Mcity Driverless Shuttle:
What We Learned About Consumer Acceptance of Automated Vehicles

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EXECUTIVE SUMMARY

Self-driving vehicles—also referred to as driverless, fully-automated, or autonomous—are today's automotive frontier. Not since the birth of the automobile more than a century ago has a vehicle technology offered such promise to improve our quality of life. Fewer traffic deaths and injuries. Decreased fuel use and energy consumption. Increased access to transportation for people without reliable mobility options: the elderly, those with disabilities, the unemployed and underemployed who struggle to find a way to get to work if they can find a job. Driverless vehicles could fundamentally change the way people and goods are transported and benefit society as a whole in tangible, meaningful ways. But only if consumers accept the technology and trust it to keep them and their families safe. So far, consumers are wary.

In the 2017 Tech Choice Study℠ performed by the global market research company J.D. Power, an affiliate member of Mcity, consumer trust in automated vehicles (AVs) shifted toward "definitely would not trust" across all generations compared to the same study a year earlier. In addition, consumer interest in AVs decreased during the same period. Nearly three-quarters of survey respondents in 2017, 73%, indicated they "probably would not" or "definitely would not" be interested in self-driving transportation, up from

67% in 2016, according to J.D. Power. The ratio of consumer trust in AVs to consumer interest in them was nearly 1:1. In other words, the benefits of driverless vehicles would be slow in coming unless consumer trust in AVs rose sufficiently to spike consumer interest in making the technology part of their daily lives.

Enter Mcity.

In June 2018, the Mcity Driverless Shuttle research project launched on U-M's North Campus in Ann Arbor as the first automated shuttle project in the United States focused primarily on consumer research and data collection. Mcity's objective was to learn more about the challenges and opportunities presented by this type of mobility service and how people interact with it.

The launch came just three months after two fatal crashes involving partially automated AVs, one in Arizona and the other in California. In the aftermath of these deaths, several studies showed a sharp decline in consumer interest and trust in AVs.

This year, separate consumer surveys from AAA and J.D. Power each found that consumer interest and trust in AVs remains low and is declining. In March 2020, AAA released results of its automated vehicles survey, conducted in January, which found that only 12% of U.S. drivers would trust riding in a self-driving car, and even more Americans, 28%, said they don't know how they feel about the technology.[1]

J.D. Power followed in April 2020 with results of its quarterly Mobility Confidence Index, which covered the first three months of 2020. The Confidence Index declined for the first time, to 35 from 36 on a 100-point scale for American consumers, and to 36 from 39 for Canadian consumers. The quarterly study measures market readiness and acceptance of driverless vehicles among consumers and industry analysts.[2]

Both surveys were fielded before fears about coronavirus shut down much of the United States and the world. Since then, the pandemic has shown consumers a real-life use case for driverless vehicles that perhaps could shift their perceptions of the technology: Contactless transportation of essential household goods, along with medications, and food.

What Mcity learned from its driverless shuttle research, not only about how consumer attitudes have shifted over time, but also about how to ensure the safe operation of an automated shuttle service running on public roads, could help inform and improve future driverless transportation services at U-M and beyond.

Key findings of the research project include:

- The Mcity Driverless Shuttle was the first automated shuttle service to operate on public roads with passengers in the United States focused primarily on consumer research and data collection. The research project ended in 2019, with a safety record free of major incidents. The shuttle, manufactured by French firm Navya, is a Level 4 AV, as defined by SAE, which means it is designed to operate without a human driver on a limited, controlled route. Mcity, in an abundance of caution, employed on-board safety conductors who manually resumed operations after the shuttle automatically stopped at certain intersections, consistent with a Level 3 AV.
- A successful driverless shuttle service should provide a viable and practical transportation solution that uses automated technology, not the other way around.
- Outreach and education are key to engaging the community and promoting ridership.
- Trust drives consumer interest in automated vehicle technology; 86% of shuttle riders, post-ride, stated they trusted the Mcity Driverless Shuttle, and 66% of non-riders trusted it.
- Riders' and non-riders' experience with the shuttle positively impacted their thinking about personal self-driving vehicles, generating more interest in the technology as a result of riding in the shuttle or seeing it in operation.
- Riders and non-riders cited the shuttle's slow speed, 10 mph on average, as a negative factor. Interestingly, the low speed appealed to riders because they perceived the risk was lower, yet it worked against the shuttle as a practical solution to daily transportation challenges. Increasing the speed of travel was the highest-rated improvement solution for both riders and non-riders, followed by improving the route, convenience, and quantity of the stops.

