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Driving the talk: examining professional truck drivers' motivations to engage in eco-driving

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Abstract

Purpose – This research examines what motivates professional truck drivers to engage in eco-driving by linking their self-reports with objective driving scores.
Design/methodology/approach – Theory of Planned Behavior (TPB) is illustrated in an embedded, single-case study of a Finnish carrier with 17 of its truck drivers. Data are obtained through in-depth interviews with drivers, their fuel-efficiency scores generated by fleet telematics and a focus group session with the management.
Findings – Discrepancies between drivers' intentions and eco-driving behaviors are illustrated in a two-by-two matrix that classifies drivers into four categories: ideal eco-drivers, wildcards, wannabes and non-eco-drivers. Attitudes, subjective norms and perceived behavioral control are examined for drivers within each category, revealing that drivers' perceptions did not always align with the reality of their driving.
Research limitations/implications – This study strengthens the utility of TPB through data triangulation while also revealing the theory's inherent limitations in elucidating the underlying causes of its three antecedents and their impact on the variance in driving behaviors.
Practical implications – Managerial insights are offered to fleet managers and eco-driving solution providers to stipulate the right conditions for drivers to enhance fuel-efficiency outcomes of transport fleets.

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Corrigendum: It has come to the attention of the publisher that the article: Jazairy, A., Pohjosenperä, T., Sassali, J., Juga, J. and von Haartman, R. (2023), "Driving the talk: examining professional truck drivers' motivations to engage in eco-driving", *International Journal of Physical Distribution & Logistics Management*, Vol. 53 No. 11, pp. 98-124. https://doi.org/10.1108/IJPDLM-07-2022-0236 incorrectly stated that 'although this study entertains both scenarios of TPB frameworks (i.e. the direct and indirect effects of perceived behavioral control on behavior), its findings are more in favor of the latter.' The sentence has now been updated to 'although this study entertains both scenarios of TPB frameworks (i.e. the direct and indirect effects of perceived behavioral control on behavior), its findings are more in favor of the former.' The authors sincerely apologise for this error.

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Originality/value – This is one of the first studies to give a voice to professional truck drivers about their daily eco-driving practice.

Keywords Transport, Theory of planned behavior, Freight, Environmental sustainability, Finland

Paper type Research paper

1. Introduction

Around 24% of direct carbon dioxide (CO_2) emissions from fuel combustion are ascribed to the transport sector (IEA, 2020); with 7% of global CO_2 emissions linked to the freight sector (ITF, 2015). Among different freight vehicles, trucks are the fastest-growing source of global oil demand, accounting for 40% of oil demand growth by 2050 and 15% of the increase in global CO_2 emissions – based on the historical development of vehicle stock, mileage and payload (ITF, 2018). Despite a 5% decline in CO_2 emissions from trucks in 2020 due to the Covid-19 pandemic, it took freight emissions only a year to rebound and return to their pre-pandemic levels (IEA, 2021). In parallel, the academic community is persistently voicing a need for more research to support mitigating the atmospheric emissions from the freight sector (Ellram *et al.*, 2022; Forslund *et al.*, 2021).

Although truck manufacturers such as Volvo and Scania are increasingly channeling their efforts towards producing trucks with more efficient engines (Electrive, 2020; IEA, 2021), the role of truck drivers in achieving fuel savings and emission reductions cannot be neglected (Thijssen *et al.*, 2014). Research findings are consistently endorsing eco-driving behavior (i.e. a set of behaviors practiced by drivers to reduce fuel consumption and vehicle emissions), with projected fuel saving potentials that range from 6.8% (Díaz-Ramirez *et al.*, 2017) to 13.6% (Zavalko, 2018) and even 27% (Symmons and Rose, 2009) – bringing both economic and environmental benefits. Carriers such as DHL and FedEx have both recognized the benefits of eco-driving and found ways to incorporate it into their fleets' daily routines (Jazairy and von Haartman, 2021). Strategic, tactical and operational decisions manifest carriers' commitment (Sivak and Schoettle, 2012), exemplified in installing in-vehicle support systems in trucks (Fors *et al.*, 2015), training drivers on eco-driving techniques (Zavalko, 2018), monitoring eco-driving performance (Huang *et al.*, 2018) and rewarding best-performing eco-drivers (Pinchasik *et al.*, 2021).

Some scholars contend that truck drivers, on their part, are showing a willingness to improve their driving style in line with eco-driving recommendations (Fors *et al.*, 2015; Pinchasik *et al.*, 2021; Thijssen *et al.*, 2014). However, most of these claims are based on truck drivers' views of eco-driving recommendations under controlled experiments and simulated scenarios – not their daily (or natural) driving practice, which may not necessarily adhere to those scenarios. The rest of eco-driving studies focus on *private* drivers' views of their daily driving (e.g. Allison and Stanton, 2019; Elliott *et al.*, 2007; Nègre and Delhomme, 2017), while professional truck drivers' perceptions of their daily practice received less scholarly attention.

Although one might expect similarity, driving trucks differs from driving passenger cars due to their heavy weight, high aerodynamic drag and slow acceleration capacity (Fors *et al.*, 2015). Moreover, professional truck drivers spend more time on the road and have a higher average age than the general driving population (Walton, 1999). Highlighting such distinctions, Fors *et al.* (2015) argued that private drivers are likely to save money by applying a fuel-efficient driving style, whereas the situation is more complex for truck drivers who operate within commercial settings and are under constant time pressure to meet delivery windows. Fors *et al.* (2015) went even further by arguing that unless carriers request or reward fuel-efficient driving, there may be no reason for truck drivers to save fuel in their driving style.

Aside from measuring objective driving scores (as prevalent in commercial driving literature), it is also necessary to consider truck drivers' perceptions to understand what motivates them to eco-drive. However, such perceptions may still fall short of accurately reflecting their actual driving on the road. Behavioral studies have long questioned the validity of self-reports (i.e. perceptions) in describing the behavior in question (cf. Schwarz, 1999).

Good research practice involves combining self-reports with objective data to offset the limitations of each (Podsakoff and Organ, 1986). Emphasizing this, Schall *et al.*'s (2016) experiment with truck drivers found that despite several interventions to stimulate eco-driving (e.g. incentives, training), drivers chose to abate eco-driving practices and return to their old driving habits. This was linked to the difficulty of changing engrained behaviors and attitudes, which requires disrupting one's current routines while adapting to new – possibly unfamiliar – ones. The authors subsequently called for further research to combine data from fleet telematics (like the one they used) with drivers' self-reports to elucidate the psychological mechanisms behind truck drivers' engagements in eco-driving.

Given the reasoning above, the purpose of this research is to increase knowledge of what motivates professional truck drivers to engage in eco-driving behavior through linking their self-reports with objective driving scores. We applied Theory of Planned Behavior (TPB) to delineate truck drivers' motivations to eco-drive, given its foundation on attitudinal, normative and intentional inclinations that can lead to long-lasting behaviors (Ajzen, 1985). We illustrated the theory through an embedded, single-case study of a Finnish carrier including 17 of its truck drivers, utilizing both interviews and fuel-efficiency scores. This study gives a voice to truck drivers on their daily eco-driving practice, complementing other works that emphasized their burnout (Thomas *et al.*, 2020), turnover (Miller *et al.*, 2021), occupational safety (Reiman *et al.*, 2018) and human-computer interaction (Loske and Klumpp, 2021). The findings contribute to the commercial eco-driving literature by revealing solid linkages between truck drivers' motivations to eco-drive and actual driving behavior, uncovering matches/discrepancies between *what has been said* and *what has been done* – or, as we call it, if drivers are *driving the talk*. The findings also offer insights to carriers and eco-driving solution providers to create the right conditions for drivers to improve fuel-efficiency outcomes of freight fleets.

2. Theoretical framework

2.1 Eco-driving

The scope and boundaries of the eco-driving concept vary among scholars. Some limit the concept to actual driving behaviors that comprise accelerating, decelerating, cruising, idling and parking (Jamson *et al.*, 2015; Mensing *et al.*, 2014; Schall and Mohnen, 2017). Others expand the concept to cover related nondriving behaviors such as trip planning, load management, cabin use, vehicle maintenance and fueling (Alam and McNabola, 2014; Sanguinetti *et al.*, 2017). Table 1 presents both types of eco-driving behaviors as discussed in the literature.

The driver's behavior is not the only determinant of the vehicle's fuel consumption; this can also be decreased through enhancing traffic infrastructure (e.g. constructing roundabouts to reduce vehicle acceleration/idling time) and utilizing advanced vehicle technologies (e.g. efficient/hybrid engines, reduced vehicle weight, aerodynamic design for lower drag/rolling resistance) (Thijssen *et al.*, 2014). Despite the efforts of infrastructure planners and vehicle manufactures to reduce fuel consumption, the behavior of truck drivers still plays a crucial role towards that end (Díaz-Ramirez *et al.*, 2017), which motivates focusing on it in this study.

