REIMAGINED MOVE 2040

APPENDIX 12:

Technology

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Smart Cities

> *"In a Smart City, a complex network of interconnected sensors, devices, and software must be built and maintained. A city is considered to be "smart" when it can collect and analyze mass quantities of data from a wide variety of industries, from urban planning to traffic management."* (**CB Insights** *"What are Smart Cities?"*)

Smart technology can be thus used to connect vehicles, infrastructure, public transit, and people to improve mobility and safety. Streets then can be outfitted with sensors that can track data both on the roads and through cars and smartphones in order to gain insights on traffic flow patterns, road blockages, roadwork, road conditions, etc. Society is just at the beginning of the creation of truly Smart Cities. This concept can be broadened to consider "Smart Regions" as well.

Smart Cities have the potential to significantly impact the economy. A whitepaper from ABI Research found that smart cities will experience a 5% yearly increase in economic development to total almost $20 trillion in 10 years (Vyas, 2019). This points to the idea that communities becoming smart cities are making a wise choice and will create a positive impact. Smart city technology presents solutions for sustainable yet resilient growth (Eggers and Skowron, 2018) in a world where environmental concerns are pressing, not to mention the fact that they are likely important to the talented professionals that cities are trying to attract.

Smart cities may also improve the economy in more unexpected ways. People who live in cities spend approximately 15% of their journeys in traffic and another 20% looking for parking (Hussain, 2019). Eliminating or massively decreasing travel and parking time will lead to more time spent on intentional actions like shopping, dining and working. Increased efficiency leads to increased economic activity.

One particular challenge will present itself: cybersecurity. As Smart Cities become more of a reality, residents will demand a higher level of cybersecurity, especially with the increased ability for cities and companies to utilize and target data. New smart cities that are growing will be keeping this as a top priority while working to combat cyberattacks. Cities have been recent targets of cyberattacks with many being unprepared to deal with the aftermath. The Department of Homeland Security established a grant program in 2019 to help states create better cyber security measures (Crowe, 2020).

There are also still challenges for smart cities concerning talent: people are needed to run them. Converting to a smarter city brings with it the need for a large number of highly skilled talent. As talent is increasingly hard to find, this presents another challenge (Ritchey, 2017). However, as smart cities create a better quality of life, they will have a better value add to attract talent (Vyas, 2019). The "economic clout" of urban centers is what attracts people to them, but in order for cities to be able to attract the educated talent necessary, they need to be exceptionally livable and home to both corporations and citizens that are active partners in their urban ecosystem. Becoming a successful smart city will be partially determined by the culture a city is able to create (Eggers and Skowron, 2018).

Intelligent Transportation System (ITS) Architecture

The ITS Architecture is essentially how the region is setup to use technology, and how it should be reasonably implemented. It provides the opportunity set up interoperability other regional approaches to technology use.

WAMPO is responsible for developing and updating the ITS architecture for the region, and KDOT is responsible for the statewide ITS architecture.

WICHWay Traffic Management Center (TMC)

The WICHway TMC was constructed in 2010 and is co-located in the Sedgwick County 911 center to aid in providing real-time traffic information. The data center serves as the hub where regional traffic information is collected, processed and transmitted. It is complemented by the public facing website www.wichway.org.

The TMC has been responsible for real time "management" of the roadway network based on given demands and constraints since 2010. Detection, response and monitoring of traffic incidents and non-recurrent congestion are the focus of the TMC. Co-location with Sedgwick County 911 is key to keeping non-recurrent congestion issues minimized and incident clearance time low through the close coordination of the first responders and traffic management personnel.

Freeway Management

Freeway management is the real-time management of the freeway system using WICHway by displaying messages on Dynamic Message Signs (DMS) message boards, designing Smart Work Zones and providing information to the WICHway traveler website. Completing the build out of the system and continuing to "manage" incidents on the freeway are keys to mitigating non-recurring congestion.

Arterial Management

Active Arterial Management is an expansion of the current functions for the TMC to address arterial operations, and a secondary support function of both the incident management and freeway management systems further enhancing WICHway's offerings to Wichita. Being able to support both an active arterial management program through use of signal timings and incident management programs is a key step toward further mitigating non-recurring congestion.

Connected and Autonomous Vehicles (CAV)

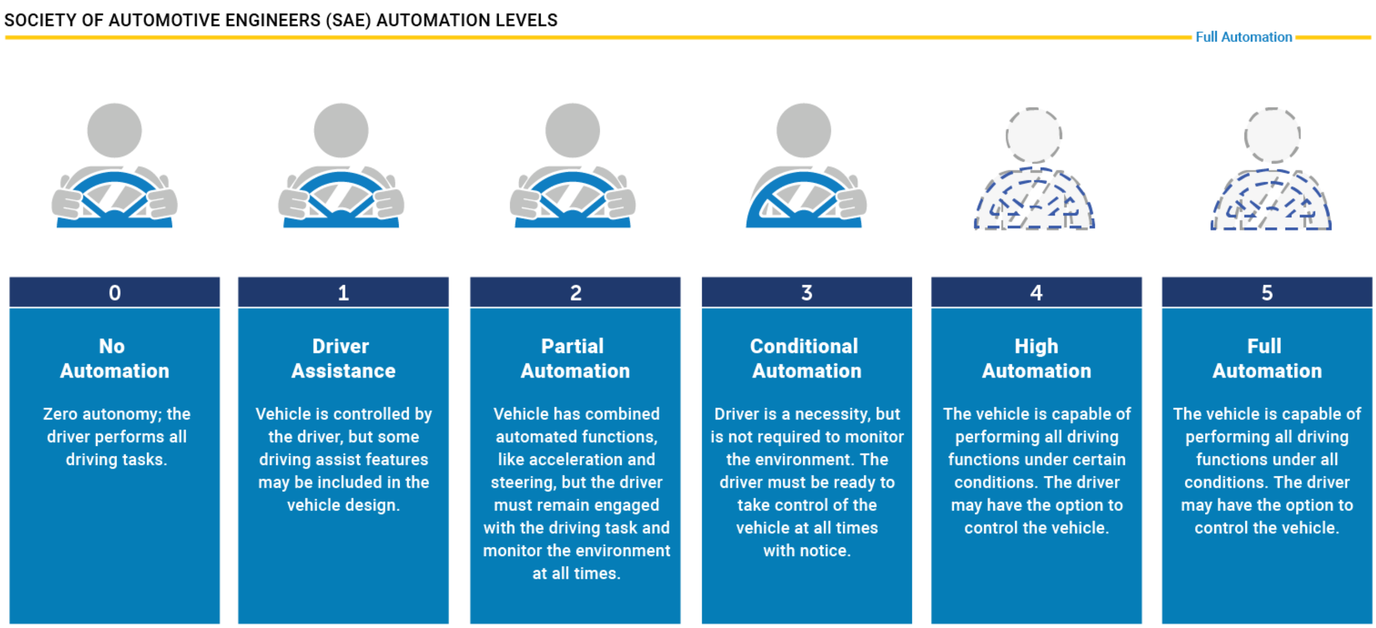
Connected and Autonomous or Automated Vehicles (CAV) have received unprecedented attention both in the media as well as from the investment community in the last few years. There does not seem to be a day that goes by without a new announcement in this space. Research and investment in CAV will reach over a half a trillion dollars by 2035 with companies such as Google's automotive subsidiary Waymo leading the way. CAV represents a confluence of technology innovations and a collision of industries. Industries considered separate in the past – the automotive and high-tech industries – are now blurring into an overall automotive tech industry. Predictions range from a few million fully automated vehicles on the road by 2030, to over 20 million.

