SELLING TECHNOLOGY: INFLUENCING PERCEPTIONS OF AUTONOMOUS VEHICLES

By

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ABSTRACT

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Disruptive products and technologies change both how we live and the ways in which we live in communities. Automated vehicles (AVs) have the potential to be both disruptive and transformative. However, a period of anticipatory ebullience ended in 2018 when two high profile crashes of automated vehicles occurred. The crashes shook the confidence of the public and of industry and called into question the merits of developing fully automated vehicles that drive on public roads without input from humans.

Although academic research on AVs has continued unabated since 2018, with the exception of a few instances, researchers have not sought insight from the industry creating these vehicles regarding the future of the technology and of how the industry is engaged in resetting expectations.

This study investigates industry strategies to influence perceptions of automated vehicles post 2018 and how current perceptions of AVs affect communities. This study is based on interpretations of information transference, information moderation, and technology acceptance. Understanding how the AV industry is influencing perceptions in a changing technological landscape contributes new perspectives on a disruptive and transformative technology and how industry-led information moderation becomes an important contributing factor to future acceptance.

Dedicated to my parents, Cornelius and Eleanor Darcy, historians, educators, and indefatigable parents who continue as coaches, guides, and role models for their children. Love, Kip

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CHAPTER 1 - Introduction

Disruptive technologies, simply put, change our lives in unanticipated ways. Sony transistor radios, inexpensive Korean cars, and Southwest Airlines are classic examples of disruptive products and technologies that changed markets (Sultan, 2013). More recent examples include the internet and the many services and capabilities ubiquitous computing has enabled; streaming entertainment, online shopping, and crypto currencies (Kassens-Noor, 2022). Communities are changing as a result of these transformative developments and so is the practice of urban and regional planning. Smart and resilient cities are powered by technology and knowledge workers enabling better-managed and safer environments residents find more appealing (Albino, Berardi, & Dangelico, 2015). The practice of planning is becoming much more technical as a result (Kontokosta, 2021).

The technology driving transformative environments is considered to be disruptive. According to Bower and Christensen (1995), the brains behind the theory of disruptive technologies, disruptive products have four attributes. First, disruptive products typically have performance attributes that are not valued by established markets and customers. Second, the performance attributes appeal to a new set of customers not served by established products. Third, the performance attributes of the disruptive product improve at a faster pace than the expectations of established markets. Lastly, established organizations struggle to bring disruptive products to market because their business planning processes are geared toward established customers and their needs. Many times the disruptive product is appealing to new customers for whom the existing options were too expensive or did not work. In the

classic cases, Sony developed a small portable radio for people who either did not want or could not afford a home console radio. Southwest Airlines, through its low-cost model, got people to fly domestically who had been using other forms of cost-effective transportation (Sultan, 2013).

This study investigates how industries that create disruptive technologies influence perceptions of the new product, and, the effect such perceptions have on communities. To narrow the field of disruptive options, this study investigates disruptive mobility, automated vehicles specifically. Within the mobility category, Yigitcanlar, Wilson, and Kamruzzaman (2019), see automated vehicles (AVs) as a disruptive technology, as do Kassens-Noor, Wilson, & Yigitcanlar (2021), with outsized potential to disrupt our communities. Well over 30,000 articles have been written about AVs and their anticipated effects on our lives and communities (Faisal, Yigitcanlar, Kamruzzaman, & Paz, 2021). AVs were chosen as the case study for this work for the volume of interest as reflected in the literature, perceived effects, and access to this researcher's professional network of mobility and technical channels, experts, and resources. Few articles include the perspectives of the creators of automated driving technologies and none explore the process of influencing perceptions of AVs.

For the better part of a decade Americans have been promised safer, cleaner, more efficient transportation in the form of automated vehicles that initiate and complete trips without the aid of human drivers (Bansal & Kockelman, 2017; Bansal & Kockelman, 2018; Fagnant & Kockelman, 2015; Lipman, 2021; Schoettle & Sivak, 2014). Billions of dollars (Baltic et al., 2019) have been invested in the development of sophisticated robotic mobility solutions by traditional auto manufacturers, start-ups,

service providers, tech companies, and suppliers. Key players in the development of AVs in the North American market include Cruise, Waymo, Nvidia, Mobileye, Aurora, and Argo AI (Abuelsamid, 2021). And, Elon Musk, one of America's passionate promoters of AVs, has promised fleets of robotaxis (Lin, 2020). It is notable that the perceived leaders are not traditional automakers but relative start-ups, aligning with the attributes of a disruptive technology.

After more than a decade and a half of technical development and mass media coverage, the touted arrival of automated vehicles has an air of uncertainty. According to Lipson and Kurman (2016), we should not be surprised. In their book *Driverless: intelligent cars and the road ahead* the authors outline seven myths associated with automated vehicles; driver assistance technology will lead to AVs, progress is linear, the public is resistant, AVs require investment in infrastructure, there will be ethical dilemmas, AVs need to be perfect, and adoption will be abrupt. Six years later, the seven myths highlight hot button issues most concerning to people following disruptive mobility.

The current push for AVs is not new, for nearly a century industry has promised to reduce crashes, congestion, and inconvenience in our car-dependent society through the application of advanced technologies (Norton, 2021). Good or bad, on time or late, self-driving technology has the potential to be transformative, even disruptive, in the ways we travel and in the use of land (Faisal, Kamruzzaman, Yigitcanlar, & Currie, 2019; Guerra, 2016; Fuller, 2016).

Considering AVs as a disruptive product (in addition to a potential disrupter of the environments in which they operate) reframes the conversation around how to assess

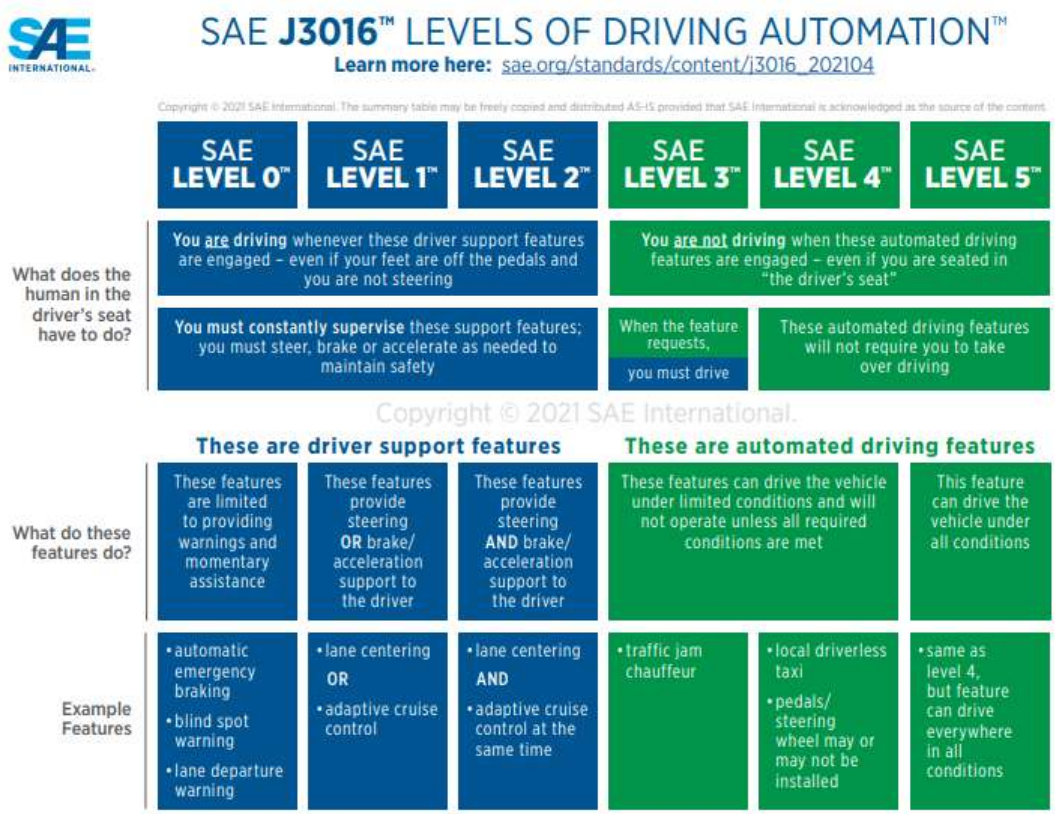
the technology. It may be that AVs are not a replacement for traditional vehicles but the start of something far more reaching, a replacement for mass transit, or the start of a completely new category of mobility. The combination of possible new business models and robotic vehicles in our communities warrants additional insight from both the perspective of how industry is influencing perceptions of AVs and how the resulting perceptions affect communities.

Vehicle Automation Levels

Vehicle automation has been codified by SAE International in standard J3016 (SAE, 2021) across six levels ranging from full human intervention to no human intervention required to complete trips. Figure 1 details each of the six levels of automation as promulgated by SAE International, a professional association and standards developing organization for engineers. Levels zero through two are automated driver assistance systems (ADAS) that provide support to human drivers under various circumstances. The technology at these first three levels is not designed to replace the human task of driving and require full driver participation at all times.

Levels three, four, and five signify automated levels of driving that either alleviate the need to drive under specific, clearly defined circumstances, level three, or remove the need for a human driver under specific circumstances as is the case for level four and under all circumstances as is the case for level five.

Figure 1: SAE Automation Levels



Source: SAE International (2021)

The distinction between automation levels is important for two reasons. Levels one through three are a progression of vehicle technology currently available in-market that may contribute to increased levels of safety and convenience but do not fundamentally change the way mobility products are used. Level Four (L4) and Level Five (L5) are automated technologies and allow vehicle users to initiate and complete trips without human intervention. Level 4 vehicles operate under limited conditions. Level 5 vehicles are designed to operate under all conditions. Vehicles that operate without drivers is a mobility paradigm shift that has the potential to change who travels, how people travel,

and, as a result, how society functions. Level 4 and Level 5 vehicles are the focus of this study and reflect popular perceptions of the capabilities of automated vehicles.

The DARPA Challenges (Defense Advanced Research Projects Agency, United States Department of Defense) of the mid-00s jumpstarted commercial interest in robotic driving through three successful competitions that demonstrated the potential of artificial intelligence (AI) as a chauffeur (Campbell, Egerstedt, How, & Murray, 2010). AI used in AV deployments is computational software designed to "learn" from experience through software architectures that simulate neural networks that enable "deep learning" processes. AI enables self-driving technology packages to gain capability as they move through both simulated and real-world environments (Lipson & Kurman, 2016). The range of experiences human drivers encounter over the course of their driving careers is broad including incredibly unique corner cases. Many researchers believe robotic vehicles have to be as good, if not better than, the best human drivers to breed confidence and trust in other mobility infrastructure users (Hulse, Xie, & Galea, 2018; Kalra & Paddock, 2016; Liu, Yang, & Xu, 2019; Patel & Hawkins, 2022).

American perceptions of AVs shifted in 2018 from cautious optimism to distrust and uncertainty when a fully automated Uber (now, Aurora) test vehicle in Tempe, Arizona struck and killed a pedestrian while accumulating test miles (Griggs & Wakabayashi, 2018). Soon after, a Tesla Model X crashed into the median barrier on Highway 101 in Mountain View, California, killing the driver. The Tesla automated support feature, Autopilot, was engaged when the vehicle crashed (Noyes, 2020). Although these were isolated incidents, the public, with aid from the media, saw both scenarios as a failure of automated driving to deliver on its core value proposition of

increased safety (Penmetsa, Sheinidashtegol, Musaev, Adanu, & Hudnall, 2021). As a result, 2018 was an inflection point where creators and developers of L4/L5 driving solutions realized there was an immense amount of additional work to be done to ensure trustworthy systems in the eyes of the public.

Even with delayed expectations, the L4/L5 AV value proposition has remained grounded in promises of increased safety, greater efficiencies, whether through efficient traffic flows, greater vehicle utilization, and greater environmental friendliness as proponents posit an electric vehicle (EV) AV future. Access and equity opportunities have bolstered the appeal of AVs, such as last mile solutions, income-based access opportunities, and as enablers for the disabled and infirmed (Kassens-Noor, Cai, Kotval-Karamchandani, & Dexaminid, 2021). As a result of these new realities, pre-2018 visions of private AVs plying the country have given way to less exuberant and more realistic operating scenarios such as tightly choreographed taxi and delivery in geofenced areas, services for dedicated populations, and route-based long haul trucking routes.

Statement of the Problem

Automated driving as a domain, is perceived as potentially disruptive and, as being delayed. Although the technology is well known in the robotics and mobility industries, it is poorly understood across the general population. One element of any new technology is the need to gain public trust and interest that promotes consideration and a positive reputation. After more than a decade and a half of technical development and media coverage, the future of automated vehicles remains unsettled. Disruptive technology perceptions, expectations, and acceptance studies do not include

direct industry insight regarding industry sentiment and strategies used to influence perceptions of AVs and how those perceptions affect communities.

Academic researchers have explored numerous aspects of AVs, most notably consumer expectations, preferences, and future deployment scenarios. These resources are highly valuable but new insight from industry regarding strategies used to influence perceptions of AVs is not generally available and is needed to shed insight on disruptive technology development processes in ways that help communities plan and prepare for new technologies.

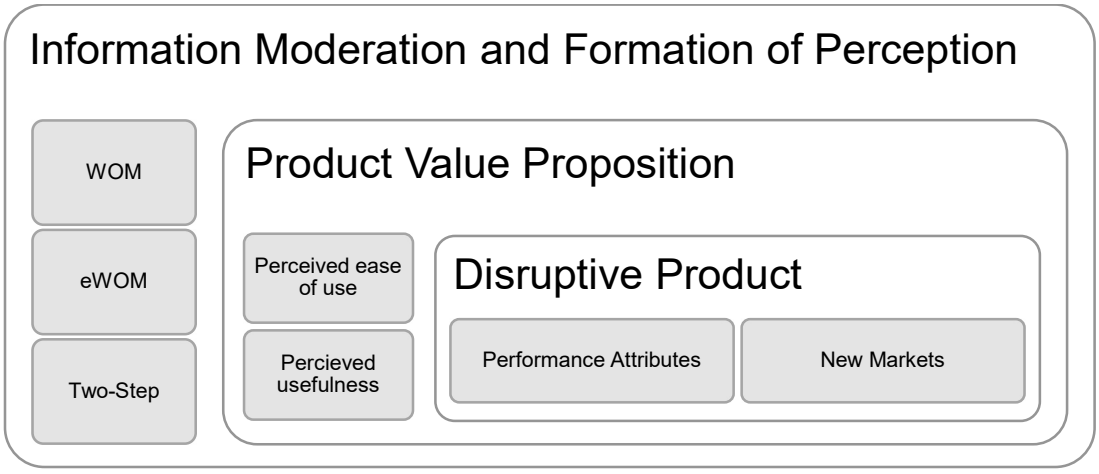
A final consideration is how technologies are marketed and how the public learns about the costs and benefits of a new product. Many forces shape public understanding, from personal experience, to word of mouth, to advertising. Perceptions of technology are not accidental but the product of concerted efforts by stakeholders to shape opinion, sometimes with competing narratives about the merits of the product.

Purpose of the Study

This study provides point in time understanding of the strategies used by industry to influence perceptions of AVs and how perceptions of the product may affect communities. Such an understanding is an asset when planning for new mobility technologies. More broadly, this study contributes to the fields of communications, technology acceptance, and planning by investigating how industry influences perceptions of a potentially disruptive technology and how such perceptions affect communities.

Figure 2 illustrates the concept of product perceptions generated through positioning based on value drawn from attributes and new markets. In the case of AVs, specific trip types for specific target users are the basis for value perceptions that become the core of communication and information transference more broadly, in a moderated manner.

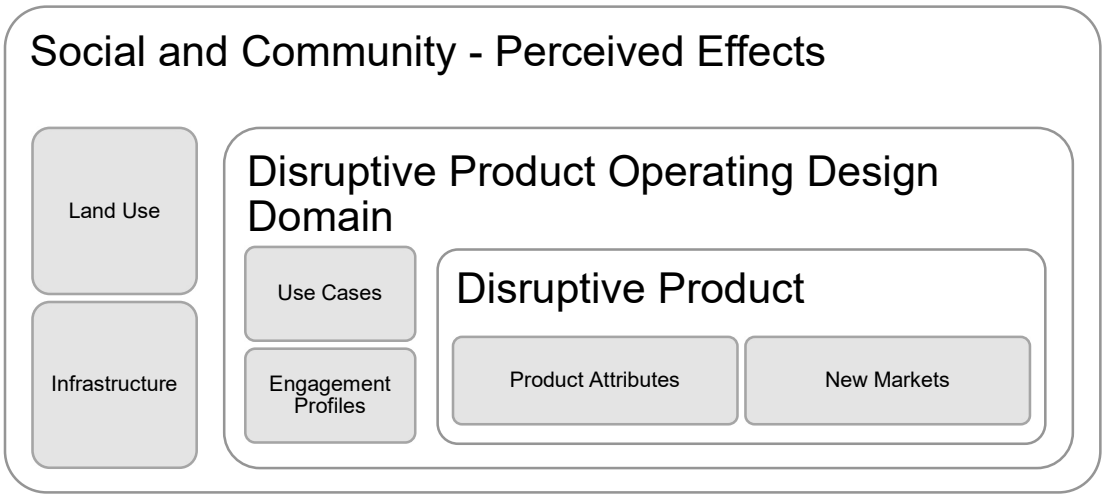
Figure 2: Concept Map, Perceptions of AVs



Source: Author

Figure 3 frames product perceptions through the lens of effects on communities. Product attributes and target markets contribute to operating environments and use cases which ultimately have potential effects on society and communities.

Figure 3:Concept Map, Effects of AV Perceptions on Communities



Source: Author

Theoretical Framework

The objectives and structure of this study reflect the researcher's belief in the power of social networks to solve problems, and professional experience in sales, marketing, communications, and sales enablement. Perceived value in products and services and how such perceptions drive behavioral outcomes has been a long-term interest. Investigating a product not yet in-market is tricky when there are no customers. Such is the challenge to existing research that positions AVs as a disruptive product while investigating perceptions and intentions through engagement with public panels and those familiar with established solutions. According to Bowers and Christensen (1995), such an audience is unlikely to see the value of AVs. The structure of industry relationships between established organizations and start-ups is well-established in this space. What is not established is how the players perceive the process of influence, their perceptions of the technology, and their perceptions of how perceptions of the technology are affecting communities. This study has sought to

narrow this gap by seeking out two audiences associated with technology, mobility, and automotive communities. Engagement with these audiences was designed to uncover their perceptions and actions associated with the process of influencing AV perceptions.

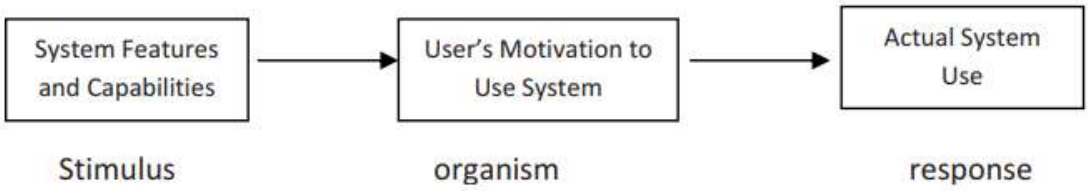
Theoretical Origins

The choice of theory for this study is based on a desire for moderated and opinion-making communication within the context of decision making that supports disruptive technology acceptance. Transactional and behavioral theories that support personal and professional networks are also of interest. The two most interesting theoretical fits are the Two-step Flow Model of Communication (including WOM – word of mouth, and eWOM, electronic word of mouth) and the Technology Acceptance Model (TAM). Two-step illuminates the process and value opinion leaders play in the moderation of mass media messages which, they in-turn, pass along to others. Today such processes are frequently digital and captured in word of mouth and electronic word of mouth studies. Theory flexibility is an important attribute when the boundaries between news media, creators, and commercial content are blurred. This study interprets Two-step flexibly, as a moderation process in which the roles of media and opinion leadership may converge. Channels have become both democratized and co-opted by big tech (think search technologies, etc.) as pay-to-play channels.

The second theory, TAM, is a behavioral theory designed to influence and predict the use of various information and communications technologies (ICT) systems such as knowledge management systems or, for example, automated transportation. Designed to facilitate the acceptance of management information systems (MIS), TAM starts with perceptions associated with product attributes and benefits, moves forward with a

bundle of psychological factors such as subjective norms, personal image, etc., factors that motivate us to adopt things like habits and tools, and culminates in system usage. TAM has high literal and subjective reliability as a tool, is well-represented in literature, and is popular with researchers of disruptive technologies. Figure 4 provides an overview of how TAM conceptually works by stimulating a need for consideration which may result in use.

Figure 4: Conceptual Model for Technology Acceptance



Source: Chuttur (2009)

The two theories are complimentary. Influential communication and word of mouth are logical contributors to the development of perceptions within a technology acceptance framework.

Communication Theory – Word-of-Mouth – WOM

Word of mouth, influencer, and social network theories emerged in the social sciences through studies initiated in the late 1930s and early 1940s. *The People's Choice* (Lazarsfeld, Berelson, & Gaudet, 1968), a groundbreaking study that investigated the process of voter decision making in the 1940 presidential election, surfaced compelling information about the transference of information in society when important decisions were to be made. Paul Lazarsfeld and Elihu Katz, social science researchers at Columbia University and collaborators on studies that built upon the

theoretical foundations of *The People's Choice*, developed and refined the theory of Two-step communications through a series of studies conducted in the 1940s and 1950s to explain the power of social/consumer opinion and influence in public affairs, marketing, and the diffusion of innovative new pharmaceuticals. Lazarsfeld and Katz's work is rooted in personal recommendations, interpersonal relationships, interpersonal communication, informal communication, and interpersonal influence. Two-step communications theory focuses on the dynamics between the adviser and advisee that facilitate the space for influence. Influence is drawn from three sources, who one is, who one knows, and what one knows (Katz & Lazarsfeld, 2017; Katz, 1987; Katz, 1957). One of their studies demonstrated that neighbors sharing shopping information were seven times more effective than newspapers or magazines, four times more effective than personal selling, and two times more effective than radio at influencing where consumers shopped (Gheorghe, 2012). These studies formed the basis for new ways to convey information about social trends, new technologies, and sales communication (Katz, 1957). This work is of interest today when attempting to gauge perceptions and behavioral intentions associated with new, advanced, and potentially disruptive technologies.

The core tenets of Two-step communications theory resonate broadly with researchers and have been updated and extended in studies as diverse as mass media agenda setting (Brosius & Weimann, 1996) and as word-of-mouth (WOM) and electronic word-of-mouth (e-WOM) in the areas of online marketing, consumer engagement (Chu & Kim, 2011; Lee & Youn, 2009). Social network theory, with its origins in sociometric analysis, interpersonal relations, and anthropology, is integral to

communications theory and joins the quest to better understand consumer influences and behavior in digital and virtual environments (Liu, Sidhu, Beacom, & Valente, 2017; Zhang & Benyoucef, 2016; Chu & Kim, 2011; Prendergast, Ko, & Siu Yin, 2010).

Within the past decade researchers have sought consumer opinion on self-driving vehicles (Schoettle & Sivak, 2014; Kyriakidis, Happee, & de Winter, 2015) but there are no published academic research sources of perceptions of AVs from the perspective of those working in the mobility industry. Lazarsfeld and Katz, and their successors, provide a tested theoretical foundation on which to explore the influence of mobility insiders and their perspective on AVs.

Technology Acceptance Model – TAM

Technology Acceptance Model (Davis, 1985; Davis, 1989; Venkatesh & Davis, 2000; Venkatesh, Morris, Davis, & Davis, 2003) was developed in the 1980's to forecast and improve the acceptance of enterprise management information systems (MIS). Grounded in concepts of psychology, personal motivation, decision making, and human factors, TAM focuses on user acceptance, system design improvements, and productivity. Fred Davis's work formalized the concept of technology acceptance, first explored 70 years ago by the previously highlighted social science researchers, Lazarsfeld and Katz (Katz, 1957) and is the basis for extensive subsequent acceptance-focused research in many fields including new forms of transportation (Al-Qaysi, Mohamad-Nordin, & Al-Emran, 2020; Lah, Lewis, & Šumak, 2020; Marangunić & Granić, 2015; Lee, Kozar, & Larsen, 2003).

TAM is prevalent in studies forecasting acceptance of AVs (Huang, 2021; Yuen, Cai, Qi, & Wang, 2021; Zhu, Chen, & Zheng, 2020; Koul & Eydgahi, 2018; Kyriakidis,

Happee, & de Winter, 2015) and has been extended by a host of researchers including Davis himself in an effort to increase the utility of the theory and to apply it to fields other than enterprise technologies (Venkatesh & Davis, 2000; Chuttur, 2009; Choi & Ji, 2015). Derivatives of TAM include Task Technology Fit (TTF), Unified Theory of Use of Technology (UTAUT), and Automation Acceptance Model (AAM). Recent researchers have been using structural equation models (SEM) to test numerous hypotheses related to consumer acceptance/preferences for in-vehicle automation (May, Noah, and Walker, 2017).

Research Questions

Selling Technology is structured around two research questions:

RQ1: What strategies are used by the automotive and tech industries to influence the perceptions of new, disruptive forms of mobility?

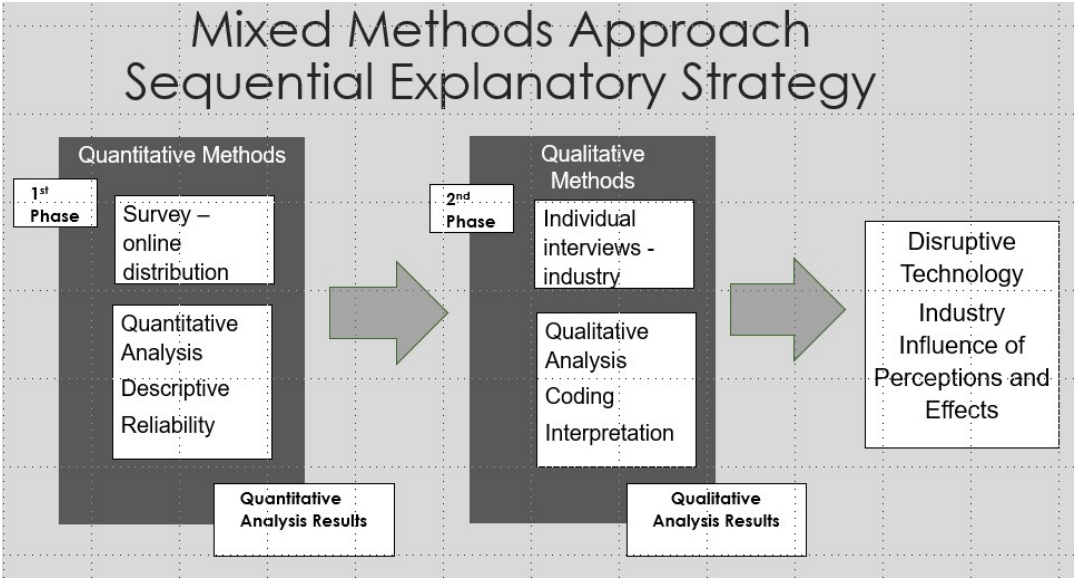
RQ2: How do the automotive and tech industries see perceptions of disruptive mobility technologies affecting communities?