2.2 Eco-driving in commercial settings

Drivers are typically the ones performing the act of driving, yet there are other factors at play that shape the way they drive. In commercial settings, both truck drivers and fleet managers share the responsibility of achieving fuel efficiency results – each based on their role-specific tasks (Larson *et al.*, 2013). Managers, for instance, are in charge of affording trucks with efficient engines (e.g. hybrid, high Euro class, alternative-fuel based) and equipping them with on-road support systems (e.g. pedal pressure displays, GPS navigation) to assist drivers in reducing fuel consumption along their trips (Fors *et al.*, 2015; Thijssen *et al.*, 2014). Managers are also expected to arrange eco-driving training programs that comply with local

	Considered parameters	References
Driving-based		
Accelerating	Accelerating moderately and evenly until reaching the desired speed; shifting gears optimally (between 2,000 and 2,500 RPM)	Huang *et al.* (2018), Sanguinetti *et al.* (2017), Schall and Mohnen (2017), Thijssen *et al.* (2014)
Decelerating	Reducing brake use; maintaining adequate distance from other vehicles; backing off the throttle; shifting gears correctly	Jamson *et al.* (2015), Sanguinetti *et al.* (2017), Zavalko (2018)
Cruising	Maintaining steady speed during the trip; avoiding over-speeding (by keeping speed below 80 km/h); applying predictive driving (i.e. proactively adjusting driving speed based on traffic); using cruise control where appropriate	Ayyildiz *et al.* (2017), Diaz-Ramirez *et al.* (2017), Huertas *et al.* (2018), Sanguinetti *et al.* (2017)
Idling	Avoiding excessive engine idling; turning off engine when stationary	Huang *et al.* (2018), Mensing *et al.* (2014), Sanguinetti *et al.* (2017), Thijssen *et al.* (2014)
Parking	Parking where the truck does not get either too hot or too cold; turning off A/C and electronics when stationary	Sanguinetti *et al.* (2017)
Nondriving-based		
Trip planning	Checking travel conditions (e.g. congestion levels, traffic signals, speed limits); selecting optimal travel times; choosing eco-routes (e.g. declined instead of inclined, short instead of long)	Alam and McNabola (2014), Sanguinetti *et al.* (2017), Zavalko (2018)
Load management	Avoiding empty running; maximizing fill rates; offloading cargo that will not be used; optimizing stacking	Diaz-Ramirez *et al.* (2017), Sanguinetti *et al.* (2017)
Cabin use	Limiting use of A/C at low speeds; conservative use of heating and electronics; reducing drag (i.e. wind resistance) by closing windows	Sanguinetti *et al.* (2017), Sivak and Shoettle (2012)
Vehicle maintenance	Keeping tired inflated; aligning wheels; following manufacturers' guidelines for, e.g. engine, oil, and air filters	Alam and McNabola (2014), Sanguinetti *et al.* (2017)
Fueling	Using proper fuel grade; avoiding topping off fuel tank; closing caps tightly	Huang *et al.* (2018), Sanguinetti *et al.* (2017)

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Table 1.
Eco-driving behaviors

policies and recognized standards (Díaz-Ramirez *et al.*, 2017). Truck drivers, for their part, are accountable for adjusting their driving style in line with eco-driving guidelines and utilizing the provided systems, equipment and training in the best way possible to attain positive fuel savings and emission reduction results (Pinchasik *et al.*, 2021; Zavalko, 2018).

Despite the variation between the tasks of fleet managers and truck drivers, the literature on eco-driving in commercial settings tends to take a holistic, firm-view when discussing what motivates firms to adopt eco-driving. Under this view, firms engage in eco-driving to enhance their green image, reduce operational cost, minimize travel time, reduce CO_2 emissions, enhance road safety and pursue other altruistic benefits (Jazairy and von Haartman, 2021; Martinsen and Huge-Brodin, 2014). Although it can be argued that managers act in line with the firm's strategic interest (Radomska, 2014), it is rather uncertain to apply the same logic to truck drivers. Employees may or may not act in accordance with management's best interest, and their willingness to act is largely contingent on the way they are rewarded or punished (Sheldon *et al.*, 2003). Based on a quasi-experiment on 400 employees, Merriman *et al.* (2016) found that employees are more likely to pursue environmental objectives when they are financially incentivized by the management. Echoing this argument on commercial driving, Fors *et al.* (2015) argued that unless fleet

operators request or reward fuel-efficient driving, there may be no reason for truck drivers to modify their driving style.

Extant driver-centric studies of eco-driving in commercial settings primarily focus on potential fuel savings of various eco-driving practices and drivers' acceptance of proposed solutions and training programs. Fors *et al.* (2015) invited 24 truck drivers to participate in a driving simulator that tests two eco-driving support systems: one that displays intermittent information (e.g. speed alerts) and another that displays continuous information (e.g. acceleration guidance). They found that drivers had positive opinions towards both systems, though their preferences varied based on the characteristics of the systems and the drivers themselves. After an experiment on truck driver's anticipation behavior (i.e. releasing the pedal at stopping points to reduce fuel consumption), Thijssen *et al.* (2014) found that drivers were willing to adopt such a behavior to attain fuel reductions of 9.5%, in exchange for 4.6% additional driving time. Zavalko (2018) conducted another experiment to estimate the potential benefits of eco-driving training with instructors on trips, finding a significant effect of training on fuel consumption over the short term, with 13.6% fuel savings on average. Zavalko also noted that the training effect diminished considerably over time, as drivers fell back to their old driving routines. Diaz-Ramirez *et al.* (2017) studied the impact of an eco-driving training campaign on 517 commercial trips in Colombia, revealing promising fuel reductions of 6.8 and 5.5% after the training. However, the authors also noted that driving errors (such as in speed, acceleration, braking) significantly reduced the effectiveness of the applied training.

These studies, among others, consistently reveal that truck drivers demonstrate a willingness to improve their driving behaviors in line with eco-driving recommendations and that there is positive association between eco-driving support systems/training programs and achieved fuel savings – at least over the short term. However, left unaccounted for is *why* truck drivers choose to eco-drive in the first place and whether what motivates them can relate to their actual driving on the road. Understanding this may enable carriers and eco-driving solution providers to arrange the right conditions for drivers to maximize desired fuel-efficiency outcomes.

One of the main theories that link what motivates people with their actual behaviors is the Theory of Planned Behavior (TPB), proposed by Ajzen (1985). TPB is "the most widely applied model of cognitive determinants of car use" (Gardner, 2009, p. 68), with a prevailing presence in the eco-driving literature (e.g. Elliott *et al.*, 2007; Lai, 2015; Lauper *et al.*, 2015; Nègre and Delhomme, 2017; Schall and Mohnen, 2017). We apply TPB in this study to critically examine what motivates truck drivers to engage in eco-driving. Unlike other motivational theories, TPB assumes that driving decisions arise from deliberation rather than habituation (Gardner, 2009), making it suitable for this study since changing one's former driving habits to comply with eco-driving instructions requires considerable effort and deliberately controlled behavior (cf. Lauper *et al.*, 2015). Moreover, for commercial driving contexts, TPB accommodates drivers' behavioral traits that are shaped both in and outside the workplace, given that both impact their work-related behavior. As such, it enables portraying a realistic picture of the mechanisms that allow eco-driving behaviors to materialize in commercial settings, fitting in with our purpose.

2.3 Theory of planned behavior

TPB associates people's beliefs to their behaviors (Ajzen, 1985). According to TPB, an individual's behavior is proximally determined by his/her intentions, and these are shaped by three key antecedents: attitudes, subjective norms and perceived behavioral control. We unpack each of TPB's concepts while projecting them onto a commercial eco-driving context, next.

Attitudes – Also viewed as beliefs or opinions; attitudes refer to whether an individual perceives a behavior as positive or negative, preferred or otherwise. Drawing from eco-driving in private contexts, a positive attitude reflects the driver's desire to engage in eco-driving for altruistic benefits such as minimizing traffic congestion, reducing air pollution,

increasing road safety and, more broadly, preserving the planet for future generations (Nègre and Delhomme, 2017). Individuals are more likely to demonstrate a pro-environmental behavior when it yields personal benefits as well (De Dominicis *et al.*, 2017). Personal benefits originate from either autonomous incentives (e.g. fulfilling own values, fun) or external ones (e.g. monetary and nonmonetary rewards) (Graves *et al.*, 2013). Following this logic, truck drivers may engage in eco-driving to simply feel better, receive a bonus on attained fuel savings and/or be recognized and praised by management. In favor of the latter, Pinchasik *et al.* (2021) found that when truck drivers actively received nonmonetary "carrots" (e.g. a jacket or a T-shirt with texts like "Certified Eco-driver"), they showed promising fuel-saving potentials over the long term. Somewhat similarly, Schall and Mohnen (2017) found that tangible nonmonetary rewards (e.g. restaurant vouchers, iPods) had a stronger effect on truck drivers' fuel savings compared to monetary rewards (e.g. bonuses).

Subjective norms – These arise from people's expectations and indicate whether the people important to the individual think he/she should engage in the behavior of interest. Being part of an organizational culture that values and rewards eco-driving may induce these norms and turn eco-driving into a "given measure" for all employed drivers. Here, truck drivers are expected to adjust their driving style to comply with the management's ambitions to enhance the firm's green image and reduce its carbon footprint. A managerial focus on minimizing fuel consumption may also motivate drivers to eco-drive (Fors *et al.*, 2015; Thijssen *et al.*, 2014), especially if accompanied by external incentives (Schall and Mohnen, 2017). Furthermore, drivers may adjust their driving style to meet their colleagues' expectations or even compete with them. Expectations of people outside the workplace, such as the driver's family members and friends, can also play a role in forming these norms.