What defines an automated vehicle?

The Society of Automotive Engineers (SAE) has created a definition of automation, called Levels of Automation. Ranging from 0 to 5, these levels spell out the technology adoption within vehicles – which range from no automation (Level 0) to full automation (Level 5).

Today, many new vehicles have **Level 2 Partial Automation** – such as driver assistance, which allows the vehicle to automatically speed up/down based on traffic, as well as some limited automatic steering functionality. Some automotive Original Equipment Manufacturers (OEMs) have outfitted their vehicles with **Level 3 Conditional Automation** technology which allows the vehicle to drive itself under certain conditions, but with a driver still behind the wheel at all times.

Low Speed AV Micro-shuttles are now operational on streets in limited capacity utilizing **Level 4 High Automation**, allowing for the shuttles to operate without an operator driving the vehicle, but with an operator able to take over if road conditions dictate. **Level 5 Full Automation**, where the human driver is completely eliminated, is still years away.



Connected vehicles have been around for over a decade. Connected vehicles include in-vehicle devices to other devices within the vehicle – but also to devices, networks and services outside the vehicle, including other cars, home, office or infrastructure. Categories of connected vehicle devices include **Infotainment** (Internet Radio, Bluetooth, etc.); **Safety** (roadside assistance such as OnStar, traffic warnings through on-board navigation apps, etc.); **Diagnostics** (servicing alerts, software updates, etc.); **Navigation** (GPS Navigation, real-time weather, etc.); and **Payments** (food purchases, gas, etc.). The future of connected vehicles will include Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) capabilities that will interact with the vehicle's surrounding environment, not only for safety reasons, but to exchange information in all the categories listed above. Connected vehicles fall within the sphere of the Internet of Things (iOT) and Smart Cities.

Smart Cities Existing Conditions

Nationwide

According to the National League of Cities, 66 percent of cities have invested in some type of smart city technology, as of October of 2017.

The **City of Columbus** was successful in their bid for a US Department of Transportation Smart City Challenge Grant which awarded them $50 million to fund a number of projects. Critical to the bid's success was the creation of a Smart Columbus Acceleration Fund, which seeks to receive both private and public funding for up to $1 billion in investments for Smart City projects. Some of these projects are:

- **Connected Vehicle Environments:** Reduce intersection crashes through the deployment of connected vehicle safety applications on buses, first responders, and public and private fleets.
- **Multimodal Trip Planning / Common Payment System:** Create a multimodal trip-planning application and payment system that allows for usage across multiple transit and parking options.
- **Smart Mobility Hubs:** Enhance bus stops with kiosks that assist in travel planning and expand on travel options such as bike- and car-sharing to reduce the reliance on city buses.
- **Connected Electric Autonomous Vehicles:** Plan to deploy a series of Level 4 autonomous vehicles against a series of use cases in a series of pilots. The fleet is expected to operate similar to traditional transit service. Successful pilots will lead to the potential for future growth of AV's.

The **City of Pittsburgh** has outlined a number of research and scenario-planning projects related to Smart Cities – including "Smart Spines", which would consist of real-time adaptive traffic signals, pedestrian detection, and V2V and V2I technology along key corridors; Smart Streetlights; and an autonomous shuttle network – amongst other project considerations.

The **City of Chattanooga** has plans to integrate autonomous cars, sensor-based infrastructures, electric cars, and connected vehicle systems. In order to be ready for some of these emerging technologies, the city has implemented an open data access program for future application development by private industry, applications for public transportation systems, and public sharing of data through social media platforms, amongst other considerations.

Wichita Metro

Advances are underway almost daily in Wichita, with many cutting-edge technologies implemented in the metro in the past 24 months. The "Smart City" movement is influencing many of Wichita's investments, pilot programs and decision-making, with the introduction of new technologies being carefully analyzed for data-driven metrics, cost-saving opportunities and efficiency measures (Barnett, 2019).

Smart City and ITS technologies impact both current and future systems, addressing today's need for stoplight synchronization and tomorrow's opportunities for autonomous transportation (Monroe, 2018; Finger, 2019). While Finger notes that many communities pilot these technologies in innovation hubs, Wichita has deployed technology throughout the city (Finger, 2019).

For example, in 2018 Wichita began a pilot program that worked to synchronize lights along Maple Street in West Wichita, with sensors installed between McLean and Maize Road that analyze and adjust traffic flow (Finger, 2019; Monroe, 2018). The pilot resulted in westbound evening commutes improving by nearly 6 minutes and about 4 minutes reduced off eastbound a.m. commutes. Similar pilots have been proposed for other areas, including K-15 near Derby. (Monroe, 2018).

