management, (3) implementing the program, and (4) determining impact through evaluation.

The *Diffusion of Innovation Theory* explains how, why, and at what rate new ideas and technology spread (Rogers, 1962). The model consists of (1) the innovation, (2) the communication channels by which the innovation is spread, (3) the time needed for diffusion to take place, and (4) the social system that influences the adoption of the innovation.

Kotter's 8-Step Change Model seeks to explain how organizations can effectively implement and manage change (Kotter, 1996). The steps consist of (1) creating a sense of urgency, (2) building a guiding coalition, (3) forming a strategic vision and initiatives, (4) enlisting a volunteer army, (5) enabling action by removing barriers, (6) generating short-term wins, (7) sustaining acceleration, and (8) instituting change.

Lewin's Three-Step Change Theory explains how behavioral change is the interaction of driving forces and hindering forces (Lewin, 1951). As shown in figure 3, Lewin's model involves three-steps, with the first being an unfreezing of the status quo behavior to the point that individual and group resistance is not hindering behavioral change. The second step is where behavior makes the transition from the old, accepted behavior to the new, desired behavior. Lastly, the third step involves refreezing the new behavior and implementing steps to ensure the new behavior is long-term.

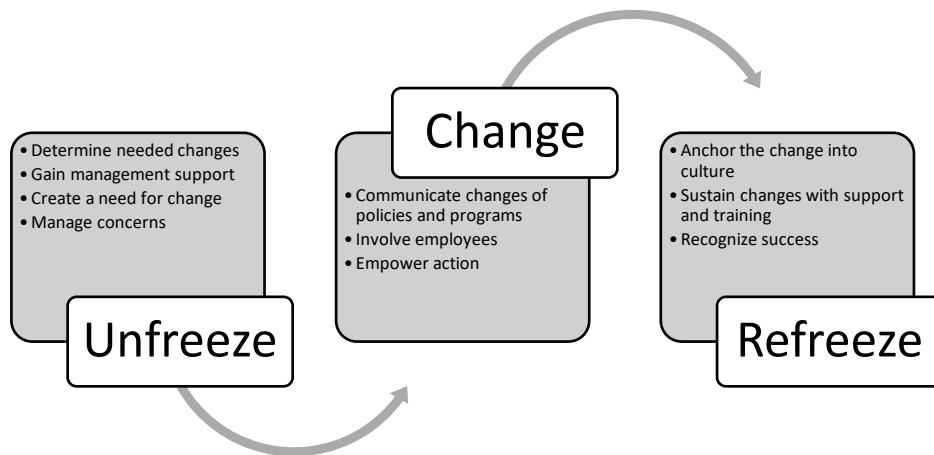


Figure 3. Lewin’s Three-Step Change Theory. Adapted from “Field theory in social science: Selected theoretical papers” by Kurt Lewin (1951).

1.3 Summary

In summary, organizations continue to invest in driver safety programs for their CMV drivers in an effort to save lives and resources. The purpose of this paper is to review the prevalence of theory-based behavioral safety programs and examine their effectiveness in the context of individual, organizational, and methodological factors. Ten behavioral change theories have been separated into theory that considers individual factors and theory that considers organizational factors and examined in the professional driver literature. The paper concludes by providing a summary of recommendations to organizations that inform the creation and maintenance of practical and effective theory-based programs for their employees.

2. THEORIES WITH INDIVIDUAL CONSIDERATIONS

An examination of the literature for the ten theories or models described in the preceding sections made it clear that three theories are more prevalent than the others within the driver safety literature. These three all consider individual level factors and take individual differences into consideration. Using the search processes described in the preceding section, 58 articles examining the driver safety of professional drivers through studies or organizational programs were identified. The articles were retained because the sample consisted of professional drivers in an organizational program. Only sixteen of the fifty-eight articles made explicit mention of a theoretical framework or model being used. Only twelve of the fifty-eight articles were driver safety program reviews from a specific organization. The Health Belief Model and Theory of Planned Behavior were mentioned the most in all of the literature reviewed, as they were presented in a total of three articles each. The Transtheoretical Model of Change was present in two articles. Two additional individual-level theories emerged that were not included in the initial literature search; (1) Len's Theory and (2) the Multiple Intervention Level Hierarchy. The purpose of this section is to examine the theory-based commercial driver safety literature that considers individual factors.

