Human Factors in Transportation, Vol. 95, 2023, 413–419
https://doi.org/10.54941/ahfe1003826

High-Speed Train Drivers' Operation Performance: A Focus Group Study With Drivers and Managers

Ziteng Wang, Yanyi Li, Yi Wang, and Wei Zhang

Department of Industrial Engineering, Tsinghua University, Beijing 100084, China

ABSTRACT

Although the rapid development of high-speed rail enhanced national transportation and boosted economic growth in China, it also had a great impact on the behavior of high-speed train (HST) drivers. To stay safe, HST drivers may need to continuously keep alert for a few hours, detect potential hazards in time, make quick reactions, and strictly follow Standard Operating Procedures. The purpose of this study is to explore the potential influencing factors of HST drivers' operation performance and provide practical management suggestions. Six focus groups with 22 HST drivers and 18 front-line managers were conducted to collect qualitative information concerning the drivers' operation performance. The results were unfolded from two perspectives. From the individual level, high-performance drivers were more experienced, more likely to detect hazards in time, and performed better in emergency handling. They also tended to be in good health, had quality sleep, and had effective anti-fatigue measures. From the organizational level, crew scheduling factors played an important role in HST drivers' operation performance. These factors include the switching frequency of HST models, intermittent rest time, and task duration.

Keywords: High-speed train driver, Focus group, Operation performance, Driver management

INTRODUCTION

The high-speed train (HST) has a significant impact on travel. China was the main driver of the expansion in HST passenger traffic, which climbed from 245 billion passenger kilometers in 2010 to 1029 billion in 2019, according to the International Union of Railways (International Union of Railways, 2021). According to the World Bank Group, China's high-speed rail network had exceeded 40,000 km by the end of 2021 (Xinhua, 2022), accounting for 66% of all lines in the world by 2017 (Lawrence et al., 2019). High speed, timeliness, environment friendliness, and a nice interior are all hallmarks of the HST. Accidents rarely happen on high-speed railways, but when they do, severe injuries or even fatalities may occur caused by the high speed (Guo et al., 2016). According to statistics from 1993 to 2017, human error was to blame for the majority of railway accidents, and one of the most frequent types of human mistakes was drivers' dangerous operational behaviors (Hani Tabai et al., 2018; Liu et al., 2019). Driving HST demands that drivers maintain a constant state of alertness for several hours, recognize potential

problems in advance, act immediately, and operate the train strictly following established operating protocols. Driving HST while engaging in risky behaviors like speeding, signaling mistakes, braking mistakes, and failing to perform status checks could compromise the safety of the HST. Therefore, it is essential for safety management to increase HST drivers' operational performance to decrease the risk.

Numerous research on conventional train drivers has investigated the aspects that affect their accident involvement. These studies have proposed several variables, such as personal characteristics including age, gender, and educational level (Cheng and Tian, 2020), drivers' experience and ability to remain alert (Dunn and Williamson, 2012), occupational environments including heat, noise, and vibration of train cabs (Birlik, 2009; Lal and Craig, 2001), and task characteristics including irregular work hours, excessive workload, and monotonous tasks (De Valck et al., 2015; Filtness and Naweed, 2017). The driving task for HST does differ significantly from that of regular trains, though. First of all, the HST driving task places demands more on drivers' ability of perception and cognition because of the substantially higher speed, up to 350 km/h (Guo et al., 2019). Second, to be proficient, HST drivers must comprehend new technologies, be familiar with new equipment and a variety of HST kinds, and quickly adjust to the HST's rapid advancement (Ye et al., 2021). Third, HST's scheduling system was very different from that of normal trains. In China, HSTs are operated for up to 4 hours by a single driver within the cabin, with or without stops. Considering all of the aforementioned variations, HST drivers are more susceptible to performance degradation due to increased workplace stress and mental pressure (Fan and Smith, 2017; Young et al., 2015). Therefore, further research is needed to determine whether the critical variables associated with the performance of conventional train drivers still have a significant impact on HST drivers.

