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The Cost-Effectiveness of the Resilient Performance of Truck Drivers in Road Freight Transportation

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ABSTRACT

Truck drivers are crucial actors in supply chains that rely on road freight transportation. Their activity is subjected to a number of expected and unexpected variabilities that demand resilient performance at the individual and organizational level. This paper presents an exploratory analysis of the cost-effectiveness of such resilient performance, adopting a qualitative perspective. Data collection occurred in the context of road freight transportation in Southern Brazil, involving the direct observation of the drivers' activities, along with semi-structured interviews with drivers, head of the employee's trade union, and managers of the freight companies. The results indicated a prevalence of resilient practices at the individual level and a number of constraints out of the drivers' control, with very limited help from supportive work systems. These practices are costly not only to the drivers' health and safety but also pose hazards to other stakeholders and society at large. At the same time, from a narrow and short-term perspective, resilient practices displayed by the drivers can be regarded by employers and clients as cheap and effective as the cargo is more often than not delivered with little delay and in good condition. From a systems perspective, the burden of resilient performance seems to be unevenly distributed in the supply chain, posing disproportional costs to the truck drivers.

Keywords: Truck drivers, Resilience, Cost-effectiveness, Complexity

INTRODUCTION

Road freight transportation plays a crucial role for the functioning of several supply chains, usually involving the use of trucks that transit large distances across a wide variety of road infrastructures. Truck drivers are the key workers for the operation of the road freight transportation system, which has a socio-technical nature and is composed of social (e.g., drivers), technical (e.g., vehicles), work organization (e.g., delivery schedules), and external environment sub-systems (e.g., regulations). The activities of drivers take place not only in the cabin but also in other parts of the truck, roads, client facilities, and distribution centres (Reiman, 2021). These activities have been a topic of interest from the human factors and ergonomics perspective. For example, Kent and Halarambides (2022) investigated the stopping points (e.g., gas stations) for the overnight stays of truck drivers in the United Stated.

These areas were found to be frequently overcrowded, creating the need for improvisations. Iseland *et al*. (2018) add that these areas offer opportunities for social interaction between the drivers, which is beneficial especially for those in long trips. There are also studies concerned with the risk of whole-body vibration, which can hinder the drivers' health and their reaction time (Joseph *et al*., 2020). These risks are compounded by factors such as the type of vehicle, drivers' age, speed, and road conditions (Kumar *et al.,* 2021).

As a consequence of the myriad of work constraints imposed on truck drivers, they develop coping strategies, defined in this paper as resilient practices. According to Hollnagel (2014), resilient performance (RP) is the ability of socio-technical systems of adjusting their functioning in order to cope with expected and unexpected variabilities, and even bouncing forward to an enhanced state after the stress is over. Resilient practices are not fully anticipated by standardized operating procedures and can be in conflict with regulations. Based on the extant literature, some resilient practices developed by truck drivers can be identified such as: long daily work journeys, often with uninterrupted driving over several hours (Mahajan *et al.,* 2019); sleeping in the truck cabin (Darwent *et al*., 2012); driving in high speeds (Adanu *et al*., 2021); use of drugs (Dominik *et al*., 2022); and unhealthy eating habits (Bschaden *et al*., 2019).

Organizational support can reduce the need for RP at the individual level, and the consequent undesired human costs (Terra *et al*., 2023). In this respect, there are initiatives such as: replanning delivery routes and schedules in real-time based on updated information from traffic conditions and client needs (Prakoso *et al*., 2022); new technologies for seats and suspension of vehicles that reduce whole body vibration (Johnson *et al*., 2018); and truck platooning, in which two or more trucks travel in convoy at a pre-defined distance from each other, virtually connected through technology and automated driving support systems (Zhang *et al*., 2020). These initiatives are investments in RP.

This article aims at presenting an exploratory cost-effectiveness analysis of the RP in the truck drivers' activity. RP in general can play out in several ways such as reactive, proactive, benefiting from resources designed in advance, from the informal self-organization of workers on the spot, during every day work, and during disasters (Righi *et al*., 2015). Thus, assessments of RP must account for its multiple dimensions, and to the possible extent separate what is worth supporting from what is wasteful and dangerous (Saurin *et al*., 2023). According to these authors, the best manifestations of RP require little or no investment and give rise to mostly desired outcomes, whose benefits are long-lasting and reaped by several stakeholders. The costs and outcomes of RP can be either technically or human oriented, and is also important to make it explicit who will be affected by RP and for how long the costs and outcomes will last (Saurin *et al*., 2023).

