

Memorandum

To: John Doan, Hennepin County
Ben Hao, Hennepin County

From: Janelle Borgen, PE, PTOE

Date: June 30, 2018

Re: Midtown Greenway Autonomous Shuttle Demonstration Summary - Hennepin County

The following technical memorandum encompasses a summary of the results of the Autonomous Shuttle one-day testing performed on the Midtown Greenway on Friday, April 27th, 2018 and the public survey from the demonstration held on April 28th and 29th, 2018.

Appendix A: Perception Survey Questions

Appendix B: Perception Survey Raw Data

MIDTOWN GREENWAY AUTONOMOUS SHUTTLE DEMONSTRATION SUMMARY

Test Results

April 27th, 2018 testing of the autonomous shuttle was performed on the Midtown Greenway between Girard Ave. and Fremont Ave. in the City of Minneapolis in Hennepin County, Minnesota. The testing results are summarized by test cases which follow and are grouped by the test scenarios listed in the test plan and performed in the field.

Representatives participating in the testing included: Janelle Borgen – WSB, John Doan – Hennepin County, Ben Hao – Hennepin County, Ken Levin – Hennepin County, Julie Swanson – City of Minneapolis.

The programmed speed of the autonomous shuttle was 6 kph for the testing and the public demonstration. RVIZ is the proprietary screen that shows any objects and background profile the shuttle sensors detect.

Test Case 1 – Uncontrolled Bicycle and Pedestrian Detection on Midtown Greenway - The team observed the RVIZ screen to identify shuttle detection of bicyclists and pedestrians using the Greenway. The shuttle was in motion (signified by a lap number) or stationary as identified below.

	Visual Count Bike	Visual Count Ped	RVIZ Count Bike	RVIZ Count Ped	Difference (Bike and Ped)	Accuracy (Bike and Ped)	Notes
Lap 1	3	6	3	6	0	100%	
Lap 2	6	5	6	5	0	100%	
Lap 3	9	7	9	7	0	100%	3 Emergency stops due to blowing dust
Lap 4	8	2	8	2	0	100%	
Lap 5	9	5	9	5	0	100%	
Stationary vehicle, bike club 1 passing	53	3	53	3	0	100%	
Stationary vehicle, bike club 2 passing	12	0	12	0	0	100%	

Test Case 2 – Controlled Bicycle Detection on Midtown Greenway – Team members on bicycles performed various maneuvers around the shuttle.

	Operation	Shuttle Response	Notes
Lap 1	Bicyclist rode in front of shuttle at a slow speed	Shuttle detected bicycle and slowed from the programmed 6 kph to 5 kph. As bicyclist slowed, shuttle slowed. Bicyclist appeared on RVIZ screen.	
	Bicyclist in front and back, lead bicycle slow.	Shuttle maintained a consistent following distance and operated at 5 kph. Both bicyclists appeared on the RVIZ screen.	
Lap 2	Bicyclists on front and side of shuttle. Side bicyclist sped up and cut in front of shuttle. Bicyclist cut off vehicle more abruptly	Bicyclists appeared on RVIZ screen. Controlled slow to 2 kph for bicyclist cutting in front of the shuttle. Bicyclist appeared on RVIZ, Emergency stop from the abrupt cut-off.	The emergency stop occurred under the bridge and there was a 5 bell error, could not reconnect, so the shuttle was positioned manually at a starting point to resume autonomous operation.

			For all activities, the bicyclists appeared on the RVIZ screen
	Bicyclists in back and in front. Bicyclist on side, shuttle slowed, cut in front.	Bicyclists appeared on RVIZ, as bicycle passed, shuttle slow to 3 kph. Controlled slow to 5 kph with bike on side, slowed as bike cut in front, followed at a safe distance.	Emergency stop due to blowing dust occurred during the lap. For all activities, the bicyclists appeared on the RVIZ screen
Lap 3	Passing and cutting bicycles. Bicyclist cut in front	Shuttle perform a controlled slow down. Maintained a safe distance behind the bicycle. Controlled slow down to 4 kph when cut off by bicycle. Maintained a safe following distance.	For all activities, the bicyclists appeared on the RVIZ screen
	Bicycle on side Bicycle close to vehicle on side Rear bicyclist approached the vehicle Rear bicyclist approached the vehicle Bicycle cut in front of vehicle	Controlled slow to 3 kph, Emergency stop Emergency stop when within about a foot Emergency stop when within about a foot Emergency stop	For all activities, the bicyclists appeared on the RVIZ screen

Test Case 3 – Controlled Pedestrian Detection on Midtown Greenway – Pedestrians walked in a variety of patterns in front of and around the vehicle.

Test Scenario 3.1 – Pedestrian Stationary in Autonomous Shuttle Drive Path

	Operations	Shuttle Response	Notes
Lap 1	Pedestrian approached Perpendicular Pedestrian walked perpendicular and then walked toward vehicle Pedestrian jumped from behind the bridge column	Controlled slow to a controlled stop, started once pedestrian starting walking and maintained a consistent distance Shuttle slowed for pedestrian and then when pedestrian took second step toward the vehicle, the vehicle did an emergency stop Vehicle did an emergency stop	For all activities, the bicyclists appeared on the RVIZ screen
	Pedestrian walked toward the vehicle Pedestrian approached at front corner Pedestrian approached in front and then walked in front of the vehicle in the same direction as the vehicle	Vehicle did an emergency stop under the bridge Vehicle performed and emergency stop. Vehicles slowed to 3 kph and followed at a consistent distance.	For all activities, the bicyclists appeared on the RVIZ screen Shuttle did five bell error when trying to reconnect, manually took vehicle back to starting location.