Description of the Research

This study of L4/L5 vehicles utilizes a sequential mixed methods approach comprised of an online survey that generated data for quantitative analysis. The survey and associated data informed the development of an interview guide to support a deep investigation of specific survey topics. Survey respondents and survey participants were drawn from the same industries, but represent different pools of informed analysts. Survey respondents were recruited through industry digital channels using paid display advertising. Interview participants were recruited through the reseacher's personal

network and personal instance of LinkedIn. The form and sequence of the methodology is presented in Figure 5.

Figure 5: Sequential Mixed Methods Schematic



Source: Author

Research Goals and Objectives

Craft and launch a mixed methods research project that nets sufficient data to assess the research questions while obtaining a snapshot of industry strategies and sentiment regarding AVs, evidence of strategies designed to influence perceptions of AVs, and an understanding of industry perceptions of AVs vis a vis communities.

- Industry methods and examples of initiatives designed to influence AV perceptions.
- Insight into industry perceptions' effect on communities.

Research Scope

This is a North American-based study that seeks communications, marketing, product development, and management information regarding SAE L4/L5 vehicles from individuals associated from the following organizations:

- Original equipment manufacturers (OEMs) – vehicle manufacturers
- Suppliers/technology providers – component manufacturers, software development, robotics
- Media – press and content developers for mobility
- Industry analysts – consultants, analysts, market evaluators
- Insurance industry – liability and property risk management
- Infrastructure experts – roadways, roadway technology

Importance of the Study

Selling Technology delivers theoretical innovation by incorporating industry influential moderation into the stimulus phase of acceptance modeling (perceived usefulness – PU and, perceived ease of use – PEU). Two-step influencer communications applied to innovations as they were in the mid-1950's study with doctors and cutting-edge pharmaceuticals, (Coleman, Katz, & Menzel, 1957) and technology adoption modeling as developed by Davis for MIS, are sensible partners in an investigation into the strategies used by the mobility industry to influence perceptions of AVs and to assess how such perceptions may affect communities which may aid the planning and management of communities. Both point in time insight and the theoretical contributions of incorporating influential communication as a stimulus in acceptance modeling extend and expand the domain of disruptive technology

acceptance modelling and forecasting in ways that facilitate proactive and collaborative planning initiatives.

Deliverables

Selling Technology: Influencing Perceptions of Autonomous Vehicles deliverables include market survey data gathered in-market specifically for this study and analyzed using traditional quantitative analysis techniques and tools, an assessment of a set of mobility industry interviews conducted specifically for this study, and consideration of the analyses within the context of a set of research questions designed to surface insight into strategies used to influence perceptions of L4/L5 vehicles, discussion around the strategies, techniques, and tools used to influence perceptions of transformative technologies to stakeholders. The study is supported by a literature review, a methods section that provides details around the mixed-methods approach deployed by this study, results sections for both survey and interview data, and a discussion of the results that explore study findings, make recommendations, and illuminate opportunities for further exploration.

Readers Guide

In the following chapters the reader will find:

Chapter 2, a review of literature associated with the domains of this study;

- Theoretical domains,
- Communications, word-of-mouth, influencers, opinion-makers, two-step,
- Social ecommerce, digital influence, and
- Technology Adoption Model (TAM).

Chapter 3, methodological foundation, data acquisition and analysis plans

- Methodological foundations, considerations, and rationale,
- Data acquisition tools, techniques, and channels, and
- Analytical methods used for both quantitative and qualitative data.

Chapter 4, research results, survey data

- An overview and an analysis of the quantitative data collected from 62 respondents,
- Descriptive and inferential analysis as ways to understand the respondents, their insight and what that insight may mean more broadly, and
- Tables and charts to facilitate an understanding of the quantitative and qualitative (open fields) of the survey.

Chapter 5, research results, interview data

- An analysis and discussion of 14 interviews with industry experts.

Chapter 6, discussion

- Provides a discussion of the theoretical foundation of the study from evolutionary and contributory perspectives.

Chapter 7, conclusion

- Provides an summary of the results presented in chapters 4 and 5 and more broadly, an interpretation of the results to the domains of advanced/disruptive technology acceptance, communications and influence, and planning and infrastructure. Chapter 6 also provides recommendations in the areas of

theoretical extensions, communications effectiveness for disruptive consumer technologies, and for extensions of this study.

A cross disciplinary investigation of industry strategies to influence perceptions of L4/L5 vehicles necessitates the use of specialized terms and language that will seem jargony.

- ADAS, Advanced Driver Assistance Systems, systems used to make driving safer and easier. ADAS examples include adaptive cruise control (ACC), forward collision braking (FCB), self-parking, automatic braking, and pedestrian detection. Night vision cameras, adaptive high beam headlights and numerous other developments may be grouped under ADAS.
- AVs, Automated or autonomous vehicles, this study specifies the study topic as the two highest levels of six levels of vehicle automation as defined by SAE International standard J3016, Level 4 (L4) and Level 5 (L5)
- Channels (industry), Go-to-market partners; sales, dealers, retailers, services
- Channels (communications), Communication platforms; web sites, social networks, print, etc.
- OEM, Original equipment manufacturer; Ford, Tesla, GM, Rivian, etc.
- SME, Subject matter expert
- SNS, Social network systems
- TAM, Technology Adoption Model, developed by Fred D. Davis as the basis for his doctoral thesis at MIT in the early 1980s.

Limitations and Expectations

This study is limited to data gathered from North American resources that were recruited within narrowly defined channels and networks. The study is a snapshot that provides point-in-time sentiment, insight, and recommendations which, by their very nature, run the risk of being out of date due to the dynamic nature of advanced and disruptive technologies.

Expected results include insight regarding AV development and communication processes, industry and end-user perceptions, and perceptions of change within communities brought on by highly automated vehicles. These finding provide the basis for further academic research and for commercial strategies such as the development of frameworks and playbooks to further communication and engagement around technology and communities.

CHAPTER 2 - Review of Literature

Selling Technology leverages the fields of planning, technology development and acceptance, and communications to enable an understanding of strategies to influence perceptions of highly automated vehicles (Faisal, Kamruzzaman, Yigitcanlar, & Currie, 2019). The expansive range of factors that influence perceptions of automated driving warrants a broad assessment of scholarly and industry sources associated with AVs in general, technology acceptance, communications, and social issues including an assessment of automotive advertising. Although numerous studies have explored the potential of self-driving vehicles, the literature includes few studies that incorporate industry insight (Abuelsamid, 2021; Litman, 2021; Raj, Kumar, & Bansal, 2020) and little regarding the strategies, techniques, and tools used to influence perceptions of AV technology (Ward, Raue, Lee, D'Ambrosio, & Coughlin, 2017; Ghasri & Vij, 2021). *Selling Technology* draws theoretically on the Technology Acceptance Model (TAM) and Two-step Theory of Communications and Two-step's more modern equivalents for two reasons, fit as reflected in the prevalence of AV-specific studies that explore TAM (Bansal & Kockelman, 2017; Bansal & Kockelman, 2018; Choi & Ji, 2015; Kyriakidis, Happee, & de Winter, 2015; Liu, Yang, & Xu, 2019; Nordhoff, De Winter, Kyriakidis, Van Arem, & Happee, 2018, Ward et al.,2017; Yuen, Wong, Ma, & Wang, 2020) and the quality of the academic literature associated with the theories and theorists (Davis, 1985; Gheorghe, 2012; Katz & Lazarsfeld, 2017; Katz, 1957; Katz, 1987; Lazarsfeld, Berelson, & Gaudet, 1968; Venkatesh & Davis, 2000).

The theoretical concepts of technology acceptance and communications/network influence as a source of opinion-making are well documented in existing literature.

Acceptance emanates from the fields of behavioral science and enterprise computing (Davis, 1985). Influence and opinion leadership are aligned with the fields of communications and marketing (Gheorghe, 2012; Liu, Sidhu, Beacom, & Valente, 2017) and have converged in the digital world of social commerce (Zhang & Benyoucef, 2016). The convergence of technology acceptance modeling, which Fred Davis (1985) refined as the Technology Acceptance Model (TAM) and informal communication within social networks, frequently referred to as word-of-mouth (WOM) (Chu & Kim, 2011), facilitates AV research using opinion and behavioral intention approaches which will aid planners, mobility solution developers, and automotive industry leaders by providing point in time insight, recommendations for planning purposes, and communications guidance.

Two-step Communication and Word-of-Mouth

Keyword search: Communications, Word-of-Mouth, Influencers, Opinion leaders, Opinion-making

Communications and social network theories associated with opinion-making, frequently referred to as WOM (word-of-mouth), provide a framework for understanding how perceptions and knowledge are formed and disseminated. Understanding how information about automated vehicles is shared and which approaches are most effective at influencing perceptions is imperative for understanding potential paths of acceptance for AVs and the development of new social and physical infrastructures to support them. A review of literature revealed articles and research associated with the fields of communications and social networks. Contemporary research in the domain is frequently associated with online social and commerce networks and influential online

communication. Selected articles focus on the theory and application of word-of-mouth as well the combination of WOM and technology acceptance. (Zhang & Benyoucef, 2016; Venkatesh & Davis, 2000).

Word-of-mouth as a theoretical domain is a product of communications and marketing (Gheorghe, 2012) and social network theory (Liu, Sidhu, Beacom, & Valente, 2017). WOM, although very much of the digital age of online commentary, reviews, and social posts, originates as a field of study from information transference studies. Some of the most notable studies in this area were initiated by the Bureau for Social Research at Columbia University at the time of the 1940 presidential election (Lazarsfeld, Berelson, & Gaudet, 1968) and were replicated and refined after the Second World War in various U.S. communities (Katz & Lazarsfeld, 2017). Over an approximately 15 year period, study topics ranged from electoral preferences to consumer goods, to the diffusion of information about innovative new pharmaceuticals (Katz & Lazarsfeld, 2017). Early in the study series, researchers identified a Two-step flow of communication whereby certain individuals within communities and social networks were seen as knowledgeable sources for specific types of information which they then shared with others within their networks. Lazarsfeld, et al., refined their concept of personal influence to include measurements of influencer traits and impact (Katz, 1957) and found interpersonal communication flows were more impactful than the media and that the Two-step process could cross demographic groups. The effectiveness of the people facilitating the flow, influencers, was the product of who they were, what they knew, who they knew (Katz, 1957). Significant effort was spent understanding the disseminators, who they were and their relationship to the people with whom they were

sharing information, whether it be about civic life, movies, fashion or new medications. Studies found in cases of consumer brand switching that the Two-step flow was seven times more effective than newspaper and magazine advertising, four times more effective than personal selling and two times more effective than radio (Katz & Lazarsfeld, 2017). The informal nature of word-of-mouth communication reduces risk for consumers and makes them more comfortable, contributing to the effectiveness of the theory. Ultimately, the attributes of the influencer and their relationship to the audience is key. Traditionally, successful networks have a high degree of homophily, meaning sameness or similarity, which contributes to source credibility (Gheorghe, 2012). Elihu Katz, continued to revisit and comment on the research and Lazarsfeld's legacy over the span of a long career (Katz, 1957, 1987). Katz noted that in retrospect, the Two-step process was an almost accidental byproduct of *The People's Choice* (1968) study that required refinement through the subsequent studies and, that much of the communication studied took place within relatively homogeneous groups.

The Two-step process has evolved. On occasion, researchers extended and flipped the model in the interest of inquiry. Brosius and Weimann (1996), for example, applied variations of Two-step flows to a German media study, although the study was inconclusive, the model derivatives are a visually beneficial way to demonstrate adjusted versions of Two-step theory (Brosius & Weimann, 1996). Figure 6 illustrates the various ways Two-step Flow of Communications has been altered to explore various forms of influential communication.

Figure 6: Classical Two-step Flow of Communication and Derivatives

Model 1: The Classical Two-Step Flow
Media Agenda → Early Recognizers → Public Agenda

Model 2: The Reverse Two-Step Flow
Public Agenda → Early Recognizers → Media Agenda

Model 3: Initiating the Classical Agenda-Setting Process
Early Recognizers → Media Agenda → Public Agenda

Model 4: Initiating the Reverse Agenda-Setting Process
Early Recognizers → Public Agenda → Media Agenda

Source: Brosius & Weimann (1996)

Two of the selected articles, Liu, Sidhu, Beacom, & Valente, (2017) and Gheorghe (2012), provide a comprehensive introduction to the current evolution of two-step and WOM in a manner that connects the theory to perceptions in the acceptance and adoption of new technologies. Gheorghe (2012) explains the importance of WOM in the selection of services and product categories in which there is a high degree of perceived risk due to a lack of information (Prendergast, Ko, & Siu Yin, 2010). Word-of-mouth today, whether that be digital or analog, helps reduce the risk of a lack of information when making decisions, much as it did when participants in the first studies were communicating either face to face or by telephone.

Several WOM-focused studies (Chu & Kim, 2011; Lee & Youn, 2009) have advanced thinking regarding influencer attributes and tie strength in a digital world. Interestingly, weak interpersonal bonds facilitate effective influence in the digital world (Chu & Kim, 2011; Liu, Sidhu, et al, 2017). As a result, perceived homophily is negatively correlated (Chu & Kim, 2011) to behavioral intent in digital settings. The

studies are significant in that they create a framework for evaluating influence as a digital marketing tool. A recent China-based study (Zhu, Chen, and Zheng, 2020) looked specifically at AV perceptions and adoption through the lens of media and social media influence. The study of Beijing-based students, is noteworthy for combining innovation acceptance with information channels. The study found traditional media and social media to be important channels in the development of perceptions about technology, traditional media informs, whereas social media provides network influence and pressure for people to conform to group norms, which may include perspectives on new technologies. The study found that those who fear new technologies may be encouraged via social media to be more adventurous. The study validates the value of different channels for different communications tasks. In a somewhat similar study, Anania, Rice, Walters, Pierce, Winter, and Miner (2018) found media headlines impacted folks' willingness to go for a hypothetical ride (willingness to ride – WTR) in an AV. Other studies (Hohenberger, Spörrle, & Welpe, 2016) have also looked at the impact of messaging on demographic preferences toward AVs. Another recent study (Ghasri & Vij, 2021), reinforces the importance of communication channels, in this case the positive effects of social and mass media sentiment on perceptions of AVs. The researchers found social channels to be of highest value.

Interestingly, Bansal and Kockelman (2018) hypothesize that consumers may be more likely to purchase AVs if their neighbors and friends do which may reflect the power of WOM and a new concept, consumer arrogance (Ruvio et al., 2020). Ruvio, et al. found that consumers who display arrogance in their purchase decisions tend to talk

about their purchases with others online which may lead to additional sales of the product featured by the arrogant consumer.

Mobility-focused Communications

Keyword search: Automotive advertising, automotive safety messaging

Communications theory cascades into the terminology and labeling used when developing and communicating new technologies and when communicating and building perceptions about opportunities for new mobility. Kassens-Noor, Wilson, Cai, Durst, and Dexaminid (2020) surveyed 963 Michiganders on AV terminology. Another study (Abraham, Seppelt, Mehler, & Reimer, 2017) explored the product names used to identify automated driver-assistance systems (ADAS) in production vehicles and respondents' perceptions of the functionality of the systems, based on the name. Both studies showed that automated mobility product and service terminology is confusing to consumers and is seen by researchers as a potential drag on acceptance and possibly dangerous to users if the confusion translates to a lack of understanding of key features of a safety service or product (Abraham et al., 2017).

Although AVs are not generally available today, they are anticipated within the next decade (Abuelsamid, 2021; Litman, 2021) at which time associated communication may move from informational and perceptional to persuasive. Persuasive communication techniques, including the psychological underpinnings, are well-documented in Vance Packard's seminal *The Hidden Persuaders* (1957) and have been applied to mobility solutions, including those with advanced technologies, for more than 100 years. A survey of messaging and advertising research associated with production vehicles through the ages illuminates a range of perceptional approaches, content

categories, approaches taken, and possible future trajectories should AVs come to fruition. Until the late 1960's, automotive marketing communication in the U.S. was often exaggerative, deploying artists' renderings of products which were made to look larger or lower or more luxurious than they actually were (Eastman, 1984) and accompanied by emotional and unsubstantiated copy (Bergh, Krugman, & Salwen, 1983).

Societal shifts to greater social engagement and an associated increase in regulation transitioned auto advertising to fact-based and more informational content. Bergh et al. (1983) found, through the analysis of 891 print ads over a 50-year time span, ad content shifted to the pragmatic which coincided with the public's interest in safety, efficiency, and the environment. It should be noted that the Federal Trade Commission (FTC) stepped-up oversight of consumer advertising at this time.

Subsequent authors have sought to connect increased safety regulation with messaging content. Burns & Lynch (2003) sought a connection with initial NHTSA-mandated crash testing requirements and messaging content and Burns, Ferrell, & Orrick (2005) revisited the topic for a later time period and found advertisers with lower fleet crash test scores (lower performing vehicles) more likely to cite safety as a benefit than brands with higher scores. Other authors (Ferguson, Hardy, & Williams, 2003) found automobile ad messaging of the period to favor performance attributes over safety and innovative technology. Only 2% of ads featured safety in that study. Airbags are identified as an exception - a safety innovation that was hyped in advance of federal mandates for the devices. A more recent study of Canadian automotive advertising (Watson, Lavack, Rudin-Brown, Burns, & Mintz, 2010) reveals a shift, 25% of ads

mention safety. As a category, consumer advertising is a direct opportunity for industry to influence perceptions. Automotive ads were traditionally one of the largest segments of the advertising market and, as the literature reveals, experienced clearly defined shifts in messaging over time.

Other messaging studies have focused on various communicative strategies and techniques such as two-sided communication (not to be confused with Two-step) where an organization uses a mea culpa to capture the attention and trust of a customer base that may have been wronged in the past (Luke & Vessels, 2004) to more recent studies that have compared messaging around charging infrastructure for electric vehicles (EVs) (Bennett, Kottasz, & Shaw, 2016) that showed, much like the auto advertising studies, OEMs tend toward emotional and theoretical content as compared to more factual content of public service entities, to which they were being compared, provided. Emotion continues to be seen as a powerful communicative force in the conceptual adoption of AVs as Anania et al. (2018) observed using media headlines and as Hohenberger et al. (2016) suggest along gender lines. The challenges of balancing communication and labeling converge in the “What’s In a Name: Vehicle Technology Branding & Consumer Expectations for Automation” (Abraham et al., 2017) ADAS study and in the Michigan State University study (Kassens-Noor, Wilson, Cai, Durst, & Dexaminid, 2020) where language has a material effect on perceptions and behavioral intent.

Interestingly, factors of trust and perceived risk associated with acceptance of online transactions (Pavlou, 2003; Lee & Youn, 2009) are identical to those identified today in the consideration of AV usage (Choi & Ji, 2015; Huang, 2021; Yuen, Ma,

Wong, & Wang, 2020). Ram and Sheth (1989) robustly detail barriers to innovation and highlight resistance to acceptance as particularly acute when innovation has high discontinuity, or is considered disruptive, which is how this study sees AVs.

Technology Acceptance Model

Keyword search: technology acceptance, technology adoption, consumer adoption, autonomous vehicle adoption

Acceptance and adoption in the digital age have become bellwethers of technological potential. Historically connected to the design, testing, and release of enterprise management information systems, the terms have increasingly become shorthand for a set of perceptional reviews used to gauge market willingness or readiness for new technologies, anything from social networking platforms to new modes of transportation (Al-Qaysi, Mohamad-Nordin, & Al-Emran, 2020). Within the AV space, populations are frequently queried regarding their willingness to ride (WTR) which means are they willing to go for a ride in a robotic vehicle. In many cases, respondents are also asked what they would be willing to pay (willingness to pay, WTP) for various automated driving technologies on a vehicular platform. These hypothetical actions are positioned as proxies for future behavioral intention regarding future automated solution selection opportunities. The literature reveals multiple acceptance and adoption theory choices, many similarly rooted in behavioral intention theories (Shabanpour, Shamshiripour, & Mohammadian, 2018; Talebian & Mishra, 2018; Raj, Kumar, & Bansal, 2020; Yuen, Cai, Qi, & Wang, 2021). This study aligns with the Technology Acceptance Model (TAM) for its proven appeal with academic researchers as reflected in five TAM literature reviews (Al-Qaysi et al., 2020; Chuttur, 2009; Jing, Xu,

Chen, Shi, & Zhan; Lee, Kozar, & Larsen, 2003; Marangunić & Granić, 2015). The reviews explore the theoretical evolution (Lee et al., 2003), domain dominance (Chuttur, 2009), modelling factors (Jing et al., 2020), and application and extensions of the theory (Marangunić & Granić, 2015). The most recent review, Al-Qaysi et al. (2020), reviewed 57 articles associated with TAM and social media to reveal subjects, methods, and factors associated with social media acceptance.

Fred Davis, as a graduate student at MIT, developed the Technology Acceptance Model (TAM) at a time when enterprises were strategically focused on management information system (MIS) adoption. TAM resonated with management experts looking to build better processes to assess the likelihood that systems would be used. Central to TAM are system attributes or benefits, behavioral intentions of the users which are influenced by user perceptions of system usefulness, and ease of use. TAM success criteria according to Davis (1985) are usage, user attitudes, and performance impacts – all criteria that can be applied to an array of innovations, including automated driving studies. However, the task of selling high discontinuity innovations is hard. The adoption barriers typically fall into two categories, functional and psychological (Ram & Sheth, 1989). To meet these challenges, Davis and his colleagues built a TAM franchise through a series of updates, refinements, and tools to improve TAM's practicality (Davis, 1989; Venkatesh & Davis, 2000).

The ease and flexibility of TAM contributes to its popularity and encouraged extensions, derivatives, and competitors to the framework. Choi & Ji (2015), Holtl & Trommer (2013), and Nordhoff, De Winter, Kyriakidis, Van Arem, & Happee (2018) adjusted TAM to fit specific research goals. Nordhoff et al. conducted a robust study of

approximately 7,000 respondents from around the globe that leveraged the Unified Theory of Acceptance and Use of Technology Model (UTAUT). Huang (2021) in a recent study positioned for designers of AVs, added an enjoyment variable to TAM when assessing AV adoption trends in China. Others have sought to add consumer insight (Panagiotopoulos & Dimitrakopoulos, 2018) or to improve the predictive capabilities of TAM (Lah, Lewis, & Šumak, 2020). May, Noah, & Walker (2017) used Automation Acceptance Model (AAM) to predict AV adoption rates.

AV-Specific Research

The literature features important AV-specific research that addresses AV perceptions in the form of market forecasts, consideration frameworks, willingness, societal benefits, user behavioral intentions, trust, and skepticism.

Forecasting AVs

AV market arrival dates are a perennial curiosity and important contributors to perceptions of AV readiness and relevancy. The most recent data based on industry analysis comes from Guidehouse Research (Abuelsamid, 2021) which estimated, based on a mixed methods methodology used within the mobility industry, that 14M AV units will be in-market by 2030, the majority of which will be robotaxi and delivery vehicles. Todd Litman (2021) predicts through qualitative assessments that 50% of all vehicles sold in 2045 will be AVs and it will take another 15 years until 50% of all vehicles on the road will be AVs. Bansal and Kockelman in two popular studies (Bansal & Kockelman, 2017; Bansal & Kockelman, 2018) predicted that between 25% and 87% of vehicles on the road 2045 would be L4 AVs, highlighting the challenges of controlling variables when modelling for AV adoption.

AV Consideration Frameworks

AV-specific research seeks more than market projections, frequently focusing on consideration and preferences for automation and the attributes of those expressing their preferences. The structure of these studies is similar, respondents are presented with descriptions of automated driving solutions, some of which are currently available in-market and may be used by the respondents. Other solutions such as advanced autonomous systems may or may not be familiar to the respondents. Descriptions of the design features and associated benefits are provided. Respondents are then questioned about their perceptions of the various solutions – around perceived usefulness and perceived ease of use. It is within the context of perception testing that respondents are asked about their reservations or inhibitions regarding the various options. Holtl & Trommer (2013) queried over 5,800 drivers on their preferences for various forms of driver automation in which the responses were generally favorable with the caveat that solutions needed to be robust in exchange for sharing data. A subsequent selection of similar studies (Kyriakidis, Happee, & de Winter, 2015; Bansal & Kockelman, 2017; May, Noah, & Walker, 2017; Ward, Raue, Lee, D'Ambrosio, & Coughlin, 2017; Bansal & Kockelman, 2018; Nordhoff, De Winter, Kyriakidis, Van Arem, & Happee, 2018; Faber & van Lierop, 2020; Raj, Kumar, & Bansal, 2020) demonstrate the viability of using scenario-based frameworks to surface perceptions. Behavioral intention in AV research is frequently positioned contextually as willingness to pay (WPT) for the technology and/or willingness to ride (WTR) in the technology. Both approaches are designed to gauge respondents' intentions and may include queries into actual solution usage in those cases where the technology is in-market or plans to

purchase or use, on a future vehicle. Hypothetical purchase or ride scenarios are used for systems that are not generally available for purchase at the time of the research. Study data is analyzed with regression tools to understand the relationships between the responses and inquiry categories to develop a picture of future acceptance and adoption.

Respondent attributes, whether they be demographic or personality-based, are studied for their effect on acceptance. For example, Hohoenberger et al. (2016) tested for gender preferences and found men more willing, women exhibited more anxiety about the technology. Koul and Eydgahi (2018) tested for age and found no relationship. Faber and van Lierop (2020) focused on elderly populations which expressed openness to AVs. Kassens-Noor, et. al (2021) sampled disabled users, and others were able to slice and dice on global geographies (Kyriakidis, Happee & de Winter, 2015). Inclusion of personality instruments within respondent questionnaires, tests whether personality traits are a possible factor in trust and willingness to try new things. However, the relationship between personality attributes and solution decision is mixed; one study found a correlation on locus of control and a preference for AVs (Choi & Ji, 2015) and another, not (Kyriakidis, Happee & de Winter, 2015). The source of research participants ranges considerably – Mechanical Turks (Anania, Rice, Walters, Pierce, Winter, & Milner 2018), vehicle drivers (Höltl & Trommer, 2013), generic panels (Nordhoff, De Winter, Kyriakidis, Van Arem, & Happee, 2018). Four studies (Abuelsamid, 2021; Litman, 2021; Raj, Kumar, & Bansal, 2020; Westenberg, Georgieva, Kolodge, & Boor, 2018) sought the insight of mobility professionals.

Societal Benefits of AVs

AVs are generally expected to reduce crashes, emissions, roadway congestion, and streetscape clutter through the application of electrification, shared service models, and automated driving. Several researchers have sought to explore the broader impacts of AVs on society. Fagnant & Kockelman (2015) estimate societal benefits of $2,000 to $4,000 per AV per year in economic benefits. In an earlier study by the authors (Fagnant & Kockelman, 2014), they performed resource allocation modeling for AVs and found shared vehicles would reduce vehicles overall with an overall increase in vehicle miles traveled (VMT) to account for high utilization rates for shared automated vehicles (SAVs). Schoettle & Sivak (2015) found similar effects in their shared vehicle modeling. Menon, Barbour, Zhang, Pinjari, & Mannering (2019) explored the importance of demographics on shared vehicle use and concluded demographics do matter – affluent men are more likely to access shared vehicles. Menon, Zhang, Pinjari, and Mannering (2020) conducted additional SAV market segmentations which were inconclusive. Australian researchers Krueger, Rashid, & Rose (2016) investigated robotaxis, or dynamic ride sharing (DRS) perceptions and found preferences directionally positive but mixed, much like other SAV studies, based on demographics. Another set of researchers (Milakis, Van Arem, & Van Wee, 2017), using literature review techniques, created a ripple effect of impacts within society with the advent of AVs.