RESEARCH METHOD

Data collection was carried out in Southern Brazil, involving: (*i*) semi-structured interviews with 10 truck drivers (five were employees of freight

companies and five were free lancers), one head of the employee's trade union, and two managers of the freight companies; (*ii*) direct observation of the trucks of the interviewed drivers, focusing on the cabin and areas for resting and preparing meals; and (*iii*) direct observation of the docks and other working areas used by the truck drivers in two supermarkets. In total, both types of observations accounted for approximately 15 hours. Notes from the observations were taken on a diary, accompanied by photographic records.

The interviews with the drivers and the head of the trade union were based on a guide with 25 questions on: (*i*) work constraints, related to social (e.g., long periods away from home), technological (e.g., vibrations), organizational (e.g., performance goals), and external environment factors (e.g., robbery); (*ii*) resilient practices at the organizational level, corresponding to the provision of resources that help workers to cope with the work constraints (e.g., warnings at the control panel, indicating the need to take a rest); and (*iii*) resilient practices at the individual level, corresponding to actions deployed by the drivers to cope with the work constraints (e.g., use of medications not to fall asleep), without organizational support. Note that these practices at the individual level are not the same as personal resilience. This type of resilience, not investigated in this study, is assessed through perceptual surveys and is associated with lifestyle (e.g., work-life balance) and personality traits such as self-efficacy, optimism, and emotional intelligence (Badu *et al.*, 2020). The drivers were randomly selected for the interviews, were on average 47.2 years-old (ranging from 28 to 63), and had 22.4 years of experience, on average (ranging from 6 to 40). The cargos they transported consisted of grains (e.g., soy, rice), meat, and industrialized food products.

Regarding the interviews with the managers, they were based on a 20-question guide aimed at understanding the planning of routes and work organization, the most frequent health and safety issues affecting the drivers, and the resources provided the company. All interviews were audio-recorded (approximately 10 hours of recordings), fully transcribed, and subjected to a thematic analysis. The procedures recommended by Clarke and Braun (2017) were adopted for the thematic analysis, starting with multiple readings of the interviews' transcripts in order to obtain familiarity with the data and the main issues. Next, four themes were defined a priori, namely the work constraints, organizational resilience practices, individual resilience practices, and the consequences of these practices. Then, coding involved highlighting excerpts of text related to the themes and grouping them according to their similarity. Data from the observations provided contextual information for analysing the cost-effectiveness of RP, allowing triangulation with the interviews. Data collection was discontinued based on the saturation criterion, meaning that findings started to converge, no new signification information emerged, and the results appeared to suffice to address the aim of the study.

RESULTS AND DISCUSSION

Table 1 exemplifies the results of the thematic analysis. Excerpts from the interviews further illustrate these findings. For example, the following remark

from the head of the employees' union clarifies the reasons for the long waiting times at the customer companies: "*many clients only accept deliveries in the morning. So, if it's past time, they can't unload. In the supermarkets, depending on the time, they close their doors for lunch and only reopen 2 hours later, or on the next day. Then, you have to rush to deliver*." The drivers also reported that waiting occurs when there are long lines of trucks for unloading, and when the client inspection detects problems such as damaged cargo and errors in the invoices.

Travel and waiting times are also affected by unexpected events as reported by one of the interviewed drivers: *the time we spend on the road, away from home, is very unpredictable. It has already happened that, because of the looming rain, the farm employees who were loading the truck* [with soy] *received orders from their boss to stop the activity and unload everything. I spent six days with the truck parked at the farm, waiting for it to stop raining* [soy cannot be loaded if a certain humidity threshold is exceeded] *and the soybean seeds to dry, so I could reload. During those six days I was left to my own, sleeping inside the truck, without earning anything. And then, all other appointments were rescheduled.*"

Regarding examples of individual resilient practices, drivers usually improvise a bed within the cabin while staying overnight in a gas station, in order not to pay for a hotel. Conditions can get worse when there is an assistant worker along with the driver. This worker may need to sleep in the back of the truck, along with the cargo. Improvisations are also usually made by the free lancer drivers for preparing food, as they set up a mini kitchen on the vehicle. Drivers employed by the freight companies receive a fixed amount of money for meals, and they usually eat in restaurants on the road. However, several drivers reported that they have an unhealthy diet, and eat too much at once as they want to limit the stoppages. According to all interviewees, consequences of the resilient practices at the individual level are mostly detrimental to their health and safety. As for the organizational resilient practices exemplified in Table 1, the interviewees made it clear that they are not yet of widespread use, being more common in large freight companies, and much less used by the free lancers.

Table 1. Examples of work constraints, individual resilient practices, organizational resilient practices, and consequences.