	<p>Pedestrian turned and walked toward the vehicle</p> <p>Pedestrian walked in front of vehicle at various speeds, stopped and started again</p>	<p>The vehicle did an emergency stop.</p> <p>Vehicle followed and adjusted speeds accordingly, slowed to a controlled stop and then started again after pedestrian started walking again.</p>	
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Test Case 4 – Ball test – A ball was tossed in front of the moving shuttle at various distances and heights, including rolling the ball.

Test Scenario 4.1 – Fixed Height Obstacle

	Operation	Shuttle Response	Notes
Test 1	Tossed a ball about 3 feet in front of shuttle	Emergency Stop	RVIZ picked up the ball
Test 2	Tossed a ball about 2 feet in front of shuttle	Emergency Stop	RVIZ picked up the ball
Test 3	Tossed a ball in front of shuttle	Emergency Stop	RVIZ picked up the ball
Test 4	Tossed a ball in front of shuttle	Emergency Stop	RVIZ picked up the ball
Test 5	Rolled ball in front of shuttle	Continued operation no slow or stop	RVIZ did not pick up the object
Test 6	Tossed a ball in front of shuttle	Emergency Stop	RVIZ picked up the ball
Test 7	Tossed a ball in front of shuttle	Emergency Stop	RVIZ picked up the ball
Test 8	Tossed a ball in front of shuttle	Emergency Stop	RVIZ picked up the ball
Test 9	Tossed a ball in front of shuttle	Emergency Stop	RVIZ picked up the ball
Test 10	Tossed a ball about 3 feet in front of shuttle	Emergency Stop	RVIZ picked up the ball
Test 11	Rolled ball in front of the shuttle	Continued operation and drove over the ball	RVIZ did not pick up the object

Test Case 5 – Object Detection Limits - Stationary Shuttle – Objects mounted to wheels at various heights were pulled in front of the shuttle. The Team watched RVIZ screen to see if sensors detected each object.

Test Scenario 4.1 – Fixed Height Obstacle

	Operation	RVIZ	Notes
Test 1	Object height = 3.5 inches	Object did not show up on RVIZ screen	
Test 2	Object height = 11.5 inches	Object was visible on RVIS screen	
Test 3	Object height = 9.5 inches	Object did not show up on RVIZ screen	
Test 4	Object height = 11.5 inches	Object was visible on RVIS screen	

Public Survey Results

More than 400 people experienced a ride on the autonomous shuttle over the weekend of April 28 and 29th. The breakdown of riders over the two days is:

Saturday April 28 th , 2018	197
Sunday April 29 th , 2018	214

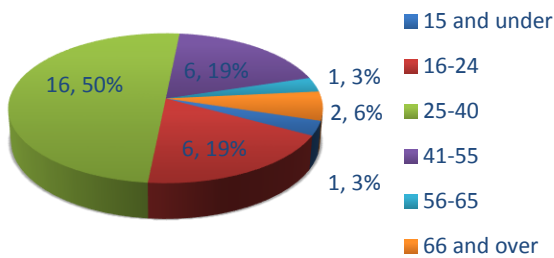
Over the two-day period it is estimated that more than 3000 people passed the autonomous shuttle via walking, running biking or another mode of transport along the Midtown Greenway.

As part of the demonstration an electronic survey was created to gather feedback from participants that wanted to share their thoughts.

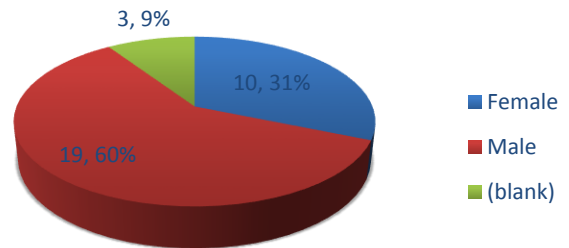
A representation of the electronic perception survey is included in Appendix A. There was a total of 37 respondents, not all respondents answered all questions, the information received from the electronic survey follows:

Demographic Information

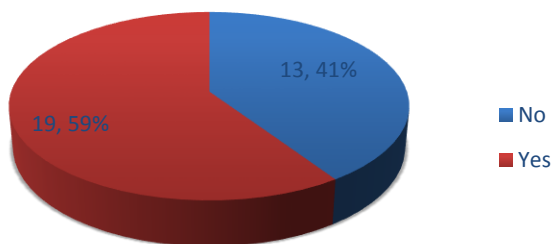
Age of Respondents



Gender Identity of Respondents

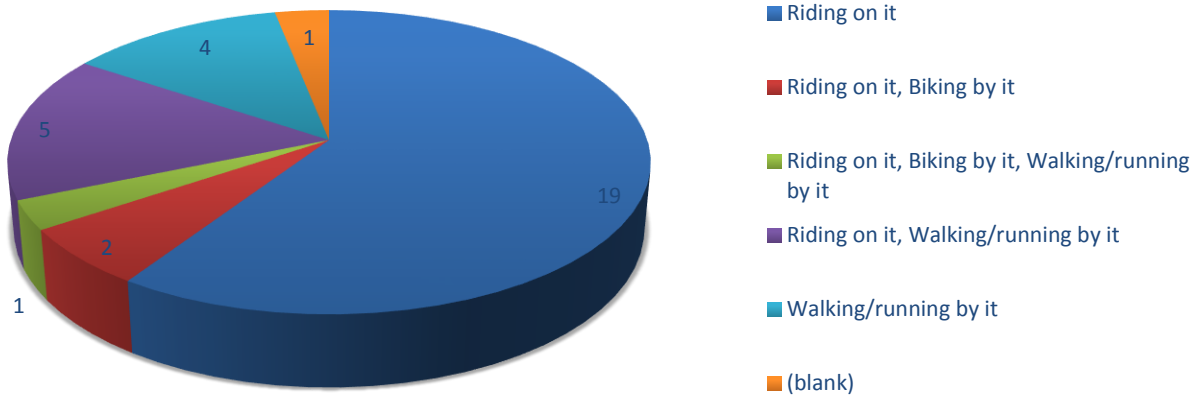


Transit Use of Respondents

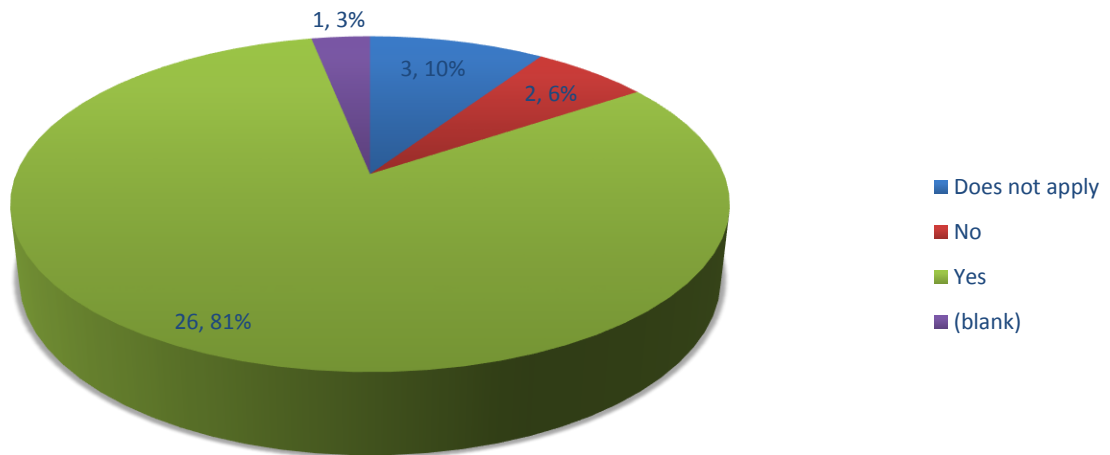


Perception Results

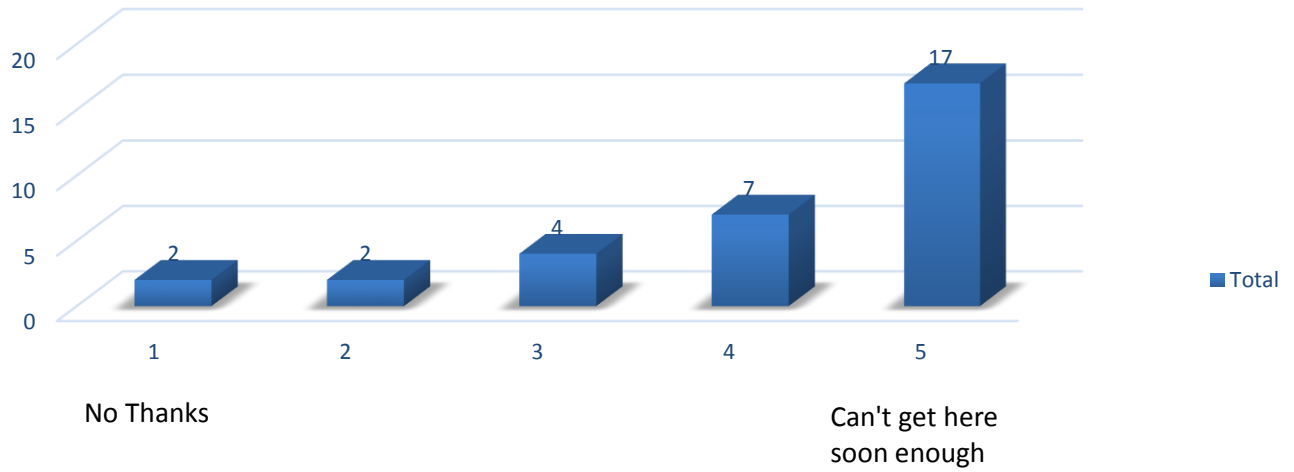
1. How did you experience the autonomous shuttle on the Greenway? (check all that apply)