2.1 Health Belief Model

The Health Belief Model was mentioned in three of the 58 articles. As described, the study or program had to include a population of professional drivers within a study or organizational program to be considered for this review. All three of the articles referencing the Health Belief Model concerned road safety programs in the form of advertising campaigns (Adamos, Nathanail, & Kapetanopoulou, 2013; Adamos, Nathanail, & Kapetanopoulou, 2014; Razmara, Aghamolaei, Madani, Hosseini, & Zare, 2018). Razmara et al. (2018) found that there

were specific components of the Health Belief Model that predicted safe driving among 184 taxi drivers in Iran. Cues to action ($r = .38$), perceived benefits ($r = .37$), and perceived barriers ($r = -.31$) all significantly correlated with safe driving and multiple regression analysis revealed these components accounted for 31% of the variance in safe driving behavior. Razmara et al. (2018) provides recommendations for future road safety campaigns with these Health Belief Model components.

Both Adamos et al. (2013) and Adamos et al. (2014) both provide an analysis of the same national road safety campaign on fatigued driving. An evaluation of the campaign through the Health Belief Model revealed that drivers were significantly more aware of the causes and effects of driving while fatigued. Self-report data indicated that after the campaign, drivers were more likely to stop and rest for 15-minute periods when they became fatigued than they were before the campaign. Adamos et al. (2013) also found significant differences in knowledge of fatigue, behavioral beliefs, risk comprehension, behavioral intentions, past behavior, and self-reported behavior before and after the road safety campaign.

Adamos et al. (2014) further elaborated on the importance of taking past behavior into consideration when measuring professional drivers' likelihood of resting for 15-minutes when fatigued. They presented prediction models for assessing the road-safety campaign through adjusted R^2 with components of the Health Belief Model as predictors. It was determined that a critical component of predicting driver behavior while fatigued is the inclusion of individual differences in drivers' past behavior. Essentially, drivers did not respond to the safety campaign in the same manner. The model that accounted for the most variance in behavioral intentions to stop and rest when fatigued included behavioral beliefs and risk comprehension (adjusted $R^2 = .52$). Adding past behavior as a predictor slightly decreased the adjusted R^2 value (47.7%). When

predicting past behavior of falling asleep at the wheel, including behavioral beliefs, risk comprehension, and behavioral intention as predictors resulted in the most variance accounted for (70.7%). These articles effectively show how the Health Belief Model can be used to understand the relationship between road safety campaign interventions and professional driver behavior by focusing on drivers at an individual level.

2.2 Theory of Planned Behavior

The next behavioral change theory that was comparatively prevalent in the literature is the Theory of Planned Behavior. A training program aimed at increasing driver knowledge and awareness of fatigue for 162 professional drivers in Greece was evaluated through a survey based on components of Azjen's (1985) Theory of Planned Behavior. Data on behavioral beliefs, risk comprehension, behavioral intentions, control beliefs, descriptive norms, past behavior, and self-report behavior while fatigued were collected before and after the training program was implemented. Adamos and Nathanail (2015) found that a questionnaire, based on the Theory of Planned Behavior, was helpful in understanding driver behavior before and after the training program, but different components were significantly correlated with different behaviors. Behavioral intentions ($r = -.40$) and descriptive norms ($r = -.40$) were significantly related to pulling over and resting for at least 15-minutes when tired. On the other hand, behavioral beliefs ($r = .75$), control beliefs ($r = .29$), behavioral intentions ($r = .26$), and past behavior ($r = .33$) were significantly correlated with ways drivers reported dealing with fatigue. One implication of this study is that different drivers may require coaching using different components of the Theory of Planned Behavior depending on what their natural inclination is toward feelings of fatigue while driving. Once again, individual considerations were a critical component to the intervention's effects.

Swartz and Douglas (2009) used the Theory of Planned Behavior in a survey administered to 281 commercial motor vehicle owner-operators in the U.S. in an effort to predict five unsafe driving behaviors (i.e., speeding, close following, prohibited maneuvers, poor lane changing practices, and over-the-counter medication use while driving). In addition, the authors also reported that attitudes had the strongest relationship with behavioral intentions ($r = .48$) followed by perceived control to commit unsafe driving actions ($r = .32$). Similar to what Adamos and Nathanail (2015) found, this article provides additional evidence that the Theory of Planned Behavior is useful for advancing the understanding of professional drivers' safety behavior. Attitudes towards driving are something that differs from driver to driver and Swartz and Douglas (2009) underscore the importance of considering individual differences when predicting driver safety.