Work Constraints	Description
Long waiting times at the customer companies	Administrative procedures of the client companies (e.g., inspection) and long lines add to the waiting times
Pressure for on-time delivery	This pressure is not only due to contractual arrangements but also to the nature of some cargos
There is no rotation of drivers	After ending a delivery, drivers are often assigned to another trip on the following day, with little resting time in-between
Areas for overnight stays (e.g., gas stations) are often unsafe and uncomfortable	Gas stations can also be overcrowded and charge drivers for using their facilities

(Continued)

Table 1. Continued

Work Constraints	**Description**
High fuel price reduces profit margin	Free lancer drives tend to be most affected by this problem as they have lower bargaining power with their clients
Individual resilient practices	Description
Long work journeys (e.g., up to 12 hours non-stop driving)	This compensates for several types of delays such as traffic jams, and unexpected events during the trip
Improvisation of mini-kitchen and fridge on the truck	It allows for the preparation of healthier and cheaper meals, while requiring extra time for this
Taking short naps (15 minutes) and then returning to driving	This depends on the availability of safe areas to stop driving
Use of drugs to keep awake for long periods	Either licit or illicit drugs are taken, bringing health and operational risks
Consequences of the individual practices	Description
Health problems such as those related to overweight and diabetes	The poor working conditions are probably associated with a myriad of health problems
Work accidents	Accidents do not involve traffic accidents but also events while doing other work activities
Sleepiness while driving and fatigue	This a common problem involving truck drivers
Organizational resilient practices	Description
Installation of automatic blockage systems at the cabin to enforce resting times	These systems activate aural warnings advising a rest break, after a predetermined length of time driving or distance travelled. If this warning is ignored, the vehicle can be automatically shut down.
Traveling with an assistant employee to help with the handling of the cargo	This can also be helpful to reduce feelings of social isolation
Provision of modern and comfortable trucks	Comfortable seats, effective air conditioning, and spacious cabins
Modern trucks have an extra fuel tank	This reduces the need for refuelling stoppages, and gas stations can be used only for toilet breaks. As a drawback, owners of gas stations are less interested in hosting drivers and providing comfortable facilities.

Overall, results suggest that RP largely rests on the shoulders of the drivers as these need to cope on the spot with economic pressures and unexpected events. The costs of such RP play out, at least more visibly, in terms of health problems and vulnerability to risks such as accidents and robbery. However, there are less visible costs to other actors. For example, the drivers practice of parking overnight in the gas station and sleeping in the cabin does not add profits to the gas station owners who can consider the drivers as unwelcome guests. The costs of RP are also paid by the society at large as road accidents involving trucks increase financial costs (e.g., insurance) across the supply chain and are more likely to be fatal for the drivers of the smaller vehicles hit by the trucks. The economic pressures on truck drivers can also occasionally reach boiling point and contribute to strikes with far reaching impacts on the national economy. In 2018, there was a major truck driver's strike in Brazil,

in protest against rising fuel prices. In a matter of days, several supply chains came close to a complete halt, causing widespread disruptions to ordinary people and companies (Nowak, 2022). The implications of such strikes tend to be more serious in countries like Brazil, where road freight transportation is vastly more important than other alternatives such as railways.

Thus, the costs of RP are high and might spread from the micro to the meso (e.g., other drivers) and macro level (e.g., society at large). The effectiveness of the RP is less clear. The prevalence and continuity of such practices can indicate that they work to some extent, regarding on-time delivery at the requested quality by clients. Supply chain disruptions due to the identified practices are exceptions rather than the norm. However, this is a narrow and short-term effectiveness definition, which misses the question of effectiveness for whom. Indeed, such effectiveness is probably most beneficial for employers and the end clients of the supply chains, and less beneficial to the drivers and society.

Finally, it is worth noting that the driving activity, in general, intrinsically involves a certain degree of autonomy, as the driver can ultimately make decisions on a number of control parameters such as speed, overtaking, and interaction with other drivers. Such autonomy, exercised daily and at length, can contribute to the development of resilient skills to cope with expected and unexpected variabilities (Saurin *et al.*, 2014), and is also likely to develop and demand personal resilience. However, there are a number of forces that constrain that autonomy. These forces are mostly out of the control of the drivers (e.g., traffic jams, waiting times at the client facilities), and are likely to undermine individual, organizational, and personal resilience.

CONCLUSION

The truck drivers study revealed the complexity of assessing the cost-effectiveness of RP. When the boundaries of the socio-technical are expanded beyond the driver-vehicle ensemble, it becomes clear that both the costs and the effectiveness of RP depend on and affect other stakeholders. The presented analysis has an exploratory character, and should be complemented by quantitative data such as accident rates, incidence of workers on-leave due to occupational illness, rates of on-time delivery, and profit margin of companies. Moreover, the cost-effectiveness analysis can be carried out for specific instantiations of RP, making it possible to rank them from the most to the least desirable. It can also be insightful to map RP across all stages of a determined supply chain, assessing the costs and effectiveness of RP to a wider range of stakeholders, shedding light on how certain actors probably benefit to the detriment of others. These and other implications of this study can be useful for the cost-effectiveness analysis of RP in contexts other than the truck drivers' activity.

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