Trust and perceived risk factor prominently in AV research. Chi and Ji (2015) extended TAM to include trust as a factor that impacts perceived usefulness. Abraham, et al. (2017) reinforce the imperative that trust impacts acceptance as reflected in the

naming of systems, those not perceived as trustworthy, will not be used. Liu, Yang, and Xi (2019) deployed a TAM study on trust in the China market. Hulse, Xie, and Galea (2018) queried over 1,000 UK road users on perceptions of risk within an automated mobility context. Respondents found scooters and bicycles to be more threatening than AVs. Other perceived AV risks include cyber-attacks, hacking (Liu, Yang, & Xu, 2019), and to a lesser extent, pranking vehicles by intentionally slowing them down (Millard-Ball, 2018).

The literature includes skeptics of the AV enterprise starting with the very concept of acceptance. Stilgoe and Cohen (2021) advocate for rejecting the concept of acceptance and the notion that the public are users to be wooed. The authors advocate for a deeper, more collaborative, level of engagement around technology considerations where citizens are integral to the consideration of new technologies within their environments. Fraedrich and Lenz (2016) share that the public enthusiasm for AVs wanes under scrutiny. And, Kalra and Paddock (2016) question the very premise that AV technology can be made statistically safer than human drivers.

Consequences of AVs

The consequences of the deployment of new automated mobility technologies is likely disruption within our communities and for individual mobility users based on a lack of understanding and planning (Legacy et al., 2019; Zakharenko, 2016). Researchers and editors challenge the assumptions on which the promise of AVs is based. Three of those challenges are identified here. First, a core value proposition on which AVs are based may be flawed. A long-standing assumptions has been that 90% or more of vehicle crashes are attributable to human errors made while driving (Fagnant &

Kockelman, 2015). Kostelec (2020) observes that although human error is attributed to 94% of automobile crashes, the reality is that other factors contribute to human error including weather, infrastructure, and non-driving humans. These problems are not necessarily mitigated by automation. And, although pedestrians see bicycles and motor scooters as greater threats than AVs (Hulse, Xie, & Galea, 2018), Millard-Ball (2018) notes that pedestrians may adapt to vehicles without human drivers by changing their behavior in ways that make AVs travel more slowly than traditional vehicles. These authors illuminate the uncertainty associated with new technologies and the possibility that elements of the core AV value proposition may not materialize.

Second, the challenge of understanding AV terminology, an issue with present consequences in the use of ADAS technologies (Abraham et al., 2017), and how that terminology is used in the engagement of stakeholders in the research and planning processes (Kassens-Noor, Kotval-Karamchandani, & Cai, 2020; Kassens-Noor, Dake, Decaminada , Kotval-K, Qu, Wilson, & Pentland, 2020) fuels uncertainty. Until folks have a better understanding of the terminology and how automated vehicle technologies function as an enabler within their communities, they are likely to be resistant (Ram & Sheth, 1989), and may become inhibitors to the technology.

Third, the challenge of general disruptions caused by a lack of forethought concerning the impacts of AVs (Faisal et al.) dovetails with what Kassens-Noor, Dake et al. (2020) see as determinism on the part of technology providers, vehicle manufacturers, and others with a stake in an AV rollout. This push at all-costs stance reinforces Stilgoe and Cohen's call to reject acceptance (Stilgoe & Cohen, 2021) and risks the creation of organized resistance to AVs.

Planning for AVs

The smart city movement and planners have critical roles to play in environmental and social preparation for automated mobility (Faisal et al., 2019; NACTO, 2019). Although the methodologies and tools exist (NACTO, 2019) to develop holistic approaches to prepare for AVs, much as Bel Geddes (1940) advocated in his seminal work, *Magic Motorways*, the future looks likely to replicate the reactive adjustments experienced in the first half of the Twentieth Century with the adoption of the automobile (Legacy, Ashmore, Scheurer, Stone, & Curtis, 2019; Norton, 2011). Although there is a recognition within the profession that opportunities exist and that without planning, the impacts will be real, little planning for AVs is taking place (Guerra, 2016; Legacy et al., 2019). Fuller (2016) advocates for a balanced urban suburban approach in advance of a time when all vehicles are automated. Most recently, Peter Norton in *Autonorama* (2021) holistically eschews determinism and our inherent car dependency and advocates investing efforts in building more walkable and bikeable communities, less dependent on automation. Whereas Anthony Townsend of Star City Group (2020) forecasts dramatic changes in both the way we move and organize our urban environments as a result of the cascade of autonomous solutions on the horizon while advocating for citizen participation in the reimagining of our communities. KPMG (Threlfall, 2020) published a report that evaluates countries and cities regarding their AV readiness. KPMG's readiness index is based on policy, legislation, innovation, technology, infrastructure and consumer acceptance. The Netherlands and Singapore rank at the top with the U.S. in fourth position. The report cites five cities to watch including Pittsburgh and Detroit.

AVs and Social Equity

Researchers and solution developers have touted the possibility of increased social equity with the advent of AVs through increased travel agility enabled through on-demand and last mile solutions, more accommodating vehicle platforms, and lower costs (Fagnant & Kockelman, 2015). Epting (2019) observes that transport systems generally inflict harm on the underserved and advocates for AV planning that mitigates the harms of the past through inclusionary approaches to planning. Researchers in Michigan (Kassens-Noor, Kotval-Karamchandani, & Cai, 2020; Kassens-Noor et al. 2021) found transit riders, particularly the disabled, leery of automated transit solutions. However, Dutch researchers (Faber & van Lierop, 2020) found, in focus groups of older adults, an appreciation for the potential of increased mobility and flexibility AVs may bring. Issues of equity extend to the development of the software that enables AVs to navigate global physical environments and to do so in morally-acceptable ways across myriad cultures (Bonnefon, 2021). However, Zhao et al. (2016) refute Bonnefon's social dilemma proposition as overstated and see AV driving systems as driven by utilitarian algorithms that prioritize passengers and minimize government regulation. Mladenovic and McPherson (2015) extend concepts of ethical and moral decision making in a contextual manner to traffic control systems envisioned as integral to automated and efficient traffic flows.

Methodology

This mixed methods approach to understanding industry insider perceptions of automated vehicles, their market timing, preferred communication techniques, and possible impacts on communities is reinforced by the methodology's use by several

studies included in this survey (Abuelsamid, 2021; Fraedrich & Lenz, 2016; Raj et al., 2020) and by Maxwell (2016) who posits that mixed methods research has been around much longer than texts would suggest. Maxwell goes further to illuminate examples of investigative richness gleaned from combining both qualitative and quantitative methodologies. Chapter Three of this document elaborates on the mixed methods techniques deployed in this study.

Summary of Literature Review

This review provides an overview of the two theories on which this study is grounded; Two-step communication and its successors, Technology Acceptance Model, and a selection of work demonstrating how the theories have been carried forward within the context of digital communications, disruptive technologies, and smart environments. This study is focused on industry strategies used to influence perceptions of technology which necessitates the inclusion of material that investigates a range of perceptional contributors for AVs; benefits, consequences, language, and considerations within the context of planning and communities. The communications review also includes a survey of automotive advertising trends which provides context for the evolution of mobility marketing, a traditional form of influence for the precursor of AVs.

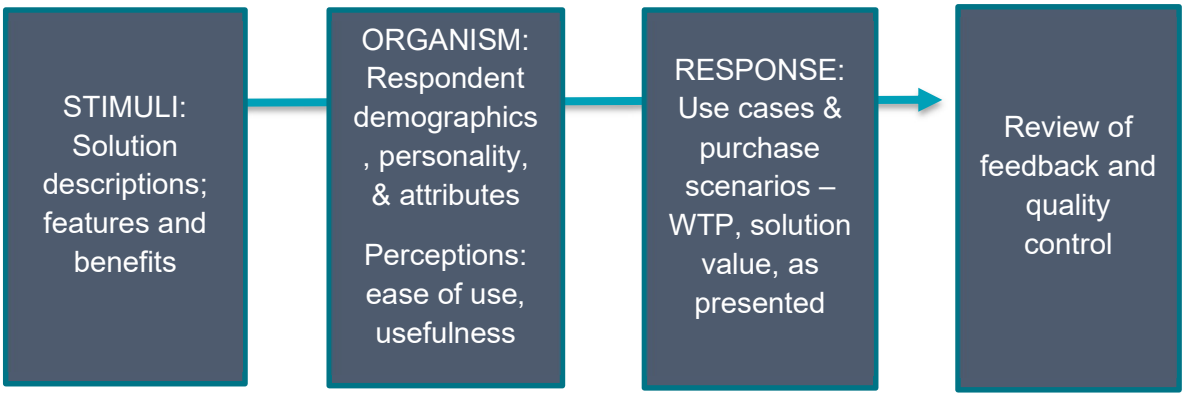
As a whole, the literature demonstrates the fascinating breadth of factors that contribute to the socialization of new ideas and new technologies. The early work of Lazarsfeld and Katz builds a transference framework starting with electoral politics and culminating in consumer products and pharmaceuticals, a sort of information conveyor belt that culminates in results, whether those results be votes cast, scripts written, or

movies seen. Decades later, Davis takes the same basic process and adapts it to enterprise work environments in an effort to lend greater understanding and predictability to the implementation of management information systems with the desired result of system use. Davis benefits from decades of advancements in behavioral, psychological, and motivational research to enrich the transference process.

Current studies, reflective of digital tools and social networks, blur the lines and the origins of the types of information and content used to influence motivations and behavior but still hew to the original format of stepwise transference. Both domains are firmly rooted in consumption or consumerism supported by the acquisition of knowledge, whether that be of an individual's own free will, as in the case of casting a vote, or based on the desires of employers and organizations as would have been the case in the original TAM studies exploring the use of enterprise technologies. Both Two-step and TAM were founded on the concepts of trusted networks of individual relationships which have evolved to include moderated digital content and, as most interestingly reflected in the plethora of AV TAM studies, as acceptance in a global context of a category of technology not currently available for consumption.

Figure 7 represents the various concepts reflected in the reviewed literature associated with choices and decisions. As Vance Packard detailed in *The Hidden Persuaders*, the variables and permutations that contribute to decision making, whether that be a vote cast or a consumer product purchased, are limitless. Stimuli include product descriptions, video content, barriers to consideration, etc. Organism are the features and attributes of decision makers and their perceptions.

Figure 7: Aggregated Information Transference Process – Literature Review



Source: Author

The literature represents a theoretical and contextual foundation on which to build this study. In the search for information transference and the impact perceptions have on future expectations for disruptive technologies, the literature demonstrates the power of moderated communication and perceptions on future intentions. All reviewed literature is presented in Table 1.

Table 1: Literature Review Summary

RESEARCHERS/ WRITERS	METHODOLOGY	ISSUES/METRICS ANALYZED	MAIN FINDINGS
(ABRAHAM, SEPPELT, MEHLER, & REIMER, 2017)	Survey - tested user's perceptions and expectations of actual ADAS system names L1 > L5 scale. Increased education needed.	ADAS naming, perceptions users have of the feature based on the name	Ambiguity and confusion. Technology naming impacts expectations and trust.
(ABUELSAMID, 2021)	Industry report - Guidehouse Market Data AVs Q2 2021 - industry survey and interviews	Industry analyst report, AV industry	Leaderboard and executive summary. Tech firms are seen as leaders, OEMs in middle, Tesla lags. 14M units by 2030.
(AL-QAYSI, MOHAMAD-NORDIN, & AL-EMRAN, 2020)	Lit review - TAM meets social media - systematic lit review of technology adoption - 494 articles cleared	Most frequent research methods, subjects, and techniques.	N=57 articles are TAM/social media adoption, study designed to categorize the TAM/SM domain. Students are most frequently studied.
(ANANIA, RICE, WALTERS, PIERCE, WINTER, & MILNER 2018)	Survey - Mechanical Turk - positive or negative headlines, WTR, experiment	How media headlines influence peoples' perceptions influences willingness to ride	importance of information, positive or negative, on WTR
(BANSAL & KOCKELMAN, 2017)	Survey - Quantitative - modelling using survey data from 2167 respondents regarding WTP for AV technologies and vehicle transaction decisions.	WTP – L1, L2 WTP- connectivity WTP – advanced technologies Opinions – AVs Opinions – AV trip usage and long-distance travel.	Simulation framework to predict adoption: AV technologies, vehicle transaction decisions – model spec. Forecast adoption rates, ran 8 scenarios,
(BANSAL & KOCKELMAN, 2018)	Quantitative - Econometric multivariate analysis opinions of AVs, their demographics and WTP. Survey – 1088 respondents. Ordered probit and interval regression models. Understand Texans' opinions/perceptions re: AVs and their WTP for the technologies and/or services	Interest in and WTP to add connectivity, WTP for automation technologies, adoption timing of autonomous vehicles, SAV adoption rates under different pricing scenarios, home location shifts due to AVs and SAVs, support for tolling policies. Study contributions; detailed summary stats illuminate perceptions and significant explanatory variables identify regions with high and low penetration rates for AVS.	41% of Texans not ready for SAVs, 7.3% ready to rely solely on SAVs. WTP for L2, L3, L4 and connectivity; $2910, $4607, $7589, $127. Talking to other passengers and looking out the window – top activity picks for L4. Affordability and equipment failure are top concerns. Expect better fuel economy and decreased crashes.
(BARBOUR, MENON, ZHANG, & MANNERING, 2019)	Survey data - AAA data from 12 states, used to create statistical adoption models.	Factors that contribute to willingness to use	demographic preferences - single vehicle families less inclined,

Table 1 (cont'd)

RESEARCHERS/ WRITERS	METHODOLOGY	ISSUES/METRICS ANALYZED	MAIN FINDINGS
(BEL GEDDES, 1940)	Book - forward-looking dissertation on roadway infrastructure needs in the U.S.	Condition and issues of current infrastructure, state of current mobility - benefits and shortcomings, methods to improve, technological opportunities. Safety, technology, society.	Current (1940) infrastructure does not support current automotive technology. Roads and drivers are the cause of crashes ~ 36,000 deaths per year. Advocates for advanced technologies including automated solutions (draws on rail & aviation) and advanced agile motorway designs to facilitate fast & safe travel.
(BENNETT, KOTTASZ, & SHAW, 2016)	Systematic study of EV promotional materials. Systematic network analysis > categorical content analysis > survey non-EV motorists	Messaging provided by OEMs vs. public entities providing EV services	OEMs much more emotional and theoretical, infrastructure providers, more factual. Drivers favor experiential approach to marketing EVs - great driving experience.
(BERGH, KRUGMAN, & SALWEN, 1983)	Content analysis - historical study of puffery in auto ads 1930 > 1980, analysis of 891 ads, all from Time	Analysis of images, headlines, copy	decline in puffery - significantly starting in the 1960s. Social and regulatory forces. FTC - advertising substantiation program started in the 1970s.
(BONNEFON, 2021)	Book - process to investigate an issue	ethically developed self-driving software. Process	Gamification for data
(BROSIUS & WEIMANN, 1996)	Content analysis and quantitative - media data set analyzed, and a survey	role of influencer/early recognizer on the agenda-setting process (2-step), direction of process	inconclusive results - language is confusing
(BURNS, FERRELL, & ORRICK, 2005)	Content analysis - 561 magazine ads - 3 channels	Safety related content analysis combined with a comparison of NHTSA crash test ratings	Those that cite safety most have lower crash ratings
(BURNS & LYNCH, 2003)	content analysis - 351 print ads - 1977 & 1981	did ad content change with advent of NHTSA crash testing requitement?	No

Table 1 (cont'd)

RESEARCHERS/ WRITERS	METHODOLOGY	ISSUES/METRICS ANALYZED	MAIN FINDINGS
(CHOI & JI, 2015)	Extended TAM – schematic for trust. Survey of 552 respondents, PLS (partial least squares analysis – type of regression) analysis,	Trust factors - predict user's adoption of autonomous vehicles. Investigate factors that engender trust in AVs. TAM Trust Perceived risk Personality traits And how they impact behavioral intention	Perceived usefulness more valuable than perceived ease of use on behavioral intention. Trust – strong effect on perceived usefulness. Perceived risk is not a significant factor to predict behavioral intention. Locus of control and driving sensation – external locus of control – greater intention to use AVs. Sensation not a significant antecedent of behavioral intention – need more research on expectations around novelty in the AV experience.
(CHU & KIM, 2011)	Survey N = 363 UG students. Test a conceptual model; tie strength, homophily, trust, normative and informational interpersonal influence – as precursors of behavior on social networking sites.	Opinion; giving, passing, seeking. SNS used SNS usage/duration SNS activity/participation SNS contacts	Tie strength positive, homophily – negative. Trust – positive. eWOM important; SNS great channel, access, relationships, cost-effective.
(CHUTTUR, 2009)	Lit review - historical review and analysis	historical evolution of TAM	TAM dominant MIS adoption theory, may have reach saturation
(DAVIS, 1985)	Quantitative – survey, 100 respondents, and experimental – user acceptance testing.	Psychological model for use/acceptance - develop and test a theoretical model of the effect system characteristics have on user acceptance; improve process of user acceptance and, provide theoretical basis for user acceptance testing methodology.	How to develop a model that predicts user acceptance prior to MIS implementation? Three success criteria; usage, user attitudes, performance impacts
(DAVIS, 1989)	scales development - PU/PEU, field studies	better measures for predicting and explaining MIS use - reliable & predictable	creation of new scales for PU, PEU (is this the dissertation research?) PU is more strongly correlated with use than PEU.

Table 1 (cont'd)

RESEARCHERS/ WRITERS	METHODOLOGY	ISSUES/METRICS ANALYZED	MAIN FINDINGS
(EASTMAN, 1984)	Dissertation - historical research; development, annual model change, safety deficiencies, horsepower race, accidents, highway safety movement, safety research.	Development of the U.S. automobile. Trade-offs of selling and safety.	Up to 1966 the industry emphasis was on sales turnover - built-in obsolescence. Eight chapters; safety of first US vehicles, Impact of annual model change on design, impact of annual model change on safety, horsepower race and impact on safety, reaction of industry to crashes, industry and highway safety movement, origins of design for safety, Development of safety research, conclusion
(EPTING, 2019)	complex moral assessment. Literature review	Assessing whether AVs will improve or diminish social justice.	Advocates for the underserved - move to the front for AV introductions. Use AVs to make society more just. Start planning now.
(FABER & VAN LIEROP, 2020)	Focus groups, 24 older adults, The Netherlands	Interest in AVs and preferred ways to use in urban and peripheral areas	generally interested and cite specific use cases that are appealing
(FAGNANT & KOCKELMAN, 2014)	resource allocation model for SAVs and associate impacts	VMT, # of vehicles, wait times, environmental metrics	Huge reduction in vehicle needs, increase in VMT - 11% - environmental mixed
(FAGNANT & KOCKELMAN, 2015)	Economic benefits modelling	Social impact study, exploration of the regulatory and liability aspects of AVs	Robust, well-cited economic impact study - benefits to society - $2,000 - $4,000 per year, AV
(FAISAL, KAMRUZZAMAN, YIGITCANLAR, & CURRIE, 2019)	systematic lit review - smart cities lens	Smart city readiness, opportunities	comprehensive review, balanced, lens of smart city - definite opportunities, planners and cities are unprepared - not factoring in disruptions
(FERGUSON, HARDY, & WILLIAMS, 2003)	Observational, coded results - ~ 561 TV ads for cars and minivans	22 messaging themes developed, each segment was coded.	only 2% of ads featured safety as a theme. 1993 was an exception - year manufacturers were installing airbags prior to US regulations. (buyers claim to be focused on safety) Performance and sales incentives are top themes.

Table 1 (cont'd)

RESEARCHERS/ WRITERS	METHODOLOGY	ISSUES/METRICS ANALYZED	MAIN FINDINGS
(FRAEDRICH & LENZ, 2016)	Chapter 31 - survey & focus groups	Behavioral motivations to drive. Appeal of AVs	Authentic - cut below the surface of AV curiosity. People drive for many reasons including values and status. 46% of respondents + to AVs. Deep dive uses cases, respondents less enthusiastic.
(FULLER, 2016)	Futurist essay: Cityscape: A Journal of Policy Development and Research	Metropolitan opportunities based on autonomous vehicle adoption	Balanced urban/suburban vision for a time when all vehicles are autonomous
(GHASRI & VIJ, 2021)	Survey - 862 residents of Sydney, then discrete choice experiment - DCE - effects of media on adoption considerations	media, social, WOM - clever tool - social network name generator - that has respondents share their contacts for modeling purposes - WOM from your friends may have higher value	social and market impact uptake of products (NWOM, PWOM) Social media as a positive effect on AV preferences
(GHEORGHE, 2012)	Literature review, theoretical review	Marketing-focused review of personal recommendations, interpersonal relationships, interpersonal communication, informal communication, personal and interpersonal influence, and informal forms of advertising.	Effective
(GUERRA, 2016)	Interview-based assessment of planning preparations for autonomous vehicles includes comprehensive overview	Metropolitan planning preparation for autonomous vehicles	Metros not formally planning at this time
(HOHENBERGER, SPÖRRLE, & WELPE, 2016)	Quantitative survey - 1603 Germans	Early adoption, TAM,	Messaging ramifications, reduce negative emotions in women and enhance positive to increase acceptance (women are less predisposed to AVs)

Table 1 (cont'd)

RESEARCHERS/ WRITERS	METHODOLOGY	ISSUES/METRICS ANALYZED	MAIN FINDINGS
(HÖLTL & TROMMER, 2013)	Quantitative – survey of 5807 drivers – Friedman test – 6 ADAS and four acceptance factors; hypotheses for system analysis, 1-5	TAM - Demonstrate the difference in acceptance of ADAS applications for the reduction of fuel consumption using predefined acceptance factors. Develop a research model that explains the relationships of acceptance factors of ADAS in a combined solution. Factors - Perceived usefulness Perceived ease of use Changed driving behavior Perceived efficiency Six solutions	Solutions seen as beneficial; feedback solutions need to be robust in exchange for giving-up data. Perceived ease of use is rated lower than other factors. Acceptance assessment process developed here is good for pre-prototype. Use experimental approach w/prototypes
(HUANG, 2021)	Survey study - TAM - China. Positioned as offering design input to successfully move AVs	Perception - trust, self-enjoyment, self-efficacy -	TAM; PU, PEU + enjoyment, etc. Data to use for designers of AVs.
(HULSE, XIE, & GALEA, 2018)	UK online survey of ~1,000. Public, quantitative and qualitative open fields	AV risks to drivers, road users pedestrians, etc.	AVs not as risky as motos and bikes. Less risky to pedestrians than human drivers. Coding priorities - prefer vehicles that protect owner/users
(JING, XU, CHEN, SHI, & ZHAN, 2020)	Literature revies - assessment of AV adoption factors using a lit review to filter - 75 papers make the cut	Assess three types of literature - behavioral theories, non-behavioral theory papers, and mathematically-based, and empirically-based.	Factor list - PEU, PU, safety, risk etc. bit of a hodgepodge
(KALRA & PADDOCK, 2016)	AV test miles model	AV test miles required to demonstrate AVs are as safe or safer than traditional vehicles	Impossible to accumulate enough test miles to statistically prove AV safety as compared to human-driven vehicles. Need to develop new metrics for AV safety
(KASSENS-NOOR, CAI, KOTVAL-KARAMCHANDANI, & DEXAMINID, 2021)	Survey - 1,861 transit riders w/disabilities	Perceptions of AVs on the part of the disabled, an underserved population	Riders that require accommodation have a negative perception of AVs. Opportunity to broaden the appeal
(KASSENS-NOOR, DAKE, DECAMINADA , KOTVAL-K, QU, WILSON, & PENTLAND, 2020)	Lit review - Commentary based on systematic review of 185 AV articles resulting in a taxonomy	state of the literature, gap assessment	Determinism, lack of awareness around consequences

Table 1 (cont'd)

RESEARCHERS/ WRITERS	METHODOLOGY	ISSUES/METRICS ANALYZED	MAIN FINDINGS
(KASSENS-NOOR, KOTVAL-KARAMCHANDANI, & CAI, 2020)	Survey of 2387 transit rider in MI	WTR - willingness to ride AV transit, fixed route vs. demand-available, disability impact choice?	a lot of complications
(KASSENS-NOOR, WILSON, CAI, DURST, & DEXAMINID, 2020)	terminology survey of 963 Michiganders	Perceptions and understanding of terms associated with AVs.	inconclusive results - language is confusing
(KATZ & LAZARSFELD, 2017)	Book - field study, Sandusky, Ohio voters	Transference of electoral information, social networks	Opinion leaders function between media and end user
(KATZ, 1957)	refinement report - 2-step flow (influencers)	validity of 2-step, interpersonal was a bit of a surprise in The People's Choice had not been empirically tested as well as it could have been - but has been now - Decatur, Elmira, and drug study,	2-step valuable form of transference. Stepwise development process; impact of personal influence, flow of personal influence,
(KATZ, 1987)	Direct update - Elihu Katz - of Lazarsfeld's work with communications panel studies 1940 > 1960. Columbia University, Bureau of Applied Social Research	influencers and 2-step flow - status after five studies - Rovere, Sandusky, Decatur, Elmira, mid-western drug study.	information sharing in these studies tends to take place in homogeneous groups - economic, religion, etc. Interpersonal relations - source of information, pressure, support
(KOSTELEC, 2020)	Commentary -	Frequently cited stat: 94% of crashes are due to human error - propagated by NHTSA	Points to fallacy of the point - distracting from finding the real issues. Fix system design errors.
(KOUL & EYDGAHI, 2018)	Survey, manufacturing company employees.	TAM + 2 demographic questions - years of driving, age.	age was not an effective factor in this study
(KRUEGER, RASHIDI, & ROSE, 2016)	AU online survey, scenario-based	Perceptions of shared AVs, determined travel time, wait times, and fares	
(KYRIAKIDIS, HAPPEE, & DE WINTER, 2015)	TAM – opinion research, diffusion, 63 question survey, 4886 respondents. 109 countries. 10 item version of the Big 5 Inventory. Individual level – descriptive statistics. Spearman International level – correlational analysis.	Driving preferences – self-driving, expectations of technology, and technology adoption. Concerns; hacking, data sharing. Alternatives to driving if automated. WTP.	Higher income countries – more concerned about data. High mileage drivers more WTP for tech. A market for AV technologies exists. 5% WTP more than $30,000 for it.