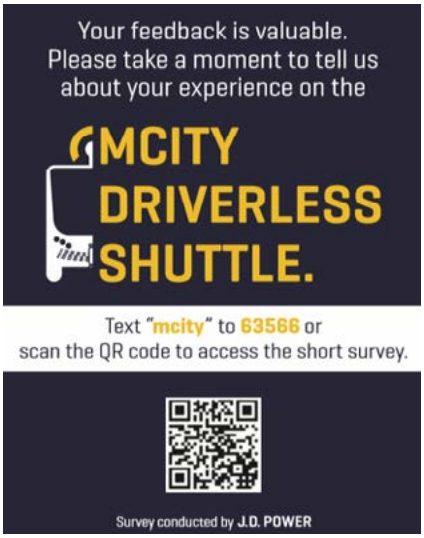
METHODOLOGY

Mcity's primary goal for its driverless shuttle research project was to understand how people—whether as passengers, pedestrians, bicyclists, or drivers—interacted with the shuttle as a way to gauge consumer acceptance of the technology.

The research project used two fully-automated, 11-seat, all-electric shuttles manufactured by the French firm Navya. In addition to LiDAR, which uses invisible laser beams to build a view of the surrounding environment, and high-accuracy GPS for localization,

the two NAVYA Autonom Shuttles were equipped with on-board cameras and Wi-Fi communications to capture data generated during operation.

Exterior cameras captured the reaction and behavior of other road users, including drivers, bicyclists and pedestrians. Interior cameras recorded the reactions of riders inside the shuttle. This included the use of video and audio recordings, and photographs from the videos. Mcity also monitored ridership and usage patterns, and surveyed users about their experience. The data gathered will help researchers understand user trust over time, as well as how to design safer vehicles and how to operate them more efficiently.



Sign encouraging riders and non-riders to complete the survey

J.D. Power and Mcity developed a short online survey and welcomed feedback from anyone who rode the shuttle, saw the shuttle, or interacted with the shuttle on campus. Pedestrians, drivers in other vehicles, bicyclists, etc., were classified as "non-riders." The survey was accessible via email, QR code, or SMS text. There were separate sets of questions for those that rode the shuttle and for non-riders. Both groups were encouraged to provide additional feedback if their experience changed substantially since they last took the survey. For instance, taking their first ride or interacting with the shuttle regularly would be valid reasons to submit new feedback.

The duration of the project was distilled into three phases marked by changes in the shuttle's route and operation dates. Project milestone dates:

- **6/4/18 – 8/24/18** – Original shuttle route (Phase One)
- **August 2018 – November 2018** – October 2018 Campus construction prohibited shuttle service
- **11/5/18 – 5/24/19** – Modified shuttle route (Phase Two)
- **June 2019 – August 2019** – Campus construction prohibited shuttle service
- **8/22/19 – 12/13/20** – Modified shuttle route – complete clockwise loop (Phase Three)

Route Maps

Phase One
June 4, 2018-Aug. 24, 2018

Phase Two
Nov. 5, 2018-May 24, 2019

Phase Three
Aug. 22, 2019-Dec. 13, 2020

Survey results were anonymized by J.D. Power and provided to Mcity industry members and researchers in 2020. The data gathered has helped researchers learn how consumers react and interact with automated vehicle technology, as well as how to design safer vehicles and how to operate them more efficiently moving forward.