Electric city buses also have been deployed and are expected to save the city $462,000 each, over their lifetime (Leffler, 2019). The buses, which were purchased with a federal grant, are expected to travel 150 miles per charge, which is more than a day's route. In addition to saving dollars and being more environmentally friendly, the director of the Federal Transportation Administration noted that bus transit provides a mode of travel in which the traveler can safely text and conduct business while in transit (Leffler, 2019)

Similarly, the Kansas Department of Transportation (KDOT) notes that Intelligent Transportation Systems (ITS) utilize integrated sensors and electronic communications to provide information for travelers and increase both safety and efficiency throughout the state (KDOT, 2019). These systems are designed to be service-oriented and to address problems of safety, inefficiency and mobility within the road and highway systems.

Quality of Life

Much of the buzz downtown is around the baseball stadium slated to open in 2020 as the WindSurge makes Wichita its home. Enhanced 5G internet, driverless trolleys, smart parking systems and more are proposed to correspond with the new build (Monroe, 2018). These will aid in increased machine learning in Wichita (Finger, 2019).

Smart technologies also could deploy crews, with trash sensors at parks or public trash receptacles notifying city staff when they have been filled, providing more timely and efficient trash collections (Finger, 2019).

Additionally, the deployment of digital hotspots to the Colvin and Atwater resource centers provided individuals without home internet the opportunity to have home access. Data revealed lower-than-expected attempts to access blocked sites, such as gambling or adult content, and found that many people used the hotspots for activities such as filling out job or college applications (Finger, 2019).

Crime

A camera system in Old Town is approaching two years old, and provides footage and technology used to fight crime in the city's entertainment district (Monroe, 2018). This led the way for the installation of gunshot sensors, which were installed in north-central and southeast Wichita neighborhoods that have higher incidences of gunshot violence (Barnett, 2019; Finger, 2019).

Technology has also initially shown success in preventing copper thefts at city facilities. In 2018, repairs related to copper theft were estimated at least $100,000. Beacon-based sensors that automatically call the police when a box is unlawfully accessed have helped mitigate this in the past year (Fox News, 2019).

Privacy Concerns

As the Internet of Things, including cameras and sensors, proliferate, everyday citizens have expressed concern about Big Brother-style intrusions on privacy. When gunshot sensors were installed in neighborhoods, citizen engagement revealed privacy concerns that were mitigated by the city working with its vendor to only record the sound of gunfire. This prevented other recordings, including conversations, from being held and potentially used as evidence for unrelated situations (Finger, 2019).

CAV Existing Conditions

Nationwide

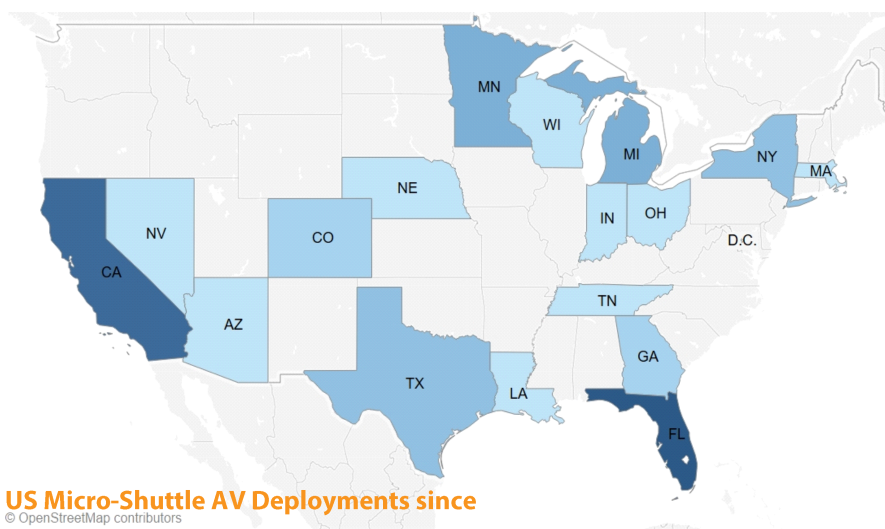
CAV pilot deployments have been occurring with increasing frequency over the past several years across the United States. These deployments have included both traditional vehicles outfitted with driverless technology, vehicles built with autonomous driving in mind and don't have traditional car features such as a steering wheel or brake pedals. Many of these deployments have occurred in warm-weather environments, on streets with relatively low speeds, with vehicles required to travel only short distances, and, in many cases, with highly controlled/limited traffic. These pilot demonstrations have yielded tremendous amounts of data that are being used by the automotive OEMs and tech companies for research and scenario planning for future deployments. In some cases, these companies are sharing data with local cities and municipalities to help with future planning; however, in many cases, companies are reluctant to share because they see data, and the ability to make future strategic decisions, as providing a competitive advantage over their competitors. The data collected, and associated algorithms that are driving these vehicles, are seen by the CAV companies as their "secret sauce".

There are a range of CAV research projects both deployed and in concept from environmental (impacts of hot, cold, salt, fog conditions) to passenger (elderly, visually impaired); from rural (platooning, high-speed) to urban (accessibility, network reliability). Two example projects are discussed below.

Waymo in Phoenix

In December of 2018, Waymo, a subsidiary of Google, officially launched Waymo One, a commercial self-driving service in the Metro Phoenix Area utilizing Chrysler Pacifica minivans that have been outfitted with driverless technology. Waymo has spent the last decade trying to perfect driverless technology in traditional vehicles, accumulating over 10 million miles driven in the attempt. The Waymo One service will be limited by both geography (the Metro Phoenix area) and ridership (a group of 400 riders that have been previously involved in testing). The vehicles will drive fully autonomously, but will have Waymo-trained drivers inside the vehicle at all times to supervise. Although Waymo has released only limited information, what is known is that they have spent considerable amount of time visually mapping the area within which their vehicles will operate, a process known as geo-fencing. Waymo has also mapped all stop-controlled intersections, traffic signals, driveways, road speeds, etc. and uses a combination of radar, camera detection and other data to navigate these vehicles through city streets. Future enhancements of the service will most likely include a wider geographic area, on-demand capabilities for ride hailing, and in the future when the regulatory environment allows, the elimination of the driver.