Table 1 (cont'd)

RESEARCHERS/ WRITERS	METHODOLOGY	ISSUES/METRICS ANALYZED	MAIN FINDINGS
(LAH, LEWIS, & ŠUMAK, 2020)	Quant survey - 3	TAM PU, PEU, testing usability predictions for TAM	mTAM - modified to test PEU - seems
(LAZARSFELD, BERELSON, & GAUDET, 1968)	Panel study	information sharing 1940 presidential election	
(LEE & YOUN, 2009)	Experimental – 247 respondents for online experiment – test impact of web site type on an apartment renting scenario. Embedded instrument: Advert. Skepticism Scale.	Trust factors and effects in digital environments that rely on eWOM. Attitude toward apt. Intention to rent Willingness to recommend	Assumption that consumer trust peers more than marketers. Rules of WOM changed w/web? Unknown folks credible? Theory – attribution theory. Causal inferences regarding why a communicator advocates a certain position.
(LEE, KOZAR, & LARSEN, 2003)	meta-analysis of lit and survey	current (2003) state of TAM within IS community	complimentary
(LEGACY, ASHMORE, SCHEURER, STONE, & CURTIS, 2019)	AU study - Literature review, interviews (qualitative)	Effects of AV rollout on transport and urban planning	Disarray - planners are well-aware of AV technology but are not actively planning for it and anticipate a reactive approach, much like the automobile.
(LITMAN, 2021)	Academic industry-analyst report, literature review, cost analysis, comprehensive	Cost/benefits, adoption, obstacles, implications for planning	2045 for 1/2 of all new vehicles AV. 2060 before 1/2 of all vehicle AV
(LIU, SIDHU, BEACOM, & VALENTE, 2017)	Historical review of network theory, 2-step presented as the foundation of network theory	Components of network theory, diffusion of innovations (corn seed)	Mass media primes networks; 2-step and beyond. Heterogeneity is a concept.
(LIU, YANG, & XU, 2019)	Risk perception study - China survey - psych model - testing three acceptance measures - general, WTP, behavioral intention - TAM	Social trust - facilitator of adoption	Moderate relationships, high levels of concern over safety, cyber-security, and legal liability
(LUKE & VESSELS, 2004)	Assessment of 1-sided vs. 2-sided advertising	Comparative assessment	
(MARANGUNIĆ & GRANIĆ, 2015)	TAM lit review - 85 articles selected, top 7 reviews PIT	Reviewed 3 areas; lit reviews, TAM extensions, TAM applications	85 articles, popular, founding, use, extensions

Table 1 (cont'd)

RESEARCHERS/ WRITERS	METHODOLOGY	ISSUES/METRICS ANALYZED	MAIN FINDINGS
(MAXWELL, 2016)	Historical review of mixed methods research, updating the record	Qualitative and quantitative concepts in one study.	Mixed methods and hybrid studies have been around much longer than textbooks would allow.
(MAY, NOAH, & WALKER, 2017)	Survey - Quantitative - Execution of SEM – 202 participants. Attitudes toward L1 & L2 systems. Included the technology experience subscale. Lange and Lagrange multiplier tests used to optimize the model	Review of acceptance models and selection and demonstration of a viable example for AV adoption. Six in-vehicle automation systems; perceived usefulness, attitude toward using, behavioral intent to use.	Fishbein and Ajzen behavioral model the basis for TAM. Attitude toward using influenced by perceived usefulness and perceived ease of use. Related to task –technology fit model Recommend Automation Acceptance Model – AAM – for automated vehicles. All conceptual. Structural Equation Modeling (SEM) testing conceptual models w/real data sets
(MENON, BARBOUR, ZHANG, PINJARI, & MANNERING, 2019)	Survey - AAA and university, SAV impact on household vehicle ownership	household vehicle ownership trends should SAVs materialize	gender, affluence, etc. impact willingness.
(MENON, ZHANG, PINJARI, AND MANNERING, 2020)	AAA and university survey respondents, cluster analysis	Consumer perceptions for adoption and barriers	Respondents split into one of four market segments, likelihood to adopt - inconclusive
(MILAKIS, VAN AREM, & VAN WEE, 2017)	Literature review; AV impacts, existing literature on implications, and research gaps	AV potential effects on policy and society, literature discussing AV effects, and identify areas for future study	Robust literature review, ordered ripple effects, no mention of leadership or planning.
(MILLARD-BALL, 2018)	Game theory approach to model interactions between pedestrians and autonomous cars	Focus; yielding at cross walks	pedestrians may take advantage of AVs, As travel times may be longer than traditional vehicles due to the caution of AVs.
(MLADENOVIC & MCPHERSON, 2015)	Conceptual framework for addressing social justice issues in traffic control technology	Equitable and ethical approaches to building traffic control systems for AVs	Notions of equality and access - important when ceding control in the driving process
(NACTO, 2019)	Design guide - autonomous urbanism	Transportation planner's design guide	Provides people-centric infrastructure guidance

Table 1 (cont'd)

RESEARCHERS/ WRITERS	METHODOLOGY	ISSUES/METRICS ANALYZED	MAIN FINDINGS
(NORDHOFF, DE WINTER, KYRIAKIDIS, VAN AREM, & HAPPEE, 2018)	TAM – predictors of acceptance. UTAUT Quantitative – survey- 7,755 respondents, 116 countries – large scale. 94 question survey; sociodemographic characteristics, Usefulness and ease of use – driverless vehicles, Attitudes re: daily travel and enjoyment of driving, Attitudes – pleasure and social influence, Personality-related attitudes – control, tech, mobility, future, car-free, skepticism, Intention to use driverless vehicles	Acceptance of driverless vehicles, attitudes toward technology, knowledge of mobility-related developments, sociodemographic characteristics. General acceptance by country (negative correlation w/national GDP)	Unified Theory of Acceptance and Use of Technology (UTAUT) is synthesis of eight influential acceptance models.
(NORTON, 2011)	Book- historical exploration of property rights, motordom advocacy, advent of traffic management	Historical records, press, courts, etc.	With the advent of the automobile, challenges ensued regarding the use of streets, their ownership, stakeholders: railways, users, motorists, business associations. Shared space to specialty space - codified, socialized, etc.
(NORTON, 2021)	Book - history of technological promise	Uses technological mega events as a framework to assess future mobility promises.	Industry strives to keep the public dissatisfied with the status quo by promising more. Unsustainable.
(PACKARD, 1957)	Book - Motivational research, antihumanistic	MR- motivational research survey, point in time state of the art.	Social science research used to boost consumption.
(PANAGIOTOPOULOS & DIMITRAKOPOULOS, 2018)	TAM extension framework (trust, social influence) - web-based survey of consumer attitudes	Factors influencing consumer attitudes re: AV usefulness, ease of use,	Relatively low-income pool, 58% positive on AVs, found constructs of trust and influence to be useful
(PAVLOU, 2003)	e-commerce study - 2 Surveys - to capture data on willingness to transact online -	trust and perceived risk when using e-commerce. Contextually - TAM, TRA	early TAM using WTT - digital
(PRENDERGAST, KO, & SIU YIN, 2010)	attributes of WOM networks - online 150 interviews/surveys collected - HK mall intercept	Source similarity and attitude predicters of transaction intent.	TRA - favorable channel, favorable to messages in channel

Table 1 (cont'd)

RESEARCHERS/ WRITERS	METHODOLOGY	ISSUES/METRICS ANALYZED	MAIN FINDINGS
(RAJ, KUMAR, & BANSAL, 2020)	Five-step process; lit review, consultation w/SMEs, decision-making framework - Grey-DEMATEL, strength analysis, and depiction in CLD.	AV barriers to adoption	Causal relationships - barriers to adoption. LCA- lack of customer acceptance - is largest barrier and can be most effectively addressed by bolstering standards & regulation
(RAM & SHETH, 1989)	TAM - Article – SME content, no science. consumer product innovations – resistance. Explain why customers resist innovations. Identify barriers and strategies to overcome.	Innovation resistance – reasons, characteristics. Functional barriers; - usage, value, risk. Psychological barriers; tradition, image, Strategies for breaking barriers – functional - usage, value, risk. Adopt a systems approach, improve product performance, leverage a well-known brand. Psychological barriers – cultural traditions, image barriers.	High discontinuity, resistance likely. Innovation may conflict w/customer's belief structure. Barriers are functional and psychological.
(RUVIO, BAGOZZI, HULT, & SPRENG, 2020)	one pilot survey, five experiments.	WOM marketing is supported by consumers' arrogant behavior.	Arrogance increases the likelihood of WOM, arrogance is a better generator of WOM than some other traits - braggadocio,
(SCHOETTLE & SIVAK, 2014)	Quantitative survey data, public, US, UK, AUS - 1,533 respondents.	Familiarity w/AVs, Familiarity w/current vehicle technology, expected benefits, concerns, overall interest, WTP	AVs, Concerns about riding, security, performance, concerns about lack of control, no WTP.
(SCHOETTLE & SIVAK, 2015)	TAM – vehicle utilization rates – shared self-driving (potential.) Quantitative model derived from NHTS data files. Extrapolated to entire US and modeled per household for total. Trip overlap is the constraining factor	Demonstrate potential reduction in household vehicle ownership based on self-driving w/return to home feature. PMT per household Drivers per household Trips per household Annual vehicle mileage	Trip overlap per household is low. Possible to move from 2.1 vehicles per household to 1.2 using shared AVs w/return home. Vehicle miles per year increase significantly – based on higher utilization rates.
(SHABANPOUR, SHAMSHIRIPOUR, & MOHAMMADIAN, 2018)	Innovation diffusion model (IDM) - survey 1,253 respondents.	anticipated AV market penetration	Decision to accept AVs: had an accident - WOM, LD traveler or pay for parking - innovative

Table 1 (cont'd)

RESEARCHERS/ WRITERS	METHODOLOGY	ISSUES/METRICS ANALYZED	MAIN FINDINGS
(STILGOE & COHEN, 2021)	Interviews - 50 with public and solution developers. Objectives: how public see engaging w/AVs and whether more democratic approaches to governance get to better alignment.	problem of "acceptance" and using the public as users as opposed to citizens	Reject technical approach and see public as citizens
(TALEBIAN & MISHRA, 2018)	Combines DOI theory with agent-based modeling to forecast adoption. Survey U of Memphis employees, N=327	Resistance - functional and psychological	Marketing and WOM to overcome resistance. Marketing - short-term. WOM more effective as measured by WTP.
(THRELFALL, 2020)	KPMG AVRI readiness report, consultants' analysis of readiness based on policy & legislation, tech & innovation, infrastructure, consumer acceptance	infrastructure-based ranking of 30 countries and jurisdictions; 28 metrics, four key areas - policy and legislation, technology and innovation, infrastructure, and consumer acceptance.	The Netherlands #1, Singapore #2, U.S. #4, five cities to watch include Pittsburgh and Detroit.
(TOWNSEND, 2020)	Book - consultant's identification and examination of issues.	How communities adapt to disruptive technologies	3 forces - specialization, materialization, and financialization. Four new urban forms; core, fulfillment zone, micro sprawl, Desakota
(VENKATESH & DAVIS, 2000)	Four field studies – 156 participants. Online questionnaire. Three points of measurement + sample = pooling of 468.	A better understanding of the determinants of perceived usefulness. Social influences; subjective norm – person's perception of what others think of a behavior. Cognitive instrument process – job reliance, output quality, result demonstrability, and perceived ease of use	Productivity paradox – lackluster returns from investments in IT. Restatement of TAM concepts – intention to use determined by; perceived usefulness and perceived ease of use.
(WARD, RAUE, LEE, D'AMBROSIO, & COUGHLIN, 2017)	Survey of 1,765 US respondents w/embedded experiment	Risk and benefit perceptions of AVs - across different ages. Test informational materials.	Materials that make viewers feel good about the technology increase their perceptions of the benefits
(WATSON, LAVACK, RUDIN-BROWN, BURNS, & MINTZ, 2010)	Analysis of print and TV auto ads 200 ads - 100 TV, 100 print	safety, unsafe driving practices, are Canadians getting helpful ads or should there be more regulation	59% of ads featured performance. 25% mentioned safety

Table 1 (cont'd)

RESEARCHERS/ WRITERS	METHODOLOGY	ISSUES/METRICS ANALYZED	MAIN FINDINGS
(WESTENBERG, GEORGIEVA, KOLODGE, & BOOR, 2018)	Two quantitative surveys; Auto owners re: ADS, liability litigators re: ADS litigation	ADR, litigation,	
(YUEN, CAI, QI, & WANG, 2021)	IDM + TAM model built, survey N=274, SEM used to analyze. Beijing respondents, specifically focused PU and PEU	behavioral intentions - AVs	Theoretical hybrid, positive intentions based on fully assessing product attributes.
(YUEN, WONG, MA, & WANG, 2020)	Theory-based investigation of explanatory variable relationships. Quantitative survey (Korea) , data analysis w/SEM	interrelationship of explanatory variables in AV adoption using innovation diffusion, perceived value, and trust theories.	perceptions of value and trust most important to potential users
(ZAKHARENKO, 2016)	"port" model-based approach -	remote parking feature frees city centers	day parking moves to periphery, density increases, sprawl may increase,
(ZHANG & BENYOUCEF, 2016)	Literature review	Social commerce - reviews, recommendations posted within social networks	First comprehensive study of social commerce lit, 2nd - conceptualizes social commerce with stimulation (SOR) framework, 3rd - framework factors are helpful to companies.
ZHAO, DIMOVITZ, STAVELAND , & MEDSKER, 2016)	Position paper refuting the need for explicitly moral AV programming.	Cognitive assistance - social benefits of AVs	utilitarian algorithms - prioritize passengers, minimum governmental regulation - social dilemma is overstated
(ZHU, CHEN, & ZHENG, 2020)	Quant survey - Beijing-based students, SEM,	Innovation adoption model w/media as a measured source of influence	Mass media - inform, accentuates positive and negative. Social - pressure to conform and tamps down AV risk concerns. Channels make a difference

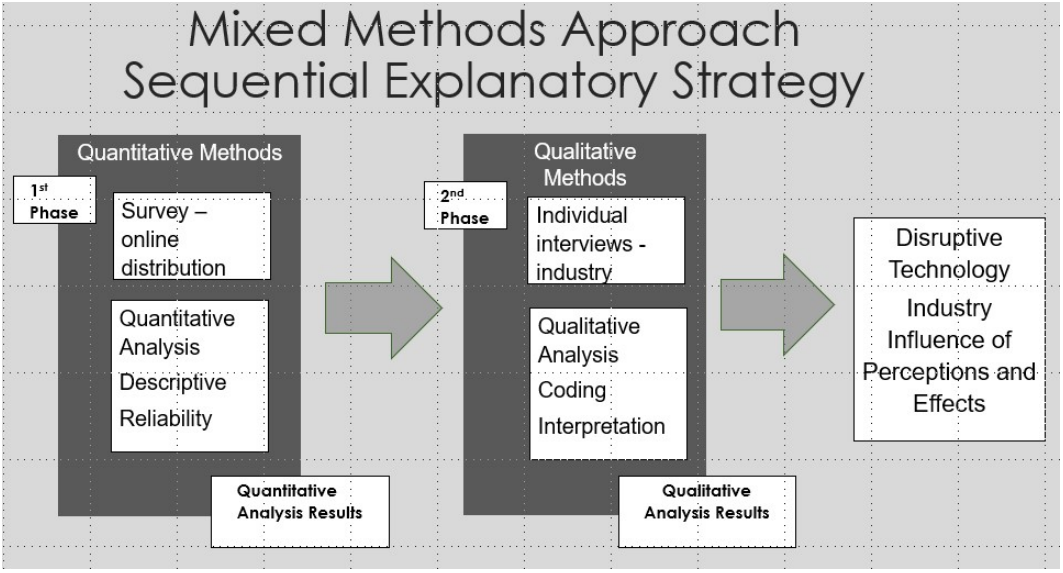
CHAPTER 3 - Research Design and Methods

Research Design

As the literature review demonstrates, this study takes a broad approach to investigating industry strategies to influence perceptions of AVs. A sequential mixed methods approach was chosen for this study to address the two research questions with a combination of quantitative and qualitative data. The sequential aspect of the study provided an opportunity to assess the survey data prior to completing the interview guide.

Creswell and Creswell (2018) advocate for awareness when utilizing a mixed methods approach to research in the social sciences as the technique is not well-known. A mixed methods investigation is designed around the collection of both quantitative and qualitative data that is rigorously analyzed independently and collectively to reveal greater insight than would be obtained through a single approach. Given the dearth of similar studies, the mixed methods approach provides several approaches to better understanding how perceptional influence is applied to AVs and how AV perceptions may affect communities. Figure 8 illustrates the process utilized by this study to explain how industry is influencing perceptions of AVs and how such perceptions may impact communities now, as they plan, and in the future should AVs become a common form of mobility. The first phase, a Qualtrics survey, was launched digitally through commercial channels. Preliminary analysis of the survey data contributed to the interview process by providing insight into expert expectations and sentiment regarding AV perceptions and AV effects on communities. The second phase of interviews was designed to acquire deeper and richer insight from experts.

Figure 8:Methodological Framework



Source: Author

Survey Design

The first stage of the research involved a survey of industry specialists and analysts who responded to a call for participation distributed via industry digital media. The population is therefore self selected, but also highly informed about the subject matter. The 36-question survey was designed to capture perceptions of AVs, the AV market, and social and community effects. The survey anonymously collected demographic information, familiarity with AV automation levels, perceptions of AV solution benefits as reflected in the reviewed literature, expectations for influence and education relating to the technology, perceptional communication preferences, and use cases and the effect such use cases may have on people and communities.

Access to industry experts necessitates the selection of media channels that attract a mobility demographic most likely to be engaged in the development of AVs.

Crain's Automotive News, Association of Unmanned Vehicle Systems International (AUVSI), and SAE International, channels used to recruit survey respondents, are specialty channels that deliver targeted content and function as forums designed for the mobility and tech industries and a subset of potential respondents specifically focused on AVs. The consumers of these channels, as defined in the channel-provided media guides, are a subset of the overall industry.

A note about value, benefits, and time to market as referenced in this study, Lai (1995) defines customer benefits and value as; perceived benefits – perceived costs = customer value. This definition dovetails with the key concepts of perceived ease of use and perceived usefulness associated with the literature of technology acceptance model (TAM) outlined in chapter 2. Time to market (TTM) as a period of time until a product is available for acquisition serves as a measure of point in time solution readiness and, by extension, a measure of confidence in the technology. The concepts of value and TTM are used in many of the reviewed AV studies and were included as foundational concepts for a new audience of industry respondents.

Survey Channels

The channels selected and opt-in recruitment approach dictate a purposive, nonprobability sample. Channel consumers were invited to become survey respondents through digital display ads on select channel web sites and in e-newsletters. The display ads were sponsored by Kettering University, an automotive engineering institute and this researcher's employer at the time the survey was in market. Use of the Kettering University brand was designed to increase the response rate though the use of a brand associated with mobility research. Channel-based

recruitment using display ads negates the ability to apply any type of stratification in the respondent selection process.

The perceptions and expectations survey is a cross sectional instrument electronically deployed Spring, 2021 (March 15, 2021) across three targeted channels consumed by mobility and tech professionals for an elapsed time of approximately 75 days. Figure 9 is a sample of a web banner ad. Digital ad formats varied based on what was available through each channel. In all cases the ad messaging remained the same and was branded Kettering University, a recognized leader in automotive engineering and robotics education. Kettering University sponsored full cost of the development and placement of the ads.

Figure 9: Sample Display Ad

Source: Kettering University

The cross-sectional approach captured the pulse and sentiment of an industry at a point time. The approach is appropriate for an academic exercise with a deadline. Each of the three channels; AutoNews.com (Crain's Automotive News), AUVSI.com (Association of Unmanned Vehicle Systems International), and SAE.com (SAE International) defines their subscribers/readers in their media guides. Table 2 provides

a synopsis of each of the three channels, the properties used, reader profiles, and anticipated and actual impressions. An impression is a viewing of the ad image.

Table 2: Survey Recruitment Channels

CHANNEL	ATTRIBUTES	PLANNED PROPERTY	WHAT RUNS	READERS	ANTICIPATED IMPRESSIONS	ACTUAL – AS REPORTED BY VENDOR
CRAIN'S AUTOMOTIVE NEWS	54,000 traditional subscribers - print. 1.7M unique site visitors per month. 28% retail, 39% OEM/supplier, 33% professional services	AutoNews.com	Digital Display Ads - 4 weeks	OEM readers	173,000	250,795
ASSOC. UNMANNED VEHICLE SYSTEMS INTERNATIONAL	Unmanned and automated systems, 19% are ground, 45,000 weekly eBrief readers	Daily eBrief. Weekly eBrief, web home page	Digital Display Ads - 4 weeks	e newsletters and home page	80,000	NA
SAE INTERNATIONAL	138,000 members, aka Society of Automotive Engineers,	SmartBrief e-newsletter, 23% of readers are c-suite	Digital Display Ads, sponsored news item	SAE SmartBrief readers, 3X per week, 17,300 subscribers	18,000	33,032

Respondents self-select by clicking on the display ads published on channel websites and in channel electronic newsletters which led to the survey. The display ads were sponsored by Kettering University, a technical institute located in Flint, Michigan recognized as a market leader in automotive/mobility engineering. The branded ads were designed to increase click through rates (ctr) by leveraging a recognized mobility brand. At the outset, respondents were assumed to be representative of the demographics for each channel. The self-selection approach further winnows

respondents based on their proclivities and intentions and may impact their attributes as compared to the industry as a whole. The survey sought to confirm mobility industry affiliation and gathered demographic information for data analysis and to compare the respondent pool to the media guide-provided profiles during the analysis phase.

Sample Size

The mobility and mobility-tech industry employs millions of people in the U.S. Headcount associated with retail sales of vehicles and the manufacturing of vehicles and parts in 2021 was over 2.5 million people (Statistica, 2021). This number does not include tech workers associated with the many technical domains associated with automated driving solutions. Technical areas include artificial intelligence (AI), robotics, sensors, etc. The selection of channels seeks to address the issue by including tech and supplier friendly platforms.

This study ties sample size calculations to channel-supplied subscriber populations for the three identified channels. The process of selecting a sample size necessitates the selection of a confidence level and a confidence interval. Together, the two parameters in association with the selected population provide a proposed sample size that is representative of the target population within a range of confidence – the interval. Table 3 depicts the inputs used to facilitate a statistically appropriate samples. This study seeks to state with a 95% degree of confidence that the respondents are 90% or higher, representative of the identified population.

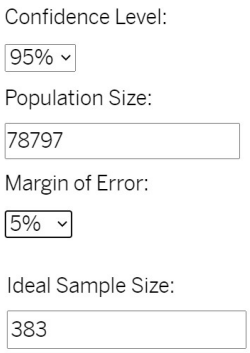
Table 3: Sample Approach

ITEM	CONSIDERATIONS	VALUE
POPULATION	Comprised of the subscriber base for AutoNews.com, AUVSI eBrief, and SAE SmartBrief. The unit of measure is unique individuals. Site readers and subscribers are often quite different. This study chose the most conservative option for each channel; AutoNews print subscribers, AUVSI membership, and SAE SmartBrief subscribers.	AutoNews.com (print subscribers) – 54,497 AUVSI eBrief – 7,000 SAE Smart Brief – 17,300 Total: 78,797
CONFIDENCE LEVEL (CL)	Confidence level refers to the reliability of the estimation procedure – that of selecting a representative sample of the identified population. Note – CL is not the probability that key indicators are to be found within the identified interval. Scientific inquiry within the social sciences frequently specifies a confidence level of 95%	95%
CONFIDENCE INTERVAL (CI)	AKA margin of error, specifies a range of accuracy of the sample to represent the stated population. The smaller the CI, the larger the sample required to support the selected CL.	5
CALCULATED SAMPLE SIZES	Qualtrics XM – 383 Survey Systems - 382	

Determining a statistically appropriate sample size is facilitated by multiple online sample size calculators. Figure 10 the two sampling calculators chosen for comparative purposes; Qualtrics XM and Creative Research Systems. Sample size calculators require three actions; sizing the population, identifying a confidence level, and identifying a confidence interval. The population is sized in the sample approach table. Common practice for survey-based research in the social sciences is the use of a 95% confidence level with an interval of five degrees. The selected measures ensure a sufficiently robust and defensible base on which to build an investigation.

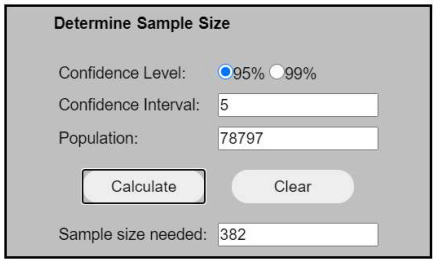
Figure 10: Sample Calculator Results

Qualtrics XM:



Source: Qualtrics

Survey Systems:



Source: Survey Systems

Instrument Development

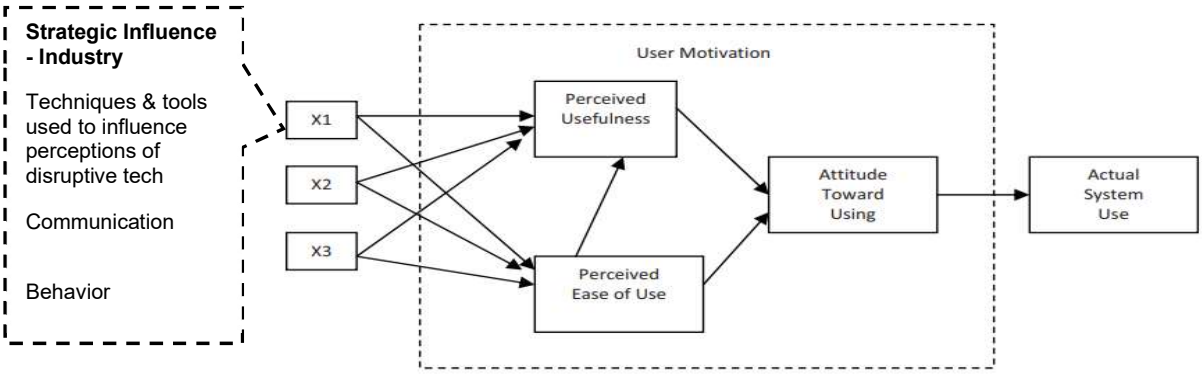
The survey instrument development process served the query requirements of the two research questions. The theoretical foundations reflected in the conceptual framework as provided in Chapter 2 are aligned with the investigative framework and the research questions:

RQ1: What strategies are used by the automotive and tech industries to influence the perceptions of new, disruptive forms of mobility?

RQ2: How do the automotive and tech industries see perceptions of disruptive mobility technologies affecting communities?

Figure 11 conceptualizes the introduction of strategic influence into the process of acceptance consideration as depicted by the TAM consideration process.

Figure 11: Conceptual Framework; Influence, Perceptions, Attitude, Response



Source: Author

Table 4 shows the relationships between the research questions, the conceptual framework provided in Figure 11, variables used in statistical explorations, and target concepts supporting this study.