The third article using the Theory of Planned Behavior sought to evaluate the effectiveness of public enlightenment programs in Nigeria to influence commercial motor vehicle driver behavior (Sunmola, 2014). Sunmola (2014) hypothesized that the Theory of Planned Behavior would be best suited to advance the understanding of the program's effects by incorporating driver intentions, behavior, and attitudes. Survey questions based on the Theory of Planned Behavior, focus group discussions, and interviews were used to measure the effects of Public Enlightenment Programs on driver behavior measured with the Commercial Drivers Behavior Inventory. In fact, regression analysis results indicated that Public Enlightenment Programs accounted for about 87% of the variance in commercial driver behavior.

2.3 Transtheoretical Model of Change

The Transtheoretical Model of Change by Prochaska and DiClemente (1983) was used in two articles with differing outcomes between the two studies. An education-based alertness

management training for long haul truck drivers followed by motivational interviewing consultations based on the stages of the Transtheoretical Model of Change did not result in any evidence for education being an effective remedy for driver sleepiness, even with a strong theoretical framework (Pykkönen et al., 2018). In contrast, Olson, Anger, Elliot, Wipfli, and Gray (2009) obtained more positive results from a study that focused on health promotion where computer-based training, a weight loss and safe driving competition, and motivational interviewing based on the Transtheoretical Model of Change were used to reduce body weight and increase safe driving behaviors. One aspect of safe driving behavior, hard braking frequency, was significantly reduced from the pre-intervention phase to post-intervention phases ($d = 0.88$), although speeding results were not significant ($d = 0.50$). The motivational interviewing component of the Transtheoretical Model of Change from both studies involved working with drivers individually to increase their likelihood of engaging with the safety program.

2.4 Len's Model

Although not a behavioral-change theory, the Lens Model seeks to explain the nature and quality of an individual's assessment of their environment compared to the reality of their environment (Brunswik, 1956). Given the nature of professional drivers' unique environment, Lens Modeling was proposed as a theoretical framework to explain the usefulness of in-vehicle monitoring systems (Horrey, Lesch, Dainoff, Robertson, & Noy, 2012). Based on Lens Modeling, drivers oftentimes fail to recognize unsafe driving due to its subtlety and due to driver individual differences (i.e., risk predisposition, awareness). In-vehicle monitoring systems pick up on these subtleties and provide feedback to drivers that was previously not present. For this reason, Lens Modeling through in-vehicle monitoring systems is an important theory to consider

when discussing safety programs that consider individual differences. In-vehicle monitoring systems compensate for each driver's areas of weakness and remind them to drive safely.

In-vehicle monitoring systems have been used in a multitude of studies and organizations, oftentimes with positive results (Albertsson, & Sundström, 2011; Chang, Lin, Chen, Wang, & Chen, 2002; Fitzharris, Liu, Stephens, & Lenné, 2017; Hickman & Geller, 2005; Horrey, Lesch, Dainoff, Robertson, & Noy, 2012; Sayer et al., 2010; "Shell International Petroleum," n.d.; "Trucking Company Rolls," n.d.; Van Houten, Malenfant, Reagan, Sifrit, & Compton, 2009; Victor et al., 2011). Using in-vehicle monitoring systems allows organizations, oftentimes safety managers, to record data on driver behavior using the in-vehicle monitoring system and then provide individualized feedback to the driver based on recently recorded driving data (Fitzharris, Liu, Stephens, & Lenné, 2017; Hickman & Geller, 2005; "Trucking Company Rolls," n.d.; Victor et al., 2011). This model has a considerable focus on individual differences because each driver receives personalized feedback from management.

2.5 Multiple Interventions Level Hierarchy

Ludwig and Geller (2000) proposed that a multiple intervention level hierarchy is an appropriate model for implementing a professional driver safety intervention. The multiple intervention level hierarchy is based on the premise that the most inexpensive and non-intrusive interventions are typically those that reach the most employees and the most expensive and intrusive interventions are likely to impact a fewer number of people. Based on an analysis of seven studies of pizza delivery drivers, Ludwig and Geller (2000) suggest that the less intrusive measures be utilized first in an effort to impact the largest number of employees, and then employees not affected should be the recipients of the more expensive and intrusive interventions. Olson and Austin (2001) applied the multiple intervention level hierarchy in a bus-

driver intervention where drivers self-reported their safe driving performance through self-monitoring forms and managers provided feedback based on these data. This type of intervention was considered the most non-intrusive and Olson and Austin presented implications for one driver whose performance only increased by 2% compared to the group average of 12.3%. This individual would be a candidate for more intrusive, and likely more expensive interventions, based on the multiple intervention level hierarchy. Although individual differences may not be considered during the first stage of the multiple intervention level hierarchy, more intrusive measures would likely do so.