Navya in Las Vegas



US Micro-Shuttle AV Deployments since

In November of 2017, Navya, an autonomous shuttle manufacturer, in conjunction with private transportation operator Keolis and AAA, launched a free shuttle service in downtown Las Vegas. The service, which lasted for over 1 year, featured a 15-passenger, Level 4 Autonomous Micro-Shuttle that operated over eight (8) city blocks along tourist-heavy Fremont Street. The Las Vegas autonomous shuttle deployment is one of over 50 micro-shuttle deployments that have occurred in the United States since 2017. As shown in the heat map, the darker the color, the more AV micro-shuttle deployments in that state. Similar to Waymo, the Navya shuttle had to precisely map its eight-city-block route, incorporate street signs, and establish V2I (Vehicle to Infrastructure) communication with six traffic signals through a technology called Dedicated Short Range Communications (DSRC). DSRC allowed the vehicle to "know" when the signal was green, yellow or red. In addition, Navya deployed a separate GPS antenna on a building rooftop to allow for the vehicle to receive line-of-sight communications from satellites in order to pinpoint the vehicle location on the road. The vehicle utilized a 3G/4G wireless connection to send and receive data at all times during operation. In addition, the vehicle used on-board cameras, LIDAR, and wheel-based sensors to determine vehicle speed and location. The future of low-speed micro-shuttles will be focused on longer-length deployments, both in terms of distance travelled as well as battery capacity; platooning shuttles to better compete with larger buses; and installing video content inside vehicles.

Wichita Metro

The feasibility of CAV in the Wichita Metro is currently being discussed. At this point, no CAV activity is taking place in the Wichita metro area.

Needs Assessment and Considerations

Public Policy

> *Public policy in regard to autonomous vehicle technology and transit systems of the future will be multifaceted. While much of the regulation is likely to come from the federal or state level, lawmakers on all levels should keep public acceptance and perception in mind while also regulating for safety and balancing the needs of major corporations and individual citizens.*

Throughout history, advances have come with a policy component, and today's changes in transportation technology will be no exception. The complexities of technology, infrastructure, insurability, liability, vulnerabilities and privacy protection will require the formation of policy at the federal, state and local levels (Rice & Tomer, 2017; West 2019).

For example, the 20th Century advent of affordable vehicles led to laws restricting where pedestrians could walk and cross, registration of vehicles and drivers, and streets designed for different speeds. These led to the ability to increase speed limits while decreasing fatalities. AV transportation opportunities require governing of overarching principles to consider land use, design, and other needs (Tomer, 2018).

The public sector, thus far, has heavily focused on engineering needs for autonomous vehicles, including design and street safety, but policy also must expand to consider zoning, built environment concerns, parking regulations, taxation and data management (Rice & Tomer, 2017).

The federal government supports advancement in technology and plans to provide "appropriate oversight" as they push to advance automated vehicle technologies and integration thereof. They plan to protect users and communities by prioritizing safety, cybersecurity, data security, and mobility and accessibility through law enforcement and regulation (NSCT & USDOT, 2020).

As of 2017, public preference is mixed in regard to whether the government should regulate self-driving vehicles and research thereof. Forty-seven percent think the federal government should not support self-driving cars on highways. Additionally, 45% believe states and localities should not support self-driving cars on highways, yet

37% believe they should (West, 2017). Many people are still unsure of how autonomous vehicles will affect their lives and whether the government should get involved.

According to another study, many Americans from a wide range of demographic groups do seem to feel more comfortable with the idea of autonomous vehicles when there are restrictions set in place. Eighty-seven (87%) percent like the requirement of having a human in the driver's seat of an autonomous vehicle to be able to take over in an emergency. Almost the same amount (83%) favor such vehicles to operate in specific, designated traffic lanes. A majority (69%) would also support geographical restrictions such as not allowing AV use near schools (Anderson and Smith, 2017). Since trust in autonomy is not fully present, it seems that most people like the idea of having some limitations on technological advancement.

Some states are already beginning to take initiative regarding the changing technology. In 2017, 33 states introduced legislation related to autonomous vehicle technology, and in 2018, 15 states enacted 18 bills related to autonomous vehicle technology, for a total of 29 states. Kansas has not enacted any related legislation (NCSL, 2019).

Some cities also are forming policy, such as Pittsburg, Pennsylvania, which issued an executive order outlining the city's expectations for AV use locally, including transparency, collaboration and the promotion of systems that encourage high occupancy of vehicles, low emissions and equitable transportation (SmartCitiesWorld, 2019).

Changing technology also begs policymakers to produce legislation dealing with gap areas (West, 2019). These include:

- Policy ensuring infrastructure and high-speed network accessibility is available in underrepresented areas
- Technical standards that ensure the formation of safe and reliable products and systems
- Regulation of local industries, such as taxi services or ridesharing. West notes that legacy programs such as taxis tend to be much more regulated than emerging systems, which creates an uneven playing field
- Data management and retention rules, which cover consumer privacy, the balancing of preventative technology versus personal privacy, and limits on personal data made availability
- Liability and the development of insurance products for emerging risks

Infrastructure Readiness

As technology and transportation changes, cities will need to adapt to support them. Since much of this technology is fairly new and evolving quickly, cities typically have not taken it into account during past planning. There are many ways that cities can start preparing for the future if they choose to support new technologies such as fiber and autonomous vehicles.

Driverless Technology

The potential impact of driverless technology is vast. According to the National Science and Technology Center and the U.S. Department of Transportation, increased productivity and efficiency and reduced commuting times are just a few of the potential benefits that autonomous vehicles offer (2020), but when it comes to widespread implementation of driverless technology, there is a lack of planning among U.S. cities.

The National League of Cities studied 68 communities (the 50 most populous in the U.S. and the largest cities in every state) and found that only 6% of city plans “consider the potential effect of driverless technology” (DuPois, 2015: 2). This demonstrates a major gap between where technology currently is, or is soon predicted to be, and actual implementation.

Driverless technology will affect more than just personal-use vehicles, but also includes potential commercial uses as well that increase efficiency in the trucking and logistics industries. There is a new “platooning” technology that will allow one human driver to control a small fleet of three or four unmanned trucks. New AVs could also decrease transport times and improve supply chain management. AVs can also help with other industries such as agriculture. For example, farm equipment can be made more efficient by being operated remotely (Forrest, 2017; NSTC & USDOT, 2020).