Perceived behavioral control – Refers to the individual's view of the ease or difficulty of performing a behavior. Perceived behavioral control can be divided into internal and external control. The former relates to how the individual views his/her own capacity to perform the behavior, which is contingent on the individual's knowledge, vocational background and discipline. External control, in turn, refers to factors that are beyond the individual's control yet determine the way he/she behaves. In behavioral studies, the concept of perceived behavioral control is commonly related to "self-efficacy," which reflects the person's confidence in carrying out the behavior under given circumstances (Ajzen, 2002). Truck drivers may not have a say regarding which truck to drive, the amount of load carried, or the scheduled time of the delivery, yet these factors can negatively impact their fuel savings and overall eco-performance. Internal and external control factors are complementary to each other and can be interlinked; installing eco-driving support systems in trucks (e.g. dashboards, haptic feedback) may fall outside the driver's control, but using them correctly during trips falls under the driver's control. Note that internal and external controls do not necessarily reflect driving-based vs nondriving-based behaviors in Table 1. For example, cabin use through limiting A/C is under the driver's control, yet it is a nondriving-based behavior.

Intentions – Intentions are a willingness to engage in a certain behavior in the future. As per TPB, intentions are shaped by the three antecedents described above. The effect of these antecedents on intentions is generally accepted in behavioral driving literature, with evidence pointing towards their collective capacity to predict 46% (Buckley *et al.*, 2018), 68% (Kaye *et al.*, 2020), or even 80% (Rahman *et al.*, 2017) of the variance in drivers' intentions to use various driving tools and equipment. Accordingly, this study assumes that the more the truck driver (1) believes that eco-driving is a positive attitude, (2) is expected by people of importance (in-/outside the workplace) to engage in it and (3) perceives him-/herself capable of performing it (by means of internal and external control factors), the greater the expectation of the driver to intend adopting eco-driving behavior.

Behavior – Behavioral research generally assumes that intentions lead to behavior, although this relationship is by no means unambiguous. In the field of health psychology,

Marks (1996, p. 8) noted that intention has "proved to be a notoriously poor predictor of health-protective action." Sheeran (2002) suggested that on average intentions account for 28% of the variance in behavior, leaving many measurement issues and additional variables to be considered to explain intention–behavior discrepancies in human action. Nonetheless, the association between eco-driving intentions and behavior is generally accepted, given the large number of studies that reported medium-to-large effects of intentions on driving-related behaviors, such as complying with speed limits (cf. Lauper *et al.*, 2015). Yet, to exercise caution, this study also acknowledges that positive eco-driving intentions do not always lead to eco-driving behavior, and sometimes eco-driving behavior can be accomplished even if intentions predicted a different outcome.

2.4 Conceptual framework

Although TPB has been widely adopted among eco-driving scholars, two issues persist to date: (1) a lack of studies that discuss TPB in commercial freight settings and (2) the fact that truck drivers' behaviors are often based only on self-reports or objective data – but not both. We address both issues in our framework to reflect actual eco-driving behavior (Figure 1). Consistently with TPB, the framework depicts the drivers' *attitudes*, *subjective norms* and *perceived behavior control* as antecedents to their *intentions* to eco-drive, which is subsequently linked to the *behavior*. Note that perceived behavioral control can directly affect eco-driving behavior in case sufficient degrees of control over the behavior existed, in line with Ajzen (2002).

3. Methodology

3.1 Method choice

An embedded, single case-study design was chosen for this research for several reasons. First, case studies are suitable for studying complex phenomena (Meredith, 1998) and linking between intricate variables (Voss *et al.*, 2002), which is the case when studying psychologically rooted motivations to eco-drive and linking behavioral antecedents with outcomes. Second, case studies enable illustrating established theories in specified contexts (Ketokivi and Choi, 2014), fitting in with our theoretical illustration of TPB in a commercial eco-driving context. Third, single cases are appropriate if they represent typical and recurrent events of the phenomenon of interest (Yin, 2018), which is in line with the overall

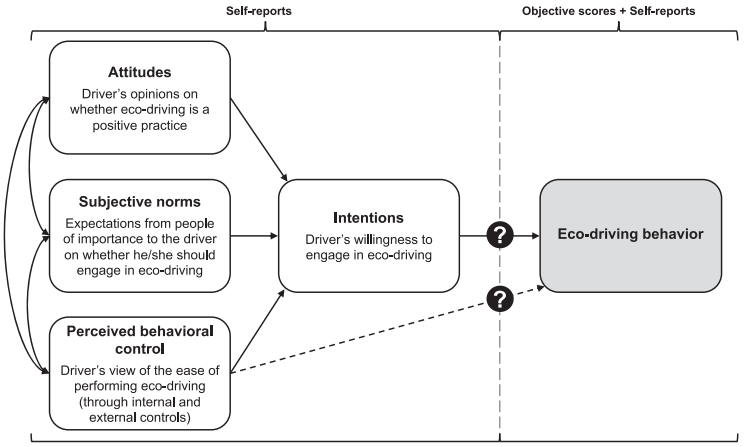

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Figure 1.
Conceptual framework

case at hand as a typical carrier regarding its operations with certain characteristics that enable recurring eco-driving patterns to materialize. Fourth, embedded, single cases are useful to distinguish the organization as a whole (i.e. main unit of analysis, which provides context) from smaller subunits within the case (Yin, 2018). This resonates with our treatment of the carrier as the overall case and individual truck drivers as subunits within the case.

3.2 Case description and motivation

The overall case company is a Finnish, family-owned carrier with an annual turnover of ~€4m. It operates a fleet of eight trucks: four high-capacity transport (HCT) trucks that comprise semi-trailers dragging two trailer units (32 meters long; 88 ton gross-capacity weight) and four full trailers (25 meters; 76 ton), of which two are temperature-controlled to accommodate certain types of food products. The trucks in each category are similar but not fully identical in terms of age, size and configuration (e.g. aerodynamics, tires, etc.). Twenty-two drivers are employed by the company (paid on hourly basis) and these mostly come from the same region where it is located. The company belongs to a larger network of carriers who jointly own a parent logistics service provider (LSP) company, which negotiates contracts with clients and coordinates transport activities across the network. Two main operational setups describe the case company's business: (1) transporting daily goods (e.g. food, groceries) from the Finnish metropolitan region (Helsinki and the neighboring cities) to northern Finland and (2) transporting industrial products (e.g. paper, timber, steel) along the way back. The operations are reasonably well balanced with typically no empty backhauls.

Selecting the overall case company for this study relied on several reasons. First, Finland, as a site for the company's operations – with 250m tons of domestic road transported annually (Statistics Finland, 2021) – is renowned for its serious environmental ambitions; exemplified in (1) its national plan to halve transport-related emissions by 2030 (FGMTC, 2021) and (2) its 7th rank in the Global Environmental Performance Index (EPI, 2020). Finland also has several characteristics that allow contrasting eco-driving behaviors to surface, including (1) flat/hilly landscapes, (2) long/short roads with straight/curvy orientations, (3) abundance of continuous roads that give drivers control over their driving and (4) dramatic changes of travel conditions across the four seasons (FRA, 2021; FTIA, 2021). Second, the overall case company itself also enables eco-driving patterns to unfold, due to (1) its managerial efforts to reduce the fleet's fuel consumption (through, e.g. integrating Dynafleet), (2) extension of its transport routes along Finland's different landscapes and road structures, (3) variety in the weights of transported goods, (4) its operation throughout the year and (5) its employment of a relatively high number of drivers (to enable treating them as subunits for cross-comparisons). As for the suitability of the drivers for the study, all of them have completed the mandatory professional qualification (DIRECTIVE, 2003/59/EC) that includes 7 h training for safe and environmental driving, which is renewed every 5 years. Further, the fleet dealer representative has provided personal education by monitoring the drivers' eco-driving performance and offering tips for improvement.

To further ensure fitness of the overall case company with the purpose of this study, a preliminary analysis of its potential to decrease fuel consumption through eco-driving was conducted. Four daily measured driving parameters (driving time, idling time, driving distance, fuel consumption) of four trucks were analyzed for a six-month period in 2020. The data were not driver specific but showed large variations in average fuel consumption for each truck and between the trucks. The variations can be partly explained by the weight of the load (loads are typically heavier heading south), time of the year (increased consumption during winter), operational routes (some routes have more hills or require tighter schedules), number of stops, etc. The results of this pre-study showed that fuel consumption of the company's trucks was on average 50.71 liters per 100 km, varying 27.57% between 42.26 and

58.35 liters per 100 km. Even if only the highest consumption peaks were reduced to the current average level, the average consumption would drop by 2.78% to reach 49.3 liters per 100 km, resulting in roughly €50,000 annual saving for the company – with €4m revenue and €0.22m net profit. In line with these results, the management of the case company estimated a 5% reduction in fuel consumption to be achieved by eco-driving.

3.3 Data collection

In line with our aim to link the drivers' motivations to eco-drive with their actual eco-driving behaviors, we triangulated qualitative and quantitative data – where self-reports represented the former (based on interviews, backed by a focus group) and objective eco-driving scores represented the latter (based on the company's fleet management system). This approach also allowed us to combine the richness of qualitative, human-centric data with the parsimony of numerical data (Podsakoff and Organ, 1986) – offering a new take in the commercial eco-driving literature. We describe the methodological steps taken for each data source next.

3.3.1 Qualitative data. Following Yin (2018), we conducted in-depth, semi-structured interviews with 17 truck drivers employed by the company – where each driver represented an embedded case. All but one driver are males. Drivers' ages ranged between 22–60 years and their years of experience ranged between 2–35 (note: no further driver-specific details can be provided to maintain their anonymity). The interviews were conducted over the phone, seeking the drivers' viewpoints about their motivations for daily eco-driving in relation to the five areas in our framework (Figure 1) – see questions in Appendix. To further validate the drivers' information, we arranged a focus-group discussion with three members of the company's management, carried out face-to-face at the company's premises. The discussion centered around the managerial efforts taken to support drivers in achieving desired fuel savings and the nature of interactions between the management and the drivers. The interviews and focus-group discussion were conducted during February–March 2021, lasting between 23-68 min with the drivers and 84 min with the management.