Table 4: Investigation Framework

RQ CATEGORY	IPAR CATEGORY	CODED VARIABLE	CONCEPTS
INFLUENCE	Influence	Communication – independent	Communication Messaging Experience
PERCEPTIONS	Stimuli	PEU, PU (confidence) – dependent	Solution benefits Solution completeness Solution readiness
EFFECTS	Response	Effects (Impact) – dependent	Community awareness Community readiness Community reaction

Pulling RQ curiosity together with the IPAR framework necessitates inspiration from the published literature – sources that explored the promise of new technologies and the impact of influential communication on franchise-building activities. Two studies; a global public opinion survey on AVs (Kyriakidis et al., 2015) and a Turkish marketing and communications study (Sahin & Zehir, 2013) demonstrated rigor and strong applicability to the concepts of ISAR.

Kyriakidis et al. published a global public opinion survey with 5,000 respondents (4,886 net) that explored user acceptability and willingness to buy all levels of driving automation. The 63 questions, the majority using Likert scale responses, were positioned to take fifteen minutes to complete. Respondents, recruited through CrowdFlower (now – appen.com), were paid ~.30 each. Questions focused on driving, the task of driving, and the application of automation – and how appealing all of that would be. Study emphasis is on the doing and associated enjoyment thereof.

The authors ran descriptive statistics for each of the variables and measured associations between respondent attributes and their stated level of enjoyment, comfort, willingness to pay, and worries about automated driving. The study included analysis about the effect of geography on responses. The authors do not specifically address a process of validation in their methods.

The Kyriakidis et al. study deployed questions and question types that directly contribute to the acquisition of information appropriate for mobility perceptions. Appendix A provides a draft survey with questions and associated sources. The code for questions adapted from this study is khd.

A second study referenced in the instrument development process, Sahin and Zehir, published a peer-reviewed Turkish study that measures brand-building behavioral intentions within the context of automotive brands, brands built on high investments in marketing and technology. The pen and paper instrument was administered to 460 respondents (382 net). The structure of the study and the focus on behavioral intentions as defined by repurchase, willingness to pay, and word of mouth are positioned in a manner that accentuates the concepts of change, change that could be associated with the advent of new technologies or as the result of the use of the technologies. Sahin and Zehir robustly document their survey methodology and their associated sources.

The researchers deploy a viscerality in question construction in comparison to the majority of AV surveys – an interesting style that has appeal when asking respondents to imagine transformative and disruptive technology solutions. The combination of brand psychology, traditional measures of commitment such as willingness to pay, and an exploration of communication effectiveness was irresistible, as a construct for evaluating specific technologies like brands – as a complete experience. Questions from this study have been leveraged in the evaluation of AV confidence and AV communication tools. The authors provide in the methods section of the article a detailed process of instrument validation that resulted in higher performing questions. Appendix A shows questions that were adapted from Sahin and Zehir.

Table 5 provides a guide to the survey developed for this study. Each section was designed with specific objectives. Question types were selected to meet the

objectives. Table 6 maps the research question variables and other variables of potential interest gleaned from the literature to individual questions.

Table 5: Instrument Sections

SECTION	OBJECTIVES	QUESTION TYPES
WELCOME	Tone, credibility, disclosures	No questions
INTRODUCTION	Opener, terminology check	2 – 1 Likert 4, 1 Likert 3
CONCEPT	Predisposition	5 – 4 Likert 4, 1 select
SOLUTION	Benefits, benefit options	7 – 3 Likert 4, 4 rank
INFLUENCE	Readiness to influence	3 – 2 Likert 4, 1 rank
CONTENT	Communication of benefits	4 – 1 Likert 3, 3 rank
WORD-OF-MOUTH	Communication technique	2 – 2 Likert 4
PRICE	Willingness to pay	4 – 1 Likert 4, 2 Likert 3, 1 rank
PLANNING	Community impact	4 – 1 Likert 4, 3 open
DEMOGRAPHICS	Descriptive, confirmation	5 – 1 Likert 9, 1 Likert 4, 1 rank, 2 open
THANK YOU	Appreciation, next steps	No questions

Table 6: Variable Mapping

VARIABLE	RQ	ITEM ON SURVEY
VARIABLE 1: INFLUENCE	Strategies to influence	10, 15, 16, 17, 18, 19, 20, 21, 22, 23,
VARIABLE 2: CONFIDENCE	Perceptions	1, 3, 5, 7, 8, 9, 13, 14, 24, 25, 26
VARIABLE 3: TIME TO MARKET	Perceptions	6, 11
DEPENDENT VARIABLE 2: EFFECTS	Effects	12, 27, 28, 29, 30, 31

The survey took eleven minutes to complete, based on preliminary timed testing. Survey question format included multiple choice, rank order lists, and open fields, each question format chosen to elicit insightful and complete feedback . Effort was taken to design valid questions with similar response options to facilitate response context and reliability. A number of open field questions asked respondents to provide a specific number of observations, generally two. The Qualtrics platform contributes to the instrument design thorough the provision of question types and response choices. Table 7 details the evaluation process for each question type.

Table 7: Question Types

QUESTION TYPE	RESPONSE MECHANISM	HOW EVALUATED
MULTIPLE CHOICE	Likert scales	Scored, various
RANK ORDER	Drag and drop	# options, score for frequency
OPEN FIELDS	Respondent-supplied	Code responses, score codes

Controls

Respondent bias, reliability, and validity are controlled in the following ways:

- Respondent bias, those self-selecting to participate in this study within the selected channels are intended to be representative of industry insiders, as defined by this study.

Reliability

The reliability of the Future of Mobility survey is addressed two ways, through the associative concepts leveraged in the incorporation of previously published instruments (Kyriakidis, Sahin), and using statistical tests for internal consistency. A third reliability metric is the performance of an instrument over repeated tests. The survey has not been retested at this time.

Seventeen of the instrument items that utilize Likert-style response mechanisms were selected for a reliability analysis. Cronbach's alpha shows that the instrument has an acceptable level of reliability, a = .773. See Table 8. Five of the seventeen questions would raise the score, if removed. The relative lack of associative power is reflective of the breadth of questions deployed in this study. One question in particular, Q3, which probes respondents' enjoyment with traditional driving, has the largest drag on the Cronbach's Alpha. Removal of the question would have increased the a to .812. Question means and inter-item correlations, available separately in the item statistics,

vary widely based on the broad range of subjects covered in the Future of Mobility Survey.

Table 8: Cronbach's Alpha – Standardized

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.773	.771	17

Validity

The Future of Mobility Survey was assessed for validity at face value, for content and construct. Face and content validity were deployed three times prior to the official launch of the survey. The Future of Mobility Survey was shared with eleven Kettering University administrators and faculty with recognized interests in research and statistics. Feedback regarding the structure, content, and tone of the questions was shared via email. Once adjusted, the survey was reviewed in-person with a full-time faculty member in the College of Engineering that researches and teaches topics and courses on automated driving solutions. Instrument adjustments were made based on responses and guidance received. Next, the survey was administered via Qualtrics to an advanced undergraduate class of students studying engineering aspects of automated driving solutions. Sixteen students took the survey, 10 of the students provided detailed reviews of the mechanics, sentiment, and clarity and value of the questions. All feedback from this group was carefully assessed. No adjustments were made after this step.

The last step, an attempt was made to validate the construct of the survey through an assessment of inter-item correlations. Seventeen of the 36 questions have a similar construct which facilitates the test. Inter-item correlations range from -.4 to .5. Inter-item correlations of .2 to .4 are preferred, indicating sufficient item variation to be cohesive but not so alike the questions are redundant. The highly negative scores are not surprising for this study seeks to bring together the disparate domains of technology adoption, communications, and planning. Item correlation is ~ .5 for factors such as change, sentiment, influence, timing, ease and value, factors the Future of Mobility Survey seeks to explain. Note: factor analysis was not performed at the inception of the instrument due to the ignorance of the researcher. Internal consistency and scale consistency were run once the data was collected and are reported with the survey results. The inter-item correlations for the 17 items are found in the SPSS reliability file reporting reliability results. Table 9 outlines the instrument testing time frame and context.

Table 9: Instrument Testing

DATES	STAGE	TARGET TESTERS	CONTEXT
FEBRUARY 2021	Preliminary observations	Ph.D. committee members, Kettering University faculty/research colleagues	Recognition of absence of an assessment plan, copy recommendations, objective guidance
FEBRUARY 2021	Timed pilots	Experienced academic researcher in the field of advanced mobility	In-person, timed emotive session, feedback focused on intent, wording,
MARCH 10 - 15, 2021	Beta testers	Students – advanced controls students – mobility	Senior undergraduate students in advanced mobility studies.
MARCH 15, 2021	Production	Specified channels	~ 75 days in-market across three channels.

Each test stage included a wrap back component for a second look by reviewers. Production changes occurred if deemed critical to the task of data collection.

Instrument Analysis

The quantitative analysis is designed to surface insight into the need for influence, preferred techniques and tools to influence perceptions, and the anticipated impact of the technology on communities. All descriptive, relationship, and predictive insight was explored with the aid of IBM SPSS.

Showcasing the contours of influence and the three dependent variables; confidence, anticipated TTM, and anticipated Impact on communities were done in a stepwise manner to facilitate exploratory factor analysis using SPSS to establish baseline correlations, run Cronbach's alpha to assess item reliability, prep data for possible regression analysis, review code and scale open fields, and establish scoring for variables.

The breadth of the survey data enabled the creation of three indices, anticipated time to market (TTM), confidence that automated driving solutions are technically viable (confidence), and effects automated driving may have on communities (impact). All three indices represent important perceptions of automated driving's viability this study explores and were created to test possible relationships using regression techniques. The concepts tested;

- Influence/communication > TTM
- Influence/communication > Confidence
- Influence/communications > Impact

Linear regression testing revealed no significant relationships between influential communication and the indices. However, insider confidence, influence preferences

and associated dependencies (TTM, Impact) may provide the basis for future investigations and engagements within the mobility and planning industries. Table 10 outlines the analytical techniques used to investigate the research questions.

Table 10: Analysis

ANALYSIS TECHNIQUE	OBJECTIVE	WHY USE	HOW ADDRESSED
EXPLORATORY FACTOR ANALYSIS	Correlational baseline, Cronbach alpha tests	Guide	SPSS – quick assessment
DESCRIPTIVE ANALYSIS	Insight regarding insiders as a group and by sub groups (age, gender)	Great insight, facilitates discussion	Slice and dice by respondent attribute against instrument items reflective of the RQs
TEXT ANALYSIS	Coding and scoring techniques for respondent-supplied copy	Provides an opportunity for richness in the collection, most questions specify a # of examples (2) to head-off stalling	Researcher – may be coded and possibly scales – 14, 29,30, 31 are structured for possible scaling.

Reporting

Survey results reporting includes description of all data, analysis of all data, discussion of the findings, and recommendations.

Interview Design

Interviews were conducted via Zoom in thirty-five-minute time periods. The timeframe was selected as a way to invite busy professionals to a quick meeting that would be seen as an interesting diversion in the work day. The format originated from an experience I had being interviewed by several MIT researchers regarding the economic climate in Genesee County, Michigan. I found the :30 meeting via a digital meeting platform to be interesting and efficient.

Interview questions were developed based on the core points in the research questions. Interviews were included in this sequential study for two reasons; to facilitate access to specific industry leadership/executives and roles engaged in mobility development and acceptance, and to provide a channel for deeper explorations of data surfaced by the survey.

Interviewees hailed from seven categories of organizations:

- Original equipment manufacturers (OEMs) – vehicle manufacturers
- Suppliers/technology providers – component manufacturers, software development, robotics
- Media – press and content developers for mobility
- Industry trade associations
- Industry analysts – consultants, analysts, market evaluators
- Insurance industry – liability and property risk management
- Infrastructure experts – roadways, smart roadway technology

Interview data was incorporated into the study through the following six steps;

1. Invitation to join the study through participation in an interview,
2. Scheduling of interviews using an instance of MSU's Zoom at the interviewee's convenience,
3. Conversational interview using an interview guide (appendix XX),
4. Interviews were audio and video recorded and transcribed to facilitate analysis,
5. Transcripts were assessed and analyzed using traditional coding techniques, and

6. Coded content were presented for readers' assessment and applied to task of validating the stated research questions.

Interview Data Analysis

A manual process was used to review, assess, code, and compile the results of the fourteen interviews. The process was undertaken in the spirit of discovery while focused on understanding interviewee insight associated with RQ concepts - TTM, solution confidence, and communication guidance and preferences for awareness and familiarity. Within the context of automated vehicles in general and this study specifically, interview data will be used to assess extension options for ISAR – an integrated communications and adoption framework for disruptive technologies.

CHAPTER 4 – Survey Results

The survey successfully performed five tasks associated with this inquiry. First, the survey established respondents as knowledgeable about self-driving technologies as reflected in familiarity with SAE automation levels. Second, respondents shared their perceptions of AV benefits associated with perceived usefulness and perceived ease of use and expectations for the technology including anticipated market timing and pricing. Third, the survey confirmed the strategic need for influence. Fourth, respondents provided in-depth preferences for forms of influence and moderated content. Fifth, respondents provided detailed perceptions of anticipated effects AVs may have on urban, suburban, and rural environments.

Paid in-market promotion of the “Future of Mobility” survey wrapped-up at the end of May 2021. The master data set was downloaded from Qualtrics as an Excel file and Qualtrics-generated reports run in early June 2021. Qualtrics reporting (Appendix B) provides preliminary insight into respondent perceptions, expectations, and preferences for highly-automated driving solutions. However, this study required more advanced tools to investigate the relationships between the dependent and independent variables outlined in the survey assessment plan. IBM SPSS was selected for managing and analyzing the Qualtrics data.

Overall response to the Future of Mobility Survey was disappointing despite a market-based approach to gathering responses. The three selected channels promote impression counts for their web and electronic newsletter properties as outlined in chapter three that are sufficient to theoretically achieve an engagement level that would net 400 respondents. Digital ad click through rates (CTR) have been declining

industrywide and are generally considered to be below .05%. Ads featuring engagements such as surveys without incentives may be much lower. Ninety-one respondents engaged with the instrument.

Preliminary data management netted 65 respondents and 29 quantitative variables for analysis. A further review of the 65 respondents revealed a respondent who did not complete the majority of the 36 questions and four respondents that did not complete the demographic questions. These five respondents were removed from the data set netting 60 respondents for analysis. Of the sixty respondents, all answered the first seven questions. Signs of survey fatigue appear with question 8 – the first drag to rank type question. Non-complete numbers by question are captured here:

- Benefits of AVs – 3 did not answer (no answer, NA)
- Conditions when – 1 NA
- Provider of – 7 NA
- Service as – 3 NA
- Content – 2 NA
- Creators – 3 NA
- Expense – 1 NA
- WTP – 1 NA
- ROI – 4 NA

There is no way of knowing why respondents chose not to answer certain questions. Possibilities include:

- Unfamiliarity with Qualtrics drag to rank feature,

- Additional effort required to drag to rank,
- A lack of familiarity with the question content, and/or
- No opinion, and/or knowledge.

Two questions with relatively high non-complete rates are noteworthy;

- Optimal provider of advanced automated driving solutions – 7 NA
- Perceived ROI – 4 NA, may indicate outstanding concepts of value.

Both questions provide opportunities for future exploration.

The first users were an advanced class of Kettering University undergraduate engineering students who were invited by direct link to complete the survey for extra class credit as provided by their professor and to provide feedback. No issues were identified with the operational aspects of the instrument and feedback was robust. Fifteen students were credited by their professor for survey participation. These students were recruited as part of the instrument testing phase. Their responses were included in the analyzed data set as their responses were representative of the data gathered through the digital display ads. The remaining 45 respondents were recruited through digital ads linking to the survey through Crain's Automotive News, SAE International, and the Association of Unmanned Vehicle Systems International (AUVSI) digital properties. The anonymous structure of the survey does not provide origination data. Results data is facilitated by the use of reporting tools available in Qualtrics and analytical tools in IBM SPSS. The data file required modifications, definitions, and value labels to facilitate analysis in SPSS.

Descriptive Statistics

Descriptive statistical analysis is the primary from of analysis for this survey data. Demographically, each record includes an IP address, an age category, country of residence, gender, and work domain area of mobility/technology. All respondents are adults. Fifty-two of the 60 respondents are male and work in mobility and technology domains of research and testing. Twelve respondents chose other as their employment category.

The 15 Kettering University undergraduate students and the respondents recruited through the Future of Mobility demand campaign self-reported a median age range of 45 – 54. Female respondents account for eight of the 60 respondents. A complete set of descriptive statistics for demographic variables can be found in the exhibits. Table 11 outlines the age categories and gender of the respondents.

Table 11: Respondent Age * Respondent Gender Crosstabulation

		Respondent Gender		Total
		Male	Female	
Respondent Age	18 - 24	10	5	15
	25 - 34	4	1	5
	35 - 44	9	0	9
	45 - 54	12	0	12
	55 - 64	7	0	7
	65 - 74	5	2	7
	75 - 84	4	0	4
	85 or older	1	0	1
Total		52	8	60

Twenty-nine of the 36 questions are scaled for quantitative analysis. Seven of the questions are open response questions. The open responses have been coded to

facilitate analysis. The 60 respondents are mobility experts as represented by their demographics, a high level of familiarity with SAE levels of vehicle automation, and the roles they hold within the mobility and tech industries. Table 12 provides a crosstabulation of profession and gender.

Table 12: Respondent Profession * Respondent Gender Crosstabulation

		Respondent Gender		Total
		Male	Female	
Respondent Profession	Research	12	3	15
	Testing	10	1	11
	Manufacturing	8	2	10
	Marketing	5	0	5
	Sales	1	1	2
	Regulatory	1	0	1
	Education	3	1	4
	Other	12	0	12
Total		52	8	60

Exploring the responses descriptively using the survey framework reveals that industry experts are familiar with the domain of highly automated driving solutions, see highly automated driving solutions as representing change and exhibit positivity regarding the concept and benefits of L4/L5 solutions. Although respondents enjoy the task of driving, they recognize value in highly automated driving solutions and ranked safety and the ability for drivers to redirect their energies when in highly automated vehicles as top solution benefits. Respondents indicated L4/L5 solutions as most useful when the task of traditional driving is challenging. Sixty-seven percent of respondents see an initial introduction of L4/L5 solutions by 2030. Eighty-five percent of respondents

don’t see a majority of vehicles on the road as being highly automated until 2045, or later, if ever.

Indicators are mixed on which organizations are best positioned to first offer L4/L5 solutions in market. Traditional OEMs are slightly favored. The service model preferences are mixed with respondents equally favoring three of the four options; as-a-service (robotaxi/rideshare), private ownership, and public transit.

Two open questions provided at the end of the solution/concept sections focus on adoption barriers and pandemic-related impacts. The responses identify a comprehensive set of barriers to adoption. Changes in perception of L4/L5 solutions as a result of the pandemic are mixed, with half of the respondents seeing no impact and the remaining 50% citing an array of issues reflective of community health concerns that create cascading impacts in the way people plan to move, how they access goods and services, and where they choose to live.

Question 13 tackles barriers to the adoption of L4/L5 solutions. Respondent-cited barriers to adoption include technical immaturity, safety, and regulatory ambiguity as topline concerns. Solution immaturity is reflected in references to the need for further solution development and/or the addition of specific capabilities before L4/L5 solutions are seen as functional and trustworthy. Ambiguity is reflected in statements for a need for standards and legal frameworks to guide developers and assure end users of the integrity and predictability of L4/L5 solutions. Safety is reflective of a lack of trust for L4/L5 technologies. References were made to specific elements of self-driving use cases, affordability, and, user reluctance for myriad reasons including personal preferences. Table X outlines the two top coded concerns and respondent sentiment

associated with AVs; legal and liability concerns and that L4/L5 automated vehicles are immature and need more development.

Table 13: Barriers to Adoption

Q13 THEMES	SENTIMENT
LEGAL/LIABILITY	Missing regulatory framework
L4/L5 IMMATURITY	More work to be done

Question 14 queried respondents on the impact Covid had on market momentum for L4/L5 driving solutions. Respondents are mixed in their impressions of Covid's impact on L4/L5. By volume, the largest response was no change. Respondents observed that vehicle use patterns changed during the pandemic as reflected in fewer trips, a reduced interest in rideshare driven by a desire to reduce interactions with strangers, and the broad adoption of options a desire on the part of users not to interact with rideshare drivers, and the broad adoption of home delivery of goods and services. Home delivery in-general increased awareness of the desire for contactless solutions that may deploy automated driving solutions. Two respondents observed that the extra time Covid-related lockdowns provided may have encouraged consumers to learn more about automated driving. Robo taxis are frequently mentioned as being potentially useful in a pandemic, if they were clean and meet the needs of users looking to reduce their dependence on personal vehicles. One respondent cited the possibility of AVs as being seen as a sanctuary during such times. Table 14 outlines the two top coded concerns and respondent sentiment associated with Covid-related impacts on AVs; no change and change and associated sentiment.

Table 14: Covid Related Impacts

Q14 THEMES	SENTIMENT
NO CHANGE	Matter of fact – no impact, no impact to trajectory
CHANGE	Seismic – isolation, public transit unappealing, pandemic sped tech, robo taxi+, rideshare-, increase in home delivery of goods

Questions about consumer interest, consumers' need for detailed information and from whom they would like to hear revealed a perceived low level of interest in L4/L5 solutions, a high need for information, and a preference for rich and immersive introductory experiences. Concept value, channels and content types that consumers may find beneficial, as interpreted by industry, confirms respondents' beliefs that consumers do need influential L4/L5 content. Social media and immersive physical experiences are identified as preferred channels through which consumers prefer to learn about advanced mobility solutions. Rich content including video and up-close events dovetail with the channel preferences. Independent content creators, influencers, reviewers, etc. are valued over content from manufacturers.

Questions 22 and 23 uncover the presence and depth of potential influence and word-of-mouth power industry members may choose to wield on L4/L5 solutions. Industry respondents are neutral to positive as to whether they will evangelize L4/L5 solutions to those in their networks and with family members.

Respondents agree L4/L5 vehicles will be more expensive, and center their responses on highly automated driving packages that are expected to cost an additional $5,000 to $10,000 per vehicle. This cost is ~ 20% more than the price of an average new car sold in the United States in 2020. The value of the additional L4/L5 solution

cost is neutral or mixed. Once a cost has been assigned to the solution package, insiders' preferences shift in the following questions from private deployments toward shared and public use cases.

Community effects based on perceptions of L4/L5 deployments is seen as a sure thing. Three open field questions encouraged respondents to share how urban, suburban, and rural environments may change with the advent of L4/L5 driving solutions.

Question 29 queries for urban changes. The two largest areas of responses for this question are associated with operational changes as to how mobility and mobility-related infrastructure may work in the future and concerns about the rights and safety of individuals in an increasingly automated environment. Operational references include changes to the current model of distributed parking, street infrastructure, etc. Respondents cited better marked streets and designated areas for ride hail load and unload as likely changes and are seen as enablers to less congestion and increased traffic flow. Responses include a possible reduction in safety and quality of life in urban settings as a result of AVs. Respondents see L4/L5 vehicles possibly contributing to increased sprawl if long commutes become easier. Collectively, respondents see changes that may contribute to greener and more accessible cities – depending on the long-term use cases associated with L4/L5 solutions. Table 15 outlines the seven top coded concerns and respondent sentiment associated with changes AVs may prompt in urban environments.

Table 15: Urban Changes – Survey Sentiment

Q29 THEMES	SENTIMENT
PARKING	Current urban parking format likely to change; formats, locations, opportunities for new land use on existing parking sites
LANE/CURB INFRASTRUCTURE	Improvements to facilitate AVs
SMART INFRASTRUCTURE CONTROLS	Improved traffic flow, pedestrian safety
SPRAWL	AVs may facilitate long commutes, desire to live further out
VEHICLE FLOW	Use case-dependent, possibility for improvements or more congestion of circling AVs
TRANSIT	Pros – new, more flexible models. Cons – existing public transit diminished by AV rideshare, etc.
QUALITY OF LIFE (QOL)	Greener, cleaner, better urban environments. Cons – a reduction in safety for pedestrians, bicyclists, etc.

Question 30 queries respondents on anticipated changes to suburban environments. Respondents see opportunity for change to both the built environment and in personal mobility practices. Suburban housing may change due to highly automated driving solutions – fewer garages, for example. Opportunities for improved road infrastructure and the addition of more smart infrastructure to facilitate the use of automation are cited. Respondents generally see an increase in flexible transit services that connect distributed suburban households to urban centers, possibly more quickly. Table 16 outlines the four top coded concerns and respondent sentiment associated with changes AVs may prompt in suburban environments.

Table 16: Suburban Changes – Survey Sentiment

Q30 THEMES	SENTIMENT
PARKING/GARAGES	New forms of suburban building with fewer garages
LANE/CURB INFRASTRUCTURE	New and improved infrastructure to accommodate AVs
SMART INFRASTRUCTURE/CONTROLS	Facilitating tech
TRANSIT	Increased flexibility

Rural environments, as explored in Question 31, are environments respondents see least likely as affected by L4/L5 technologies. Some respondents noted that super

commuters remain a potential impact for rural environments. Respondents noted that L4/L5 solutions require improved infrastructure – fewer dirt roads, for example – to successfully deploy in rural environments. Several respondents shared that many farmers currently use automated solutions to run their operations including driverless equipment to harvest crops. Table 17 outlines the four top coded concerns and respondent sentiment associated with changes AVs may prompt in rural environments.

Table 17: Rural Changes – Survey Sentiment

Q31 THEMES	SENTIMENT
ROAD INFRASTRUCTURE	Upgrades needed to accommodate AVs
AUTOMATION	In use by farmers
CHANGE	Rural environments least likely to change
SPRAWL	AVs enable super-commuters and more remote industry

Questions 32 through 35 ask respondents about their age, residence, gender, and work. All respondents are 18 or older. Ages span all available ranges; 18 – 24 and 85 and older. The largest age group for the 60 respondents is in the 45 – 54 age group. The 18 – 24 category is the second largest group, reflective of the Kettering University student participation. Fifty-seven of the 60 respondents are U.S. residents. The survey instrument was designed to attract respondents working in the U.S. mobility and technology domains. Eighty-seven percent of respondents identify as male. Research, other, testing and manufacturing account for 80% or respondents' categorization of their work domains. Other as a category is impossible to parse.

Twenty-two respondents responded to Question 36; "Is there anything else you would like to share?" Six of the respondents acknowledged the question with information unrelated to the data collection process. Incremental data was shared by a

four respondents – demographic data, preferred deployment channels, etc. The remaining respondents tackled ADS terminology and definitions, messaging in the market place, the complexity of anticipating the future considering mobility business models, and the completeness of current solutions.

Ninety one percent of Future of Mobility respondents see AVs as potentially disruptive. Ninety percent of respondents are familiar with SAE driving levels confirming baseline knowledge of automated driving concepts. Respondents confirmed that AVs will be easy to use and useful, under a variety of conditions. Their willingness to convey that enthusiasm with friends and family is more muted. Thirty-one percent of respondents will recommend AVs when asked and 41% will encourage friends and family to consider the benefits. Sixty-seven percent of respondents see an initial introduction of highly automated driving systems in the by 2030 timeframe. Eighty-five percent of respondents see a majority of vehicles as having L4/L5 driving systems 2045, or later, at the earliest. They see AVs at the consumer level a being more expensive than conventional vehicles by approximately $10,000.

Over 90 percent of respondents embrace strategies to influence, inform, and educate users on the technology and ranked their preferences regarding sources of content, content channels and content types that are preferred.