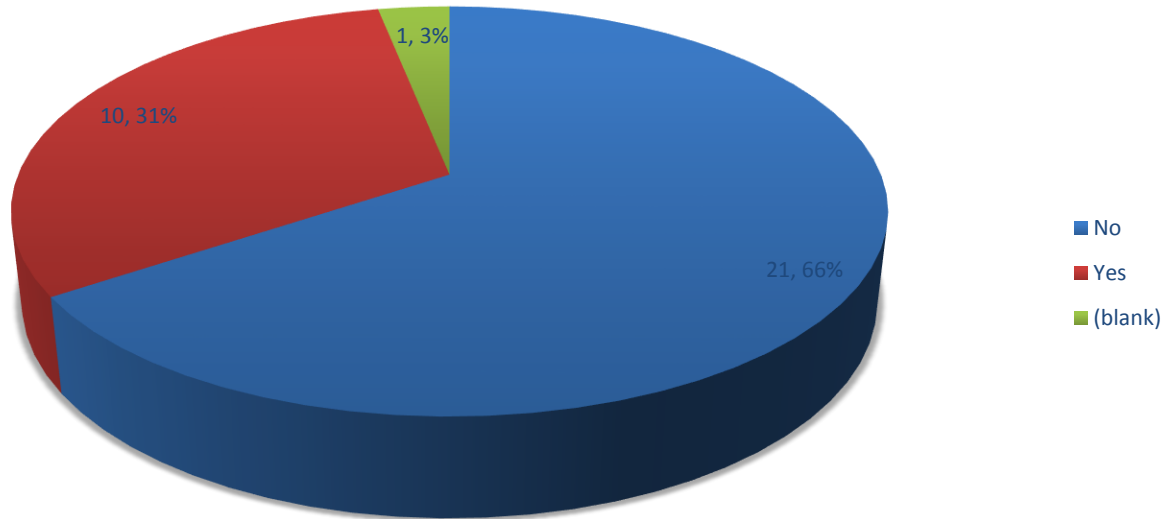
2. If you rode on the shuttle today, was is your first ride on an driverless vehicle?



3. What did you think about driverless technology before today?



4. Based on your experience today, has your opinion of driverless technology changed?



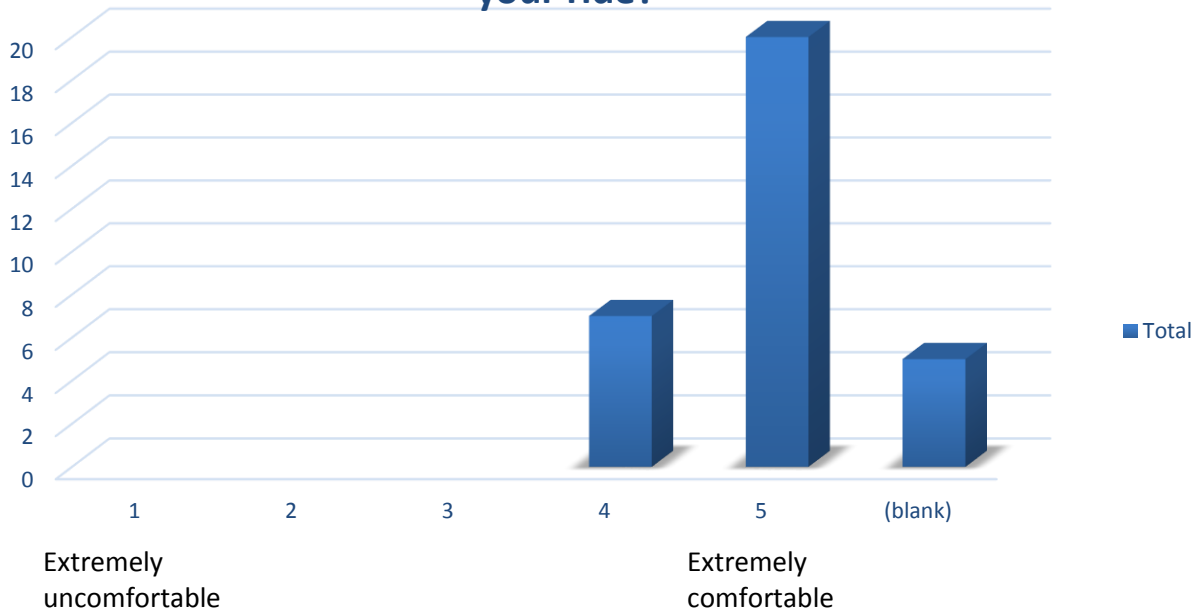
Please explain:

So cool!!