As a secondary source of qualitative information, 11 informal meetings were arranged with the case company's management between September 2020 and January 2022. These enabled us to further understand the company's operations, ensure a correct presentation of the data in the article, get their feedback on the findings and seek their final approval to publish in an academic journal.

3.3.2 Quantitative data. These were obtained from the case company's fleet management system Dynafleet, developed by Volvo Trucks. The system enables drivers to view several eco-driving parameters in real time, including optimal usage of engine, proper braking, cruise control, auxiliary braking, hill driving and engine idling. For reporting and analysis purposes, the system calculates an aggregate fuel-efficiency score (FES) for each driver based on four criteria: (1) engine and gear utilization, (2) speed adaptation, (3) anticipation and braking and (4) idling. FES varies between 0 and 100 and is calculated for each driver on average during a specified period. The system ascribes three rating zones to FES: 80–100 good; 60–79 mediocre; 0–59 low. FES is supposed to be entirely based on driving behaviors; other factors, such as load weight or weather conditions, do not impact the calculation of the score – at least not directly.

The FESs analyzed in this study were obtained for each of the 17 drivers over the first half of 2021 (i.e. during and after the interviews were conducted). No extra driving for research purposes was arranged. The FESs captured the drivers' performance while driving real trucks with actual loads. Note that FES is driver-specific, regardless of the truck being driven. Preliminary analysis revealed considerable differences between the drivers' FESs, creating a useful base for comparison. To guarantee that the selected time frame reflects the drivers' typical driving behaviors with no period-specific abnormalities, we compared the included

FESs with those from the entire previous year; no significant differences were detected. Further, to ensure that drivers behaved as naturally as possible, they were not told that their FESs will be used in this study until its six-month period was over – their consent was sought then. Note that for Driver G, only data from the preceding year (2020) were available due to employment status changes. To maintain accuracy of data for the selected time frames, one of the researchers had direct access to the company's Dynafleet system.

To check whether drivers' age, experience, or driving conditions (winter vs. summer) had any significant impact on their FESs, we ran (1) a correlation analysis between age (in years), driving experience (also in years) and FESs for the entire year and (2) a paired sample *t*-test between the mean value of FESs for winter months and summer months. No statistically significant correlation ($p < 0.5$) between FESs and age nor experience was found. Average summer FES (81) was somewhat higher than winter's (78), but not statistically significant ($p < 0.5$). Since there was only one female driver in the sample, there was no opportunity to analyze the effects of gender on FESs.

3.4 Data analysis

The transcribed interview data were coded and categorized in accordance with the theoretical constructs using QSR NVivo. We used the software to display and interpret the data from different angles: driver-wise (Drivers A, B, C, . . .), topic-wise (attitudes, subjective norms, . . .) and actor-wise (drivers, management) – which added rigor to the analysis (Strauss and Corbin, 1990). Following Voss *et al.* (2002), a comprehensive table-form matrix was then prepared with pre-coded interview transcripts matched against the topics/subtopics of the conceptual framework. The table included original citations in Finnish and summarized translations in English for the benefit of the non-Finnish-speaking authors. This enhanced inter-rater reliability through involving all authors in deriving the study's findings and conclusions (Voss *et al.*, 2002), bringing both confirmation and complementarity of perspectives.

Three of the authors, who did not partake in the interviews or the coding, independently studied the tabulated data matrix to assess the drivers' assertions based on the motivational and behavioral dimensions of the conceptual framework. Without prior knowledge of the drivers' FESs, the authors gave numerical judgments of the drivers' eco-driving behaviors, supported with motivations. There was a statistically significant correlation ($p < 0.01$) between the authors' average judgment of the behaviors and the FESs, indicating that (1) in most cases drivers were able to appropriately describe their eco-driving behaviors and (2) the dimensions of the TPB framework created a robust foundation for evaluating those behaviors. Noteworthy, *intentions* of the drivers (i.e. willingness to engage in eco-driving) did not always match their eco-driving behaviors (both self-reported and FESs), which was also remarked by the independent judgments of the authors.

3.5 Quality assessment

Following Yin (2018) and Voss *et al.* (2002), construct validity of this study was enhanced by (1) securing multiple sources of evidence (i.e. triangulating qualitative interview data and quantitative FESs); (2) presenting the findings to key informants for verification and approval purposes and (3) having the manuscript iteratively reviewed and discussed among the authors. These measures also supported the objectivity of the analysis and minimized researcher bias, which is common in qualitative research. Internal validity was improved through pattern matching between theory and evidence (Yin, 2018). External validity (or generalizability) was enhanced through relying on a solid theoretical basis for the analysis, bearing in mind that the findings should be *analytically* generalized (i.e. by use of theory) and not statistically (Yin, 2018). As for reliability, the interview records were transcribed verbatim and electronically filed, which also sustained a chain of evidence.

4. Empirical findings

This section starts from the outcome: the drivers' eco-driving *intentions* and *behavior*. This will lay the basis for grouping the drivers in different categories. Then, we backwardly link these categories with the three antecedents (*attitudes*, *subjective norms*, *perceived behavioral control*) to distinguish the motivational traits across the drivers.

4.1 Eco-driving intentions and behavior

The eco-driving *behavior* of the drivers was initially measured in a straightforward manner using the drivers' FESs from Dynafleet (Figure 2). The figure shows that FESs varied considerably between the drivers during the specified six-month period, with six drivers in the *good* zone, ten drivers in the *mediocre* zone and one driver in the *low* zone (note: the three zones are adopted from the Dynafleet system).

In addition to FESs, we used the interview material to ascertain how well the drivers knew about their driving style. All drivers get to know their FESs and their eco-efficiency rank in the company, but not the scores or ranks of the other drivers. They also received feedback on the different components of their FESs and the vehicle dealer has offered training and tips to help them enhance their performance under each component. Thus, the drivers were generally well aware of their own eco-driving behavior, and they were also ready to disclose it in the interviews:

> Once a vehicle dealer representative showed me the figures of my driving behavior and encouraged me to keep on going. In addition, I can use the mobile phone application to see whether my Dynafleet scores are good. (Driver K)

> I don't think my driving is very economical. Hurry, tight schedules and driving time restrictions are the reasons for that. (Driver E)

Going back one step from the behavior, we analyzed the drivers' *intentions* to eco-drive. Here, it is important to remember that intentions do not necessarily reflect the actual behavior. In other words, even if a driver demonstrated a positive eco-driving behavior, he/she may still lack the intention to pursue eco-driving in the future. Intentions towards eco-driving were first inquired in the interviews with direct questions about the aim to adopt or continue using environmentally sound practices during daily driving. The answers were coded as *enthusiastic* or *unenthusiastic*. The drivers were fairly open about their intentions towards eco-driving, as can be seen below with two exemplary quotations reflecting *enthusiastic* intentions:

> I intend to adopt eco-driving and I put a lot of efforts to enhance my eco-driving performance. (Driver O)

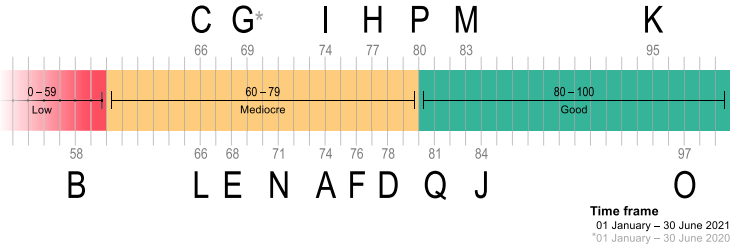


Figure 2.
Dynafleet FESs with grading zones

Source(s): Created by authors

> I aim to drive as ecologically as possible to save fuel, which makes the business more profitable and my job in the company last longer . . . I admit that there are still possibilities for me to enhance my eco-driving. (Driver A)

And another two quotations reflecting *unenthusiastic* intentions:

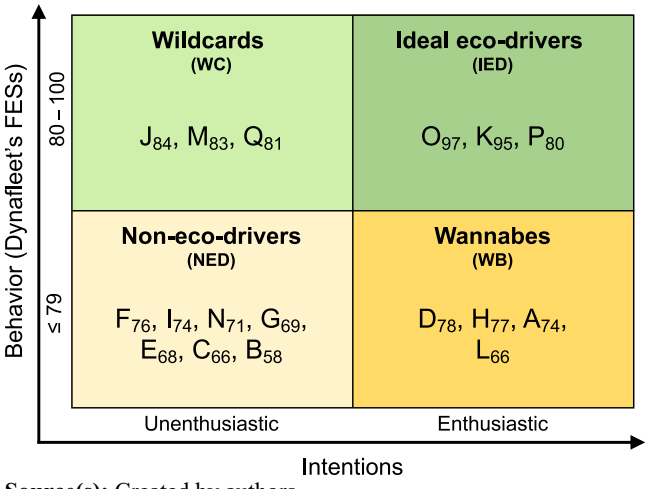
> I could drive environmentally when I'm not in a hurry, but I don't. Maybe if I had my own fuel in the tank, I would change my intention. (Driver G)

> Sometimes I don't have the patience to drive slowly, especially when the weather is fine . . . perhaps I have spent quite much time here in the cab so I may not be interested in spending any excess time on the road. (Driver J)

Some drivers showed mixed intentions towards eco-driving, often with various external/internal conditions that hinder their intentions from materializing. Therefore, we spent extra effort to validate the intention-related categorization by independently grading the drivers' quotations in the tabulated-data matrix. These independent evaluations proved highly congruent with the dichotomic categorization of *enthusiastic* and *unenthusiastic*; hence, it was accepted as a basis for subsequent analyses.