Respondents provided detailed insight into the anticipated effects AVs may have on urban, suburban, and rural environments. Infrastructure changes such as less parking and more green space, traffic and curb management techniques dominate for urban environments. Suburban effects highlight a reduction in garages, improved

access for non-drivers, and migrations to more distant suburbs. Rural changes focus on no change, agriculture, and super commuters.

CHAPTER 5 - Interview Results

As outlined in the methodology chapter, the test plan specifies interviews as a method to deeply explore topics covered by the survey. Fourteen 35-minute digital interviews were conducted between May and August 2021 via the Zoom digital communications platform. Topics include industry perceptions regarding the state of AV technologies, industry leadership, and communication strategies. In addition, interviews provided opportunities to gain more nuanced insight into anticipated time to market and anticipated effects on and opportunities for communities. Interviews were recorded with the participants' permission and transcripts for each interview were logged.

Obtaining access to experts for academic research interviews was challenging. I used my network of mobility contacts, LinkedIn, and referrals to build my roster. If I did not personally know the contact, it was difficult to capture their attention. I had two contacts turn down the opportunity to interview based on organizational restrictions about speaking with outsiders. Several important interviews were done with the express condition that they were off-the-record and that the ideas and opinions shared were not necessarily those of the organization as a whole. All interviews were done anonymously, meaning I do not name the person or their company. I have shared a detailed roster of my interview subjects with Dr. Mark Wilson.

Table 18 provides an overview of the 14 interviewees, their roles, and their organizations. In addition, I have captured my impressions of the interviewee's sentiment based on my memory of the interview and multiple reviews of the transcript. Each interviewee was highly professional in their engagement and, even in cases in

which we know each other well, off the record conversation was kept to a minimum and within the context of the task at hand – a professional fact-finding corporate interview.

Table 18: Notable Interview Quotes

ORGANIZATION	ROLE	NOTABLE QUOTES	SENTIMENT – INTERVIEWER'S ASSESSMENT
TRADE ASSOCIATION – AUTOMOTIVE SAFETY SUPPLIERS	President	"my question is, who programs your ethics?" "Tesla claims they are almost there, even though they have taken almost all of the sensors off the cars.." "some kind of national campaign at the right time"	Annoyance – plenty of work to be done improving the safety and safety compliance of traditional vehicles. AVs are a distraction.
STATE INFRASTRUCTURE – OWNER/OPERATOR	Sr. Project Manager – Connected and Automated Vehicles	"the legality part..the insurance part…both continue to be unanswered questions"	Technologically agnostic, facilitating the mission of zero fatalities.
STANDARDS DEVELOPING ORGANIZATION - ENGINEERING	Editorial Director	"I don't think any good scientist or any good developer, any good academic would deny the efficacy and the intent of having standards" "everybody pays attention to Tesla"	Skeptical
REINSURANCE COMPANY	Professional	"insurance does not equal safety" "I wouldn't say they were mistrusted before 2018, but they were mistrusted after 2018" "the difference about aviation is that all the passengers on the plane don't actually know how to fly the plane" "the difference in this technology (AVs) is that we have something to compare it to and it's ourselves"	Pragmatic problem solver serving a community of AV organizations testing on public roads
DATA ANALYTICS AND CONSUMER INTELLIGENCE COMPANY	Executive Director – HMI – and Driver Interaction	"we felt it was critical to start being forward looking…to set the industry up for success" "we need to set ourselves up for success…there's a misalignment in expectations"	Enabling – working to understand current ADAS HMI issues and improve for AVs – aligning expectations
ORGANIZATION	**Role**	**Notable Quotes**	**Sentiment – Interviewer's assessment**
EUROPEAN OEM	Automated Vehicle Engineer/Strategist, DARPA alum	"commercial applications, because the business cases are a lot cleaner" "there's the fundamental aspect that 95% of Americans think they're fantastic drivers and safety is great for everyone else"	Intellectually engaged – seeking practical ways to deploy AV technologies.

Table 18 (cont'd)			
U.S. OEM	Senior Competitive Intelligence Manager	"(here in the U.S.) …so restricted by more conservative consumers that may not be as adept at accepting (AV) technologies, perhaps even have some technological mistrust" "average new car buyer (is) in their 50's"	Skeptical
MULTI-INDUSTRY PUBLISHING CONGLOMERATE	Editor	"too many technology challenges to really take level five seriously right now" "Elon Musk, I hate to put it on one person….in my opinion, overblown"	Neutral to skeptical
TIER 1 – AUTOMOTIVE COMPONENTS SUPPLIER	President and COO	"I was actually in-charge of our autonomous programs there" "electrification…autonomous vehicles …their not natural partners" "ideal is actually hybrid"	Pragmatic, experienced leader in AV space, insightful, guarded as to how viable approaches are, other than Waymo and Argo.
AUTONOMOUS SYSTEMS COMPANY	Sr. Manager, Safety Policy	"if we look at the….hype cycle in the trough of disillusionment. I don't think we are at the bottom yet" "they held what they called a robotic petting zoo"	Enabling, engaged
HISTORY MUSEUM	Curator of Transportation	"the introduction of the car…there were no rules, there were no regulations, there were no guidelines as to how these things should be dealt with…I see a lot of parallels" "I would argue the road starts with the development of the electric starter introduced by Cadillac in 1912"	Curious, historical context, active at archiving AV history
U.S. EV OEM	Director, Manufacturing Quality	"all of these publicly traded companies have invested billions dollars, I mean billions of dollars in this technology" "these companies don't want to go back to the public and say you know, this is a lot harder than we thought"	Pragmatic to skeptical, big picture
CONSULTANCY	Managing Partner	"it's easy to make a vehicle drive by itself. It's hard to make it drive by itself safely and then repeatedly"	Pragmatist
SMART ROAD INFRASTRUCTURE	VP, Project Development	"for a lot of people…trusting a robot to drive for them is going to take a lot of cajoling" "no one really cares about safety"	Skeptical

As a group, these experts were factual, for the most part, unemotional, and on-topic. Overall, they exuded guarded positivity and determinism – automated driving as a solution is coming – but more slowly than originally planned and in use cases that are different from what captured consumer's and the media's attention five or more years ago. Everyone I spoke with cited Tesla and Elon Musk as the de facto influencers on for automated driving with the understanding that Tesla does not currently sell AV vehicles.

The interviews contextualized the data sought by the research questions. The interviews reference the depth of disillusionment within the industry associated with the events of 2018, the need to complete the mission of functional AVs, and that perceptions will need to be renovated. The interview data reveals the existence of industry influencer strategies, specifically, Tesla as a primary influencer both as a brand and the CEO, Waymo's annual safety report and the formation and ongoing work of Partners for Automated Vehicle Education (PAVE). All three initiatives are designed to enhance the perceptions of AVs and do so through a moderated voice.

This report is based on information gleaned from the 14 interviews. Editorial insight and analysis regarding this content can be found in Chapter 6 in the Discussion section.

In General

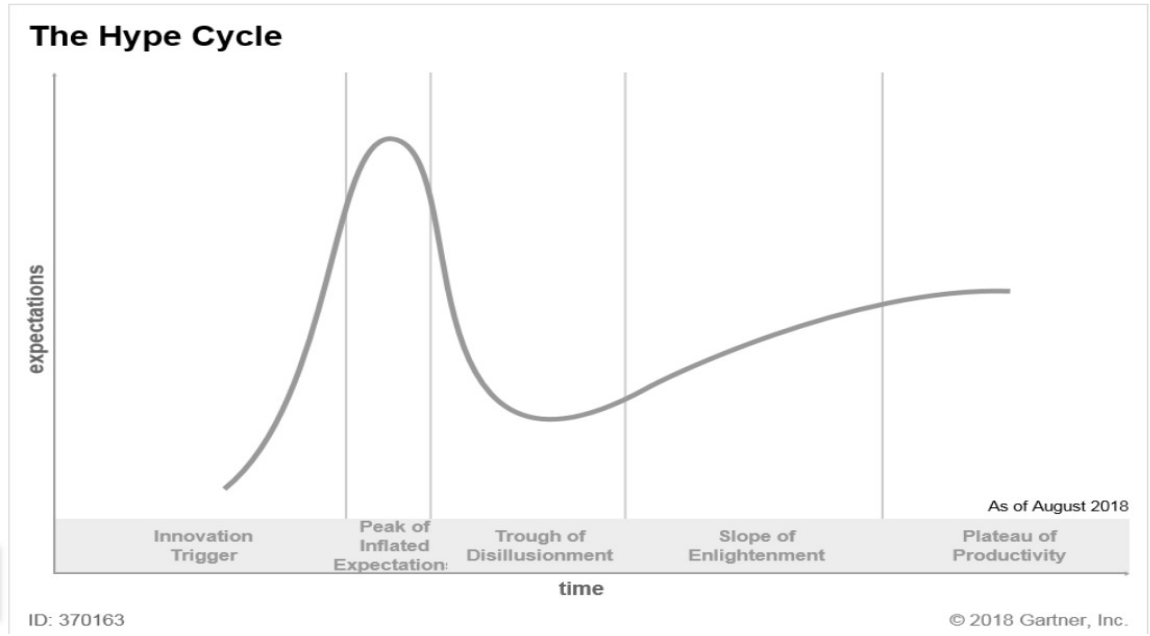
Everyone interviewed sees AVs as a coming, buoyed by Waymo's deployment of proofs of concept in Arizona and more recently in San Francisco. But the landscape has changed over the past five years from optimism for consumer-oriented solutions to more tempered timelines based on business case realities. Interviewees cited three

reasons as contributors to this new stance; the 2018 Uber crash with a pedestrian, the difficulty of corner cases, and the aggregated investment attached to the initiative.

“they (AV companies) are very policing of themselves…a fatality for one is a fatality for all” Professional – Reinsurance Company

The 2018 crash of an Uber test vehicle that hit a pedestrian was frequently cited as a pivotal moment that knocked the wind out of the industry. An insurance industry professional noted that a crash for one AV developer is a setback for the entire industry. A single incident can affect perceptions, confidence, and trust associated with the technology. By various estimates from this group, between 10% – 20% more work needs to be done on perfecting AV solutions. As a consequence, it is taking much longer than originally anticipated and as the collective investments in the space continue to rise, is influencing organizational behavior, according to a manufacturing quality manager. One interviewee, working for an AV technology developer, categorized the current state of affairs as on the downward side of the “trough of disillusionment” citing the Gartner Hype Cycle model for new technologies. A CEO of a tier-1 supplier noted that the benefits to society associated with AVs lost a little bit.

Figure 12: Gartner Emerging Technologies – Hype Cycle



Source: Gartner (2018)

Analogies

The Language, references, and analogies experts use when speaking about advanced technologies are worth noting. In these interviews the most frequent references were to aviation – on at least four occasions. The gist being that passenger aviation was once seen as risky and as a setting in which the traveler gives up control to avail themselves of a service. Interviewees used the analogy to both suggest why AV travel is likely to be accepted in the future and to contrast how passenger flight is different from AV travel in that fliers typically do not know how to fly whereas AV passengers are likely to know how to drive.

Also cited were vaccines, a timely reference to new medical developments, and to elevators and the fact that it took decades after the development of automatic

elevators for Americans to relinquish the notion that an elevator needed an operator. Also, several interviewees referenced a turn of phrase, to paraphrase; “everyone loves driving, no one loves their commute” to imply no matter how much you may claim to like something, there are circumstances in which a greater level of convenience may be appreciated.

State of the Technology

Consensus is that Waymo is the organization furthest along among organizations building automated driving technologies. Waymo has been working on the technology the longest, has the most experience testing, and has at least two ride hail pilots in-market. Other organizations cited in interviews included Argo AI, majority owned by Ford and Volkswagen, Nuro, and Peloton Technologies. Both Nuro and Peloton focus on automated solutions for robotic delivery and trucking.

“the AV system, right now, could pass a driver’s test….but it needs to be much better than that” – CEO, Tier-1 Supplier

“last 18 months, it’s harder than some of the technology companies thought it would be” – Managing Partner, Consultancy

“my question is, who programs your ethics?” – President, Safety Trade Association

“I think Waymo (is) number one by far” – CEO, Tier-1 Supplier

Interviewees repeatedly noted that production-quality AVs have turned out to be a tougher problem than anticipated. The technology works well in controlled, geo-fenced environments whereas L4/L5 deployments in open territory are difficult. One person said the notion of L5 is “nonsensical”, implying that fully automated travel without

operator participation in the world at large is unrealistic. Solution standards as outlined in SAE J3016 were cited as facilitating standards and collaboration across the problem space.

Which Business Models

The most discussed AV business model going forward is the movement of goods, logistics, and trucking in general. (long haul) Trucking is an $800B annual business (ride hail , by comparison, is seen a $40B - $50B business) in which there is plenty of opportunity to extract costs – even with relatively expensive solutions. Three factors are contributing to the appeal of trucking and delivery; a lack of drivers, the need for financial models that match investment profiles, and the fact that much of logistics takes place out of the prying eyes of the public. One notable conversation with an AV strategist highlighted public/private trucking opportunities in association with an organization such as the Port of Los Angeles. Such a public/private partnership would allow AV firms to join forces with the public sector to drive automation around the efficient movement of shipping containers without the current need for vehicle queuing, saving driver time, emissions, and increasing port efficiency. This same speaker recommends adding overhead electric lines within a 200-mile radius of LA so that trucks could run emissions-free in the LA basin.

“commercial applications, because the business cases are a lot cleaner” Automated Vehicle Engineer/Strategist, European OEM

“over the road trucking because companies are dying to take costs out” Dr. Manufacturing Quality – EV OEM

“what you are seeing is a very strong pivot towards the truck” – Sr. Manager, Autonomous Systems Co.

Other interviews surfaced enthusiasm for dock to dock, delivery, and last mile solutions. Several interviewees noted Amazon’s eagerness to get automation out to the end points. Others mentioned food delivery bots (Nuro) and the benefits of EV AVs in warehouse environments, no exhaust fumes.

Market Timing

Five or six years ago we would have thought there would be some AVs by now, so said one interviewee. Timelines have been revised for the reasons cited above. Estimates of commercial applications of AV technology ranged from two to 15 years, depending on deployment type. Geo fenced and truck platooning solutions are seen as the most viable in the near-term with deployments in the next two to three years. After that, the vision is hazy. Some see L4/L5 solutions in the next four or five years, others 10 or more years out. Personal use vehicles are on the further end of the spectrum. A safety expert noted that the duty cycle for the U.S. fleet is 35-years implying it will be a very long time for a majority of vehicles on the road to be AVs.

“There’s just a lot of obstacles….Waymo CEO….said about six months ago ‘you do know, we are about 10 to 15 years away…’” – President, Safety Trade Association

“”those early promises…automated vehicles on the road by 2020-2021…you don’t hear that…last 20% that truly has been more difficult” - Executive Director, Data Analytics and Consumer Intelligence Company

“Some people are saying they don’t know if we’ll ever get there, for the general public” - President, Safety Trade Association

“we’re not going to have our own personal self-driving cars, I think, anytime soon” – Editor, Multi-Industry Publishing Conglomerate

“my personal view is level five is very far off” – CEO, Tier-1 Supplier

Inhibitors

The sense of these interviews is that there is mismatch on consumer messaging, expectations, and reality. Two experts noted that although ADAS and AVs are different, ADAS gives researchers and manufacturers opportunities to study customer use and acceptance. A senior partners at a data analytics and customer company noted that there are plenty of opportunities to engage with users to build better systems. It was noted that technological forgiveness has diminished over time – meaning technology that does not work well right out of the box is soon discarded implying a need to get AV technologies right up front. An interviewee recommends exploring a mobility research lab: MIT advanced vehicle technology consortium. https://lexfridman.com/avt/ as a source of HMI research for further insight into customer reactions to advanced vehicle automation. Regarding targeting customers for AV technologies, responses were mixed on which consumers are most likely to find AVs appealing. Experts waivered on whether young, technologically savvy users or the elderly and disabled would gain the greatest benefits from AVs.

“when we lose our own agency and our own control….that could be a big hurdle for folks” – Curator, History Museum

“I think there should be some minimum standards established” – President, Safety Trade Association

“the legality part…the insurance part…both continue to be unanswered questions” Sr. Project Manager, State Infrastructure

“I was so surprised at how little the government wanted to get engaged in this” – CEO, Tier-1 Supplier

Experts noted the tension of safety in AV consideration. AVs are positioned as being a more safe mobility choice. However, multiple experts shared that safety is not a top decision variable when choosing mobility solutions as it is considered a given which implies positioning AVs as a more-safe mobility option may not make sense to consumers and could possibly be an inhibitor.

Trust was identified as an important issue, particularly in engagements with direct consumer interaction whether that be as passengers in vehicles or as cohabitants on the public roads. An OEM employee cited technology mistrust as particularly prevalent in in North America. One expert said Waymo is particular good at building trust, citing Waymo’s regularly updated safety reports. An infrastructure expert used vaccine hesitancy as a stand-in for consumer discomfort for robotics – indicating a broad spectrum of comfort for robotic mobility.

Regulation and regulatory frameworks are cited by those interviewed as ways to build trust and confidence in new technologies. AV regulation is needed for three reasons; to set expectations, clarify liability, and enhance consumers’ perceptions of AVs. Experts believe there should be governmentally-administered standard

performance expectations which may be reflected as minimum competencies which could be tested through simulations and/or real-world testing which would function as a stamp of approval. Interviewees stated that the federal government has been unengaged on the subject of AVs and three interviewees observed the lack of an AV liability framework and associated retail insurance products.

Other inhibitors, include a possible lack of market interest in personal AVs qualified by one AV strategist as a mismatch of customer interests - 95% of drivers think they are great at driving and as a consequence are not asking for AVs, according to this source. Drivers may prefer more ADAS - assists to make things easier under difficult circumstances. Another challenge is the current new vehicle sales model in the U.S. The same strategist observed that car sales people are not good at selling technology and in fact, are an inhibitor. This interviewee recommends Apple Genius Bar-type set-ups to ensure tech-qualified sales associates that can help enable customers in ways that build comfort.

A few trucking inhibitors include drivers' unions that resist technology that may impact sector employment. And, cross border collaborations for North American trade which involve navigating Canada, U.S. and Mexico.

Both the CEO of a tier-1 supplier and the managing partner of a consultancy observed that there is a general assumption that AVs will be EVs but, in fact, he two technologies are not great partners; AVs use prodigious amounts of power to process driving data and EVs are striving for range – the two objectives don't go together. The CEO recommends hybrid platforms as the basis for AVs.

Preferred Communications

Several interviewees shared their experiences in earlier phases of their careers where they were engaged in the communication and adoption of new safety and technology features. One interviewee has experience with seat belts and airbags. Another noted their involvement with ABS on light-duty trucks. In both cases, government campaigns were cited as critical tools to support the communication of benefits and compliance. Specifically, national and state click it or ticket campaigns were cited as effective in seat belt usage; a vehicle requirement mandated by the federal government with compliance falling to the states. This same expert discussed the importance of awareness campaigns associated with airbags. The initial deployment of airbags in the 1990s was fraught as the devices were not tuned sufficiently to accommodate for different types of front-seat occupants. The observational point was that communication is vital to the adoption of new technologies and safety devices and the process may be more complicated than anticipated.

"…some type of mass education program by the government" - President, Safety Trade Association

"when we ask consumers how they are learning how to use it (ADAS)….realistically less than half are getting any type of explanation or demonstration from a dealer" - Executive Director, Data Analytics and Consumer Intelligence Company

Specific to AVs – communicators, communications techniques, and content were identified in the interview process. Cited communicators include standards organizations, OEMs, trade associations, academic entities and government. Four experts citied PAVE – Partners for Automated Vehicle Education,

https://pavecampaign.org - as an example of an alliance doing beneficial work in the furtherance of AVs. The U.S. Department of Transportation was also cited as a good source of information. One expert noted Tesla's efficacy at AV communications. Another noted OEMs in general are seen as owning the customer relationship, implying their motivations are focused on their business. An editor for a standards organization noted that academic and governmental sources are more credible than OEMs or tech organizations.

Effective communication techniques fell into four categories; content, enablement, experiential, and partnerships. Content is the broadest category which includes everything from safety reports, to videos. Waymo publishes a safety report that was cited by three experts as an example of good communications that educates and informs consumers of the technologies and benefits associated with AV mobility. An editor cited the importance of SAE J3016 as a facilitator of efficient technical collaboration. In general, experts cited the power of video content to explain technical solutions. Additional beneficial communication include infographics and social media posts. Cited examples of effectiveness include a GM Super Cruise video. A mobility editor and a manufacturing quality director both emphasized the importance of creating content with visual diversity and people of color.

"consumer education in the modern era, it's like the Genius Bar Apple did" Automated Vehicle Engineer/Strategist, European OEM

"car salesmen don't understand cars…they're not good advocates" Automated Vehicle Engineer/Strategist, European OEM

An AV strategist advocated for a new approach to selling highly technical vehicles. Their recommendation is for OEMs and tech providers to lift a page form the Apple playbook and develop Genius Bars – places where users can come to learn about vehicle technology, solve problems, and be introduced to new techniques and features.

A public policy expert cited a robotic petting zoo as an effective method of introducing consumers to new robotic technologies in an up-close and personal manner. Also cited were auto shows, and trade displays.

Several companies were cited for their engagement with communities in advance of and during promotional events and pilots. Motional and Hyundai work with community partners in Las Vegas, Waymo's work in Arizona, and Voyage's use of public forums.

Tesla and Elon Musk

Based on the interviews conducted for this study, Tesla creates its own conversation. Almost everyone brought-up Tesla unaided. The reaction was mixed for three reasons, Tesla messaging promotes Autopilot as full-self-driving, Tesla is the largest luxury vehicle brand, by volume, and the associated brand bravado Elon brings to the table. Referred to as a modern-day Henry Ford, a manufacturing executive noted that Tesla does no advertising, only social and word-of-mouth and is the largest WW luxury vehicle brand, by volume. It was noted by several interviewees with a mix of frustration and respect that Elon dominates consumer conversation for L3 and above driving systems while manufacturing L2 systems. The disconnect surfaced in two interviews as irresponsible and dangerous. A situation where a manufacturer is over

promising which caused problems, trust, integrity, etc. for the industry as a whole. In other interviews awe was expressed at what was taken to be Elon's hutzpah.

"there are what I would call high vision idealists…Elon Musk…someone who is looking down the road…if he creates the future he wants…the profits will come" "it's about the new future, it's about changing the world" - Dr. Manufacturing Quality, EV OEM

"everybody pays attention to Tesla" – Editor, Standards Developing Organization

"I'm loath to say Tesla…they have done a very good job of….getting some audiences very excited about the technology" – Sr. Competitive Intelligence Manager, U.S. OEM

"Elon Musk, I hate to put it on one person….in my opinion, overblown" – Editor, Multi-Industry Publishing Conglomerate

Summary

Interviewees shared a profile of an AV industry humbled by the magnitude, cost, and complexities of developing automated driving systems which is anticipated to have an effect on the choice of deployment models. Most experts queried in this study aligned on commercial trucking and delivery use cases as most viable options and see in-market possibly as soon as three years.

Ride hail and personal vehicle products are seen as expensive options with limited broad appeal. Fully automated personal vehicles are seen as the most remote AV option, on an extended timeline of 10 or more years. In the interim, enhanced ADAS will provide high levels of driver assistance to consumers seeking automation.

Tesla and Elon Musk dominate communications around personal AVs, an approach perceived by this group of experts as unconventional, if not misleading. Tesla's technology is not seen as AV-grade. This group of experts advocates for experiential, expert, and visual forms of communication to build awareness and familiarity with robotic mobility.

In addition to the influential an moderated capabilities of Tesla and Elon Musk, interviewees cited the annual Waymo safety report and the Partnership for Automated Vehicle Education (PAVE) as examples of strategic communication that seek to influence perceptions of automated vehicles.

CHAPTER 6 – Discussion

Selling Technology was designed to surface industry strategies to influence perceptions of AVs and how such perceptions affect communities now and in the future. But, also, more broadly, to facilitate the exploration of disruptive technologies in general. A research framework was constructed using theoretical foundations selected from the fields of communications and enterprise technology acceptance. Both Two-step Flow and TAM, as noted in the literature review, are theories evolved to support modern consideration and decision making. The evolutionary process reveals two factors that contextualize the importance the contributions this study makes to the field of technology perceptions and to the theoretical domains of Two-step Flow, TAM, and to the hybrid framework for disruptive technologies as provided by this study (see Figure 11).

First, both theories are born of American consumerism; Two-step Flow as a consideration framework for the transference of external information generated by mass media, an industry, to individuals, consumers. TAM, as an acceptance framework for technology-based productivity tools organizations acquire to make their businesses more efficient and profitable. Recognizing a shared foundation in consumerism clarifies consumerism as a force and enables evaluations of how such forces potentially impact disruptive technologies and their effects on communities. Much like previous disruptions, automobiles or elevators, for example, AVs will have both positive and negative effects on society. Consumption of both the products and the services disruptive products enable such as remote delivery or ride share, will generate effects.

Second, Two-step Flow and TAM are complementary. Two-step Flow was founded to explain external communication in environments in which most individuals had agency. Externally-focused communication is a useful explanatory tool when influencing perceptions of socially-disruptive technologies such as AVs. TAM was created for use inside organizations where stakeholder relationships were hierarchical and the decision to accept technology was associated with employment. As TAM has been coopted by researchers to predict consumer preferences for categories of externally-focused forms of disruptive technology, there is a need to open the TAM consideration framework to strategic externalities in the forms of agency and strategic influence, as provided by Two-step Flow. Together, these theories facilitate an evolutionary approach to evaluating technology perceptions and associated opportunities in environments in which opinion leadership and moderation take many forms and participants.

This contextual framework positions how this study contributes to the theories of Two-step communications and to TAM. Two-step contributions are within the context of communicating the value and benefits of a disruptive technology in a moderated format to influence perceptions in two ways. First, this study provides industry preferences for influential strategies and content. Second, this study demonstrates examples of moderated communications for a potentially disruptive technology under development that has experienced setbacks. The examples provided by the data demonstrate the attributes of moderation by taking industry information and filtering it through expert channels; educational organizations, reports, and CEO Twitter accounts, that moderate how the information is perceived by recipients.

Contributions to TAM illustrate processes to influence perceptions (stimuli) of TAM for a disruptive technology through the lens of industry insight, a key differentiator from most studies. Both contributions, more generally, extend the joint Two-step/TAM collaboration to disruptive technologies under development.

Many studies have proposed enhancements and augmentations of TAM to increase its forecasting effectiveness (Yuen, Wong, Ma, & Wang, 2020; Yuen, Cai, Qi, & Wang, 2021; Venkatesh, Morris, Davis, & Davis, 2003; Venkatesh & Davis, 2000; Panagiotopoulos & Dimitrakopoulos, 2018; May, Noah, & Walker, 2017; Lah, Lewis, & Šumak, 2020; Huang, 2021). Several TAM-based frameworks deliver detailed communications approaches for enhanced acceptance, most notably Zhang & Benyoucef (2016), developers of a complete theoretical framework for consumer behavior in social commerce. The framework, based on an extensive literature review, functions as a sales framework for any technical solution. Zhu, Chen & Zhang (2020), using structural equation modeling techniques, have established a framework specifically for AVs. This study recognizes the prior work within the field and demonstrates how industry insight and strategy may be incorporated into the development and evaluation of TAM stimuli for a category of disruptive technology.