RESULTS

Consumer Survey

Overall, an estimated 6,000 passengers rode the shuttle during the period of the research. Faculty, staff and students comprised the majority of the 318 respondents for shuttle riders and 60 respondents for non-riders. The quantity of non-rider respondents is considered a small sample, per J.D. Power sampling criteria, and should be taken into account with the subsequent results reported. During Phase Three, new on-campus advertising was added to Mcity's communications strategy to raise awareness of the ability to ride the shuttle and comment on the experience for those interacting with it on campus, as well as to encourage responding to the survey across multiple experiences.

Key Findings

- Awareness of the shuttle's technology was high with 97% of respondents aware that it was fully automated.
- The majority of respondents (86%) rode the shuttle one time, and the shuttle replaced mostly pedestrian transportation (47%), with most rides taken during afternoon hours (63%). Interest in automated vehicles and general curiosity remained primary factors for riders.

- Removing the hassle of finding parking and improving current mobility methods were predicted to be more relevant to the respondents, but, in fact, were negligible.

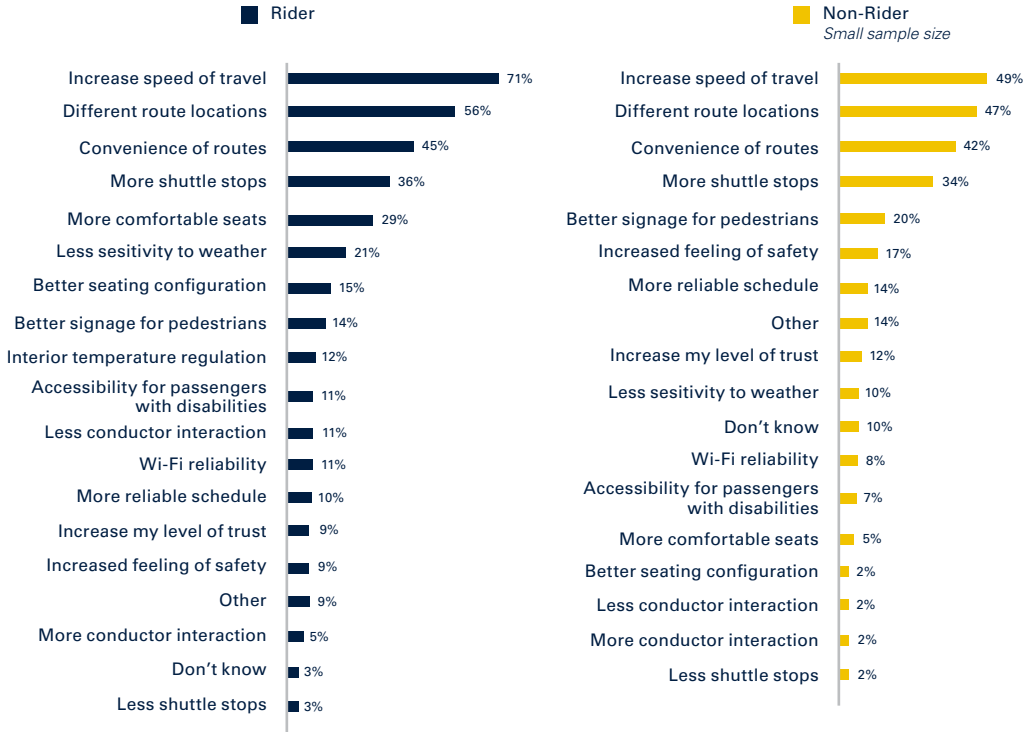
Reason for Choosing to Ride the Driverless Vehicle