The results of the analysis of eco-driving intentions and behaviors can be summarized in a two-by-two matrix, showing the intention towards eco-driving (*enthusiastic* vs. *unenthusiastic*) on one axis and the observed eco-driving behavior (based on Dynafleet's FESs) on the other axis (Figure 3). Given that the drivers' self-reports of their eco-driving behaviors matched their FESs (as discussed earlier), using FESs as a sole indicator of eco-driving behavior is accepted from this point onward in the paper. In the matrix, we combined the *mediocre* and *low* rating zones of FESs to get enough drivers in each quadrant.

Descriptive names were given to the four quadrants for illustrative purposes. "Non-eco-drivers" (N = 7) comprise the group whose intentions towards eco-driving are unenthusiastic and their eco-driving behavior is mediocre-to-low. "Wannabes" (N = 4) have a positive intention towards eco-driving, but their driving behavior is, for some reason, not very eco-efficient. "Wildcards" (N = 3) depict a group who drive in an eco-efficient manner, even if the intention to do so does not seem supportive. Finally, "ideal eco-drivers" (N = 3) are a group whose intentions to eco-drive are enthusiastic and their driving behavior is also eco-efficient.



Source(s): Created by authors

Figure 3.
Resultant eco-driving intention and behavior matrix

4.2 Antecedents to eco-driving intentions and behavior

As per TPB, three central antecedents are put forth to explain the behavioral intentions and consequently the behavior: attitudes, subjective norms and perceived behavioral control. These are now examined in the context of freight transportation to see how they relate to the drivers' eco-driving intentions and behavior. Table 2 shows the extent to which each TPB topic/subtopic was emphasized by each driver in the study. The drivers' FESs and their positioning across the four quadrants in the matrix are displayed at the bottom of the table.

4.2.1 Attitudes. As could be expected, positive environmental attitudes accompanied the drivers' intentions towards eco-driving and high FESs. In the "ideal eco-drivers" category, it could even be seen that attitudes are ingrained in deeply rooted personal beliefs and feelings:

> I am an eco-minded person and I do more for it than is normally expected. I for example pick up trash at gas stations or terminal yards and bring it into the trash bin. I also try to encourage others to drive in an eco-friendly manner; for instance, if I'm driving with a trainee, I teach them how to drive environmentally. (Driver K, IED)

> I drive environmentally because it makes me happy. I have my own goals and I always try to enhance my eco-driving performance. It's good for the company and it's good for me. (Driver O, IED)

Similarly, drivers in the "wannabes" category shared a predominantly positive environmental attitude, often coupled with motives to save fuels, although this was expressed less directly than among the "ideal eco-drivers":

> I think eco-friendliness is a good thing. I try to be nature friendly at work and in my free time. I see eco-driving as a positive thing – it saves fuel and prevents pollution. (Driver H, WB)

> Eco-driving saves fuel and thus money in my personal life but especially at work where the fuel consumption is much bigger. I want the company to be profitable so it can offer me work also in the future. (Driver A, WB)

For drivers in the "wildcards" and "non-eco-drivers" categories, positive attitudes towards the environment and eco-driving were far less prominent. One "wildcard" driver associated eco-friendliness with safe driving while also emphasizing the role of bigger players, such as vehicle manufacturers:

> Safety is important for me in my driving, and I think that eco-driving increases safety on the road . . . Rather than my own efforts, I see that vehicle manufacturers have a big role in eco-driving as they should provide more eco-friendly vehicles. (Driver J, WC)

In turn, some "non-eco-drivers" seemed to rather downplay or disregard the role of eco-driving in tackling the environmental question altogether, whereas one other driver recognized the importance of it for a strictly job-related economic reason:

> Maybe I should consider the environment, but I don't see it having a clear connection to my driving. (Driver C, NED)

> I don't throw trash in nature but I'm not a tree hugger either. (Driver N, NED)

> I am aware that eco-driving saves a lot of fuel, which is the second largest expense to the company. So, if all of us drivers saved a little bit it would have a notable impact on the company level. (Driver G, NED)

Willingness to learn is often seen as a reason for positive attitudes towards an action, especially if viewed from a self-betterment angle. "Ideal eco-drivers" pointed this out on several occasions, for instance by expressing how modern vehicles opened possibilities for them to improve their eco-driving:

TPB's topics			Drivers																
	Topic	Subtopic	O	K	J	M	Q	P	D	H	F	I	A	N	G	E	C	L	B
Attitudes	Positive	Fuel saving	●		•		•	●	●	○	•	○	●		●		○		○
		Job retention	●										●	•	•				
		Environmental concern	●	●					●	○			○					○	
		Better Dynafleet scores											●				•	•	
		Safety			•		●		●										
		Happiness	●									○							
	Neutral	Neutral			•	•	•	•	○		•			●	•	●	•		•
	Negative	I don't care									•			•	•		●		
		Other drivers don't care	●	•	•				•	○	○	○		○	●			•	
		Other countries/industries should do more			•						•	○							
Subjective norms	I'm expected to adopt eco-driving by …	Management	●	•	•	○	○	●	•	○	•	•	●	●	○	•	•	●	•
		Society			○										○				○
		Colleagues															•	•	
	I'm not expected to adopt eco-driving	No (or not enough) discussion with employer about eco-driving	○	○		●		○						○					
		No discussion with colleagues about eco-driving			○	•	●	○						•					●
Perceived behavioral control	Eco-driving is under my control (external)	Company and the work itself enable me to eco-drive	•	•	•	○	○	○	○	○	○		○	○	●	○		○	○
	Eco-driving is under my control (internal)	My educational background supports my eco-driving	•	•	●	•	○	○	○	•	•	•	•	○	●	•	•	○	•
		Technology for eco-driving is under my control	•	•	●	○	○	•	•	•	•	○	○	○	•	•	○	○	○
	Eco-driving is not under my control (external)	Tight schedules	○	○	○	○	○	○	●	•	•	•	•	●	•	•	●	●	●
		Tight schedules (validated by managerial records)							X			X	X				X	X	X
		Winter conditions	●	●	●		○	•	•	•	●		•	●	○	●		•	•
		Other road users		○	•	•	○	○	○	○	○			○	○	○		•	•
		Broken or bad technology	•	○	○	○	○		●	○	•	○			○	●	•		•
		Bad road maintenance	●	●	○		○	•	•					●	○			●	●
		Driving time legal restrictions				•			●	○			•	•	●	●	○		•
		Bad management							●	●	○	○			○	●	○		
		Poor planning by customer			•				●		●		•			●			●
		Bad road infrastructure				•					○				○				○
		Speed limits					○		○						○				
		Hilly roads			•		○					○		○		○			○
		Heavy loads	●														○		•
		Weather conditions								●						○			
		Unusual working hours															●		
	Eco-driving is not under my control (internal)	I unintentionally drive too fast			•		○				•				•				
Intentions (2 = enthusiastic; 1 = unenthusiastic)			2	2	1	1	1	2	2	2	1	1	2	1	1	1	1	2	1
Behavior FESs: 01/01/2021–30/06/2021 *01/01/2020–30/06/2020			97	95	84	83	81	80	78	77	76	74	74	71	69*	68	66	66	58
Category			IED	IED	WC	WC	WC	IED	WB	WB	NED	NED	WB	NED	NED	NED	NED	WB	NED

Strong statement ● Moderate statement • Just mentioned ○ Post-hoc managerial validation X

Source(s): Created by authors

Table 2. Participating drivers' motivations and eco-driving behaviors

> The reason why I wanted to start driving HCT vehicles was that it gave me new possibilities to enhance my eco-driving. (Driver O, IED)

Or by stating how eco-driving training at work helped improving their private driving:

> . . . experience of eco-driving at work has helped me drive more economically with my private car. (Driver K, IED)

Modern technology also seemed to inspire some of those drivers that otherwise have shown lower motivations to eco-drive. For instance, one "non-eco-driver" expressed that as a young person it is easy for him to learn how to use new equipment and that the technology helped him drive more efficiently. Thus, new technology may lead to improved eco-driving behaviors despite a lack of intention.

4.2.2 Subjective norms. For a driver, social pressures regarding the environment might come from the company's management, other drivers, family and friends, or other members of the driver's immediate social network. As mentioned previously, the drivers were aware of their eco-driving behavior through the FESs they received from the system and the training/feedback from the vehicle dealer. In addition, the company's management gave regular feedback to the drivers, typically by calling them – and, as they admitted, providing negative feedback more often than positive. Based on the interviews, it seemed that the drivers were accustomed to the feedback they received, and their reactions were quite neutral irrespective of the category to which the driver belonged to. These quotations from an "ideal eco-driver" (Driver P) and a "non-eco-driver" (Driver N) serve as an illustration:

> The management encourages me to adopt eco-driving. In practice, they have relaxed the schedules and there are mobile applications where I can see my eco-driving performance. (Driver P, IED)

> They [the management] say that it's good to drive economically if the schedule allows it. Just saying that aloud is enough from the management's side, I reckon. Sometimes they call me if they see from their computer that I should slow down to save fuel. (Driver N, NED)

Both Drivers P and N drive the same kind of trucks along the same routes, with mostly similar schedules that are not very tight. Also, both are told by the management to drive eco-efficiently. Perhaps for Driver P ("ideal eco-driver") these instructions are easier to follow, whereas Driver N ("non-eco-driver") tend to drive too fast even if the schedule allows driving more eco-efficiently. Thus, managerial instructions can be perceived very differently among the drivers.