Opportunities and Next Steps

This study looked at the initial steps of the Two-step and technology acceptance processes. Moving to the right in both models provides an opportunity to assess how specific techniques further impact the efficacy of the acceptance process through direct feedback from the targeted stakeholders. Such an exploration would further develop effective concepts of moderated communication for disruptive technologies.

Experimental research – an exploration of possible neural stimulation studies to evaluate emotional responses to AV or other disruptive technologies is conceptually interesting. Measuring neural stimulation levels and qualities within experientially-based disruptive introductions would further contribute to the combined value of Two-step and TAM for disruptive tech.

Limitations

This study has several limitations. First, survey respondents self selected to participate in the survey. As such an approach is not a randomized sample, the results of the survey are not assumed to represent the AV and mobility industries as a whole.

Second, survey data was collected across two dimensions; an advanced undergraduate mobility engineering class and through digital display invitations that were sponsored by the author's former employer, Kettering University, an engineering institute known for automotive engineering. The fact that both sources of survey data were associated with an automotive engineering entity, as were many of the interviewees, may contribute regional and domain bias to the results.

Third, the data gathered from the student respondents, for which permission was requested and authorized by Kettering University's institutional research board, were included in the overall survey results as the response data was similar to that collected through the digital ads, are studying automated driving with the intent to work in technology-related fields, and, as Kettering University is a cooperative education institution, are working or have worked in technology and mobility-related environments while students.

CHAPTER 7 – Conclusion

Summary

Disruptive technologies and products challenge assumptions through the introduction of new functionalities that are different from those embraced by established markets. Should such products be perceived as useful and easier to use than existing options, there is a likelihood that such inventions will be accepted by society and lead to great transformations. Evaluating and forecasting the effects innovations will have on established markets, communities, and society is difficult for two reasons. First, new innovation may not be available in markets for evaluation which limits the effectiveness of assessments and forecasts. Second, established markets and users of established products struggle to appreciate the benefits of products that do not hew to the status quo. As a result, such insight, although contextually interesting, may not represent possible future realities. A solution to this problem is to access the creators and industries associated with the innovation in question to understand their perspectives and expectations. *Selling Technology* advocates for such an approach to increase the accuracy of information associated with the potentially disruptive effects of new technologies. It is within this context that *Selling Technology* sought industry insight regarding the state of automated driving, a technology on the horizon for more than a decade and around which the public has a limited understanding.

Selling Technology tackles the importance of perceptions to acceptance of disruptive technologies by understanding what strategies industry uses to influence perceptions of AVs and how such perceptions may affect communities. To facilitate such an investigation, a theoretical collaboration comprised of opinion leadership, word

of mouth, and moderated communications as reflected in the theory of Two-step Flow of communications and product and solution perceptions as promulgated in the Technology Acceptance Model were chosen. A theoretical argument, outlined in detail in chapter 6, as to why the theories of Two-step Flow and TAM work better together when assessing the trajectory of disruptive technologies and the associated effects such technologies may have on communities and society underpins the study.

A mixed methods approach was selected to collect point in time industry insight into automated vehicles, strategies used to influence perceptions, and associated perspectives of how perceptions of the technology may affect communities now and in the future. Data collection techniques included a 36-question survey launched in commercial industry channels and 35-minute interviews with industry representatives working in mobility, technology, infrastructure, and consulting organizations. The theoretical collaboration of Two-step and TAM structures well in the quest for evidence of strategic influence of perceptions and effects on communities as the theories complement each other; the influential power of Two-step exerting pressure on perceived usefulness and perceived ease of use (tenets of TAM), foundational principles of safer, easier, and enabling AVs.

The combination of survey and interview data have tested the presence of evidence supporting the theories on which this research is based and answered the research questions. Industry sees AVs as potentially disruptive, is using strategies to influence perceptions of AVs, and has an awareness of how AVs may affect communities. Survey respondents strongly endorsed the need for informational and educational material and shared preferences for the types of engagement and content

they see as most effective in influencing perceptions of AVs. Interview respondents reinforced the importance of influence on AV perceptions and provided evidence in the form of opinion leadership and moderated content associated with the Two-step Flow theory in the form of two highly-recognized examples of strategies that are seen as effective. First, the annual Waymo safety report, is an example of a company-specific tool that is highly regarded for its robustness, quality of content, and ability to address a range of concerns about AVs under the umbrella of safety. The framing is important as safety is a key concern through the literature and this investigation. Under the umbrella of safety, Waymo has an opportunity to address an array of additional concerns and to introduce content associated with core value propositions (perceptions -TAM) on which the AV promise is based including convenience, access and equity, and a reduction in congestion. Waymo was noted by study participants as the organization farthest along in the development of self-driving technologies and as a result, the organization, one can infer, with the most communications experience. This experience comes together in the quality of communication and sophistication in the moderation of information important to their audiences.

Partnership for Automated Vehicle Education (PAVE) was the second influential strategy identified in the interview process that dovetails with the experiential content preferences of the survey respondents. PAVE is very different from a company specific safety report. PAVE is an industry association comprised of over 80 members collaborating on educational initiatives designed to influence perceptions of AVs. The membership works through a professional staff to create awareness and influence the market through events, many of which are virtual, and cover topics as diverse as the

future of urban environments, robotic delivery initiatives, and professional opportunities associated with a future AV market. PAVE presents a collaborative façade to the market under the umbrella of education. PAVE's mission and approach dovetail with the stated preferences of survey respondents by delivering education in an interactive format and is a robust example of opinion leadership and moderated content.

The Waymo safety report and PAVE demonstrate the power of the theory of Two-step communication. PAVE much more strongly as a defined and separate organization that moderates information in collaboration with its members. The Waymo safety report, in the blurred world of content, news, and media, functions as a franchise (the annual safety report has been around for years) through which Waymo may communicate key messages in a moderated manner. An inspection of the Waymo safety report and a tour of past PAVE events reveals that both organizations seek to influence perceptions of AV effects on communities, whether that be images or specific experts speaking on PAVE panels about the future of cities.

Further evidence of strategic influence in the forms of Tesla, the car company, and Elon Musk, the individual, are recognized as key contributors to perceptions of AVs through their use of moderated communication and through the ability to sell vehicles that, with advanced software upgrades, are perceived by the public as being automated. Tesla and its founder have an outsized presence in the market and, as noted in the interview results, have earned the ire of many in established sectors of mobility for the promotion of ADAS as "self-driving" systems. This polarizing stance ensures Tesla is closely watched as a disrupter.

Survey respondents provided strong perceptions of how AVs may impact communities across three dimensions, urban, suburban, and rural. A synopsis of the results is available in chapter 4. The full content is available in Appendix B. Many of the recommendations dovetail with content seen throughout the literature and through organizations such as NACTO. Pedestrian vulnerability, mixed traffic comprised of AVs and traditional vehicles, and increased commuting enabled by AV ease of travel are three community effects seen as concerns based on AV perceptions. Improved street infrastructure to ensure both physical and emotional considerations are addressed for those in shared spaces with automated vehicles is seen as a need. Curb concerns were identified as a potential issue for loading and unloading of passengers from SAVs. One respondent suggested that there should be dedicated lanes for AVs.

Super Commuters, folks that travel long distances for work, are seen as a potential mobility growth category due to the ease and convenience provided by AVs. Super commuters are seen as a possible impact on rural communities. Impacts include increased sprawl and a need for improved rural infrastructure to support an increase in traffic.

Two topics surfaced through this research that were unanticipated. First, the success accorded Tesla in influencing public perceptions about highly automated driving while not having a high profile SAE L4/L5 vehicle agenda. Tesla was cited as a key influencer in both survey and interview data. Although much of the respondent sentiment is negative, Tesla is recognized as a dominate influencer by industry. Respondents to this study find this success and the associated perception that Tesla is a leader in the automated vehicle space galling for two reasons. First, Tesla self-driving

technology is not seen by respondents and industry analysts (Abuelsamid, 2021) as market leading. Second, Tesla is seen as irresponsible for releasing Beta software on customer-owned vehicles. The perception of Tesla gleaned from this study is one of arrogance and irresponsibility. The sentiment hints at a lack of integrity and a willingness to play fast and loose. As one interviewee noted, the culture of irreverence led by an international influencer in his own right (Elon Musk), has paid off. Tesla is the largest selling luxury vehicle manufacturer in the world, and all of the vehicles are electric. And, these noteworthy sales are done without advertising and without franchised dealerships. Tesla is a disrupter in the way it behaves, powers its vehicles, and goes to market.

The second unexpected topic that surfaced was the extent and depth of the "trough of disillusionment", as one interviewee referred to the funk pervading the AV industry as a result of the two high profile crashes in 2018. Not apparent in the survey data, the trough emerged in the course of the interviews which may explain the relatively light amount of industry-generated communication in the market.

More generally, the data shows that study respondents are committed and deterministic about highly automated driving as represented by survey responses and interview content associated with core AV value propositions of ease, convenience, and safety. Commitment to the core value of AVs is a reflection of the strength of industry perceptions around usefulness and ease of use, the foundations on which TAM is based and is clear evidence of the importance of perceptions in the process of consideration and acceptance of disruptive technologies. Respondents see fully automated L4/L5 vehicles entering the market on a limited basis by 2030. The path to

50% or more AV traffic is seen as a long way off – 2045, or later, if ever, which dovetails with the findings of numerous academic resources (Litman, 2021; Bansal & Kockelman, 2017; Bansal & Kockelman, 2018; Legacy, Ashmore, Scheurer, Stone, & Curtis, 2019; Raj, Kumar, & Bansal, 2020). Survey respondents favor transit and shared vehicle use cases over private ownership models by a slight margin. However, in-depth interviews reveal that as industry investment increases to complete automated driving solution development and public trust perceptions of the technology shift due to high-profile crashes, the industry is coalescing around business cases with strong fundamentals and predictable revenue such as trucking, transit, and last mile delivery. Shifting business cases are a reflection of new social realities brought-on by Covid-19 and the increased investments required to develop L4 driving solutions. The pandemic has brought a diminished enthusiasm and need for shared mobility services as workers moved to remote work environments and seek to limit their interactions in shared environments including ride share vehicles. The pandemic also rocketed demand for delivery and logistics services.

Survey respondents were queried regarding the impact the Covid-19 pandemic may have on AVs. The responses vary and reflect concerns about the use of shared space in robotaxi and shared vehicle scenarios. There is an alternative perspective that sees increased demand for personal automated solutions that protect users against public interactions.

Selling Technology, as a study, advocates for industry insight and intelligence as an approach to assessing the acceptance of disruptive technologies. Expert insight combined with stepwise communication techniques, as the results of this study show,

contribute richness to acceptance modeling for technologies deploying in the public sphere by recognizing the breadth and importance of voice. Surfacing influence of perceptions contributes to transparency and facilitates more robust discussion and evaluations of disruptive tech. It is the author's goal to bring more voices, particularly those in industry, to the research of disruptive technologies in the social sciences and the effects perceptions of these technologies have on communities.

APPENDICES

APPENDIX A: Michigan State University IRB Approval

MICHIGAN STATE
UNIVERSITY

EXEMPT DETERMINATION
Revised Common Rule

January 27, 2021

To: Mark Ian Wilson

Re: **MSU Study ID:** STUDY00005486
Principal Investigator: Mark Ian Wilson
Category: Exempt 2ii
Exempt Determination Date: 1/27/2021
Limited IRB Review: Not Required.

Title: SELLING TECHNOLOGY: HOW INFLUENCE AND PERSUASION FACILITATE MARKET ADOPTION OF AUTOMATED VEHICLES

This study has been determined to be exempt under 45 CFR 46.104(d) 2ii.

Principal Investigator (PI) Responsibilities: The PI assumes the responsibilities for the protection of human subjects in this study as outlined in Human Research Protection Program (HRPP) Manual Section 8-1, Exemptions.

Institutional restrictions to in-person human subject research activities conducted by MSU employees, MSU students, or agents of MSU are in place, but MSU is phasing in human research that has the potential for in-person interactions with participants, using a Tier approach. Restrictions to in-person interactions with human research participants by MSU employees, MSU students, or agents of MSU are in place until the activity is permitted under a Tier and a Human Research Plan for a Safe Return is approved. Visit http://hrpp.msu.edu/COVID-19/index.html for the restrictions, Tiers, forms, and the process.

Continuing Review: Exempt studies do not need to be renewed.

Modifications: In general, investigators are not required to submit changes to the Michigan State University (MSU) Institutional Review Board (IRB) once a research study is designated as exempt as long as those changes do not affect the exempt category or criteria for exempt determination (changing from exempt status to expedited or full review, changing exempt category) or that may substantially change the focus of the research study such as a change in hypothesis or study design. See HRPP Manual Section 8-1, Exemptions, for examples. If the study is modified to add additional sites for the research, please note that you may not begin the research at those sites until you receive the appropriate approvals/permissions from the sites.

Office of Regulatory Affairs
man Research ction Program

000 Collins Road
Suite 136
sing, MI 48910

517-355-2180
ax: 517-432-4503
ail: irb@msu.edu
www.hrpp.msu.edu

Please contact the HRPP office if you have any questions about whether a change must be submitted for IRB review and approval.

New Funding: If new external funding is obtained for an active study that had been determined exempt, a new initial IRB submission will be required, with limited exceptions. If you are unsure if a new initial IRB submission is required, contact the HRPP office. IRB review of the new submission must be completed before new funds can be spent on human research activities, as the new funding source may have additional or different requirements.

Reportable Events: If issues should arise during the conduct of the research, such as unanticipated problems that may involve risks to subjects or others, or any problem that may increase the risk to the human subjects and change the category of review, notify the IRB office promptly. Any complaints from participants that may change the level of review from exempt to expedited or full review must be reported to the IRB. Please report new information through the study's workspace and contact the IRB office with any urgent events. Please visit the Human Research Protection Program (HRPP) website to obtain more information, including reporting timelines.

Personnel Changes: After determination of the exempt status, the PI is responsible for maintaining records of personnel changes and appropriate training. The PI is not required to notify the IRB of personnel changes on exempt research. However, he or she may wish to submit personnel changes to the IRB for recordkeeping purposes (e.g. communication with the Graduate School) and may submit such requests by submitting a Modification request. If there is a change in PI, the new PI must confirm acceptance of the PI Assurance form and the previous PI must submit the Supplemental Form to Change the Principal Investigator with the Modification request (available at hrpp.msu.edu).

Closure: Investigators are not required to notify the IRB when the research study can be closed. However, the PI can choose to notify the IRB when the study can be closed and is especially recommended when the PI leaves the university. Closure indicates that research activities with human subjects are no longer ongoing, have stopped, and are complete. Human research activities are complete when investigators are no longer obtaining information or biospecimens about a living person through interaction or intervention with the individual, obtaining identifiable private information or identifiable biospecimens about a living person, and/or using, studying, analyzing, or generating identifiable private information or identifiable biospecimens about a living person.

For More Information: See HRPP Manual, including Section 8-1, Exemptions (available at hrpp.msu.edu).

Contact Information: If we can be of further assistance or if you have questions, please contact us at 517-355-2180 or via email at IRB@msu.edu. Please visit hrpp.msu.edu to access the HRPP Manual, templates, etc.

Exemption Category. The full regulatory text from 45 CFR 46.104(d) for the exempt research categories is included below. [123M]

Exempt 1. Research, conducted in established or commonly accepted educational settings, that specifically involves normal educational practices that are not likely to adversely impact students' opportunity to learn required educational content or the assessment of educators who provide instruction. This includes most research on regular and special education instructional strategies, and research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

Exempt 2. Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) if at least one of the following criteria is met:

> (i) The information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects;
>
> (ii) Any disclosure of the human subjects' responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation; or
>
> (iii) The information obtained is recorded by the investigator in such a manner that the identity of the human subjects can readily be ascertained, directly or through identifiers linked to the subjects, and an IRB conducts a limited IRB review to make the determination required by 45 CFR 46.111(a)(7).

Exempt 3. (i) Research involving benign behavioral interventions in conjunction with the collection of information from an adult subject through verbal or written responses (including data entry) or audiovisual recording if the subject prospectively agrees to the intervention and information collection and at least one of the following criteria is met:

> (A) The information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects;
>
> (B) Any disclosure of the human subjects' responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation; or
>
> (C) The information obtained is recorded by the investigator in such a manner that the identity of the human subjects can readily be ascertained, directly or through identifiers linked to the subjects, and an IRB conducts a

limited IRB review to make the determination required by 45 CFR 46.111(a)(7).

(ii) For the purpose of this provision, benign behavioral interventions are brief in duration, harmless, painless, not physically invasive, not likely to have a significant adverse lasting impact on the subjects, and the investigator has no reason to think the subjects will find the interventions offensive or embarrassing. Provided all such criteria are met, examples of such benign behavioral interventions would include having the subjects play an online game, having them solve puzzles under various noise conditions, or having them decide how to allocate a nominal amount of received cash between themselves and someone else.

(iii) If the research involves deceiving the subjects regarding the nature or purposes of the research, this exemption is not applicable unless the subject authorizes the deception through a prospective agreement to participate in research in circumstances in which the subject is informed that he or she will be unaware of or misled regarding the nature or purposes of the research.

Exempt 4. Secondary research for which consent is not required: Secondary research uses of identifiable private information or identifiable biospecimens, if at least one of the following criteria is met:

(i) The identifiable private information or identifiable biospecimens are publicly available;

(ii) Information, which may include information about biospecimens, is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained directly or through identifiers linked to the subjects, the investigator does not contact the subjects, and the investigator will not re-identify subjects;

(iii) The research involves only information collection and analysis involving the investigator's use of identifiable health information when that use is regulated under 45 CFR parts 160 and 164, subparts A and E, for the purposes of ''health care operations'' or ''research'' as those terms are defined at 45 CFR 164.501 or for ''public health activities and purposes'' as described under 45 CFR 164.512(b); or

(iv) The research is conducted by, or on behalf of, a Federal department or agency using government-generated or government-collected information obtained for nonresearch activities, if the research generates identifiable private information that is or will be maintained on information technology that is subject to and in compliance with section 208(b) of the E-Government Act of 2002, 44 U.S.C. 3501 note, if all of the identifiable private information collected, used, or generated as part of the activity will be maintained in systems of records subject to the Privacy Act of 1974, 5 U.S.C. 552a, and, if applicable, the information used in the research was collected subject to the Paperwork Reduction Act of 1995, 44 U.S.C. 3501 et seq.

Exempt 5. Research and demonstration projects that are conducted or supported by a Federal department or agency, or otherwise subject to the approval of department or agency heads (or the approval of the heads of bureaus or other subordinate agencies that have been delegated authority to conduct the research and demonstration projects), and that are designed to study, evaluate, improve, or otherwise examine public benefit or service programs, including procedures for obtaining benefits or services under those programs, possible changes in or alternatives to those programs or procedures, or possible changes in methods or levels of payment for benefits or services under those programs. Such projects include, but are not limited to, internal studies by Federal employees, and studies under contracts or consulting arrangements, cooperative agreements, or grants. Exempt projects also include waivers of otherwise mandatory requirements using authorities such as sections 1115 and 1115A of the Social Security Act, as amended. (i) Each Federal department or agency conducting or supporting the research and demonstration projects must establish, on a publicly accessible Federal Web site or in such other manner as the department or agency head may determine, a list of the research and demonstration projects that the Federal department or agency conducts or supports under this provision. The research or demonstration project must be published on this list prior to commencing the research involving human subjects.

Exempt 6. Taste and food quality evaluation and consumer acceptance studies: (i) If wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the Food and Drug Administration or approved by the Environmental Protection Agency or the Food Safety and Inspection Service of the U.S. Department of Agriculture.

Exempt 7. Storage or maintenance for secondary research for which broad consent is required: Storage or maintenance of identifiable private information or identifiable biospecimens for potential secondary research use if an IRB conducts a limited IRB review and makes the determinations required by 45 CFR 46.111(a)(8).

Exempt 8. Secondary research for which broad consent is required: Research involving the use of identifiable private information or identifiable biospecimens for secondary research use, if the following criteria are met:

> (i) Broad consent for the storage, maintenance, and secondary research use of the identifiable private information or identifiable biospecimens was obtained in accordance with 45 CFR 46.116(a)(1) through (4), (a)(6), and (d);
>
> (ii) Documentation of informed consent or waiver of documentation of consent was obtained in accordance with 45 CFR 46.117;
>
> (iii) An IRB conducts a limited IRB review and makes the determination required by 45 CFR 46.111(a)(7) and makes the determination that the

research to be conducted is within the scope of the broad consent referenced in paragraph (d)(8)(i) of this section; and

(iv) The investigator does not include returning individual research results to subjects as part of the study plan. This provision does not prevent an investigator from abiding by any legal requirements to return individual research results.

[1] Exempt categories (1), (2), (3), (4), (5), (7), and (8) cannot be applied to activities that are FDA-regulated.

[2] Each of the exemptions at this section may be applied to research subject to subpart B (Additional Protections for Pregnant Women, Human Fetuses and Neonates Involved in Research) if the conditions of the exemption are met.

[3] The exemptions at this section do not apply to research subject to subpart C (Additional Protections for Research Involving Prisoners), except for research aimed at involving a broader subject population that only incidentally includes prisoners.

[4] Exemptions (1), (4), (5), (6), (7), and (8) of this section may be applied to research subject to subpart D (Additional Protections for Children Involved as Subjects in Research) if the conditions of the exemption are met. Exempt (2)(i) and (ii) only may apply to research subject to subpart D involving educational tests or the observation of public behavior when the investigator(s) do not participate in the activities being observed. Exempt (2)(iii) may not be applied to research subject to subpart D.

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STUDY00005486: AV Market Adoption

This is to confirm that Cornelius Darcy worked on STUDY00005486: AV Market Adoption under my supervision, and that he has received appropriate training to undertake the research.

I serve as Mr Darcy's PhD advisor and have contributed to the research and was kept informed of its progress.

Please contact me if I can provide any additional information.

Sincerely

Mark Wilson PhD
Professor, Urban and Regional Planning
Program Director, PhD in Planning, Design and Construction
April 11, 2022

School of Planning, Design & Construction

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APPENDIX B: Kettering University IRB Approval

Letter of Determination

28 January 2021

File number: *2021-01*
Project title: *SELLING TECHNOLOGY: HOW INFLUENCE AND PERSUASION FACILITATE MARKET ADOPTION OF AUTOMATED VEHICLES*
PI: *Mark Wilson (MSU) and Kip Darcy*
Project date: *2/15/2021, two months*

Thank you for providing information about your project. Based on the description of the interactions and/or interventions with human subjects participating in your research, this project is exempt from review by the Kettering University IRB.

Thank you, also, for providing the letter of determination from the Michigan State University Office of Regulatory Affairs Human Research Protection Program. The Kettering University IRB concurs with their determination.

The specific category of research into which your study falls is listed below. This category does not require limited review by the IRB. You are encouraged to obtain and document the informed consent of your participants in alignment with Kettering University Human Subjects Policy (Policy 15) and the Kettering University Institutional Review Board Charter and Standard Operating Procedures.

Category of Research Exempt from Review

> These are the categories as described in 45 CFR 46.104(d).
>
> (2) Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) if at least one of the following criteria is met:
>
> ...
>
> (ii) Any disclosure of the human subjects' responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation; or...

This project falls into this category due to the nature of the questions and topics included in the survey instrument and possible interviews.

During your project, if there are changes to study personnel, changes to the protocol or the handling of data collected from interventions and interactions with human subjects, or adverse events occur, you

must contact the IRB with a written description, at irb@kettering.edu. You may also use that to ask questions about your study or the protection of human subjects generally at Kettering University.

Thank you for your commitment to the protection of human subjects in research.