Due to the high relevance to the safety of HST, this study focuses on HST drivers' operation performance, which aims to contribute to the literature by identifying the possible factors influencing HST drivers' operation performance.

METHOD

Focus Groups With HST Drivers and Their Frontline Managers

We conducted six (2 hours in length) focus groups. A total of 22 HST drivers (all male, mean age = 40.9, SD = 6.5) and 18 HST frontline managers (all male, mean age = 44.0, SD = 3.3) participated in the focus groups (see Table 1). They were held at three railroad bureaus (Beijing, Shanghai, and Lanzhou) in China from March 2021 to May 2021. At each bureau, 7 or 8 HST drivers and 6 frontline managers participated in driver focus groups and manager focus groups, respectively. This study was conducted under the ethical guidelines of the American Psychological Association and the ethical guidelines set by the Department of Industrial Engineering at Tsinghua University.

Upon arrival, participants were asked to sign an informed consent form, complete a demographic questionnaire, and were briefed on the purpose

Table 1. Demographic data provided by participates.

	HST drivers	Managers
Age		
25–34 years	13.6% (n = 3)	0% (n = 0)
35–44 years	50% (n = 11)	66.7% (n = 12)
45–54 years	36.4% (n = 8)	33.3% (n = 6)
Total	100% (n = 22)	100% (n = 18)
Gender		
Male	100% (n = 22)	100% (n = 18)
Mean Age	40.9(years)	44.0(years)
Mean HST driving experience	7.41(years)	

of the discussion. The focus groups were designed to gather their views on potential influencing factors on HST drivers' operation performance. Participants were informed that all comments were equally valued and welcomed. They were informed that the entire discussion would be audio-recorded for research purposes only and would subsequently be handled anonymously. All recordings were transcribed verbatim for further analysis (Meng et al., 2016). The focus groups were semi-structured and centered around a few open-ended questions (see Table 2). They were conducted in a manner that was consistent with the study's findings. The process followed an established focus group discussion format. To gradually engage participants in the discussion, we set up several open-ended questions at the beginning. Subsequently, we used several transition questions to gradually guide them through the discussion of the study's key questions. Finally, participants discussed several closing questions and concluded the discussion.

Data Analysis

All recordings from the focus groups were transcribed verbatim and analyzed using a computerized version of the long-table approach (Krueger and Casey, 2014). We first transcribed the recordings verbatim and analyzed them using a combined Excel file. Video recordings were reviewed during the transcription process to supplement the recordings. First, the original transcripts

Table 2. The questions for focus groups.

Questions for HST Drivers	Questions for Managers
1. Please talk something about yourself. How many years have you been an HST driver?	1. Please talk something about yourself. What is your specific management role?
2. Please talk about the evaluation system of HST drivers' operational performance.	
3. Please talk about the characteristics of excellent HST drivers in terms of operation performance.	
4. Please talk about possible aspects that may affect the operation performance of HST drivers.	
5. Is there any factor that may affect the HST drivers' operation performance if not mentioned above?	

were broken down into complete sentences. Next, each of the three members of the research team categorized the sentences and identified the main categories they belonged to. During this process, if three members disagreed on the ranking result of a sentence, they would vote on the final ranking result of the sentence. The results of each category were reported below, and the frequency with which the topic was mentioned in the discussion was also calculated.

RESULT

Operation Performance Evaluation

The operation performance of HST drivers consists of two main components: task performance and safety performance. The task performance mainly examines whether the HST driver can drive the train safely and ensure the smooth operation and on-time arrival of the train, while the safety performance is evaluated by HST managers based on the severity and number of unsafe operations performed by HST drivers. Unsafe operations during driving include discontinuous lookout, speeding, signaling errors, braking errors, missing status checks, etc. All of these operations can compromise the safety of the HST.