3. THEORIES WITH ORGANIZATIONAL CONSIDERATIONS

Within the ten behavioral-change theories introduced previously, four of them were identified as theories with clear organizational considerations. The prevalence of the following theories was examined in the literature: the Workplace Health Model, Diffusion of Innovation Theory, Kotter's 8-Step Change Model, and Lewin's Three-Step Change Theory. This examination resulted in the identification of only one article that used Lewin's Three-Step Change Theory, and no articles utilized the Workplace Health Model, Diffusion of Innovation Theory, or Kotter's 8-Step Change Model. Although only one example of a theory with organizational considerations was found, comments about safety culture and safety climate were comparatively far more prevalent in the literature. Safety culture and climate are discussed in this section because they provide insight into the organizational factors being considered in the professional driver literature. When it comes to long-haul truck drivers, information exchange between drivers and dispatchers often serves as the means for how drivers interpret the organizational environment (Dragoni, 2005). This driver-dispatcher relationship is a complicated but important element in understanding the safety climate perceptions of professional drivers (Dragoni, 2005; Zohar, 2014). Although direct relationships between safety climate and driver accidents are not available here, some evidence for the relationship between safety climate and safe driving behavior is presented. The objective of this section is to examine the theory-based commercial driver safety literature that takes organizational factors into consideration. In addition, safety climate is also examined due to its prevalence within the articles reviewed.

3.1 Lewin's Three-Step Change Theory

In an effort to understand the most effective organizational safety interventions for professional drivers, Gregersen, Brehmer, and Moren (1996) reviewed four different types of

safety interventions; the interventions included driver training, group discussions, safety campaigns, and driver bonuses. Each of the four were examined for their ability to influence accident free driving in four separate groups of drivers, each consisting of approximately 900 drivers from a Swedish telephone company. A control group with the same number of drivers was included. Measures of effectiveness took place after a two-year implementation period. Results suggest that the four intervention groups experienced reductions in accident costs while the control group did not. Gregersen et al. (1996) report that the most effective method of reducing accident risk, which was calculated by the number of accidents per 10,000 km, was the group discussion intervention. Although in-depth analyses were not conducted, it was reported that the driver group utilizing group discussions had the highest accident risk (.17 accidents per 10,000 miles) two years prior to the intervention phase, but had the lowest accident risk two years after the intervention (.08 accidents per 10,000 miles). In addition, the average cost per accident two years after the intervention phase for the group utilizing group discussions was lower than the three other intervention groups and control group.

The group discussion intervention was the only one of the four interventions which utilized Lewin's theory. Following the steps of Lewin's three-step process, driver group discussions were held focusing on the unfreezing of group norms, transitioning to new norms of behavior, and the refreezing of driver group norms (Gregersen et al., 1996). The group discussions were designed to make group norms more explicit and influence driver decisions to alter their behavior behind the wheel. Drivers exchanged information on aberrant driving behavior and worked to come to conclusions regarding its dangers. After coming to an agreement on safer driving methods through group discussion, management worked with drivers on ways to support these behavioral changes, thus refreezing organizational norms. This is the

only theoretical example with organizational considerations that was found in the review of the literature.

3.2 Safety Culture and Safety Climate

Although they do not represent specific behavioral change models or theories, safety culture and safety climate are described here because in addition to being far more prevalent in the literature on safety programs with an organizational level theoretical focus, they are organizational level constructs and associated interventions that are considered to have substantial potential to change commercial motor vehicle driver behaviors. Within the fifty-eight studies or programs utilizing professional drivers, eleven considered safety climate or culture as a factor in the discussion of driver safety. While culture is considered more abstract than climate in nature, culture is best conceptualized as an enduring set of beliefs and assumptions that which give meaning to employee experiences at work (Schein, 1992). Climate refers to specific organizational elements of culture, such as company policies, procedures, and practices about safety. Safety climate is therefore less abstract than safety culture and is often considered a snapshot of a specific element within safety culture that can be measured at a specific point in time (Dedobbeleer & Beland, 1991), but safety culture and climate are ultimately unique constructs. Although not a direct representation of safety culture, safety climate is therefore often used as a measurement of an organization's safety culture (Flin, Mearns, O'Connor, & Bryden, 2000). It is believed that enduring climate perceptions can ultimately influence a change in culture through solidified beliefs and assumptions (Goldenmund, 2007). Both safety climate and culture were present in the professional driver safety literature.