Infrastructure Needs and Requirements

The infrastructure needed for AVs to operate safely and at full capacity will require planning ahead for strategic investment. A community’s choices in regard to AV infrastructure may determine the level to which shared autonomous mobility (SAM) takes hold (Duvall et al., 2019). Additionally, planning for SAM now can help a community avoid the need to retrofit later

One challenge noted by a report issued by McKinzey & Company is the current quality of roads in the United States. They note that potholes, poor striping, deteriorating road conditions and other maintenance issues create safety issues now, but also present challenges to AVs, which rely on highly accurate information about the road surface, width and other factors (Duvall et al., 2019). However, AV growth also could prompt capital planning investments for streets, allowing not only the repair of the physical structure, but also upgrades such as highly retroreflective lines on the roads or additional preventative maintenance (Duvall et al., 2019).

Other considerations that will be required with the adoption of autonomous vehicles include support facilities, where they can be serviced and charged, and changes in the use of physical infrastructure (Duvall et al., 2019). Much of this reflects a future of transportation in which people utilize a blend of transportation, including personal vehicles, ridesharing, mass transit and AVs. The literature also emphasizes a change in how curbs are used, with reduced personal parking and increases in drop-off, pick-up and mobility hub uses (Duvall et al., 2019; West, 2019).

Other types of investments and accessories will be needed less as autonomous vehicles become the norm. These include parking spaces, stoplights, street signs and other signage, raised curbs and guardrails and wide urban streets, as part of the infrastructure, as well as bulky mirrors and bumpers on the vehicles (Duvall et al., 2019; West, 2019).

Connectivity also is key to full automation, and will come from a combination of four types of communication:

- Vehicles talking to each other (V2V)
- Vehicles talking to people (V2P)
- Vehicles talking with a city’s infrastructure (V2I)
- Vehicles talking to the network (V2N) (Schumann, 2019)

Some experts argue that sensors should be built into the roads, and vehicles already are being prepared for these sensors (West, 2019; Beevor, 2019; Llanasas, 2019). According to Beevor, one-way cities should be preparing for the future is by implementing road sensors. These sensors can quickly measure traffic conditions and obstacles. Instead of an AV performing these calculations individually, they can upload the data taken from the path ahead of them quickly as an entire package. This helps the AV ahead of time, making it easier to travel down the road (Beevor, 2019).

These sensors will generate tremendous amounts of data, and part of the challenge for cities will be ensuring that data is shared in all directions so that it can be analyzed and acted on in real-time. This requires not only the physical infrastructure, but also IT infrastructure capable of managing the 4 terabytes of data each self-driving car might produce daily (Llanasas, 2019; Beevor, 2019)

5G and Related Advances

The installation of 5G infrastructure, which began in Wichita in 2019, is key to unlocking and enabling all of this potential. While 4G allows streaming video, instantaneous status updates and supports requesting rides, it is not responsive enough to outpace human reflexes and support autonomous traffic (Khosravi, 2018; Llanasas, 2019). A human can examine inputs and make a decision in as little as 2 milliseconds, and the 5G network is the first network capable of this level of operations (Llanasas, 2019). In fact, Schumann notes that 5G could potentially react 20 times faster than humans can detect and communicate (Schumann, 2019).

Fear, Trust, and Willingness to Embrace Change

While some aspects of automation have long been part of the personal transportation landscape, the level of autonomy present in today's technology is quickly changing. Automated advances began with convenience features such as cruise control and safety features including anti-lock brakes have advanced throughout the 21st century. The first decade brought blind spot detection and forward collision and lane departure warnings (NHTSA, 2020). Automatic Emergency Braking, Rearview Video, Lane Keeping Assist, and Self-Park applications have added to automated technology, with advances toward fully automated safety features and highway autopilot in the coming decade (NHTSA, 2020).

Earlier this year, fully autonomous prototypes were unveiled for both passenger and cargo transport. GM and Honda together revealed conceptual designs for the Origin, a six-seat autonomous, electric vehicle that lacks steering wheels, pedals, wipers, rear-view mirrors and other features traditionally needed by drivers, in favor of passenger space (McFarland, 2020). The vehicle is planned for GM subsidiary ridesharing app, Cruise. Meanwhile, Silicon Valley startup Nuro has been cleared to deploy up to 5,000 of its autonomous, self-driving RT delivery vehicles, initially in partnerships for delivery on behalf of businesses like Domino's Pizza and Walmarts in the Houston area (McFarland, 2020)

> *Research does not show an overwhelming amount of trust in unmanned vehicles and driverless technology, but instead there are very split or mixed opinions on the life-changing technology. There are some demographic patterns that might help indicate a person's level of trust or preference, however, there seems to be a lack of consensus regarding public perception.*

Generally, people are aware of autonomous technology, but awareness is not indicative of an individual's willingness to embrace a more automated transportation system. Anderson and Smith found that 94% of Americans have heard at least something about the issue (2017) and people agree that autonomous vehicles will provide benefits such as improved fuel economy, fewer car accidents and safer options for tired or bored drivers (Gartner, 2017). This, however, does not necessarily correlate with one's personal willingness to utilize autonomous technology.

There are mixed feelings regarding the development of automated vehicle technologies. 40% of those surveyed are at least somewhat enthusiastic, yet 54% are at least somewhat worried (Anderson and Smith, 2017). It seems it's hard to take a risk and try something new, especially one so disruptive to the common culture. A 2017 survey that polled 1,519 people in Germany and the U.S. found that 55% of respondents will not even "consider riding in a *fully* autonomous vehicle." Despite the vehement opposition, interestingly, 71% of respondents "may consider riding in a *partially* autonomous vehicle" (Gartner, 2017). It's possible that many people are not sufficiently informed about the details of driverless vehicles, as most of the new vehicles on the market now are partially autonomous, but this does display a significant lack of trust in autonomy.

There is likely an even greater divide of asymmetrical information when it comes to safety information. In a 2017 Brookings study, even after hearing positive information regarding increased safety of autonomous vehicles (regarding reduction of human error), 51% percent of respondents said they did not think AVs would help decrease the number of car accidents (West, 2017).

In another study, some 42% of people expressed a *general* lack of trust in automated technology, while others mentioned *specific* safety concerns such as the danger of giving up control or the inability for machines to handle the unpredictable events that occur while driving. Many people believe only humans have the capacity to make the intricate and multi-faceted choices that need to be made while driving in today's society (Anderson and Smith, 2017).