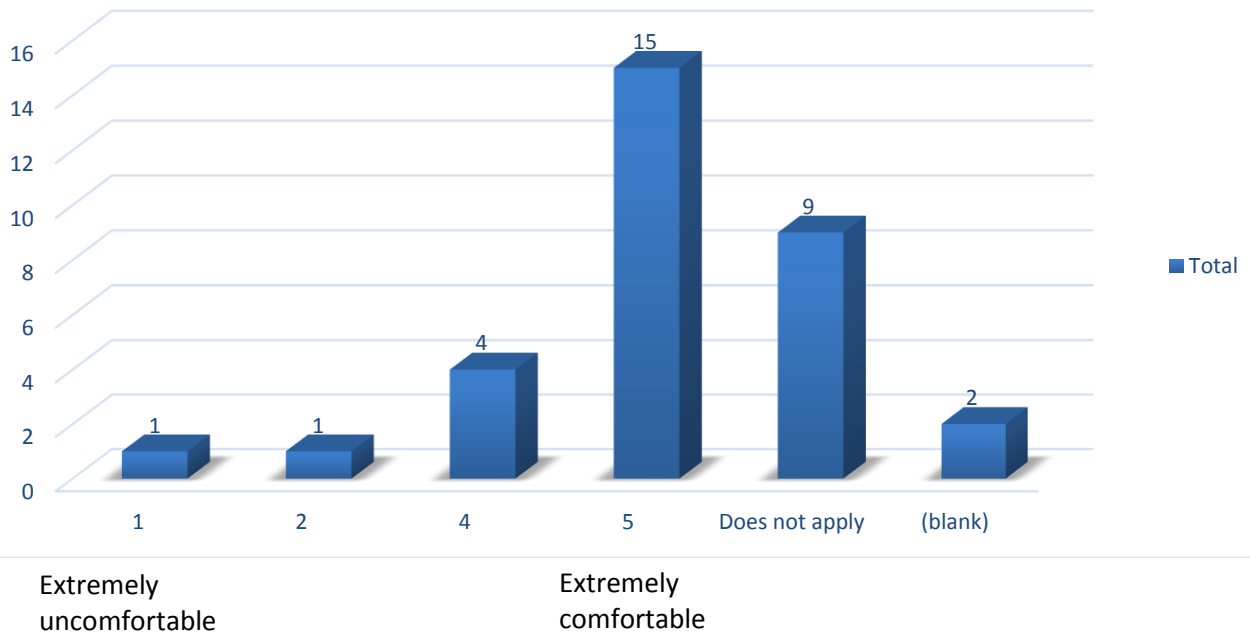
It's great

The greenway is for non-motor vehicles. Don't ruin a good thing.
I still am a believer in driverless technology. I now also think it has a role to play in expanding our transit system
I am still enthusiastic for driverless technology and especially for small vehicles
I always thought this was a good idea
Practical for controlled access roads such as the Greenway.
I'm excited by it.
I still do not think this is a good idea.
Best ever
I knew it was part of the future, but I wasn't convinced until today.
Still like it
I was impressed at actually experiencing the technology.
I'm still extremely excited for it to be available throughout the metro area
I've always been a supporter
I still think driverless technology is a good thing to work towards
I didn't know how the whole thing worked, after experiencing it and hearing about the technology it made it realistic and attainable.
It was all theoretical before. This is the first concrete usage I've experienced.
Just like shuttle train from airport terminal to terminal, except this driverless vehicle is on regular streets and not on tracks. I understand the technology is not the same-livht sensors
I'm all for it
I agree that the technology has excellent potential, from shuttle and taxi services, bus and rail, and long distance travel, with the added safety and liberation from the requirement to drive. My concern comes in where the technology would revolutionize the world to a similar degree that electric streetlights replace oil lamps. Gone are the legions of drivers, cabbies, and truckers needed to keep it all flowing, and I worry if the economy is able to handle such a radical shift without millions of unemployed individuals being left in the lurch.

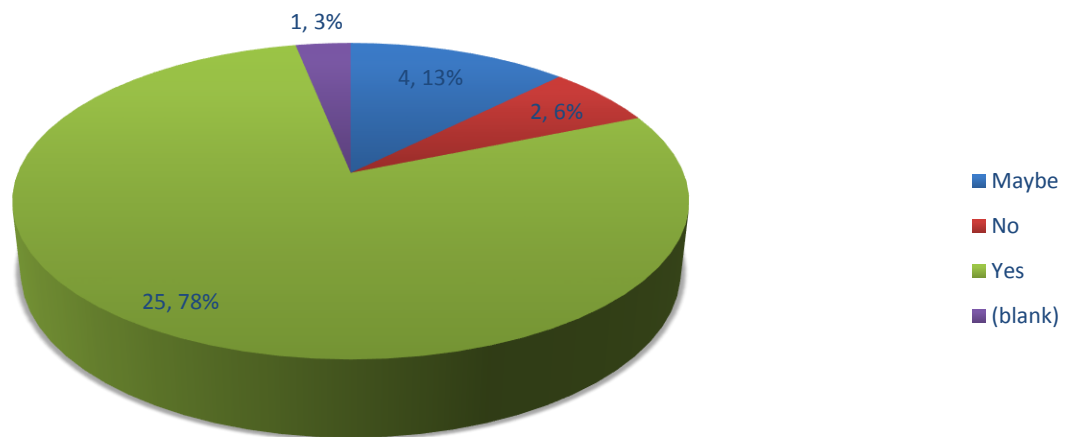
5. If you rode the shuttle today, how comfortable was your ride?



6. If you walked, biked, ran or rolled past shuttle today, how comfortable was it?



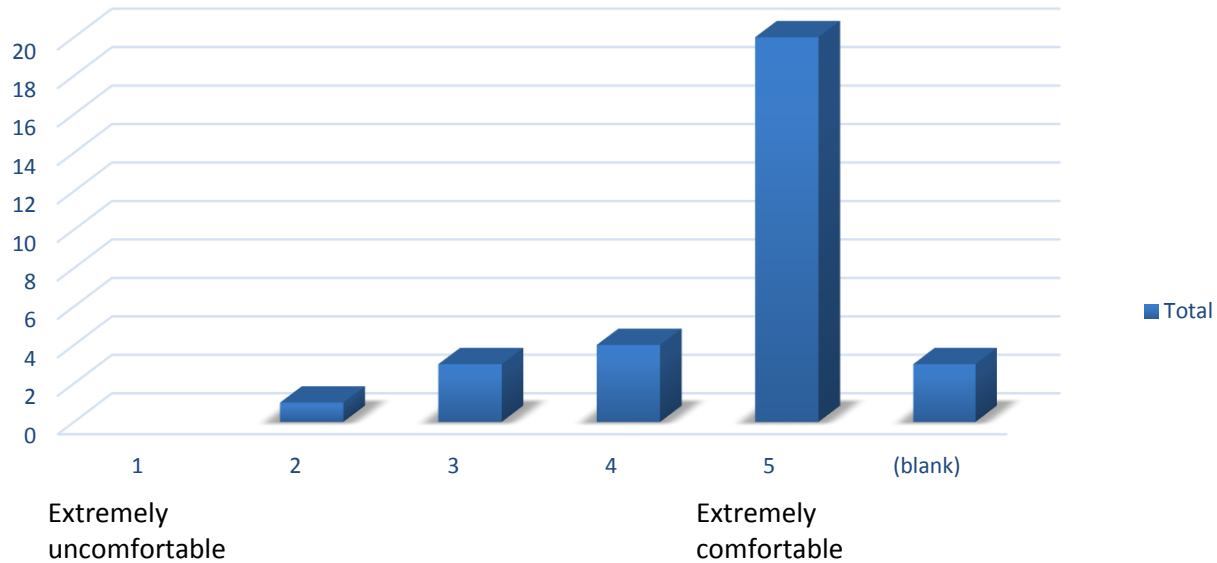
7. Would you be likely to use a driverless shuttle like this one if it were operating in your community?