Zohar, Huang, Lee, and Robertson (2014) describe how the unique work environment of many professional drivers is an important consideration in regards to safety climate. Long-haul

truck drivers may experience very limited interaction with co-workers other than occasional conversations with dispatch managers. Zohar et al. (2014) explain that given the typical nature of occupational driving, safety climate of drivers should be measured through psychological rather than organizational safety climate where perceptions are shared among workers. Psychological safety climate differs from organizational climate in the sense that psychological climate refers to individual perceptions of their organization's safety policies, procedures, and practices while organizational climate is the shared perception of the same (Christian, Bradley, Wallace, & Burke, 2009). For professional drivers, aggregating scores across drivers through organizational climate measures may not be an accurate representation of safety climate due to this lack of developed shared perceptions among drivers (Huang, Lee, McFadden, Rineer, & Robertson, 2017).

Although understanding safety climate through drivers' relationships with peers may lead to a lack of precision, Zohar et al. (2014) provide evidence for driver-dispatcher relationships being an important factor in commercial drivers' safety climate perceptions. The literature outside of driver safety supports the idea that managerial support is important and has found management support to be a critical component of employee safety. Among the various safety climate domains, Beus, Payne, Bergman, and Arthur (2010) provide evidence for perceived management commitment to safety as the best predictor of employee injuries. Zohar et al. (2014) found that the quality of driver-dispatcher relationships and safety climate scores were significantly correlated ($r = .49$), with safety climate in turn significantly correlated with self-reported safe driving behavior ($r = .40$) and driver hard-braking frequency ($r = -.09$). However, there is some evidence for drivers and their employers to have varying safety perceptions. Spielholz, Cullen, Smith, Howard, Silverstein, and Bonauto (2008) found that drivers and

employers differed significantly on safety climate items within a measure. For instance, one of the nine items asked the likelihood of being injured on the job over the proceeding twelve months and 42% of drivers reported this being a likely scenario while only 2% of employer responses indicated the same.

Additional research on employer safety climate by Swartz and Douglas (2009) showed that drivers perceive employer safety practices as supportive or directive. Supportive practices involve behavior such as employers providing safety information to drivers and spending time and money on safety training. Directive practices are those where employers constantly monitor and try to control driver behavior, such as always pushing them to stay on schedule no matter the circumstances. Olson et al. (2009) showed that even if driver safety values are promoted at an organizational level, time constraints may push some fleet managers to promote these behaviors significantly less than the organization desires, as shown by differences in mean safety values between fleet managers and their organization as a whole ($M = 3.80$ vs 4.60). Although the authors considered a p -value $< .10$ as being significant, Swartz and Douglas (2009) found that supportive safety climate practices were related to behavioral intentions to drive safely ($r = -.17$) while directive practices were not ($r = .15$). Taken with the findings from Zohar et al. (2014), it seems that driver-dispatcher relationships is important to the understanding of professional drivers' safety climate perceptions, although the motivation behind manager's safety practices may be best understood through a multi-faceted approach.

Although professional drivers face work environments uncharacteristic of the environments where safety climate is typically discussed (Zohar et al., 2014), the research does provide evidence for its value in driver safety. For example, Olson et al. (2009) found that safety climate scores correlated with self-reported time wearing a seat belt ($r = .50$). Morrow and Crum

(2004) found that safety climate had a moderate relationship with fatigued driving behavior ($r = .25$). Similarly, Caird and Kline (2004) reported that safety climate was a significant factor in determining the amount of planning that drivers conducted before trips ($r = .25$) which then correlated with on-the-job accidents ($r = -.19$).

Several studies provided evidence for a relationship between safety climate and driver errors and violations (Öz & Lajunen, 2008; Şimşekoğlu & Nordfjærn, 2017; Sullman, Stephens, & Pajo, 2017). Öz and Lajunen (2008) found that a general safety scale regarding organizational safety was related to more reports of driver errors and violations ($r = -.34$). However, a work specific safety scale showed a significant relationship between safety culture and driver errors and violations ($r = .27$). This suggests that although the number of errors and violations may increase when organizations are supportive of drivers reporting errors and violations, it is still possible to minimize errors and violations by focusing on worker specific safety such as the unique driving environments experienced by professional drivers. Consistent with this, Sullman et al. (2017) found safety climate scores to be negatively related to driver errors and lapses ($r = -.24$) and violations ($r = -.28$), although no association between safety climate and crashes was present. In summary, safety culture and climate may not be behavioral change theories or models, but the evidence for their influence on driver behavior is strong.