On some occasions, the management has attempted to motivate the drivers by arranging an internal eco-driving competition among them. This has not been a regular practice since it was found problematic to determine good criteria for measuring performance and to decide on suitable rewards. The competition was not considered a success by the drivers either; some asserted that they never heard the results. Nonetheless, some drivers mentioned receiving positive feedback, but whether this has had any effect on their driving is rather uncertain because it has not been an established practice. One "ideal eco-driver" conceded:

> I understand that the management expects me to adopt eco-driving. There was a competition, but the winner was never announced nor rewarded. I have received some praise about my driving style but that was many years ago. (Driver O, IED)

The drivers also did not seem to feel much pressure from their colleagues to embrace eco-driving. Environmental questions and eco-driving practices were not a common discussion topic, although some of the more eco-minded drivers, such as Driver K, often bring up these issues and even offer advice to new drivers. Dynafleet's FESs and the eco-driving competition could have been discussed occasionally among the drivers, but so far there was quite little evidence to support the formation of these factors as social norms to promote eco-driving:

> We don't talk about eco-driving with colleagues. My colleagues are not showing environmental concerns. (Driver B, NED)

> Other drivers don't expect me to drive environmentally . . . We do make phone calls to each other, but we do not talk about eco-driving. (Driver J, WC)

Other normative influences related to the transportation industry were variously known to the drivers; for instance, they take mandatory courses dealing with some key aspects of EU policies. However, these were not personally internalized to the extent that they would form a subjective norm for eco-driving. Further, customers (large retail groups in this case) would be expected to communicate their environmental goals/standards so that they reach the drivers, but no direct indication of this was found in the interviews. This may be because customers mostly interact with the LSP who organizes operations between them and the case company.

4.2.3 Perceived behavioral control. Both the management and the drivers were aware of the internal and external control factors alongside the fact that their importance varies in different conditions. As mentioned before, the management saw that considerable fuel savings could be easily accomplished by changing driving habits. The drivers looked at the problem from their own angle, often thinking of the route and type of cargo that they are used to operate with. One "non-eco-driver" put high emphasis on the driver's role:

> There are issues in the external factors, but mostly I see that it is in the driver's hands how economical the driving is. (Driver F, NED)

Most drivers recognized that external conditions, especially tight schedules on certain routes, were of critical importance for fuel consumption. This was often combined with a fear of exceeding regulated driving hours, which can result in fines that should be paid out of the drivers' own pockets (which was more of an issue compared to speeding tickets). Drivers also seemed to "push hard" under tight-delivery schedules to avoid arriving late to their homes. In fact, all the drivers who expressed driving on routes with tight schedules were categorized as "non-eco-drivers" or "wannabes" – see Table 2 for moderate/strong statements about "tight schedules." This may indicate that even if drivers' intentions were favorable towards eco-driving, external conditions (especially in terms of tight schedules) can make it unattainable for them to eco-drive. Before making such a strong claim, we performed a post-hoc validation by checking the schedules assigned by the management for drivers (Table 2). Interestingly, only 6 out of the 11 drivers who held moderate/strong views about tight schedule were actually assigned to such schedules. This suggests that *perceiving* a tight schedule can hinder eco-driving behavior even if that perception did not reflect reality. These perceptions could have been provoked by pressures from customers (in this case the LSP who coordinates the network) or regulators to follow delivery schedules while also carrying out additional duties related to transport assignments, such as spending time at terminals; as expressed below:

> The customer [LSP] expects us to drive the tightly-scheduled route faster than it is possible. Loading many trolleys alone takes so much time. Often the unloading also takes so much time that I am already late when I arrive at the next loading site. (Driver D, WB)

> Driving time regulations force me to drive fast. (Driver G, NED)

> At some level I'm concerned about the company's financial situation and therefore I feel I should drive more economically, but it is not possible with these schedules. (Driver G, NED)

> Some customers [LSPs] hinder my eco-driving by having messy warehouses. There is no room to properly unload the goods. We need to tidy up the places and this consumes our valuable driving time. (Driver E, NED)

Aside from transport schedules, other external conditions were also expressed as a hindrance to eco-driving, especially in northern Finland where weather conditions can be very

demanding. Although we found no significant summer-to-winter difference in FESs ($p < 0.5$), the interviews left clues that winter conditions may indirectly affect eco-driving performance irrespective of the driver's attitudes or intentions. One "non-eco-driver" said:

> Winter conditions hinder my eco-driving. On slippery roads I cannot use cruise control and I must accelerate to full speed to get to the top of the hill. In slippery conditions, other road users may also slow down so that I have to speed up later. (Driver E, NED)

Besides physical conditions, perceived behavioral control is also manifested in the form of personal capabilities and mental orientation. All drivers mentioned that they were aware of eco-driving principles and that training had been offered to help them implement these principles in practice. Vocational background, workplace training and the ability to utilize driving technology were seen as key enablers for eco-driving, as follows:

> My vocational background supports my eco-driving exceptionally well. Also, technology for eco-driving is under my control. (Driver J, WC)

> My vocational background supports my eco-driving. Predictive driving [to avoid unnecessary braking/accelerating] is the most important thing. EU directive courses are mandatory, and the company has arranged truck-specific training. Also, driving-based technology supports my eco-driving. The truck gives instant feedback and the system offers monthly reports on how environmentally I drive. (Driver H, WB)

Based on the interviews, drivers know how to eco-drive but for different reasons they are not always doing as they should. In other words, they know slowing down conserves fuel but drive fast anyway. Therefore, it seemed that the differences in eco-driving performance cannot be attributed to a lack of awareness or shortcomings in capabilities; rather, how drivers *use* their capabilities. Physical constraints or attitudinal issues played an important role here, but there was also a broader perception of situational control that the driver has. Below are comments by an "ideal eco-driver" and a "non-eco-driver", respectively, for comparison:

> I want to keep control by maintaining safety distance . . . eco-driving with cruise control is best accomplished when I have free space ahead of me and other vehicles do not create disturbances. (Driver O, IED)

> Sometimes if there is someone driving more slowly and you overtake, you want to keep higher speed for a while to get some distance . . . once you've increased speed, you often keep it up for the rest of the leg even if time savings are insignificant. (Driver F, NED)

These comments reflect the contrasting perceptions among drivers regarding not only coping with different traffic conditions, but also being confident in navigating eco-efficiently in different conditions – with high self-efficacy, in more theoretical terms. Thus, perceived behavioral control was also closely associated with the driver's attitude at least in circumstances where timetables and other compelling constraints did not restrain eco-driving.

5. Discussion

Although our empirical analysis revealed that *attitudes* of truck drivers towards eco-driving played a key role in differentiating between their intentions (as seen with, e.g. Drivers O, A vs. Drivers G, J), it also indicated that attitudes alone cannot entirely explain the drivers' observed eco-driving behaviors. For instance, both "ideal eco-drivers" (e.g. Drivers O, K) and "wannabes" (e.g. Drivers D, A) expressed positive attitudes (and intentions) towards eco-driving, yet their FESs varied dichotomously across the scale (Figure 3). Similarly, both "non-eco-drivers" (e.g. Drivers N, G, E) and "wildcards" (e.g. Drivers J, M, Q) expressed neutral/negative attitudes (and intentions), yet their FESs also varied. These observations bring an important note to the

commercial eco-driving literature. Studies that propose cutting-edge eco-driving solutions often account for the participating drivers' acceptance of those solutions under experimental settings or training arrangements (e.g. Fors *et al.*, 2015; Pinchasik *et al.*, 2021; Thijssen *et al.*, 2014). Just as this study revealed discrepancies between the drivers' attitudinal traits and intentions to eco-drive and their objective eco-driving scores, it also questions whether experimentally gauging the drivers' acceptance of new eco-driving solutions guarantees that the drivers will use them in real life – especially with the risk of drivers falling back to their old driving habits post eco-driving training (Schall *et al.*, 2016; Zavalko, 2018).

Dissecting *attitudes* further, we found that despite expressing fuel savings as a motive to eco-drive (which is a rather job-related motive), this attitude did not reveal distinctions in the drivers' eco-driving performance. That is, drivers within all four categories portrayed eco-driving as a means to save fuels and promote the firm's economic status (Table 2), yet their FESs varied broadly (although some had enthusiastic intentions). Even if fuel savings were escorted with a motive to retain one's jobs (as seen with Driver A, a "wannabe"), this did not seem "good enough" to improve their FES (74). This finding indicates that job-related attitudes towards eco-driving do not necessarily yield better eco-performance (in contrast to personal attitudes), which may dispute Fors *et al.*'s (2015) note that drivers engage in eco-driving only for job-related motives.

However, when drivers' intentions *and* eco-scores pertain to the same quadrant in the two-by-two matrix, we found that *attitudes* played a more evident role in explaining the best/worst eco-performers within that quadrant. For example, each of Drivers O, K and P within the "ideal eco-drivers" quadrant demonstrated enthusiastic eco-driving intentions, yet the FES of Driver O (97) and Driver K (95) noticeably exceeded that of Driver P (80), which can be attributed to stronger attitudinal inclination to pursue eco-driving as a means to attain self-betterment (Driver O) or protect the planet (Driver K), something that Driver P did not express. This finding corroborates the notion that individuals are more likely to engage in pro-environmental behaviors when such behaviors yield personal benefits as well (De Dominicis *et al.*, 2017).