Please explain:

Not on the green way. It should be tested in a traffic lane not displacing pedestrians
I don't know if it would be more like hailing an über, calling an elevator, or traditional transit, but if it took me where I needed to go, I'm all in favor
I understand that there isn't currently a lot of demand or current activity in my area now for a new bus line, but I think that smaller capacity vehicles like this one would be more likely to be implemented in my area, and I'm happy with that.
Especially useful in the winter when I cannot bike or walk.
This project does not solve any problems. Instead of putting fancy autonomous vehicles on the Greenway how about investing in some actual transit? Midtown Rail would make a much bigger difference than these cars but I don't hear the County talking about that?
If it was free or very cheap
It would be great on the greenway to get from uptown to the light rail and back
If I needed to get somewhere close by, I would choose this over uber or something similar.
I would autonomous vehicles as a first option whenever I traveled
If it took me where I needed to go, I would happily use it
If it was convenient to use and helped me get somewhere more easily and cheaper than Uber/Lyft I would like to use it. I have no worries about not having a driver
I think in the winter especially! Also depends on accessibility. If I don't have to walk far, wait long, and it saves time, I would use it all the time!
It would be great to shuttle between our neighborhood commercial node and SWLRT extension, or between our commercial nodes, or up & down along France Ave. S.
I worry about the implications for others, but in the event that a middle ground is found, ignoring the technology and not making use of it seems foolish.

8. If you were unable to drive due to a disability, how comfortable would you be using a driverless shuttle if it were available?



9. Do you have any additional thoughts or feedback you would like to share?

As I said before, the enjoyment as a runner and a biker on the greenway will be severely altered by a motorized presence. There are plenty of roads outside of the greenway. Keep the trails motor free.
If something like this gets us Midtown Greenway transit faster than it would take to build light rail, let's do it
The question in this survey is very vague very limiting. "Wheelchair" is the disability that many people think of. We also didn't see the ramp lowered during demonstration. The test vehicle did seem very small for someone in a wheelchair.
Other notes: I really enjoyed the bell sound.
Please put some kind of transit line on the greenway. It would be nice to have an option that bypasses lake street's lights and traffics.
I hope the Greenway will be the first Minnesota application.
It should get rid of vehicles not add more.
I do not trust autonomous vehicles - let's invest in transit and get rid of our car dependence instead!
The sooner the better
I hope this new technology can be implemented within 5 years to almost everywhere.
I love the idea of quiet transport like this along the greenway corridor and in other areas.
Please add electric and autonomous vehicles to the metro fleet as quickly as possible. The Twin Cities is quickly falling behind other areas that are more open to non-traditional transit options
I live somewhat near a light rail station, but not quite within walkable distance. Would be great to have one of these circling the neighborhood and then going to the station.

I think that for small trips like up and down Nicolette Mall it could have benefit as currently described. The really cool thing would be if it could have customized routes and drive faster. For example if it could pick me up from my house and carpool with others to the UMN campus for class.

I hope this gets the funding and attention it needs to launch. It would be great to have this as a mode of transportation and I think we could all benefit from it

The seats were hard! Not very comfortable. Otherwise, it was nice inside.

Org change management to handle future jobless bus drivers, and how to deal with unruly passengers

I believe the shuttle itself will be of limited applicable use, as higher speeds may be needed to allow meaningful transportation.

APPENDIX A: PERCEPTION SURVEY QUESTIONS

HENNEPIN COUNTY
MINNESOTA

Survey: What did you think about the autonomous shuttle demonstration on the Midtown Greenway?

Driverless technology is not a thing of the future, anymore. It is already here. To help plan for the future of transportation in Hennepin County, we're observing this technology in action and invite you to learn along with us. If you experience the EasyMile EZ10 shuttle on the greenway this weekend—as a rider or a trail user—tell us what you think.

Hennepin County has no specific plans to implement this technology. We are in the discovery phase—learning more about how it could work as one part of a broader transportation system.

Your feedback is valuable as we continue to plan for the future of transportation in our communities.

Tell us about yourself

Age

- 15 and under
- 16–24
- 25–40
- 41–55
- 56–65
- 66 and over

Gender identity:

Area you a current transit user?