4. RESEARCH DESIGN AND METHODS

Exploring the literature for organizational driver safety programs or studies with populations of professional drivers resulted in the identification of fifty-eight articles. The prevalence of behavioral based change theories was examined and both individual and organizational factors were discussed. This section addresses methodological aspects of the fifty-eight articles and their associated strengths and weaknesses. Sixteen of the fifty-eight articles explicitly mentioned a theoretical framework. These articles are the focus of discussion in this section. The study designs and evaluation frameworks of these articles will be discussed. More specifically, the organizing framework for methodological factors in this section includes whether the study design utilized an experimental, quasi-experimental, or other non-experimental approach, and whether an evaluation taxonomy of effectiveness was used. Lastly, the effectiveness of studies and programs using theory is discussed in the context of their methodological factors.

4.1 Overview of Study Designs

Within the fifty-eight articles originally identified as containing a population of professional drivers, only two provided experimental designs, sixteen were quasi-experimental, twenty-seven used another non-experimental approach, and twelve were safety program reviews or studies where no experimental methodology was presented. The sixteen articles with theoretical components comprise of two experimental designs, three quasi-experimental designs, ten non-experimental designs, and one program review with no mention of methodology. In recognition that experimental and quasi-experimental designs are the preferred designs for achieving high reliability and measuring effectiveness (Fylan, Hempel, Grunfeld, Conner, & Lawton, 2006), the experimental and quasi-experimental designs of theory-based and model-

based articles will be addressed first. An examination of these study designs will speak to the level of evaluation rigor in theory-based driver safety programs.

One of the articles that utilized an experimental design assessed the ability of a Commercial Driver Assessment and Training System (CDATS) to increase professional drivers' capacity to detect road hazards. The theoretical model used the Salience, Effort, Expectancy, and Value (SEEV) model of visual processing, which seeks to understand the allocation of a person's visual processing behavior (Park, Hickman, Pitoniak, & Rosenthal, 2018). Post-test results indicated a significant difference between training groups and the control group when compared to pre-test measures ($d = 3.71$). The results suggest that a simulator is a viable option for improving hazard detection in the professional driver population. However, results are based on performance in a simulator and do not necessarily reflect drivers' hazard detection improvements on the job.

The second article, which used an experimental design, is by Pylkkönen et al. (2018) and was previously discussed. This was an education-based alertness management training program that used components of the Transtheoretical Model of Change, but it failed to find a meaningful relationship between the training program and sleepiness countermeasures (SCMs) during periods of driver sleepiness. Driver behavior was monitored in the morning and at night, with neither time period resulting in behavioral change. These results are not sufficient in determining a lack of relationship between training and driver sleepiness countermeasures, but it does raise doubts about the ability of this intervention to change behavior.

Three articles used quasi-experimental designs in their theory-based programs. Similar to Pylkkönen et al. (2018), these three articles were described earlier, but study design was not previously discussed. Olson et al. (2009) utilized pre-existing groups of drivers from four

trucking carriers in the Pacific Northwest. Similarly, Adamos and Nathanail (2015) made use of eight pre-existing groups of drivers, each located in a different city in Greece. The third article with a quasi-experimental design by Gregersen et al. (1996) involved study groups that were created by combining existing working units of about 30 drivers until each group contained about 900 drivers. Working units were combined based on regional similarity, the number of drivers, and previous driving behavior so that each final group of 900 drivers were as similar as possible. Gregersen et al. (1996) acknowledged that randomly selecting driver groups would have been ideal, but the practical and organizational limitations led them to strategically combine groups for a quasi-experimental design instead.

These two experimental designs and three quasi-experimental designs represent the preferred designs for rigorous evaluation (Fylan et al., 2006), but non-experimental theory-based driver safety studies were far more common in the literature. An examination of the ten studies revealed that a popular method was administering a survey to drivers and correlating responses on the survey to one another and sometimes with other safety data. Eight of the ten studies reported using a survey in their non-experimental design (Adamos et al., 2013; Adamos et al., 2014; Morrow & Crum, 2014; Newnam, Tay, & Mason, 2006; Razmara et al., 2018; Sunmola, 2014; Swartz & Douglas, 2009; Zohar et al., 2014).

Additionally, only two of the ten non-experimental designs utilized a dependent variable that was not self-report (Olson et al., 2009; Zohar et al., 2014). Swartz and Douglas (2009) discussed how difficult it is to measure driver behavior in an objective and rigorous manner. They explain how drivers are often under pressure to perform both safely and productively, with some safety behaviors often being ignored for the sake of efficiency. However, Zohar et al. (2014) showed that even in a non-experimental design, driver behavior can be measured in a

rigorous manner, as shown through their use of GPS-based deceleration data collected from drivers' trucks. This use of in-vehicle monitoring systems was discussed previously, and their ability to collect data from a non-biased perspective as shown in Zohar et al. (2014) provides a more rigorous approach to collecting data than self-report. Similarly, Olson et al. (2009) used hard braking frequency and driver time spent speeding, both of which were collected from engine computer records. These considerations of evaluation design are important when determining the validity of program effectiveness.

