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Autonomous Shuttle Implementation and Best Practices

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Introduction

Autonomous shuttles have the potential to help address significant transportation issues such as safety and sustainability—but that depends on the environment and time of deployment. The successful deployment of autonomous shuttles could depend on where they are implemented (e.g., neighborhood, campus, business park, hospital, recreational park, etc.) and the users served. The operational characteristics of autonomous shuttles, such as capacity, speed, incidents/crashes, comfort and convenience, etc., differ and have an obvious influence on their successful deployment. Success might also depend on the road characteristics (e.g., number of lanes, speed limit, grade, curve, private and or public roads, etc.) where they are deployed. Researching existing autonomous shuttles and documenting their success and limitations helps practitioners and policymakers with the planning of future deployments. With a potential for planning and deploying many autonomous shuttles in the near future, there is an immediate need to perceive their areas of success and identify strategies for enhancing their effectiveness. This research examines past autonomous shuttle deployments, survey perceptions of practitioners, industry experts, and transportation system users toward autonomous shuttles, and their best practices.

Study Methods

This study compares the operational and policy-related data from 120 autonomous shuttle deployments worldwide. Additionally, an analysis was conducted to identify the strengths, weaknesses, opportunities, and threats associated with autonomous shuttle deployments.

The study also comprehensively analyzes the perceptions of practitioners and industry experts, as well as transportation system users and proposes best practices for effectively deploying autonomous shuttles into public transportation networks. Critical barriers to adoption—including underutilization, safety concerns, seating arrangements, reliability, data security, operational aspects, sensor technology, and lane use—are identified using Principal Component Analysis and Multiple Input Multiple Cause Structural Equation Modelling.

Findings

The key findings from this study are:

- Autonomous shuttles exhibit efficiency in diverse applications, including enhancing first-mile and last-mile connectivity to promote public transit usage, facilitating medical services, and efficiently delivering goods and services.
- Extending pilot deployment trials to 6–12 months will help better understand operational challenges, the role of autonomous shuttles in enhancing first- and last-mile connectivity, and the association with infrastructure improvements.
- Data security to safeguard autonomous shuttle functionality and user confidence against cyber threats is another important aspect.
- Well-trained operators remain pivotal during the transition to full autonomy.
- Autonomous shuttles may pose safety concerns in areas experiencing extreme weather conditions, such as heavy rainfall or snowfall. A comprehensive assessment of the autonomous shuttle's operational performance under various weather conditions is needed before considering its permanent deployment.
- Existing infrastructure and data security are barriers to autonomous shuttle deployment, highlighting the need for specific data-security policies and autonomous shuttle-friendly infrastructure to deploy autonomous shuttles successfully. In addition, low speed and limited passenger capacity are also possible barriers to adopting autonomous shuttles.

- The inability of autonomous shuttles to switch lanes on the road and the lack of designated lanes for these shuttles can impede their widespread adoption.
- Perceived safety, comfort, trust, and familiarity with autonomous shuttles are critical determinants shaping users' willingness to use these services.

Users' trust and perception of safety strongly influence autonomous shuttle adoption, emphasizing the necessity of fostering trust in the technology while data-driven policies guide best practices.

Policy/Practice Recommendations

This study is a crucial step toward understanding and addressing users' concerns and expectations regarding autonomous shuttles. It provides a data-driven framework for decision-making, aiming to ensure a smooth transition toward the widespread acceptance and use of autonomous shuttles in public transportation systems.

Achieving fully driverless transportation and adapting infrastructure to mixed traffic conditions presents a lengthy and challenging journey. To ensure successful deployment, aligning technology improvements with infrastructure, connectivity, safety, regulations, and human factors is crucial. Longer trial periods, improved data and passenger safety measures, operator training, better road signage, and considering dedicated lanes for autonomous shuttles are recommended in future deplyoments.

Shared responsibility among stakeholders for operation, maintenance, and liability management enhances operational efficiency. Introducing an independent regulatory body ensures adherence to safety protocols and guidelines while addressing user concerns related to safety, travel time, schedule adherence, and reliability, which is pivotal for effective integration.

Allocating additional budgets for successful implementation within existing networks ensures sustained operation and maintenance. Furthermore, including autonomous shuttles in strategic transportation planning supplements traditional services and fosters long-term success and acceptance.

About the Authors

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To Learn More

For more details about the study, download the full report at transweb.sjsu.edu/research/2321

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