As per *subjective norms*, we found that managerial expectations may facilitate creating eco-driving awareness among drivers, yet those expectations fell short of explaining the variance in their eco-driving performance. This is because drivers within all four quadrants conveyed similar stances towards the management's routine follow-ups of their eco-driving (Table 2), possibly turning it into a "given measure" in the workplace. Nonetheless, managerial instructions can be *perceived* differently by the drivers, with a potential impact on their FESs too. For instance, the FES of Driver P ("ideal eco-driver") outpaced Driver N's ("non-eco-driver") despite receiving akin instructions and being assigned to similar routes/schedules.

In line with TPB, the case revealed instances where subjective norms were not only created by the management but also by the driver's colleagues. For example, Driver G ("non-eco-driver"), who did not quite care about his eco-driving, expressed that other drivers also did not care about their eco-driving – possibly pointing at Drivers F, N and C (Table 2). Such negative attitudes could have formed a norm of indifference among drivers, thus harming their and their peers' eco-driving intentions and scores. Before drawing this conclusion, we noted that Drivers O, K and J ("ideal eco-drivers"/"wildcards") also expressed the indifference of other drivers despite their high eco-scores. This may suggest that these drivers are more inclined to resist negative subjective norms, possibly due to the dominance of their positive attitudes in ordaining their behavior. Taking these observations in aggregation reinforces the inter-causality between TPB's antecedents (e.g. attitudes can lead to subjective norms and vice versa), in line with the general premise of the theory.

Subjective norms could have played a more important role here if they were accompanied by tangible incentive schemes (monetary or nonmonetary) to reward best performers (Pinchasik *et al.*, 2021; Schall and Mohnen, 2017) – with a possibility to make eco-driving a frequent discussion topic between the drivers (contrary to our findings). Yet, this study

remains inconclusive regarding the role of incentives in promoting eco-driving behaviors, since managers did not adequately follow up on the competitions they arranged, resulting in the drivers not taking them seriously [1]. Further, this study gives no clear indication of whether expectations of customers, society or the drivers' family/friends create solid eco-driving-related norms – inviting further research in this area.

In turn, our analysis suggests that *perceived behavior control* (especially in relation to delivery schedules) seemed to always have an impact on the drivers' eco-driving behavior, to the extent that it can even bypass the mediating role of intentions. That is, all mediocre/low-performing drivers emphasized being constrained by tight schedules (Table 2), no matter how enthusiastic (e.g. Drivers D, L) or unenthusiastic (e.g. Drivers I, C, B) their intentions towards eco-driving were. Contrary, all high-performing drivers did not emphasize (rather, just mentioned) being constrained by tight-delivery schedules – despite the fluctuation in their intentions between enthusiasm (e.g. Drivers O, K) and the lack thereof (e.g. Drivers J, M). But attention should be paid; the management's records revealed that many under-performing drivers were assigned to schedules similar to those assigned to high-performing drivers, and these were not very tight (see managerial validation – Table 2). This signals that it is rather the *perceptions* of tight schedules that can negatively impact eco-driving behaviors, even if those perceptions deviated from the reality of one's driving. One explanation here is that those drivers might have witnessed tight schedules on a few occasions only (especially if pressure from customers is present), which might have magnified the effect of tight schedules in their view.

As such, we examined the *attitudes* of drivers exaggerating their tight schedules (Drivers H, F, N, G, E), deriving that such stances may stem from their failure to see eco-driving as a means to elicit safety or personal happiness (observed with all five drivers), or their indifference towards their own eco-driving behavior (e.g. Drivers F, N, G) – Table 2. On the flipside, all but one driver who had enthusiastic intentions (coupled with low eco-scores) expressed positive attitudes for engaging in eco-driving (e.g. safety, job retention, improving FES). This suggests that behaving positively, even when assigned to tight schedules, can arise from the driver's positive attitude, provided that those schedules are relaxed to achieve the desired FESs. The formation of tight schedules may relate to several factors under perceived behavioral control, such as bad management, poor planning by the customer, legislations on driving times and bad road maintenance – as emphasized by several under-performing drivers (Table 2).

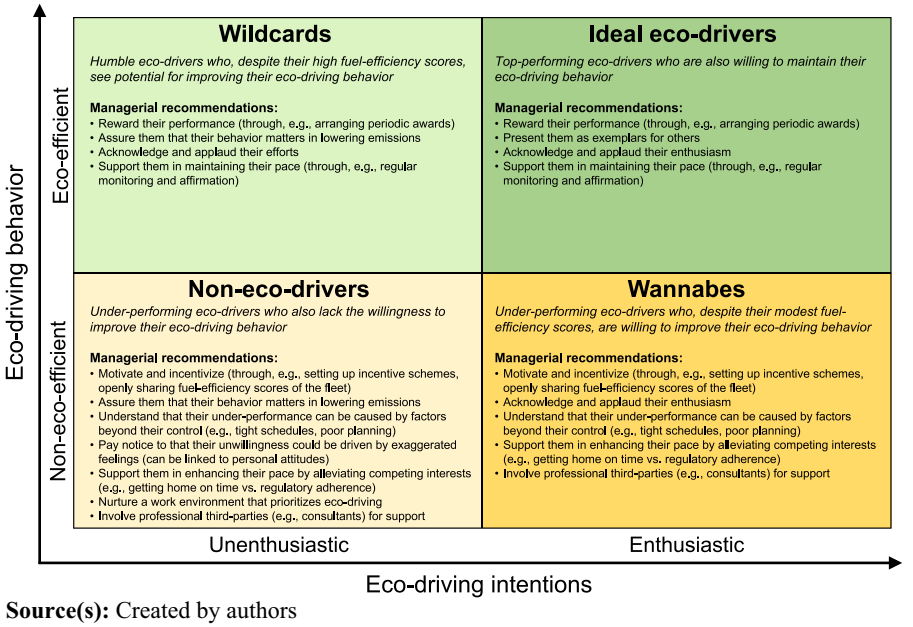
Accordingly, this study carefully identifies delivery schedules as an antecedent to eco-driving behavior, distinguishing whether this impact is based on perceptions alone or if it has actual effects. We derive three inferences from this finding: (1) drivers may take note of the possibility of exaggerating tight schedules' effect on their eco-driving; (2) developers of fleet management systems (such as Dynafleet) may factor in the effect of delivery schedules before computing FESs – enabling more accurate (and just) comparisons between the drivers and (3) managers may consider delivery schedules before rewarding/penalizing drivers based on their FESs – especially if the effect of tight schedules was not factored in during score calculations.

When looking at other external factors (e.g. winter conditions, road maintenance, heavy loads), we found that despite the evident effect of these factors on shaping the drivers' attitudes and intentions towards eco-driving, these factors did not seem to play a dominant role in differentiating between their eco-performance – at least not considerably. For instance, drivers within all four categories similarly expressed winter conditions as a hindrance to their eco-driving efforts (Table 2) – despite the variation between their FESs. The insignificant difference between summer and winter FESs ($p < 0.5$) validates this finding, albeit summer FESs were slightly higher. An alternative explanation here is that those external factors have a rather *indirect* effect by influencing other antecedents (e.g. attitudes), which, in turn, affected drivers' intentions and behaviors.

Finally, this study confirmed the role of vocational background, workplace training and the ability to utilize driving technology as enablers for eco-driving. This finding not only corroborates previous research (Jamson *et al.*, 2015; Zavalko, 2018) but also adds that the impact of these enablers is more likely to last if drivers recognized the importance of utilizing them. In other words, the case revealed that the differences in eco-driving behaviors cannot be attributed to a lack of awareness or shortcomings in capabilities; rather, the difference lies in how the drivers *used* their capabilities to eco-drive.

6. Conclusions

This research examined what motivates professional truck drivers to engage in eco-driving behavior through linking their self-reports with objective driving scores. TPB was used to build a conceptual framework, which was subsequently illustrated through an embedded, single-case study of a Finnish carrier with 17 of its truck drivers. Although this study showed that truck drivers were generally cognizant of their eco-driving behavior, it also revealed discrepancies between the drivers' intentions to eco-drive and actual eco-driving behavior. These were illustrated by a two-by-two matrix (with "intentions" on the X-axis and "behavior" on the Y-axis), classifying the drivers into four categories: ideal eco-drivers, wildcards, wannabes and non-eco-drivers (Figure 4). We analyzed the attitudes, subjective norms and perceived behavioral control of the drivers within each category, which facilitated deriving the following findings: (1) attitudes alone cannot explain eco-driving behavior (yet they play important roles in explaining the best/worst eco-performers), (2) job-related attitudes do not necessarily yield better eco-driving behavior (compared to personal attitudes), (3) expectations from people of importance to the drivers (e.g. management, colleagues) play a rather minimal role in shaping eco-driving behavior (though managerial expectations may create a sense of awareness among drivers), (4) perceived behavior control (especially in terms of delivery schedules) seems to always have an impact on eco-driving



Source(s): Created by authors

Figure 4. Drivers' categories based on their eco-driving intentions and behavior

behavior (even if *only* perception-based) and (5) differences in eco-driving behavior cannot be attributed to drivers' lack of awareness or shortcomings in capabilities – rather, how drivers *use* these capabilities.

This study gives a voice to truck drivers about their daily eco-driving practice, complementing previous research that handled other aspects of truck drivers' concerns, such as burnout and turnover. It also contributes to the commercial eco-driving literature by revealing solid linkages between truck drivers' eco-driving intentions and behaviors, as illustrated by the two-by-two matrix (Figure 4). Because this matrix shows discrepancies between intentions and behaviors, it also contributes to the ongoing debate of behavioral studies within TPB by showing that intentions do not always lead to behaviors – at least not in commercial eco-driving contexts. Moreover, although this study entertains both scenarios of TPB frameworks (i.e. the direct and indirect effects of perceived behavioral control on behavior), its findings are more in favor of the former. This suggests that sufficient degrees of control over eco-driving behaviors seem to exist in commercial driving, which may restrain the role of intentions in such contexts.

