Eco-Driving at UVA: Safe and Sustainable Fleet Management with Big Data Analytics and Personalized Education

(Technical Paper)

The Psychological and Interpersonal Effects of Tracking Vehicle Driver Performance in the Workplace

(STS Project)

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

I. Introduction

The leading type of fatal work-related events in the United States is highway accidents (Horrey et al., 2012) and driver behavior has been shown to be a major causing factor of these incidents (Toledo & Lotan, 2008). The estimated direct cost of car crashes in the United States was over two hundred billion dollars in the year 2000. In the year 2000 it was also estimated that 20-65% of company vehicles are involved in car crashes each year (Toledo & Lotan, 2008). There is a need for vehicle driver safety analysis and training, but sustainability concerns are also prevalent. In the European Union, approximately twenty five percent of carbon dioxide emissions are produced by the transportation industry (Abrell, 2010). In urban environments, commercial vehicle fleets account for nearly twenty percent of total transportation distance (Kanaroglou & Buliung, 2008). Therefore, extensive opportunities exist within commercial vehicle fleets for safety and environmental improvements.

Recently, in-vehicle performance monitors have become a popular tool for tracking driver behavior, especially among vehicle fleet managers. For example, many insurance companies have started using telematic data to classify driver risk and adjust premiums accordingly (Chen & Jiang, 2019). One study that sought to evaluate the use of in-vehicle monitors as an effective method of improving driver performance found that "risky driving behaviors declined significantly," when drivers were coached on optimal habits in parallel with feedback received from the monitors (Bell et al., 2017).

While the efficacy of the use of in-vehicle monitors with regard to improving vehicle fleet safety has been established, the psychological and interpersonal effects of performance tracking technology on individual drivers requires further exploration. For example, "location-based tracking and monitoring" (a category in which in-vehicle performance monitors

fall) shows profound social impacts in “four key areas: control, trust, privacy and security.” (K. Michael & M. Michael, 2011). These technologies have potentially major social implications, yet little research has been conducted to explore how this can occur within commercial vehicle fleets.

The technical investigation discussed in this prospectus focuses on the development of a driver education program, specific to the University of Virginia Facilities Management drivers, based on an analysis of in-vehicle driver performance monitoring data. The goal of this analysis and training program is first and foremost to improve driver safety and sustainability, but also to gain insights into how driver behavior can most effectively be altered by employers. The STS research paper in this prospectus seeks to evaluate the extent to which vehicle fleet drivers are psychologically and interpersonally affected by their employer’s usage of tracking data to evaluate their performance and alter their behavior.

II. Technical Topic

In 2018, the transportation sector accounted for 28.2% of greenhouse gas emissions primarily including “burning fossil fuels for cars, trucks, ships, trains, and planes” which accounts for the greatest proportion of emissions in the United States (US EPA, 2018). To lower these emissions, eco-driving programs have emerged to influence changes in driving behavior around topics such as braking, driving speed, and the impacts of idling on overall fuel consumption (Huang et al., 2018). Such changes in behavior can lead to a decrease between 5-20% in overall fuel consumption which helps drivers both save money and lower their carbon footprint (Rakotonirainy et al., 2011). A reduction in overall fuel consumption of this magnitude translates to significant improvements in fleet performance, especially concerning sustainability.

The University of Virginia's Facilities Management department is starting to use in-vehicle monitors as a way to track the performance of their vehicle fleet. Currently, UVA Facilities Management does not have a suitable method for using driver performance data to improve fleet safety and sustainability by altering driver behavior. A leading cause of Facilities Management's complacency is their lack of a comprehensive driver training program. Over the past three years UVA Facilities Management has installed Geotab telematic tracking sensors on every vehicle in their fleet. These in-vehicle sensors constantly collect and compile a broad range of driver performance metrics such as harsh acceleration, hard braking, hard cornering, speeding, fuel consumption and seat belt usage. This data is then stored on a server where management can access the raw data directly, or choose to produce scorecards which highlight the number of incidents that occurred based on specified criteria and thresholds. These incident counts are then normalized based on distance driven, and standardized between zero and one hundred (Geotab, 2018). Finally, a weighting system is applied to these metric scores to obtain a single vehicle score that can be used to classify and compare the performance of different vehicles.

The development of a comprehensive driver education program must be supported by relevant prior research, as well as an extensive analysis of UVA-specific driver performance data. "Performance" in this context is understood as the extent to which a driver complies with safety laws and engages in sustainable driving behavior. Facilities Management has specified that vehicle drivers must comply with seatbelt laws and speed limits at all times. As such, driver compliance will be measured by the frequency of speeding and seatbelt misuse incidents. As a result, driver safety will be measured by both the degree of driver compliance along with the frequency of harsh acceleration, hard braking and cornering incidents. In terms of measuring sustainability, or "eco-driving" driving speed and idling have been shown to be among the most

crucial metrics to consider in regard to fuel consumption (Huang et al., 2018). In the context of this technical project, vehicle speed and idle fuel consumption will be used to classify driver behavior in terms of their contribution to the sustainability of the overall fleet.

Using these various methods of classifying driver behavior, the developed personalized training program will be curated to identify opportunities for improvement for individual drivers. In order to evaluate the efficacy of a personalized training program, a multi-week pilot test will be conducted with a selection of UVA drivers and vehicles. Driver performance will be measured before, during, and after the implementation of the training program. Results of the pilot test will be compiled and analyzed with the intention of improving the training program through further iterations. This project's final deliverable will be a fully developed training program that could be implemented across UVA Facilities Management's entire vehicle fleet to improve the fleet's safety compliance and eco-driving behavior.