- Yes
- No
- Does not apply

Please explain: _____

Tell us about your experience today

1. How did you experience the autonomous shuttle on the Greenway? (Check all that apply)

- Riding on it
- Biking by it
- Walking/running by it
- Other: _____

2. If you rode on the shuttle today, was it your first ride in a driverless vehicle?

- Yes
- No
- Does not apply

(Over please)



3. What did you think about driverless technology before today?

No thank-you 1 2 3 4 5 *Can't get here soon enough*

4. Based on today's experience, has your opinion of driverless technology changed?

- Yes
- No

Please explain:

5. If you rode on the shuttle today, how comfortable was your ride?

Extremely uncomfortable 1 2 3 4 5 *Extremely comfortable*

- Does not apply

6. If you rode, walked, or ran past the shuttle today, how comfortable was your ride/walk/run?

Extremely uncomfortable 1 2 3 4 5 *Extremely comfortable*

- Does not apply

7. Would you be likely to use a driverless shuttle like this one if it were operating in your community?

- Yes
- No
- Maybe

Please explain:

8. If you were unable to drive due to a disability, how comfortable would you be using a driverless shuttle if it were available?

Extremely uncomfortable 1 2 3 4 5 *Extremely comfortable*

9. Do you have any additional thoughts or feedback you would like to share?

Thank you for taking this survey!