4.2 Evaluation

In an effort to further evaluate measures of effectiveness of safety programs that were centered on the behavioral change theories, two major taxonomies of effectiveness were chosen for their ability to be applied to this literature. These models of evaluation are Kirkpatrick's (1959, 1976) and Kraiger, Ford, and Salas's (1993) taxonomies of program evaluation. Kirkpatrick's taxonomy comprises of four levels of evaluation, including behavior and results. These are considered the most likely to be used in this literature because behavioral change theories seek to change driver behavior, the third level of evaluation in Kirkpatrick's model, and ultimately, outcome criteria such as crash statistics or cost of accidents, which represent Kirkpatrick's fourth level of evaluation (results). Kraiger, Ford, and Salas's taxonomy includes affective, cognitive, and skill-based evaluation outcomes.

However, only one of the sixteen theory-based articles evaluated their program with the explicit mention of either Kirkpatrick's or Kraiger, Ford, and Salas's taxonomy. Following Kraiger, Ford, and Salas's taxonomy, Pylkkönen et al. (2018) used subjective measures of driver motivation (affective evaluation) through a questionnaire, measured driver knowledge (cognitive evaluation) through a written assignment during training, and administered a driver sleepiness

scale to measure subjective reports of sleepiness at the wheel (skill-based evaluation). With only one theory-based article directly applying one of these frameworks and the high number of non-experimental designs, this seems to indicate there are areas for improvement when evaluating theory-based driver safety programs. This is not an indication that there are no other examples of Kirkpatrick's or Kraiger, Ford, and Salas's models of evaluation in the literature, but no other examples were present in this review.

Although not explicitly mentioned within the articles discussed here, an examination of the studies and programs reveals that there seem to be examples of said taxonomies through the dependent variables used. For example, the use of in-vehicle monitoring systems, as discussed previously, allows organizations to collect objective data on driver behavior (Chang et al., 2002). The use of driver deceleration data collected from in-vehicle GPS systems as reported by Zohar et al. (2014) is another example of an objective driver behavior outcome. Overall, the theory-based literature on driver safety does provide some examples of preferred design and evaluation methodologies. Similarly, driver behavior in response to fatigue, driver speeding, hard-braking frequency, and near-miss accidents could reasonably be conceptualized as behavioral criteria within Kirkpatrick's model. An evaluation based on Kirkpatrick's results level was also present in the literature through Gregersen et al.'s (1996) study where the average cost per accident after an intervention was reportedly reduced. In conclusion, although evaluation taxonomies were rarely discussed in the studies and programs here, one can still find examples of their use through several of the dependent variables reported in the literature.

4.3 Most Effective Behavioral Change Theories

In conclusion, there are many important considerations when evaluating the effectiveness of driver safety programs. The literature provides examples of rigorous methodologies that are

grounded in theory. However, there are more examples of self-report and non-experimental designs compared to other-report experimental designs, underscoring room for improvement. There may not be enough theoretically grounded literature to draw any conclusions on the most effective behavioral change theories. On one hand, the Health Belief Model and Theory of Planned Behavioral were most prevalent, but there are only three examples of each. Evidence for the Theory of Planned Behavior's ability to help advance the understanding of driver behavior is strong, with all three articles showing significance, and one of them being a quasi-experimental design (Adamos & Nathanail, 2015) and the other two being non-experimental (Sunmola, 2014; Swartz & Douglas, 2009). The Health Belief Model was present in three articles with non-experimental designs, but all found significant results (Adamos et al., 2013; Adamos et al., 2014; Razmara et al., 2018). The Transtheoretical Model of Change was only used twice, but each example came from an experimental design, with one showing positive results for changing driver behavior (Olson et al., 2009) and the other reporting null results (Pylkkönen et al., 2018). Lastly, two non-experimental articles using the Multiple Intervention Level Hierarchy presented evidence for the utility of this model in influencing driver behavior (Ludwig & Geller 2000; Olson & Austin, 2001). In summary, there is certainly evidence speaking to the effectiveness of behavioral change theories in driver safety programs, but conclusions as to which single theory or model is most effective is not possible at this point. The implications of this conclusion for employers are discussed in the subsequent section.

