One-Size May Not Fit All: Wheelchair and Scooter Users Compare the Usability of Different Public Bus Layouts

A study funded by the National Institute on Disability, Independent Living, and Rehabilitation Research (NIDILRR).

People with mobility disabilities may use public buses to travel to work, medical appointments, or recreational or social activities. Buses in the United States are required to be accessible to riders who use wheelchairs or scooters. Many of these buses are designed with a low vehicle floor and features that allow the driver to lower the bus closer to the curb or extend a ramp for easier boarding. However, past studies have identified some problems that wheelchair and scooter users may face when riding these conventional “low-floor” buses. These problems may include trouble going up steep ramps to board the bus, as well as crowding in the seating area and difficulty maneuvering in the tight space. In a recent NIDILRR-funded study, researchers compared the usability of three different bus layouts for passengers who use wheelchairs or scooters. The researchers wanted to find out which parts of the boarding and exiting process were most difficult for wheelchair and scooter users, how the experience of boarding and exiting the bus was impacted by having more passengers on the bus, and which bus layout was preferred by wheelchair and scooter users overall.

Researchers at the Rehabilitation Engineering Research Center on Accessible Public Transportation and the project on Investigating Performance Indicators in Accessible and Inclusive Public Transportation enrolled 48 wheelchair and scooter users in the study. The participants used a manual wheelchair, a power wheelchair, or a scooter for mobility. The participants’ average age was 50 years old (range: 25-68 years) and they had been using a wheelchair or scooter for an average of 7 years.

The participants tested three different bus layouts using a full-scale bus mockup. All three layouts featured regular seating for passengers and two areas where seats could be folded and a wheelchair could be safely secured facing the front of the bus. For each bus layout, the researchers set up two different levels of crowding by placing mannequins on the seats, low-load and high-load. In the “low-load” condition, about half of the seats were empty and no one was seated in the wheelchair securement areas, while in the “high-load” condition, most seats were occupied and a mannequin in a wheelchair was placed in one of the wheelchair securement areas to simulate a passenger sharing the space.

Layout 1 was based on buses currently in operation and featured a single door at the front of the bus opposite the driver to be used for both entry and exit, with a farecard reader mounted on a stand on the floor in the front area of the bus next to the driver (Figure 1). Wheelchair securement areas were available in the middle of the bus on
both the curb and street sides. The layout included both forward-facing and center-facing seats for other passengers.

**Figure 1**: Plan view of Layout 1: Front Entry-Exit, along with mannequin placement for simulated conditions of low (shown in red) and high (both red and blue) crowding.

Layout 2 featured separate doors for entry at the rear of the bus and exit at the front of the bus, with the farecard reader mounted on a panel near the rear entry door (Figure 2). Wheelchair securement areas were available in the middle and rear of the bus on the curb side, with center-facing passenger seats on the street side.

**Figure 2**: Plan view of Layout 2: Rear Entry – Front Exit, along with mannequin placement for simulated conditions of low (shown in red) and high (both red and blue) crowding.

Layout 3 featured a single door at the rear of the bus to be used for both entry and exit, with a farecard reader mounted on a panel near the door (Figure 3). Wheelchair securement areas were available toward the rear of the bus on both the curb and street sides. This layout included both forward- and center-facing seats for passengers on both sides of the bus.
During the study, each participant tested all three layouts in both load conditions, for a total of six tests per participant. The participants were asked to use the access ramp to board the bus, attempt to pay their bus fare, move their wheelchair or scooter into and out of the designated area, and then exit the bus. After each test, the participants rated their overall opinion of each layout and ranked them in order of preference. They also rated how difficult each part of the boarding and exiting process was for them during high- and low-load conditions.

The researchers found that most of the participants preferred Layout 3, with the entry and exit at the rear of the bus and wheelchair securement areas close to the door. Layout 2 ranked second and Layout 1 ranked third. The participants tended to prefer using a ramp at the rear of the bus rather than at the front for boarding and exiting and could maneuver into the securement areas with less difficulty. Although Layout 2 allowed participants to enter and pay at the rear of the bus, the participants had to move past other passengers through a narrow space to get to the wheelchair securement area in the middle of the bus, and some of the participants accidentally bumped into the mannequins while testing this layout. The position of the farecard reader presented some challenges as well: Some of the participants had trouble reaching the reader when it was freestanding on the floor at the front of the bus as in Layout 1 rather than mounted on the rear side panel in Layouts 2 and 3.

When the researchers asked the participants to rate difficulty of specific parts of the boarding/exiting process, the participants who used manual wheelchairs rated going up the entry ramp as the most challenging part of the boarding process in all three layouts, with Layout 1 proving the most difficult. For the power wheelchair and scooter users, the most challenging aspect of the process was making their way into and out of the wheelchair securement area, especially when the bus was more crowded in the “high-load” conditions in all three layouts. The participants also reported difficulties when they needed to turn around in the securement area, or when they needed to make
a sharp turn before exiting the bus. These problems were rated as more severe in the “high-load” than in the “low-load” conditions.

The authors noted that, even though public transit buses in the U.S. are technically compliant with federal access requirements, bus designs can present a number of problems for wheelchair and scooter users. Manual wheelchair users in this study had difficulties going up ramps which required upper-body strength. However, users of all three devices reported some difficulty going up and down the ramp at the front of the bus in Layout 1, where the ramp extended into the interior of the bus and they were required to turn more sharply to avoid the farecard reader. Power wheelchair and scooter users also reported difficulties navigating inside the bus when it was congested with passengers. While most public transit buses in the US feature a single door at the front for entry and exit, rear-entry, rear-exit design was rated significantly higher by the participants than the other designs.

The authors noted that, due to these challenges, some wheelchair and scooter users may feel self-conscious or anxious about using public transit buses and may avoid using them as a result. Vehicle manufacturers and transit agencies may wish to evaluate bus designs to ensure that entry ramps are not too steep, and that wheelchair securement areas are wide enough to accommodate scooters as well as wheelchairs. In addition, clinicians may want to create bus mock-ups like the one used in this study or set up similar situations in a clinic to help individuals with mobility disabilities practice boarding and exiting public transit buses, and to learn the best methods for maneuvering in crowded conditions.

To Learn More

The Rehabilitation Engineering Research Center on Accessible Public Transportation and Project ACTION produced a factsheet, Universal Design & Accessible Transit Systems: Facts to Consider When Updating or Expanding Your Transit System, to guide policy makers and transit system managers in making purchase decisions to meet the needs of riders with disabilities: http://es.easterseals.com/site/EcommerceDownload/Universal_Design_FactSheet-5821.pdf?dlid=90752-5821-761N6ivu74JPUrFe


To Learn More about the Rehabilitation Engineering Research Center on Accessible Public Transportation (RERC-APT): http://www.rercapt.org/

To Learn More About this Study

Technology, 2017. This article is available from the NARIC collection under Accession Number J77907.

For Boarding and Disembarking Durations, please see


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NARIC operates under a contract from the National Institute on Disability, Independent Living, and Rehabilitation Research (NIDILRR), Administration for Community Living, Department of Health and Human Services, contract #GS-06F-0726Z.