III. STS Topic

Crucial to the effectiveness of technologies that seek to improve driver performance is the acceptance of the devices by drivers, and their willingness to work within a system that relies on technology to measure and alter driver behavior (Brookhuis et al., 2001). Not only is acceptance of the technology by drivers necessary, but fleet operators, those that employ the drivers, must also have a willingness to allow technology to track, analyze, and alter their employees' behavior. In many ways, the employer-employee relationship relevant in this context is similar to a parent-child relationship. When asked about their feelings on installing a performance tracking device in their child's vehicle, responses from parents differed widely with regard to both comfort-level and motivation. "Most parents thought parents should feel obligated to install the [tracking] technology," while others worried "such a system might serve to erode their [the

parent's] relationship with their son or daughter," (Guttman & Lotan, 2011). Applying this research to the relationship between fleet managers and vehicle drivers, the motivations for stakeholders with decision making power of implementing driver performance tracking technology are evident, but reservations about the potential impacts on drivers are also clear. Despite possible psychological and personal effects of tracking technology on drivers, little research has been done to examine what these effects are and the extent to which they are prevalent in commercial vehicle fleets. This sociotechnical project seeks to investigate how performance tracking by employers can impact the psychological state and social relationships of employees in the context of commercial vehicle fleet management and drivers.

A useful framework for better understanding the complex problem of the sociotechnical effects of performance tracking on employees such as vehicle drivers is Actor-Network Theory (ANT). Developed by Bruno Latour alongside Michel Callon and John Law, ANT "contains within it concepts that, when abstracted from the multiple trajectories of ANT, can be used as tools to better reveal the complexities of our sociotechnical world," (Cressman, 2009). This project seeks to apply Cressman's contention in the context of examining the behavioral and social implications of using technology to track, measure, and modify employee performance. In order to utilize ANT, actors must first be defined. In the context of commercial vehicle fleets, there are three most relevant actors to consider. The first two, fleet managers and vehicle drivers, operate within their own network of social relationships and interpersonal dynamics. As the employers of the drivers and the implementers of the tracking technology, fleet managers hold a considerable amount of power over the drivers. At this point it is important to note that fleet managers should be considered a single actor, one decision-making body that controls the fleet's drivers. On the other hand, drivers are a collection of many actors, each of whom may be

impacted differently by the usage of performance tracking technology. The third actor to consider is the performance tracking system itself. This system is comprised of the physical monitoring device, as well as the collected telematic data and the analytical system used to interpret that data for the purposes of measuring driving performance.

As described by Cressman, 2009, " a network in the ANT sense should not be confused with the conventional sociological or technical applications of this concept: ... "we are concerned to map the way in which they [actors] define and distribute roles, and mobilize or invent others to play these roles" (Law & Callon 1988, p.285)." Therefore, the problem presented by this prospectus is best viewed through the lens of Actor-Network Theory by examining the roles played by each of the relevant actors, fleet management, drivers and the performance tracking technology. A common critique of ANT is the difference in interpretation of actor roles within the network by both outside observers and internal actors. As was previously mentioned, every driver is different and they can each be expected to be affected by tracking technology differently. In order to avoid potentially detrimental conflicting definitions of roles, expectations and requirements of human actors (drivers and FM management) must be clearly established before any implementation of training. Providing actors with a solid and consistent understanding of their responsibilities will ensure both a better chance of increased training program efficacy and a more appropriate situation in which to apply ANT.

IV. Research Question and Methods

The manner and extent to which driver tracking technologies impact the social and mental states of the drivers on which the technology is being used is largely unknown. This reality, coupled with the technical project associated with this prospectus resulted in the following research question: How are commercial vehicle fleet drivers psychologically and

interpersonally affected by their employer's usage of tracking data to evaluate their performance and alter their behavior?

Central to the argument against implementing vehicle tracking technology is the potential "erosion of trust and confidence in drivers." (Guttman, 2011). Thus, the impacts of tracking technology on drivers should be analyzed with regards to driver perception of their employer as well as the personal impacts on individual drivers. The data which will be used to investigate this research question will primarily come in two forms. Telematic tracking data will be used as a quantitative measure of driver acceptance of the usage of performance tracking by their employer. Improved performance (as defined in the technical project description) resulting from would indicate a generally positive impact on drivers. Qualitatively speaking, impacts of the usage of in-vehicle trackers on drivers will be evaluated through surveys and longer-form discussions with drivers whose employers have implemented such technology. The goal of surveying drivers and conducting feedback sessions is to gauge the general perception of in-vehicle tracking technology and the employers who implement it by drivers. Qualitative data collection will be aided by prior research related to the sociotechnical impacts of tracking technology on employees. The relevance of prior research will be evaluated using various keywords and phrases including (but not limited to) "employer usage of telematics", "impacts of performance tracking on drivers", and "influential driver management practices".

V. Conclusion

In conclusion, the technical project addressed in this prospectus will deliver a personalized driver training program to UVA Facilities Management with the goal of using collected vehicle telematic data to improve fleet performance. Through an application of actor-network theory in addition to training program feedback from vehicle drivers, the variety

of potential social impacts on individual drivers from the use of in-vehicle tracking technology will be analyzed. It is expected that the development of a data-driven training program in parallel with an investigation of how the collection and use of that data impacts drivers will resolve many reservations about the implementation of in-vehicle driver performance trackers.

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