Operational Drivers of Passenger Safety Risk and Behaviour in a High-Demand Bus Terminal

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Abstract

Public transport terminals in rapidly growing African cities are critical safety spaces where operational inefficiencies lead to prolonged passenger exposure and behavioral adaptation. Traffic safety research has been known to traditionally focus on the study of crash outcomes. Recent advances are increasingly studying pre-crash conditions such as congestion, queuing, and prolonged waiting that shape passenger behavior and risk. In high-demand bus terminals, irregular headway, extended dwell time, and internal congestion often prompt informal (risky) passenger behaviors. Some of the risky behaviors of passengers include standing in boarding lanes, boarding outside designated areas, route switching, and competition for space. Despite their safety implications, such behaviors are rarely quantified within terminal-based safety assessments, particularly in African contexts. This study addresses this gap by examining the operational determinants of passenger waiting time and safety risk at a major urban bus terminal.

The aim of this study is to quantify the relationship between terminal operating conditions, passenger waiting time, and safety-related behavior. The study also strife to develop a Passenger Safety Risk Index (PSRI) for assessing safety risk exposure in high-demand bus terminals.

Primary operational data comprising 481 observations were collected at Terminal 3 of the Oshodi Transport Interchange, Lagos, Nigeria. The variables derived from the data collected are headway, bus dwell time, bus queue time, boarding time, number of passengers, and actual passenger waiting time. Descriptive statistics were used to characterize operational variability, followed by correlation analysis to examine bivariate relationships. The linear regression was employed to identify key predictors of passenger waiting time. A passenger safety risk index (PSRI) was subsequently formulated using normalized passenger waiting time, bus queue time, and bus dwell time. The PSRI obtained enable the classification of terminal conditions into low, medium, and high safety risk categories.

The result of the descriptive statistics showed that the mean headway is 11.24 minutes (SD = 13.73), dwell time is 67.82 minutes (SD = 98.33), queue time is 6.38 minutes (SD = 94.24), and waiting time is 39.52 minutes (SD = 29.42). The correlation result show that waiting time has a positive, significant association with boarding time ($r = .13$, $p = .003$), headway ($r = .10$, $p = .013$), dwell time ($r = .10$, $p = .011$), and queue time ($r = .10$, $p = .015$). The correlation results prove that waiting time increase as the operational variables increase; that is, the variables exert a measurable influence on waiting time. The regression analysis identify boarding time as the strongest predictor of waiting time ($\beta = 0.123 – 0.135$, $p < 0.01$), followed

by headway and queue time, at p-value < 0.05. The mean PSRI (approximately 0.16), median (0.10), and maximum PSRI (0.87), show that the majority of the observations are below the minimum PSRI (0.33). Although most of the operating conditions fall under the low (60–65%) to moderate (25–30%) risk level, there are extreme congestion episodes (5–10%) that generate substantially elevated safety risk. The risk levels are indication of high-level safe practices by passengers at the terminal. The high-risk condition correspond to periods of prolonged dwell, queuing, and waiting, when anxiety that trigger risky behaviors by passengers.

The study demonstrate that passenger safety risk in high-demand bus terminals is primarily driven by operational inefficiencies that prolong waiting time and encourage adaptive behaviors. The following are key conclusions from the study:

- Passenger waiting time is a robust proxy for safety exposure within bus terminals.
- Boarding time, headway irregularity, and queue time are the dominant operational drivers of elevated safety risk.
- High PSRI are episodic but coincide with behavioral adaptations such as informal queuing, standing in boarding lanes, and route switching.
- The PSRI provides a practical, data-driven tool for identifying high-risk terminal operating conditions.

Consequent upon the above conclusions, targeted operational interventions focusing on boarding management, headway control, and real-time congestion monitoring are recommended to reduce passenger exposure and improve safety performance in urban bus terminals.