While the relative risk of a self-driving car currently is estimated to be less than the risk of a human-driven vehicle, and this technology stands to improve as refinements are made, trust still is hard to come by (Eliot, 2019). Some of this lack of trust results from high-profile coverage of failures in early autonomous technology. Fatal accidents, such as a pedestrian who was hit and killed by a driverless Uber vehicle in Arizona, and a Tesla Model S that wrecked while in semi-autonomous "Autopilot" mode, highlight glitches and human error that must be overcome through ongoing software updates and machine learning (Karsten & West, 2017; Tomer, 2018).

Still there is no consensus on whether people believe AVs will improve safety, according to Anderson and Smith; public perception is still mixed. For example: 39% think the number of injuries or deaths caused by traffic accidents will decrease with a pervasive implementation of driverless vehicles; 30% think traffic fatalities will increase; and 31% think there will be no change (2017).

While much of the hesitation to try driverless technology comes from safety concerns, there are outlying factors or special interests for why some people do or don't support autonomous vehicles. Some are unwilling to ride in autonomous vehicles because they simply enjoy driving and don't want to give it up. For those who are interested in riding in a driverless vehicle, some 37% expressed that it was because of their love for evolving technology and the novelty of the experience (Anderson and Smith, 2017).

Early adopters of other transportation technologies are also more likely to embrace autonomous vehicles and perhaps other forms of advanced transportation technologies. In fact, people who use car services such as Uber and Lyft are more likely to support (use and/or purchase) autonomous vehicles (Gartner, 2017).

Transportation and Equity

> *Equity issues are a challenge for all cities. Historically, discrimination was prevalent in transportation models, both intentional and unintentional determined by social norms at*

different times. This section explains how equity can be affected by different aspects of multi-modal transportation systems and how cities should look to combat issues in the future.

Ride Sharing

While discrimination has decreased overall, there are still some biases present in the transportation space. Historical data shows cab drivers in the past were more or less willing to pick up passengers based on skin color. While the advent of ride sharing applications such as Uber and Lyft were partially created to increase equity by eliminating this possibility and providing transportation options to those who had less access to personal vehicles or adequate means of travel, many discriminatory biases may still exist. In 2013, a Washington D.C.-based study found that taxis were 25% less likely to pick up a black rider than a white rider (Bliss, 2018). In 2016, black riders using Uber or Lyft in Seattle reportedly waited about 16-28% longer than white riders did (White, 2016).

Another study in Washington, D.C. in 2016 found that neighborhoods with more people of color have longer wait times for Uber due to the surge-pricing algorithm. The surge-pricing model's goal is to increase the supply of drivers to a particularly busy area. Instead of increasing the absolute supply of drivers, the drivers already on the road are redistributed to the busy area. The study found these busy areas are predominantly white, leaving underserved the neighborhoods inhabited by people of color (Stark, 2016).

Other data suggests ride-sharing apps contribute to *reducing* this phenomenon and creating a more equitable transportation model. A 2018 study of Lyft data in L.A. County showed there was no neighborhood in L.A. County that was systematically excluded from the service. The study also found that "users living in low-income areas made more Lyft trips per person, compared to middle and high-income communities," meaning the applications provided a much-needed transportation service for low-income areas. Lyft was also utilized in L.A. County more often by users who did not own a vehicle. The neighborhoods with the lowest car ownership rates in L.A. County are majority-black, making this increased mobility more encouraging for increased equity. There is, however, still some discrimination present on an individual basis. On average, black riders have about a 43 second longer wait time than white riders (Bliss, 2018). This report offers no exact determination as to why black riders have a longer wait time, but it could be caused by drivers cancelling on a ride that is too far away or in a certain area of town, which contributes to inequity, but not necessarily deliberately.

There is also some cause for concern regarding the current practice of subsidizing the cost of ride sharing. Since these applications are a newer invention, there is still some subsidization in order to keep the service running. The companies reduce the cost of the service, which actually may be discouraging the use of public transportation: "By reducing the cost of individual rides, Uber and Lyft also draw a privileged subset of passengers away from public transit systems. That, in turn, undermines support for public transportation". Subsidizing the cost may also eventually prohibit the use of the apps once subsidization is no longer possible, which would cause a harmful decrease in transportation options for low income populations (Kim, 2019).

The success of ridesharing platforms, however, is linked to support for a holistic, multi-modal transportation system that has accessible options for all. American rideshare frequent users are more likely to not own a vehicle, but they are also more likely to use a variety of other transportation options (Smith, 2016). The creation and frequent use of ride sharing could be encouraging as cities move forward in an effort to create multiple transportation options for citizens that are affordable and adequate to efficiently travel door-to-door.

Enhanced Mobility

Transportation options today can be quite sparse for individuals with limitations. More than 57 million people in the U.S. have a disability and 6 million have difficulty getting adequate transportation (ITS America, 2019; Bin-Nun, Claypool, Gerlach, 2017:5). The Americans with Disabilities Act of 1990 does require public transit to offer services to people with handicaps or conditions that disallow them from driving, but paratransit services can be expensive, making cities cut costs and service availability. A report from 2012 shows that paratransit can be three to four times more expensive than traditional mass transit (Saripalli, 2017), a number that could be lowered with the advent of autonomous technology.

In fact, solving some of the transportation-related needs for people with disabilities could also save about $19 billion in healthcare costs from missed medical appointments every year (Bin-Nun, Claypool, Gerlach, 2017:5). Mitigating some of these transportation limitations will lead to massive savings, in addition to creating more equity. Moreover, advancements are not only likely to create enhanced mobility for those with a variety of limitations, but also reduce waste associated with customization (NSTC & USDOT, 2020; ITS America, 2019).

New technologies will help, especially for populations that previously could not operate human-operated vehicles, such as citizens with visual impairments. The public seems to agree as Brookings found that "42 percent thought they would be helpful to senior citizens and 40 percent said they would be helpful to the visually impaired" (West, 2018). John G. Pare Jr., executive director for advocacy and policy at the National Federation of the Blind says autonomous vehicles will give the blind a greater amount of flexibility than a traditional mass transit system (Halsey, 2017). Ashley Helsing, Director of Government Relations at the National Down Syndrome Society, says AVs will also lead to a large increase in the opportunity for independence among the Down syndrome community, as transportation is a common barrier for people with Down syndrome to be employed (Halsey, 2017).