5. CONCLUSION AND ORGANIZATIONAL IMPLICATIONS

The U.S. Bureau of Labor Statistics Census of Fatal Occupational Injuries (2012) reported a total of 396 fatalities associated with the 2010 truck driver population. This translates into a rate of 31.8 fatalities per 100,000 workers, roughly ten times the number of fatalities associated with in-house drivers. These numbers make the professional driver population, especially truck drivers, an appropriate population for studying the prevalence of theory in employer-based driver safety programs. This paper began with ten behavioral change theories and models and reviewed them in the context of professional driver safety programs through an examination of individual, organization, and methodological factors in order to provide organizational recommendations. Additional theories were also discussed after they emerged during the review of the literature. A brief summary is presented here as well as recommendations for employers as they seek to create and maintain practical and effective theory-based programs for their driving populations.

Examining the literature for theories and models that consider individual differences resulted in the identification of five theories, with some being more prevalent in the literature than the others. Although not an exhaustive list, there is evidence in the literature for the Health Belief Model, Theory of Planned Behavior, Transtheoretical Model of Change, and The Multiple Interventions Level Hierarchy as being effective avenues for influencing and aiding in the understanding of safe driver behavior. In addition, in-vehicle monitoring systems provide a reliable method of recognizing unsafe driving practices at an individual level and although not a behavioral change theory, this process can be explained through the theoretical framework of Len's Modeling. In summary, theory that considers individual differences is an important factor when attempting to change professional driver safety behavior.

Within the theories or models in the literature that consider organizational factors, Lewin's Three-Step Change Theory was the only theory identified with evidence supporting its effectiveness in advancing or influencing driver safety. However, articles addressing safety culture and climate were comparatively far more ubiquitous. Safety culture and climate are not behavioral change theories, but the evidence in the literature suggests they have substantial potential to influence commercial motor vehicle driver behavior. An understanding of organizational factors through Lewin's Three-Step Change Theory, safety culture, and safety climate may serve as effective methods of changing professional driver behavior.

Aside from individual and organizational factors, the research design and methods of evaluation within theoretical programs was examined. Although there are examples of rigorous programs such as experimental and quasi-experimental designs, the majority of theory-based programs utilized a non-experimental approach. With that said, the literature still provides evidence supporting the effectiveness of several theories at improving driver safety. It is recommended that this evidence should be considered in future program design.

5.1 Organizational Implications

From an organizational perspective, the most important takeaway here is that the inclusion of a theoretical foundation when designing and maintaining a driver safety program could lead to significant gains in employees' safe driving behavior. Specifically, employers should strive to include factors at both the individual and organizational levels by creating driver safety programs that are based on one of the effective theories presented in this paper. The majority of theoretical evidence stems from theories or models that consider individual differences, which may prove to be a good starting point for program design and development. Employers should first find ways to differentiate between drivers' safety behaviors and then

proceed to influence behavior change through a theory or model that considers individual differences.

Additionally, employers should consider organizational factors by utilizing Lewin's Three-Step Change Theory, safety culture, and safety climate. Based on a current examination of the literature, Lewin's Three-Step Change Theory is the only theory with organizational factors with evidence for being effective in designing and developing driver safety programs, although it was only used in one study. Additionally, because enduring climate perceptions can lead to a culture change (Goldenmund, 2007), organizational programs should seek to influence organizational safety climate perceptions. There is more evidence for safety climate being helpful in influencing driver behavior than theory with organizational considerations.

The literature suggests that the use of theory will advance driver safety behavior, but employers should also strive to use the most rigorous program designs and evaluation methods possible. Experimental or quasi-experimental designs that refrain from self-report evaluation methods are recommended. There is evidence for this being feasible within commercial motor vehicle driver populations. It is advanced that an employer-based driver safety program that includes these recommended best practices will see positive results in the safety behaviors of their driver population.

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APPENDIX A

SEARCH TERMS INCLUDED IN THE REVIEW OF LITERATURE

The search terms used in the review of literature include: Traffic safety, transit safety, safety training, driver training, driving training, driver safety training, employer-based driver training, safety promotion, translation or translational research, safety culture, behavioral, behavior, behavioral science, health promotion, safety climate, behavioral change theory/models, Lewin's Three-step Change Theory, Prochaska and DiClemente, Transtheoretical Model of Change, Kotter's 8-step Change model; Nudge Theory, Health Belief Model, Social Cognitive Theory, Diffusion of Innovation, Socioecological model, Workplace Health Model, Theory of Planned Behavior, employer, work, employee, occupational, driver, operator, taxi, bus, truck, commercial vehicle, and transit.