Learn more at: hennepin.us/av-demo

APPENDIX B: PERCEPTION SURVEY RAW DATA

Timestamp	Age Group	Gender	Are you a current transit user?	Please explain.	1. How did you experience the autonomous shuttle on the Greenway? (check all that apply)	2. If you rode on the shuttle today, was it your first ride on a driverless vehicle?	3. What did you think about driverless technology before today?	4. Based on today's experience, has your opinion about driverless technology changed?	Please explain.	5. If you rode on the shuttle today, how comfortable was your ride?	6. If you walked, biked, ran or rolled past the shuttle today, how comfortable was it?	7. Would you be likely to use a driverless shuttle like this one if it were operating in your community?	Please explain.	If you were unable to drive due to a disability, how comfortable would you be using a driverless shuttle if it were available?	8. Do you have any additional thoughts or feedback you would like to share?
4/27/2018 18:01:02	41-55	Woman	Yes	Monthly transit pass. About half my trips.		Does not apply	3			Does not apply	Does not apply	Maybe	Not on the green way. It should be tested in a traffic lane not displacing pedestrians	3	
4/28/2018 12:22:24	25-40	Male	No		Riding on it	Yes	4	No		4	4	Maybe		4	
4/28/2018 12:25:33	25-40	Female	No	This is my first time in Minnesota.	Riding on it	Yes	5	No		5	5	Yes		5	
4/28/2018 14:19:07	25-40	Female	Yes	Light rail to airport and bus	Riding on it	Yes	5	No	So cool!!	5		Does not apply	Yes	5	
4/28/2018 14:32:38	41-55	Male	No	I drive my own vehicle	Riding on it	Yes	5	Yes	It's great	5		Does not apply	Yes		
4/28/2018 14:35:39	25-40	Female	Yes	Bus on occasion	Walking/running by it	Does not apply	1	No	The greenway is for non-motor vehicles. Don't ruin a good thing.	Does not apply	1	No			As I said before, the enjoyment as a runner and a biker on the greenway will be severely altered by a motorized presence. There are plenty of roads outside of the greenway. Keep the trails motor free.
4/28/2018 14:46:09	25-40	Male	Yes	I occasionally take the 17 to downtown or Uptown for entertainment	Riding on it, Walking/running by it	Yes	5	Yes	I still am a believer in driverless technology. I now also think it has a role to play in expanding our transit system	4		5	Yes	3	If something like this gets us Midtown Greenway transit faster than it would take to build light rail, let's do it
4/28/2018 14:57:29	25-40	Female	Yes	I take bus and light rail occasionally to events downtown Minneapolis mostly. I live directly on a bus line, but the route doesn't go to many areas near me. I'd have to take a bus away to a larger hub and transfer to go back to the same area I came from. I live in Saint Louis Park.	Riding on it, Walking/running by it	Yes	5	No	I am still enthusiastic for driverless technology and especially for small vehicles	4		5	Yes	3	The question in this survey is very vague very limiting. "Wheelchair" is the disability that many people think of. We also didn't see the ramp lowered during demonstration. The test vehicle did seem very small for someone in a wheelchair. Other notes: I really enjoyed the bell sound.
4/28/2018 15:09:15	15 and under	Male	Yes	I ride lite rail occasionally	Riding on it	Yes	4	No	I always thought this was a good idea	5		Does not apply	Yes	5	
4/28/2018 15:19:25	25-40	Male	Yes	I ride the 11 or 17 bus to work.	Riding on it, Walking/running by it	Yes	5	No		5		5	Yes	5	Please put some kind of transit line on the greenway. It would be nice to have an option that bypasses lake street's lights and traffics.
4/28/2018 15:46:01	66 and over	male	Yes	bus	Riding on it	Yes	2	Yes	Practical for controlled access roads such as the Greenway.	5		Does not apply	Yes	5	I hope the Greenway will be the first Minnesota application.
4/28/2018 23:50:24	41-55	Male	No	I use but not often	Riding on it	Yes	4	No	I'm excited by it.	4		4	Yes	4	It should get rid of vehicles not add more.
4/29/2018 0:31:11	16-24	Male	Yes	I use transit for nearly all of my trips and live a car-lite lifestyle.	Walking/running by it		1	No	I still do not think this is a good idea.			2	No	2	I do not trust autonomous vehicles - let's invest in transit and get rid of our car dependence instead!
4/29/2018 8:58:47	41-55	Male	No		Riding on it	Yes	4	No		5		Does not apply	Yes	5	
4/29/2018 11:49:42	25-40		Yes	Limited transit due to distance and ease of getting to light rail	Riding on it	Yes	4	Yes	Best ever	5		5	Yes	5	The sooner the better
4/29/2018 12:14:13	16-24	Male	No	Haven't taken the time to do it, yet.	Riding on it	Yes	5	Yes	I knew it was part of the future, but I wasn't convinced until today.	5		5	Yes	5	I hope this new technology can be implemented within 5 years to almost everywhere.
4/29/2018 13:09:12	41-55	Male	Yes	Occasionally use light rail	Riding on it, Walking/running by it	Yes	5	No		5		5	Yes	5	I love the idea of quiet transport like this along the greenway corridor and in other areas.
4/29/2018 14:48:40	16-24	Male	Yes	Use the bus to commute to work	Walking/running by it	Yes	5	No	Still like it	5		5	Yes	5	
4/29/2018 14:56:10	16-24	Male	No	I commute via car to work and never bus or light rail.	Riding on it	Yes	5	Yes	I was impressed at actually experiencing the technology.	5		5	Yes	5	If I needed to get somewhere close by, I would choose this over uber or something similar.
4/29/2018 14:56:26	25-40	Male	Yes	I sold my car when I moved to Minneapolis and use a combination of Lyft and metro transit to get around town	Riding on it	No	5	No	I'm still extremely excited for it to be available throughout the metro area	5		Does not apply	Yes	5	Please add electric and autonomous vehicles to the metro fleet as quickly as possible. The Twin Cities is quickly falling behind other areas that are more open to non-traditional transit options
4/29/2018 15:46:37	25-40	Male	Yes	Typically commute via bus/LRT	Riding on it, Biking by it	Yes	4	No		5		5	Yes	4	
4/29/2018 17:44:10	56-65	F	No		Riding on it	Yes	2	Yes		5		5	Yes	5	
4/29/2018 19:49:44	25-40		Yes	Occasional bus rider	Riding on it, Biking by it, Walking/running by it	Yes	4	No		4		5	Yes	5	
4/30/2018 12:38:06	25-40	Female	Yes	Very occasionally, when it snows a lot I'll ride the bus to work	Riding on it, Biking by it	Yes	5	No	I've always been a supporter	5		5	Yes	5	I live somewhat near a light rail station, but not quite within walkable distance. Would be great to have one of these circling the neighborhood and then going to the station.
4/30/2018 13:08:06	16-24	Male	No	Commute from SW suburbs to UoMN campus by car	Riding on it	Yes	5	No	I still think driverless technology is a good thing to work towards	4		Does not apply	Yes	5	I think that for small trips like up and down Nicolette Mall it could have benefit as currently described. The really cool thing would be if it could have customized routes and drive faster. For example if it could pick me up from my house and carpool with others to the UMN campus for class.
4/30/2018 14:44:27	25-40	Female	No		Work at WSB	Yes	3	No		5		Does not apply	Maybe	4	
5/1/2018 12:11:07	25-40	Female	No	I have a car, I drive everywhere. Minnesota's infrastructure makes it hard to take public transportation. I lived in Chicago for 4 years and always took the train. Here it's more inconvenient to take public transportation so I drive. In MN, due to the location of stops on trains/buses my commute would double in time to get where I'm going. Whereas, in Chicago it would either save time or only add about 15 mins.	Riding on it	Yes	5	Yes	I didn't know how the whole thing worked, after experiencing it and hearing about the technology, it made it realistic and attainable.	5		5	Yes	5	I hope this gets the funding and attention it needs to launch. It would be great to have this as a mode of transportation and I think we could all benefit from it
5/2/2018 6:29:11	41-55	Male	Yes	Occasional user of transit, but I have a car, too	Riding on it, Walking/running by it	Yes	5	Yes	It was all theoretical before. This is the first concrete usage I've experienced	4		4	Yes	5	The seats were hard! Not very comfortable. Otherwise, it was nice inside.
5/3/2018 15:24:38	25-40		No		Walking/running by it	Does not apply	3	No		Does not apply	4	Maybe			
5/3/2018 16:04:22	66 and over	Female	Yes	Lrt	Riding on it	No	5	No	Just like shuttle train from airport terminal to terminal, except this driverless vehicle is on regular streets and not on tracks. I understand the technology is not the same-lyft sensors			Does not apply		5	Org change management to handle future jobless bus drivers, and how to deal with unruly passengers
5/4/2018 19:32:49	25-40	Male	No		Riding on it	Yes	5	Yes	I'm all for it	5		5	Yes	5	
5/10/2018 14:02:45	16-24	Male	Yes	I use MetroTransit to commute to work each day.	Riding on it	Yes	3	No	I agree that the technology has excellent potential, from shuttle and taxi services, bus and rail, and long distance travel, with the added safety and liberation from the requirement to drive. My concern comes in where the technology would revolutionize the world to a similar degree that electric streetlights replace oil lamps. Gone are the legions of drivers, cabbies, and truckers needed to keep it all flowing, and I worry if the economy is able to handle such a radical shift without millions of unemployed individuals being left in the lurch.	5		Does not apply	Yes	I believe the shuttle itself will be of limited applicable use, as higher speeds may be needed to allow meaningful transportation.	