Survey by J.D. Power

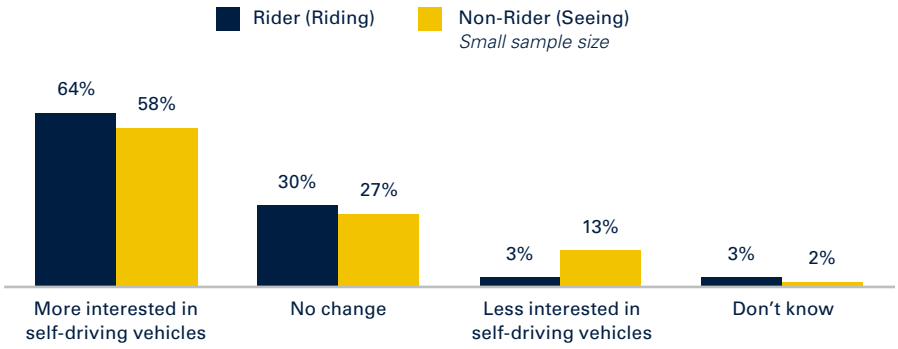
- Lapses in shuttle service due to campus construction and lack of awareness that the shuttle could be ridden were the most common reasons non-riders did not ride the shuttle, 25% and 24% respectively.
- Another reason non-riders didn't ride the shuttle echoed feedback provided by riders – other modes of transportation were faster. The speed of the shuttle was restricted to 12mph and averaged about 10 mph. The slow speed made riders feel comfortable because the perceived risk was lower, yet it undermined the shuttle as a viable solution to daily transportation challenges. Increasing the speed of travel was the highest-rated improvement solution for both riders and non-riders, followed by improving the route, convenience, and the number of the stops.

Aspects to Be Improved

Survey by J.D. Power



- Regardless of the feedback for improvement, shuttle riders were very satisfied with their driverless shuttle experience. On a scale of 1-10 with 10 being "truly exceptional," riders rated their experience a 7.87 (mean). Furthermore, 75% of riders said they would be willing to ride the driverless shuttle again, with only 5% stating that they would not.
- Non-riders had a lower satisfaction level, 6.05 (mean), though there was a small sample of respondents. About one-third of non-riders experienced no impact on pedestrian or vehicle traffic due to the driverless shuttle. Nearly one-quarter stated the vehicle traffic flow was worse as a result and pedestrian traffic flow was reported as worsened by 13% of respondents. Inconsistent stops and the shuttle being too cautious at intersections were reasons provided as to why pedestrian traffic flow was negatively impacted. The shuttle speed was the primary complaint among those stating the shuttle had negatively impacted vehicle traffic flow.
- Trust is a large factor in driving consumer interest in automated vehicle technology. Post-ride, 86% of shuttle riders stated they trusted the Mcity Driverless Shuttle; 4% did not trust it and 10% were unsure. Riders appreciated the shuttle safety conductor's role in being a back-up driver, if the situation warranted. Non-riders had a lower level of trust, but still high with 66% saying they trusted the shuttle, while 17% of non-riders did not trust it and 17% were unsure. Even with that response, the shuttle positively impacted both riders' and non-riders' thoughts regarding personal self-driving vehicles, thus generating more interest in the technology as a result of riding or seeing it in operation.



Safety and Operation

Mcity's driverless shuttle research provided a deep understanding of what it takes to successfully deploy an automated shuttle service, and identified potential roadblocks.