The Chinese railway system has developed a comprehensive safety performance evaluation system for the drivers, which uses the evaluation method of positive and negative points. Positive points are scored when the HST driver meets the discipline and standardized operation set by the bureau, while negative points are scored when the HST driver has safety issues.

Theme Identification

For the focus groups, the thematic analysis allowed the three researchers to independently identify a total of 12 themes. These were then agreed upon and categorized into 2 levels: individual-level and organization-level. These categories or themes are listed in Table 3, with details of how many times

Table 3. Themes identified during research analysis.

Category	Theme	Frequency
Individual-level		50
	Sense of honor, responsibility	18
	Personality traits	12
	Health condition	9
	Fatigue	9
	Emergency handling	2
Organization-level		53
	Crew scheduling	12
	Lookout	10
	Switching frequency of train models	9
	Communication during driving	5
	Rest	7
	Cab equipment	6
	Cab working environment	4

they were mentioned respectively. The individual-level category contained 5 themes while the organization-level category contained 7 themes.

Individual-Level Influencing Factors

From the individual level, HST drivers and frontline managers mentioned several factors that might distinguish high and low-performance drivers.

In terms of personality traits, both HST drivers and managers agreed that sense of honor and responsibility are important characteristics of excellent HST drivers. As some drivers said: "… *responsibility that's the creed we need to bear in mind all the time*". Managers believed that an excellent driver should be ready to give up his personal benefit for the sake of the whole team. In addition, other traits that excellent HST drivers should be studious, self-disciplined, calm, and independent. With the help of strong learning ability, they are more likely to enjoy observing things at work, learn from past working experiences, and perform better in the future.

Many participants also discussed the health condition as an important factor affecting their operation performance. High-performance HST drivers should be in good health to ensure that they are physically fit enough to drive HST at their best.

Emergency handling was identified as another important factor affecting the operation performance of HST drivers. Some participants agreed that since high-performance drivers are more experienced, they are more likely to follow strict Standard Operating Procedures (SOPs), identify hazards in a timely manner, and perform better in emergency situations. As one driver said: "*The timetables of high-speed rail are relatively tight, so the rules or regulations are relatively strict. Since the response time is quite short, you have to make the right and quick decisions after the occurrence of some emergencies*."

Organizational-Level Influencing Factors

From the organizational level, both drivers and managers enumerated some factors that could affect the operation performance.

The crew scheduling, which determines the driving task duration and intermittent rest duration of HST drivers, has a significant impact on their operation performance. It was worth noting that cases of poor crew scheduling still existed. For example, as a special type of rest for HST drivers, intermittent rest determines their mental state when leaving for work. However, as some drivers said: "*...there is a conflict between the (intermittent) rest and work*". Managers also acknowledged themselves that crew scheduling was a universal issue in rail system.

Besides, the more frequent switching of HST models may place a higher workload on drivers, which can affect their operation performance. As one driver described, "...I have to master many models of HST; the overall demand of the operation is very high." The use of unfamiliar models of HST can influence the driver's performance, especially in emergency situations.

Last but not least, both managers and HST drivers acknowledged the importance of the resting environment, which includes the company's accommodation apartments as well as the intermittent resting places near the stations. While the work environment refers to the temperature, humidity, brightness, vibration, noise and odor in the train cab, some drivers suggested that there are problems such as loud noise, ill-designed sun visors in some older HST models, etc. They believed that these unreasonable designs could also negatively affect their working status when driving, thus affecting their overall operation performance.

CONCLUSION

This study used focus groups to uncover potential factors that may influence HST driver's operation performance. We developed an interpretation of these potential factors at both individual-level and organization-level. Both drivers and managers in this study recognized the aspects which needed be put more emphasis. The study used focus groups to identify potential factors that may affect the performance of HST drivers in China. The study looked at both individual and organizational factors and found that both drivers and managers recognized the areas that needed more emphasis. The results may be useful in improving the performance of HST drivers in China.

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