In 2018, the unemployment rate for Americans with disabilities was 4.3% higher than those without and the labor force participation rate was almost 40% lower. Plus, about 25.5 million people reported that they have disabilities that limit their capacity to travel. Of those in this group who are of working age, only about 20% actually work. Part of the existence of these demonstrated gaps in employment is caused by the significant barrier that is the lack of accessible transportation. Automated vehicles and the evolution of the American transportation model have the potential to create a much more equitable space and significantly impact the nation's workforce and economy (ODEP, 2019).

As major companies in the automation industry push forward, it is critical within the next few years that they take accessibility design standards into account. Historically, accessible design has been a secondary thought, and firms lock into certain inflexible designs. Choosing an accessible model is paramount to meet the needs of all people (Bayless and Davison, 2019: 30).

The Texas A&M Unmanned Systems Lab and the Texas A&M Transportation Institute are developing autonomous transportation products for people with or without disabilities. These vehicles communicate via words, sounds and electronic displays. As of late 2017, the team's self-driving shuttle had given 124 people rides for 60 miles of total travel. They think and hope that their new option is a better method of transportation for people with impairments or disabilities (Saripalli, 2017).

It is important to clarify that these progressions do not negate the need for ride sharing services, rather they serve as complementary parts of a multi-modal system. Lyft Chief Strategy Officer Raj Kapoor recognizes that many elderly or people with disabilities may still need some help from a human. This is where the ride sharing services come in - to have someone to provide a helping hand. However, ride sharing service drivers are not typically trained to help disabled people, nor are many of the vehicles suitable for wheelchair accessibility or other potential needs. (Halsey, 2017; Saripalli, 2017).

While there is a huge possibility for improvements and considerations, new technology is a hopeful means of increasing equity through offering mobility where it did not exist before.

Urban/Rural Disparities

As rural areas decline, public transportation plays an even more important role in combating poverty, road accidents and inactive lifestyles (Litman, 2017). A study by the Community Transportation Association of America indicates that rural ridership is increasing and that the extra miles traveled by rural residents make rural populations far more likely to be involved in fatal accidents, with 19% of the population accounting for 49% of traffic fatalities (Litman, 2017; RAND, 2018). In its report “The Road to Zero” the RAND Corporation notes that twice as many people die in rural areas for the same number of miles driven as in urban areas (RAND, 2018).

Not only do people in rural areas have fewer options for transportation, but because of the decrease in population density in rural areas, ridesharing and transit services cite more “dead miles” where vehicles sit empty, which means less profit. This creates less incentive for companies to have vehicles in rural areas (ODEP, 2019: 11). This is even as rural ridership is increasing, with a 7.8% increase in rural ridership from 2007 to 2015, compared with a 2.3% increase in urban public transportation ridership in the same time period (Litman, 2017).

Rural areas also have a lack of “complementary infrastructure” such as reliable broadband, which AVs need to operate correctly (ODEP, 2019: 11). This serves as a major barrier to rural areas advancing their forms of transportation.

There is no expectation of uniformity in how automation impacts different metro areas, and it is likely to also create different hardships between urban and rural areas. Local policymakers must consider connections between where people live and work (Rice & Tomer, 2017).

Recommendations

New mobility technologies have been part of the transportation system for decades. The past few years have seen a proliferation of technologies and modes of transportation that have the ability to disrupt the driving habits and living patterns of entire cities and regions. With this disruption comes opportunities to improve residents’ lives by lowering travel costs, increasing travel mode choices, decreasing pollution and – over time – changing the way cities and towns are planned, are developed and function.

Shared Mobility

Shared mobility can be thought of as including a wide range of transportation modes involving fleet ownership or operation. The five most prevalent adopted categories for shared mobility are:

- Micromobility
- Car-sharing
- Ride-hailing services

- Public Transit
- Microtransit.

WAMPO Action: Current regulatory or public policies related to shared mobility should be reviewed and updated to encourage the deployment of these technologies. In addition, incorporating these services into a region-wide transportation application would also be a good investment for the region. More potential features of the regional mobility application are discussed in this paper.

Connected, Autonomous, and Electric Vehicles

Connected and Electric Vehicles are already being used within the local transportation system and within the region with Automate Vehicles right around the corner. Specific investments tied to these technologies will be critical to increase these vehicles' penetration within the region's transportation network.

Connected Vehicles

Most new vehicles on the road include connected vehicle technology. V2X (Vehicle to Everything), which includes V2V and V2I technologies, was tested in an automated vehicle shuttle pilot in Las Vegas, as previously described, and is currently being tested by the Wyoming Department of Transportation CV Pilot program. These pilots, along with future rollouts, will help to optimize regional transportation systems to maintain speed limits, increase the number of vehicles on the road, and increase safety for non-vehicular system users, specifically bicyclists and pedestrians, by avoiding crashes. Cities around the country are investing in a range of V2I and V2V infrastructure equipment including:

- **Emergency Vehicle Preemption Detectors** - Help reduce response times and improve safety at intersections by providing green signal time to emergency vehicles approaching traffic signals.
- **Bicycle Detection Systems** – Help detect bicycles at intersections and change the signal without the need of a motorized vehicle or pedestrian being present.
- **Road and Weather Information Systems (RWIS)** – Provide maintenance crews with constant updated information on current weather, air temperature, amount/type of precipitation, etc.
- **Dedicated Short Range Communication (DSRC)** – Used at intersections to wirelessly communicate and exchange information about vehicle location, speed, heading and traffic signal changes.
- **Traffic Management Centers (TMCs)** – Allow the monitoring and management of traffic through video cameras and vehicle detection systems. In the future, TMCs will include ramp metering, dynamic speed limits, lane controls, smart tolling, transit signal priority and smart parking.

WAMPO Action: Currently, the Wichita Traffic Operations Center monitors approximately 30 miles of roadway and includes 41 closed circuit television cameras (CCTV), 49 traffic sensors, and 23 dynamic message signs (DMS) through their WICHway program. An investment for the WAMPO region to consider would be the expansion of the regional Traffic Operations Center. Due to the current costs for the existing technologies listed above and those technologies that are on the horizon, an investment in expanded Traffic Management Center technology may be the best investment for connected vehicles and the future layered technology transportation advancements.