After triangulating the drivers' perceptions with objective data (e.g. FESs, managerial records), this study, quite unexpectedly, revealed the dominance of drivers' *perceptions* in shaping their eco-driving behaviors – even if objective data from fleet telematics indicated otherwise. Therefore, we encourage researchers who apply TPB to study behavioral driving to always consider the perceptions of the study's participants, while maintaining objective data for validation purposes. We also recommend being mindful of the inherent limitations of TPB; while our study showed that TPB's three antecedents can influence one another, it should be noted that the theory does not fully explain how these antecedents come into existence. For example, we observed that drivers with similar positive attitudes towards eco-driving achieved different levels of eco-performance, despite receiving similar training and being subjected to comparable policies. Our analysis suggested that this variance could be linked to whether these attitudes are job-related or personal; drivers seemed further motivated by the latter. Yet this also invites further research to apply complementary theories to better elucidate the origins of human attitudes, such as Social Cognitive Theory.

Our matrix directs the attention of carriers' management to that truck drivers differ in their motivations to eco-drive and so should their treatment. This inspired us to offer managerial recommendations to support in dealing with drivers under each category – which, if followed, may not only benefit the drivers, but also enhance the fuel efficiency of the fleet. These recommendations were guided by the theoretical and empirical artifacts of this study and validated through a follow-up meeting with the firm's management. In the meeting we also discussed whether drivers should be assigned to different routes/shifts based on their categorization; for example, by assigning ideal eco-drivers to routes with tighter schedules. Although this strategy may be beneficial, it can backfire. Under-performing drivers who also lack the motivation to eco-drive might exploit easier routes by non-eco-friendly behaviors even if they were not constrained by delivery schedules, hence posing risks to the fuel-efficiency outcomes of the entire fleet.

This study provides further insights to the following stakeholders: (1) eco-driving solution providers, to be attentive to the fact that truck drivers may not use the proposed solutions as expected (even if they expressed acceptance under experimental settings), (2) truck drivers, to pay attention to the possibility of self-exaggerating external factors (e.g. tight schedule, winter conditions) as barriers to eco-drive, (3) carriers, to consider tight delivery schedules (alongside other external conditions) before rewarding/penalizing drivers on their eco-driving performance, (4) fleet management system developers, to factor in the effect of external factors (especially tight schedules) before computing fuel-efficiency scores and (5) clients (e.g. LSPs), to ease tight schedules on carriers to enable achieving desired fuel savings and other

environmental benefits. Furthermore, our implications may also help societies in reaching their ambitious goals related to emissions, road safety, and even driver shortage if enhancing driving conditions makes the profession more appealing for potential new drivers.

One of the main limitations of this study is that it is based on a single case, which calls for caution before generalizing its findings (bearing in mind that the findings should be *analytically* generalized, not statistically). This limitation is especially critical when comparing the findings beyond Finnish settings, for two main reasons: (1) drivers pertaining to different cultures may have different ways of expressing their opinions about environmental concerns and driving behaviors and (2) freight operations in Finland can differ from other countries due to Finland's low(er) traffic volumes, extreme winter conditions and long bright/dark hours depending on the season. Future research may replicate the analysis in other countries, preferably with driving conditions opposing those of Finland. Further, this study revealed possible trade-offs between competing priorities when pursuing eco-driving outcomes, such as driving speed, safety, fuel economy, on-time delivery, regulatory compliance and getting home on time – urging further research to systematically unravel these trade-offs to better understand the challenging reality of truck drivers. This could be accomplished by utilizing a theory that emphasizes the influence of goal hierarchy on drivers' motivations, such as Goal Framing Theory. Another avenue for further research is to validate the revealed effects of TPB's antecedents on eco-driving behavior through a survey on a wide population of truck drivers – combining both self-reports and fuel-efficiency scores. This will enable understanding if drivers with different personal/working traits (e.g. age, gender, experience, family status), cultural backgrounds, or national working conditions differ in their eco-driving motivation and performance. Moreover, testing the resultant two-by-two matrix in such a survey, along with the offered managerial recommendations, may validate their applicability across various freight arrangements.

Final note – We eagerly look forward to seeing zero-emission trucks, with electrified batteries and fuel-cell technologies, replacing conventional fossil-fuel trucks on the road – thanks to the extensive commitments of truck manufacturers and policymakers, among others. This makes one wonder why eco-driving behavior matters in the first place. We argue that it does matter – more now than ever. Year-to-year freight volumes are increasing at an unprecedented pace, bringing along further emissions despite recent green innovations. Before zero-emission trucks see the light, with full-scale production and widespread adoption, the 1.5 °C threshold set by the Paris climate agreement will probably have been breached already – unless we amend our behaviors to take full advantage of the solutions right at our disposal today. In light of this, we refer the reader to an article published in World View column of *Nature*: "Climate change won't wait for future innovation – we need action now."

Note

1. During a follow-up meeting with the management in January 2022 (i.e. after the study was completed), we learned that they started rewarding drivers based on their FESs from October 2021 onwards. The plan was twofold: (1) to reward the entire fleet if they reach a collective, average FES of 90+ on a yearly basis with a weekend getaway (while sharing monthly scores on a WhatsApp group to enable follow-ups), and (2) to reward individual drivers with the best FESs every fourth month with a gift card worth €100. The takeaways thus far: (1) the drivers noticeably improved their FESs once the management shared them openly every month, (2) the drivers' FESs gradually decreased as they approached the end of the month, and (3) the management started expressing concerns on whether these competitions were taken too far. For example, some drivers started cheating by removing their digital ID cards when idling the truck, and others stopped their engines excessively such that it posed risks to the engine. Noteworthy for the individual competition, the management decided to divide drivers into two groups based on their delivery schedules: tight and flexible – which was inspired by this study's findings.

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Further reading

Nature (2022), "Climate change won't wait for future innovation — we need action now", available at: https://www.nature.com/articles/d41586-022-00560-2

Appendix
Interview questions

(1) **Introduction**

- **[context]** Name, age?
- **[context]** Which trucks do you drive in the company?
- **[context]** How long have you worked in the transport sector?
- **[context]** What kind of career plans do you have?
- **[context/attitude]** How would you define eco-driving? *(interviewer provides the definition if needed)*
- **[behavior]** How would you describe your driving pattern compared to the features of eco-driving?
- **[attitudes]** What do you think about eco-driving: in your work, in your free time?

(2) **Support for eco-driving**

- **[context]** How has driving and driving technology developed during your career?
- **[perceived behavioral control]** How do you use driving technology in your driving?
- **[perceived behavioral control]** How do you see your ability to perform eco-driving?
  - **[perceived behavioral control]** Fleet and information systems?
  - **[perceived behavioral control]** Competence (education)?
- **[perceived behavioral control]** Can you use the technology that supports eco-driving?
- **[perceived behavioral control]** Do you get the right information about your driving (management, Dynafleet?)
- **[perceived behavioral control]** When was the last time you studied eco-driving? What kind of education?
- **[perceived behavioral control/behavior]** Have you implemented in your driving the things you have learnt?

(3) **Drivers' experiences**

- **[context]** Please describe the routes/shifts you drive for work.
- **[context]** What kind of experiences do you have about eco-driving at your work?
- **[perceived behavioral control]** What kind of possibilities are there for eco-driving (in the company and overall)?
- **[perceived behavioral control]** What kind of factors promote or prevent eco-driving (e.g. schedules, fleets, electronics, software, . . .)?

- **[perceived behavioral control]** What kind of external factors affect eco-driving (e.g. traffic, road conditions, speed limits, rush, customer needs, . . . ?)
- **[intentions]** How would you enhance your eco-driving behavior considering the current situation?
  - **[intentions]** Would you like to make it better?
  - **[intentions]** What could make you change your driving to be become environmental?
  - **[attitudes]** What is your priority in your driving? (fast departure, eco-driving, safety . . .)

(4) **Environmental concerns**

- **[attitudes]** How do you see environmental concerns overall?
- **[attitudes/subjective norms]** Is the environment important to you? Does it show in your private life?
- **[attitudes/subjective norms]** Does the environment show in your work life?
- **[attitudes]** What do you think about eco-driving?
- **[subjective norms]** Colleagues – Do they see eco-driving as something they want, or want you, to achieve? Why/why not?
- **[subjective norms]** Colleagues – What kind of differences about eco-driving is there in their opinions?
- **[subjective norms]** Colleagues – Could their opinions be changed? How?
- **[subjective norms]** Company – How does your employer promote eco-driving? Does it show in daily practice? How?
- **[subjective norms/attitude]** Company – Are there incentives by the company for eco-driving? Do they matter? Do theymotivate you?
- **[subjective norms/attitude]** What kind of incentives would be the best to enhance eco-driving?
- **[context]** What other practices could affect the environment aside from eco-driving? *(if cannot answer, elaborate: alternativefuels, green vehicle technologies, green packaging, . . .)*
- **[attitude]** How effective do you see eco-driving compared to the other practices?
- **[attitude]** How important do you see eco-driving compared to the other practices?
- **[attitude]** Who do you see is responsible for eco-driving?
- **[context]** Do you have any questions related to this research?
- Thank you for the interview!

Note(s):

(1) The questions were asked in this order to maintain the flow in the conversation.

(2) Some drivers elaborated on certain questions, leading to additional follow-up questions in such cases.

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