Key Findings

- Extensive safety conductor training, well-defined safety protocols, and daily communication among Mcity staff, the safety conductors and the Navya support team during operating hours served an important oversight role of the automated system, and helped maintain a safety record free of any major incidents or injuries.
- Outreach and education are key to engaging the community and promoting ridership. For similar deployments operating on a limited, controlled route, providing on-demand stops along the route is important to attract first time riders, and gain repeat riders. Mcity's route lacked stops that potential riders could easily incorporate into their daily travel, which affected ridership numbers, and failed to attract repeat riders.
- Manual takeover of shuttle operation should take place only if absolutely necessary. Over time, Mcity safety conductors noticed how pedestrians and drivers of other vehicles responded to the shuttle. The conductors began regularly stopping the shuttle manually when, for example, pedestrians were waiting to cross at a crosswalk, overriding the automated technology which would have stopped closer and more abruptly. They took this action for comfort reasons, not safety. A regular review of conductor takeover scenarios would help determine best practices, and ensure safety conductors are familiar with the shuttle's programmed behavior, leading to greater understanding of human expectations and machine behavior. If running the shuttle without a safety conductor is a future goal, a continuous loop of communication between the operating team, users, system designer, and manufacturer is recommended so the operating team better understands and trusts the shuttle, and shuttle performance can be fine-tuned to be more human-like.

CONCLUSION

Mcity deployed the first driverless shuttle on public roads with passengers in the United States. The primary focus of the research was consumer behavior and data collection, and the project ended in 2019, with a safety record free of major incidents.

The project demonstrated the efficacy of first testing the technology's capabilities in a closed environment reflective of the desired operating domain—the Mcity Test Facility—then deploying to public roads with a trained safety conductor.

This approach is challenging, though, as the attention of the conductors required limited shifts, constant training and practice, and vigilance. As former National Transportation Safety Board Chair Christopher Hart says, "Humans are terrible monitors of reliable systems," and that applies here. Mcity's human safety conductors were never called on to act in a situation where the shuttle failed to do so throughout the 18-month project.

The consumer research aspect of the project produced valuable insights. Exposure to and experience with the technology garnered trust and acceptance among riders and non-riders.

Ultimately, 69% of shuttle riders perceived the Mcity Driverless Shuttle to be an improvement to campus mobility solutions and 56% of non-riders felt the same way. Moving forward, areas of optimization for the driverless shuttle are increasing the speed of operation, though this comes at a balance with perceived risk, making the shuttle route and stops more useful to the users, and having a consistent operation schedule such that users can become reliant upon the service.

In essence, a driverless shuttle service needs first to become a viable transportation solution that uses automated technology, not the other way around. Also the basics of the shuttle design itself should not be ignored: Speed, configuration and comfort matter.

While interest in automation and general curiosity were the main draws for shuttle riders, other strategic levers need to be incorporated to provide sustainability once the honeymoon phase ends. Awareness of the technology is critical along with knowledge about how the shuttle as a transportation solution fits into the mobility ecosystem as a whole. Communication within the ecosystem of riders and non-riders must occur at all stages and be sustainable.

LOOKING AHEAD

The number of driverless shuttle services operating in the United States and globally is likely to grow in the coming years. The COVID-19 pandemic ushered in a new era of "contactless" service that could be the start of a long-term shift in day-to-day life in America. Mcity's experience operating an on-campus driverless shuttle at U-M brought valuable lessons learned that could help future shuttle services run smoothly and effectively.

Recommendations:

Focus on the basics.

- An automated shuttle service should provide a solution to an existing transportation challenge.
- Offering popular routes and reliable service during peak demand are key to a successful deployment.
- Do not overlook physical attributes of the shuttle itself: speed, seating configuration, and comfort impact the rider experience.

Communicate regularly.

- Awareness of the technology is critical.
- Communication within the ecosystem of riders and non-riders must occur at all stages and be sustainable.
- Robust communication among the operating team is necessary to ensure a smooth, safe deployment.

Capture the customers' voice.

- Direct access for feedback and input is important.
- E-mail contact (65% of respondents) was necessary for a university setting which is most likely not feasible elsewhere.

About Mcity

Mcity at the University of Michigan is leading the transition to connected and automated vehicles. Home to world-renowned researchers, a one-of-a-kind test facility, and on-road deployments, Mcity brings together industry, government, and academia to improve transportation safety, sustainability, and accessibility for the benefit of society.

RESOURCES

Mcity Driverless Shuttle: A Case Study
Mcity

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