The 2019 Regional Transportation Systems Management and Operations Plan calls for several specific advancements to the WICHWay Traffic Management Center's operations. It is at, h**ttps://www.ksdot.org/Assets/wwwksdotorg/bureaus/wichitaMetro/PDF_Files/2019_02_06_TSMO%20 Plan.pdf.**

Autonomous Vehicles

As noted previously, Level 5 fully automated vehicles are years away from being allowed to operate on open roads. Automated vehicle manufacturers are putting much of the intelligence into the vehicles themselves. On-board Global Positioning Systems (**GPS**) help triangulate vehicle position on the road at all times. Light Detection and Ranging (**LIDAR**) on the vehicle creates a three-dimensional image of an object and when operating, allows the vehicle to detect objects that may lie in its path in order to eliminate an incident or reduce its severity. **Odometry** sensors embedded in the wheels allow for a vehicle to "know" how far it has travelled. **Stereovision Cameras** allow for vehicles to visualize where they are – and in the future, auto-detect traffic signal color changes. Investing in reflective lane markings, roadside beacons and other products to assist automated vehicles may not be necessary because most of the functionality of these products provide will be incorporated onto the vehicle itself. .

WAMPO Action: An investment or regulatory change that the region should consider to improve the reliability of automated vehicles is the rollout of **5G** networks and installing more fiber optics along corridors. 5G high-speed Wi-Fi networks would allow for automated vehicles to send/receive large amounts of data, thereby allowing for them to be able to operate at higher speeds in more congested areas.

The future roll-out of automated vehicles may lead to higher rates of single/zero-occupant vehicles – which could lead to more vehicle trips, more congestion, and potentially impacting driving times in the region. Public policy and regulatory changes may need to be considered to address the impact of automated vehicles when they are deployed.

Electric Vehicles

Electric vehicles have been manufactured for over 100 years, but have become more prevalent within the market for the past decade. With the cost of batteries falling, electric vehicles are proliferating. In order to spur future adoption of electric vehicles and future automated electric vehicles, not only do battery costs need to fall, but local cities and regions need to have a higher density of electric vehicle charging stations. The costs for public entities are relatively low since many of the major automotive OEM's are either building their own networks (as in the case of Tesla) or are utilizing a number of electric vehicle charging network providers.

WAMPO Action: In order to spur adoption of electric and automated vehicles, the region should work towards streamlining the permitting process for deploying electric vehicle charging stations. This is a relatively low-cost approach to encouraging these vehicles being used in the region.

Networked Transportation System

An optimized regional transportation system relies on real-time traffic information to optimize traffic flow. In order to achieve this goal, a significant investment is needed in equipment and software to collect and analyze data, and to communicate to the Traffic Management Center in real time. An active, networked transportation system would incorporate adaptive signal control technologies to improve traffic flow, reduce congestion, and maximize use of highway and transit investments. DSRC, Transit Signal Prioritization (TSP), cameras, higher bandwidth of connectivity (5G, fiber), as well as integration with regional agencies and private operators, are all critical steps for deploying a truly networked transportation system. Such a system can be built over time, with future technologies incorporated into the system as costs come down and / or technology functionality improves.

WAMPO Action: Creating a networked transportation system, or building off of an existing system, will allow for the WAMPO region to continue to evolve toward a Smart Region. This type of investment would also tie into further investment in the traffic management center.

The 2019 Regional Transportation Systems Management and Operations Plan recommends a regional assessment of communications needs should be completed to help support future activities. MOU's regarding sharing for fiber/communications as well as MOU's to share data need to be defined, negotiated and maintained as a regional resource. The Wichita Regional ITS Architecture and Standards should be updated and maintained to further support these initiatives.

Travel Information and Payment

Several cities around the country are integrating trip planning across multiple transportation modes with single payment service to create true Mobility as a Service (MaaS) software applications. Transportation modes such as Micromobility (Shared bicycles, scooters, etc.), Ride-hailing, Microtransit, Smart Parking, and Bus Transit (and, in the future, Automated Vehicles) are all integrated within a single mobility application.

WAMPO Action: Integrating transportation information from various modes and sources into a single regional mobility application may be the best, and potentially lowest-cost investment, for moving towards a truly Smart Region. Future technology innovations, such as automated vehicles and other modes of transportation, can be layered onto this application.

Freight and Delivery

Freight and delivery activity is critical for both business and consumers. Technology and investments are increasing the use of freight and delivery activity within the United States. Similar to consumer travel, freight and delivery options are utilizing a multi-modal approach. Companies such as Grubhub, Uber Eats and others are already in the region, delivering food to consumers. Other companies such as Deliv and Roadie are focusing on delivering packages and other "stuff", to consumers and businesses, utilizing a network of 3rd party drivers. The advent of automated technologies will allow for further disruption to the existing delivery model while allowing for lower future delivery costs. The Wichita region boasts two airports, which will see growth in both freight and intermodal traffic due to technological trends. According to Transparency Market Research,

"The global air cargo market is projected to be worth $130.12 billion by the end of 2025. All throughout 2025, the global market is expected to exhibit a steady CAGR of 4.9%".

WAMPO Actions: The region may experience growth of freight and delivery in and around the airports due to the relative ease/low costs of moving goods throughout the region. Integrating new freight and delivery transportation technologies (including Automated and Electric Fleet Vehicles, Vehicle Telematics Management Systems, Smart Routing, etc.) into a regional transportation software application may prove to be a good investment for the region. While some of these technologies are years away, creating a flexible application that can incorporate future transportation modes will be critically important.

In addition, London's Heathrow Airport implemented an automated cargo pod for three weeks in 2018. This trial demonstrated the coming automation of transloading operations. Working with the local airports and freight operators, the automation of transloading operations presents an opportunity for WAMPO to be a leader in this emerging trend. WAMPO may want to consider creating a consortium of members from the airports, freight operators and technology providers to apply for Federal grants to trial this technology.

The region should prioritize overall technology investments based on an assessment of short- and long-term benefits. 5G and fiber, electric vehicle charging stations, the creation of a Regional Transportation Network System, and a region-wide Mobility Application are investments that will pay off in the short and long term. Other technology investments, while helpful in the short term, may not be the right investments to make at this time.

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