Sincerely,

Daniel O. Ludwigsen
Chair, Kettering University IRB

CC: Office of Sponsored Research

APPENDIX C: Draft Survey Instrument

Table 19: Draft Survey Instrument

Category	Q #	Question	Unit/Coding	Variable	Source
Introduction	1	Automated driving will change the future of personal mobility	Likert 4 scale	Confidence	Darcy
	2	Are you familiar with SAE levels of vehicle automation? Note - this survey speaks to the two highest levels of automation - SAE L4/L5	Likert 3 scale	Demographic	Darcy
		Solution Context - Respondent			
Concept Context	3	How exciting is the idea of SAE L4/L5 automated driving?	Likert 4 scale	Confidence	Khde
	4	How enjoyable is conventional driving?	Likert 4 scale	Demographic	Khde
	5	How enjoyable will SAE L4/L5 automated driving be?	Likert 4 scale	Confidence	Khde
	6	When do you think the majority (over 50%) of cars on U.S. roads will be driving in a fully automated manner?	2025, 2035, 2045, 2045+, Never	Time-to-market	Khde
	7	How much easier will fully automated driving be than conventional driving?	Likert 4 scale	Confidence	Khde
		Concept Value			
Solution Readiness	8	SAE L4/L5 driving will, as compared to conventional driving,… Drag to rank order potential benefits	1. be safer, 2. enable riders to spend time on other activities while traveling, 3. shorten travel times, 4. reduce congestion, 5. consume less fuel, 6. be more environmentally friendly, 7. not provide benefits over conventional driving	Confidence	adapted from Khde

Table 19 (cont'd)

	9	SAE L4/L5 driving will be beneficial when ... Drag to rank order benefit opportunities	1. driving is stressful, 2. commuting to work, 3. tired, 4. on everyday trips, 5. driving is boring and/or monotonous, 6. impaired by drugs, alcohol, or medications, 7. SAE L4/L5 driving will never be beneficial	Confidence	adapted from Khde
	10	Which auto makers/technology providers are best-prepared to offer SAE L4/L5 vehicles to the U.S. market? Drag to rank order potential preparedness	1. traditional OEMs (Ford, GM, Stellantis), 2. new automakers (Rivian, Tesla, Lucid, etc.), 3. ride share companies (Lyft, Uber), 4. Tech companies (Aurora, Waymo), 5. Other	Influence	Darcy
	11	When do you think automakers/technology providers will first offer SAE L4/L5 vehicles in the U.S. market for purchase by service providers and/or consumers?	2025, 2030, 2040, can't say	Time-to-market	Darcy
	12	How should SAE L4/L5 vehicles be offered in the U.S. market? Drag to rank order offerings	1. as a service, 2. as a subscription, 3. private ownership, 4. as public transit	Impact	Darcy
	13	List 2 barriers to the introduction/adoption of SAE L4/L5 vehicles	open	Confidence	Darcy
	14	List 2 ways Covid changed consumers' perceptions of SAE L4/L5 vehicles	open	Confidence	Darcy
		Sources - spokespeople/influencers (physical/people)			
Sources/Influence	15	How interested are consumers in SAE L4/L5 vehicles?	Likert 4 scale	Influence	Darcy
	16	How important is it that consumers have access to detailed information and experts to explain SAE L4/L5 vehicles?	Likert 4 scale	Influence	Darcy

Table 19 (cont'd)

	17	What forms of influence are consumers likely to prefer when learning about SAE L4/L5 vehicles? Drag to rank order forms of influence	1. general media, 2. automotive media, 3. a spokesperson identified as an AV expert, 4. an expert they personally know, 5. a sales person, 6. an introduction to the physical product (ex. showroom) 7. an immersive event (ex. ride & drive)	Influence	Darcy
		Channels & Types (content)			
Channels/Content	18	Do consumers require descriptive and explanatory content to understand SAE L4/L5 vehicles?	Likert 4 scale	Influence	Darcy
	19	Consumers prefer to learn about SAE L4/L5 vehicles using … Drag to rank order channel preferences	1. social networks, 2. general media web sites, 3. automotive media web sites, 4. print media, 5. physical experiences (showroom, demonstration, etc.)	Influence	Darcy
	20	Consumers prefer to learn about SAE L4/L5 vehicles from … Drag to rank order content preferences	1. video content, 2. online copy/images, 3. immersive content such as virtual reality (VR), 4. physical experiences (ex. showroom, demonstration, etc.)	Influence	Darcy
	21	Content to influence consumers is best created by … Drag to rank order content creator preferences	1. manufacturers, 2. evaluators/testers, 3. independent influencers, 4. technology providers, 5. other	Influence	Darcy
		WOM			
WOM	22	I will recommend SAE L4/L5 vehicles to people who seek my advice	Likert 3 scale	Influence	Sahin
	23	I will encourage friends and relatives to consider the benefits of SAE L4/L5 vehicles	Likert 3 scale	Influence	Sahin
		Price Premium			

Table 19 (cont'd)

Concept Value - Price Premium	24	SAE L4/L5 vehicles include technologies which will make them more expensive to use/lease/purchase than traditional vehicles	Likert 4 scale	Confidence	Darcy
	25	Compared to an average new vehicle- $38,638 (Kelly Blue Book, 2020) - how much more will consumers likely pay for SAE L4/L5 vehicles?	Likert 4 scale, Nothing/$0, Less than $5,000, $5,000 > $10,000, More than $10,000	Confidence	Darcy
	26	If SAE L4/L5 vehicles are more expensive than traditional vehicles, the additional cost (price) will be worth it.	Likert 3 scale	Confidence	Darcy
	27	Considering the anticipated cost to purchase SAE L4/L5 vehicles, how will consumers use these vehicles? Drag to rank order uses	1. private ownership, 2. ride hailing services, 3. subscriptions, 4. public transit	Impact	Darcy
		Planning			
Disruptions to the Practice of Planning	28	SAE L4/L5 vehicles will change the way residential and commercial areas are developed	Likert 4 scale	Impact	Darcy
	29	List 2 aspects of **urban** environments most likely to change with the advent of SAE L4/L5 vehicles.	open	Impact	Darcy
	30	List 2 aspects of **suburban** environments most likely to change with the advent of SAE L4/L5 vehicles.	open	Impact	Darcy
	31	List 2 aspects of **rural** environments most likely to change with the advent of SAE L4/L5 vehicles?	open	Impact	Darcy
		Demographics			
Demographics	32	What is your current age?	Likert 9	Demographics	Khde
	33	In which country are you a resident?	open	Demographics	Khde
	34	What is your gender?	Likert 4	Demographics	Khde
	35	In which mobility/automotive/transportation domain are you engaged?	1. Research 2. Testing 3. Manufacturing 4. Marketing 5. Sales 6. After-sales 7. Regulatory 8. Education, 9. Other	Demographics	Darcy
	36	Is there anything else you would like to share?	open		Peters

APPENDIX D: Interview Guide

SPDC – Dissertation Research – DARCY
AUTOMATED VEHICLES: HOW INFLUENCE AND PERSUASION FACILITATE MARKET ADOPTION OF AUTOMATED VEHICLES

Interview Guide – single interview with industry subject matter experts

Interview Goals:

Primary:

- What messaging are industry experts using when communicating to markets about L4/L5 automated driving systems?
- What effect/response do various communication and messaging techniques have on the anticipated adoption of L4 and L5 automated driving systems?

Secondary:

- Anticipated opportunities and impacts of automated vehicles on communities

Responsive Interview Guide:

Warm-up

- Welcome, thank you for agreeing to spend time with me
- We will spend approximately and :45 together in this virtual meeting
- As I mentioned in our email exchanges, I will be recording our conversation. Your role in this research is completely confidential unless you specifically request attribution. I'll explain how I maintain your confidentiality in more detail when we review the consent process together.

Set-up

I am a Ph.D. candidate at Michigan State University in Urban Planning and am writing a dissertation on how influence and persuasion facilitate adoption of automated vehicles. My

research draws upon the insight of industry experts, those directly involved in the development, manufacturing, marketing, sales, service, and regulation of mobility solutions. I am passionate about vehicles and new technologies. In another life, I worked for nine years for Kettering University (GMI), twelve years in Silicon Valley for Hewlett Packard and for an enterprise security provider that is now part of Broadcom. I am fascinated by the concept of automated driving systems and what that may mean for the future of mobility and for our communities. My role as interviewer is as a student and the information gained through our conversation will be used to educate me and to aid me in the writing of an insightful dissertation.

Housekeeping

Would you mind if I take notes during our conversation? As I mentioned, I will be recording our session.

As a matter of practice, I need your consent for the study. Let's take a few minutes to discuss consent. We can then review the form and sign. The informed consent form informs you of important issues such as confidentiality. (Discuss the concept of consent, introduce the form, have interviewee sign and hold up to the camera for the record.)

[START RECORDING]

What does the future look like – Main Question 1

So now that we are organized, tell me – when thinking of automated driving systems – specifically fully automated vehicles – SAE L4/L5, what comes to mind? What does the future look like? [tour the future, where are we headed, identify two or three key concepts]

Modes of transportation

- Innovation
  - Technical

        - Product
    - Adoption
        - Innovators; who, business model
            - Service/subscription/ownership
        - Early adopters; who business model
            - Service/subscription/ownership
    - Volume
    - Categories

- New technologies [concept content]
    - Dominant
    - Hype

- Use patterns
    - Similarities (traditional driving)
    - Changes
- Timelines [solution readiness]
    - Innovators
    - Early adopters

Influencers [Two-step, WOM]

- Who/how is this future vision being built?
    - Who is behind it?

- What factors drive the vision?

    - Social
    - Economic
    - Environmental

Solidify future vision

- Of all of these elements, strongest trends?
    - Business model
- Geographic considerations?
- Who is particularly good at evangelizing these concepts? [channels/content]
    - How done?

Best sources

- Are there favorite types or techniques you and your organization use for innovation/consumer sentiment?
    - How do you test and validate your organizational assumptions for messaging?

The Reality – Main Question – 2 [emotional response to the solutions]

- How does this play out? [Explore the interviewee's insight]

- Where are the cracks in the vision?
    - Specific inhibitors
    - Specific concerns

- Tell me what you think is the single greatest inhibitor to this future vision

- Why such a big deal?

- How does that affect consideration and adoption? [behavior]

- How is it expressed in-market?

- Who is doing the expression?

Repeat for two inhibitors

Shifting gears – broadening the applicability

We are really talking about advanced technologies and their anticipated impact on society

- What drives society's interest in advanced technologies?
    - How does that relate to mobility?
    - Tell me about a specific focus in market
    - Who
    - What

- More broadly, where does the thought leadership come from?
    - How is it created?
    - Channels
        - Media
        - Enterprise
        - Consultancies

- Are there specific marketing and/or communications frameworks you are familiar with that are utilized to gain thought leadership in a specific space?
    - Messaging/experience techniques used?

Hold here – and move to wrap-up

Transition: [watch the clock and leave :20] I want to circle back to ensure I captured things correctly;

Key Messages and drivers – Main Question #3

- Considering advanced technologies such as SAE L4/L5 driving technologies, you cited a number of key drivers
- Recap drivers
- Best examples of positioning
- Categorically
- Specifically
- Opportunities exist to communicate…….
- Regarding our cities and communities…..

Wrap-up

- This has been really informative
- Do you have questions for me?
- How was this experience?
- If I have follow-up questions, may I contact you?
- Thank the participant

Back-up questions

- Who is the consumer for SAE L4/L5 automated driving systems?
    - Adopters
        - Innovators
        - Early adopters
- What will convince them to use/acquire SAE L4/L5 automated driving systems?
- Who will come to market first?
- What are the three greatest inhibitors to the use of SAE L4/L5 automated driving systems?
- Who will most successfully communicate the benefits of SAE L4/L5 automated driving systems?

APPENDIX E: Qualtrics Survey Results

Autonomous Driving Survey, Abridged Report

Data date: June 28th 2021, 11:49 am EDT

Q1 - Automated driving will change the future of personal mobility

Table 20: Survey Q1 Responses

#	ANSWER	%	COUNT
1	Strongly agree	55.71%	39
2	Somewhat agree	35.71%	25
3	Somewhat disagree	8.57%	6
4	Strongly disagree	0.00%	0
	Total	100%	70

Q2 - Are you familiar with SAE levels of vehicle automation? Note - this survey speaks to the two highest levels of automation - SAE L4/L5

Table 21: Survey Q2 Responses

#	ANSWER	%	COUNT
1	Yes	54.29%	38
2	Somewhat	35.71%	25
3	No	10.00%	7
	Total	100%	70

Q3 - How exciting is the idea of SAE L4/L5 automated driving?

Table 22: Survey Q3 Responses

#	ANSWER	%	COUNT
1	A lot	44.93%	31
2	A moderate amount	27.54%	19
3	A little	20.29%	14
4	Not at all	7.25%	5
	Total	100%	69

Q4 - How enjoyable is conventional driving?

Table 23: Survey Q4 Responses

#	ANSWER	%	COUNT
1	A lot	59.42%	41
2	A moderate amount	28.99%	20
3	A little	8.70%	6
4	Not at all	2.90%	2
	Total	100%	69

Q5 - How enjoyable will SAE L4/L5 automated driving be?

Table 24: Survey Q5 Responses

#	ANSWER	%	COUNT
1	A lot	21.74%	15
2	A moderate amount	28.99%	20
3	A little	27.54%	19
4	Not at all	21.74%	15
	Total	100%	69

Q6 - When do you think the majority (over 50%) of cars on U.S. roads will be driving in a fully automated manner?

Table 25: Survey Q6 Responses

#	ANSWER	%	COUNT
1	2025	0.00%	0
2	2035	14.49%	10
3	2045	31.88%	22
4	2045+	44.93%	31
5	Never will	8.70%	6
	Total	100%	69

Q7 - How much easier will fully automated driving be than conventional driving?

Table 26: Survey Q7 Responses

#	ANSWER	%	COUNT
1	A lot	49.28%	34
2	A moderate amount	26.09%	18
3	A little	17.39%	12
4	Not at all	7.25%	5
	Total	100%	69

Q8 - SAE L4/L5 driving will, as compared to conventional driving,... Drag to rank order potential benefits

Table 27: Survey Q8 Responses

#	QUESTION	1		2		3		4		5		6		7		TOTAL
1	be safer	46.77%	29	29.03%	18	12.90%	8	1.61%	1	4.84%	3	1.61%	1	3.23%	2	62
2	enable riders to spend time on other activities while traveling	41.94%	26	32.26%	20	11.29%	7	3.23%	2	4.84%	3	4.84%	3	1.61%	1	62
3	shorten travel times	1.61%	1	4.84%	3	19.35%	12	38.71%	24	16.13%	10	17.74%	11	1.61%	1	62
4	reduce congestion	4.84%	3	17.74%	11	30.65%	19	20.97%	13	19.35%	12	3.23%	2	3.23%	2	62
5	consume less fuel	1.61%	1	3.23%	2	11.29%	7	17.74%	11	33.87%	21	25.81%	16	6.45%	4	62
6	be more environmentally friendly	1.61%	1	4.84%	3	9.68%	6	8.06%	5	17.74%	11	41.94%	26	16.13%	10	62
7	not provide benefits over conventional driving	1.61%	1	8.06%	5	4.84%	3	9.68%	6	3.23%	2	4.84%	3	67.74%	42	62

Q9 - SAE L4/L5 driving solutions will be beneficial when ... Drag to rank order benefit opportunities

Table 28: Survey Q9 Responses

#	QUESTION	1		2		3		4		5		6		7		TOTAL
1	driving is stressful	11.11 %	7	14.29 %	9	26.98 %	17	22.22 %	14	15.87 %	10	9.52 %	6	0.00 %	0	63
2	commuting to work	19.05 %	12	22.22 %	14	12.70 %	8	22.22 %	14	19.05 %	12	1.59 %	1	3.17 %	2	63
3	tired	22.22 %	14	30.16 %	19	15.87 %	10	15.87 %	10	11.11 %	7	4.76 %	3	0.00 %	0	63
4	on everyday trips	3.17 %	2	7.94 %	5	7.94 %	5	12.70 %	8	25.40 %	16	36.51 %	23	6.35 %	4	63
5	driving is boring and/or monotonous	15.87 %	10	17.46 %	11	14.29 %	9	15.87 %	10	15.87 %	10	15.87 %	10	4.76 %	3	63
6	impaired by drugs, alcohol, or medications	26.98 %	17	7.94 %	5	15.87 %	10	9.52 %	6	9.52 %	6	26.98 %	17	3.17 %	2	63
7	SAE L4/L5 driving will never be beneficial	1.59 %	1	0.00 %	0	6.35 %	4	1.59 %	1	3.17 %	2	4.76 %	3	82.54 %	52	63

Q10 - Which automakers/technology providers are best-prepared to offer SAE L4/L5 vehicles to the U.S. market? Drag to rank order potential preparedness

Table 29: Survey Q10 Responses

#	QUESTION	1		2		3		4		5		TOTAL
1	traditional OEMs (Ford, GM, Stellantis)	35.09%	20	36.84%	21	15.79%	9	12.28%	7	0.00%	0	57
2	new automakers (Rivian, Tesla, Lucid, etc.)	29.82%	17	36.84%	21	21.05%	12	12.28%	7	0.00%	0	57
3	ride share companies (Lyft, Uber)	3.51%	2	8.77%	5	22.81%	13	54.39%	31	10.53%	6	57
4	tech companies (Aurora, Waymo)	31.58%	18	17.54%	10	33.33%	19	17.54%	10	0.00%	0	57
5	other	0.00%	0	0.00%	0	7.02%	4	3.51%	2	89.47%	51	57

Q11 - When do you think automakers/technology providers will first offer SAE L4/L5 vehicles in the U.S. market for purchase by service providers and/or consumers?

Table 30: Survey Q11 Responses

#	ANSWER	%	COUNT
1	2025	20.00%	13
2	2030	47.69%	31
3	2040	16.92%	11
4	can't say	15.38%	10
	Total	100%	65

Q12 - How should SAE L4/L5 vehicles be offered in the U.S. market? Drag to rank order offerings

Table 31: Survey Q12 Responses

#	QUESTION	1		2		3		4		TOTAL
1	as a service	29.51%	18	45.90%	28	22.95%	14	1.64%	1	61
2	as a subscription	4.92%	3	11.48%	7	45.90%	28	37.70%	23	61
3	private ownership	31.15%	19	18.03%	11	14.75%	9	36.07%	22	61
4	as public transit	34.43%	21	24.59%	15	16.39%	10	24.59%	15	61

Q13 - List 2 barriers to the introduction/adoption of SAE L4/L5 vehicles

Table 32: Survey Q13 Responses

List 2 barriers to the introduction/adoption of SAE L4/L5 vehicles
Public acceptance and ethical / legal issues
Establishing and proving sufficient safety, anticipating edge cases, establishing industry-government safety collaboration
public opinion/fear; people who feel they're infallible and do stupid things (cross the street regardless of traffic); congestion in cities from people who have a car circle rather than park
bad press, randomness of travel and infrastructure
The drivers who enjoy conventional driving; People who love the traditional mechanism of the cars.
They have to handle every situation; People will not tolerate mistakes from computers like they do from people.
Public adoption and public policy
Infrastructure needs to be standardized. L4/L5 vehicles are expensive to make.
Public trust in the safety of L4/L5 vehicles, High cost/benefit ratio of the technology
public perception, collisions from intermingling with non-L4/L5 vehicles
Public perception and concern, Mix of automated/conventional vehicles on the road
unclear liability in case of accident; conventional drivers intentionally triggering emergency maneuvers of SAE L4/L5 vehicles
Consumer lack of confidence; Legal/liability framework

Table 32 (cont'd)

Safety as perceived by public, limited ODD
Public acceptance of L4/L5 vehicles being involved in collisions; technical barriers dealing with edge case scenarios
Liability assignment for crashes; reliability of the infrastructure to meet the needs of L4/L5 vehicles
Unexpected problems and bugs often experienced with new technology.
Several ADS developers are creating an impression that they care more about profits than the safety of customers. Many ADS businesses cases are built on asssumptions that are inconsistent with what human anthropology tells us.
Trust/Adoption, Regulation
Lack of interest by consumers that still have a unique passion including younger generations.
Sensors getting obstructed by contamination/snow/mud etc. (LiDAR, Cameras)
Cost, Lack of ability to program for all scenarios
driver reluctance, technology hurdles do to weather etc.
Pedestrians, price
Working out all the edge cases / getting it to actually work, Expanding geofences
Roadway variables (LA streets vs. Boston streets), unexciting (pods are about as exciting as a subway car designed for the streets)
testing & regulation
technology & safety are intertwined and, cost
Reliability and speed
True L5 appears to be impossible. Even the best sensor suites (which combine cameras, radar, and lidar) get confused by rain, snow, fog, et cetera. Level 4 autonomy will be deployed, but if it cannot work in inclement weather, it probably loses most of its appeal.
safety, public trust
(1) Technological hurdles such as the large amount of data needed to processed in a short amount of time, processing and electrical power that is needed; (2) overcoming public doubt in the safety and reliablility of autonomous driving systems
Going to countryside. Weather conditions
passenger ride discomfort (motion sickness), lack of ability to handle roadway situations.
attorneys, safety
Government regulations, Lack of affordability
fear and the unknown that consumers have
Government bureaucracy, faith in technology
1) non-autonomous cars on the road; 2) weather/road condition variation
Average life-cycle of driver-driven cars. Assuming AVs and driver-driven cars cannot operate safely side-by-side, 16M units a year in the US x 11-year average lifecycle. That's a long time for US PARC of driver-driven vehicles to decline.

Table 32 (cont'd)

Critical Mass, Infrastructure
Lack of personal control; Actual enjoyment of driving
AI reasoning and people who enjoy driving
The trolley problem/ethics of who dies when there is a zero sums scenario, Those unwilling to give up collectable cars or those that don't want a vehicle to drive for them.
Trust in the AI technology & Technology barrier
Product liability attorneys, public acceptance.
cost and infrastructure
safety concerns, elimination of the personal joy of driving
People driving is unpredictable not everyone will be able to afford it for years
Cost, extensive proliferation of current technologies that will take decades to be displaced.
Vehicles that are not SAE L4/L5 still on the road. AI driving/collision avoidance errors
Public perception about the safety or reliability of the automated systems. Legal complexities related to who is at fault in the event of an accident.
Laws/regulations and safety
The rework of roadways that would have to be considered and the safety issues in "think fast" situations that may put the passengers in danger.
2 barriers: Still can get into an accident with someone driving their car vs being autonomous. Need lots of coding experts who can work to make autonomous cars usable. There is still work required in an autonomous vehicle, just no work that is primarily done by those in the vehicle.
cybersecurity, affordability, safety regulations
Trust and safety
Public opinion, tech barriers
High degree of reliance on a complex design
Inconsistent road markings and customer inertia

Q14 - List 2 ways Covid changed consumers' perceptions of SAE L4/L5 vehicles

Table 33: Survey Q14 Responses

List 2 ways Covid changed consumers' perceptions of SAE L4/L5 vehicles
Increased acceptance due to noticeable drop in environmental emissions and also made them more interested in private forms of travel.
Eh. I suppose the appeal of non occupied ride service, but then there's the problem of cleaning the vehicle between riders
not convinced this had any lasting effect
Less personal contact in the car for transportation will speed up the process of L4/L5 vehicles
I don't think it did
Viable option instead of high occupancy transit. Safety in transporting goods.
People are working from home more, so are needing transport less. Advance of technology during COVID seemed to happen faster to meet needs - Could this mean that L4/L5 gets achieved faster?
Are L4/L5 vehicles going to be safe (clean) enough? I would like L4/L5 to be transporting goods rather than people.
work from home = Less driving = less need for personal vehicle;
No impact
I don't see a change in consumer's perception of SAE L4/L5 vehicles directly related to COVID
Car ownership vs ride-sharing; Lots of ways to die beyond driving
With MaaS, reduced risk to health with no driver
Robotaxis without drivers would be welcomed in COVID times; People commuted less, so the need for vehicle ownership was less and so L4/L5 robotaxis would be more accepted if COVID times continued in the future
The need to travel for many things.
Need to avoid contact with strangers (e.g., taxis, public transport).
Data shows that Covid has decreased the interest in car/ride sharing and increased in the interest in private ownership. Work from home reduces the nature of trips (fewer commutes), more specific trips.
Reconsider transportation choices in to accommodate social distancing, realizing the benefit of contactless/driverless delivery
Covid will have minimal, if any, impact.
I don't think it has.
None
Nor sure Covid has had any impact.
less of need - just work from home, resources to develop L4/L5 could be used in better ways
Other than public transit, none

Table 33 (cont'd)

Shared vehicles less appealing (which reduces most/all of the environmental benefit of AVs), However, interest could be higher due to not wanting to use public transit
sanitation concerns (uber and lyft are gross as it is), personal space/freedom of the road (or, as Lincoln shows us - the power of sanctuary)
Safety & need for personal vehicle
Less important and, misunderstanding
Have not
Nothing I have encountered suggests any amount of change in consumer perceptions due to COVID. Tesla's habit of using its customers as beta testers - on public roads no less! - has caused measurable damage to consumer's perceptions of the safety of vehicle automation, however.
Not sure;
No change
?????
Inability to be in closed quarters with members outside the household for reliable transport, I can't think of another one
May reduce public transportation options
Public transportation strategy, ride sharing benefits
none
none - average consumers don't understand what L4/L5 means.
Reduced use of public transport, new awareness to data
Less work travel; People more accepting of change
Not sure, people can work from home now and a lot will stay like that meaning less driving in general
People needed a way to get around, but wanted to avoid other people and public transit. With working from home, it would be more convenient if they could continue to perform their job while traveling in their car.
People don't travel as much as they used to & People have had a lot of time on their hands and may have done research on the topic that leads to them not trusting them
Didn't change perceptions.
reduced willingness to carpool
reduced need for full time auto ownership, rapid increase in technology
I am not sure Covid has had an impact on L4/L5
People in big cities weren't able to take taxis due to Covid, a driverless system would allow for transportation without human contact. Consumers had more free time to look up SAE L4/L5 vehicles and learn more about them and how they work.
Ride sharing could be less popular. Less traffic congestion could lead to less of a demand for L4/L5.
Financial issues have made more expensive vehicles less appealing.
It has reduced consumer interest due to hard times in some ways, but also possibly influenced more through need for less contact in vehicle

Table 33 (cont'd)

Less people driving because of working from home. This means less congestion. Covid makes people order more packages, and autonomous semis would make shipments potentially arrive more quickly due to better efficiency.
traveling less, more technology dependent
It could affect public transit
Unsure
I can't think of a reason it should change any perspective at all.
no ride share

Q15 - How interested are consumers in SAE L4/L5 vehicles?

Table 34: Survey Q15 Responses

#	ANSWER	%	COUNT
1	A lot	10.77%	7
2	A moderate amount	43.08%	28
3	A little	43.08%	28
4	Not at all	3.08%	2
	Total	100%	65

Q16 - How important is it that consumers have access to detailed information and experts to explain SAE L4/L5 vehicles?

Table 35: Survey Q16 Responses

#	ANSWER	%	COUNT
1	Very important	76.92%	50
2	Moderately important	15.38%	10
3	Slightly important	4.62%	3
4	Not at all important	3.08%	2
	Total	100%	65

Q17 - What forms of influence are consumers likely to prefer when learning about SAE L4/L5 vehicles? Drag to rank order forms of influence

Table 36: Survey Q17 Responses

#	QUESTION	1		2		3		4		5		6		7		TOTAL
1	general media	21.54%	14	13.85%	9	12.31%	8	16.92%	11	10.77%	7	16.92%	11	7.69%	5	65
2	automotive media	1.54%	1	12.31%	8	10.77%	7	13.85%	9	43.08%	28	13.85%	9	4.62%	3	65
3	a spokesperson identified as an AV expert	9.23%	6	9.23%	6	20.00%	13	23.08%	15	7.69%	5	27.69%	18	3.08%	2	65
4	an expert they personally know	24.62%	16	13.85%	9	20.00%	13	15.38%	10	13.85%	9	10.77%	7	1.54%	1	65
5	a sales person	0.00%	0	0.00%	0	0.00%	0	4.62%	3	7.69%	5	18.46%	12	69.23%	45	65
6	an introduction to the physical product (ex. showroom)	6.15%	4	32.31%	21	20.00%	13	12.31%	8	13.85%	9	6.15%	4	9.23%	6	65
7	an immersive event (ex. ride & drive)	36.92%	24	18.46%	12	16.92%	11	13.85%	9	3.08%	2	6.15%	4	4.62%	3	65

Q18 - Do consumers require descriptive and explanatory content to understand SAE L4/L5 vehicles?

Table 37: Survey Q18 Responses

#	ANSWER	%	COUNT
1	Definitely yes	70.77%	46
2	Probably yes	20.00%	13
3	Probably not	9.23%	6
4	Definitely not	0.00%	0
	Total	100%	65

Q19 - Consumers prefer to learn about SAE L4/L5 vehicles using ... Drag to rank order channel preferences

Table 38: Survey Q19 Responses

#	QUESTION	1		2		3		4		5		TOTAL
1	social networks	38.10%	24	30.16%	19	14.29%	9	11.11%	7	6.35%	4	63
2	general media web sites	6.35%	4	19.05%	12	42.86%	27	26.98%	17	4.76%	3	63
3	automotive media web sites	6.35%	4	17.46%	11	23.81%	15	38.10%	24	14.29%	9	63
4	print media	4.76%	3	3.17%	2	6.35%	4	15.87%	10	69.84%	44	63
5	physical experiences (showroom, demonstration, etc.)	44.44%	28	30.16%	19	12.70%	8	7.94%	5	4.76%	3	63

Q20 - Consumers prefer to learn about SAE L4/L5 vehicles from ... Drag to rank order content preferences

Table 39: Survey Q20 Responses

#	QUESTION	1		2		3		4		TOTAL
1	video content	37.70%	23	34.43%	21	27.87%	17	0.00%	0	61
2	online copy/images	1.64%	1	4.92%	3	39.34%	24	54.10%	33	61
3	immersive content such as virtual reality (VR)	8.20%	5	29.51%	18	22.95%	14	39.34%	24	61
4	physical experiences (ex. showroom, demonstration, etc.)	52.46%	32	31.15%	19	9.84%	6	6.56%	4	61

Q21 - Content to influence consumers is best created by ... Drag to rank order content creator preferences

Table 40: Survey Q2 Responses

#	QUESTION	1		2		3		4		5		TOTAL
1	manufacturers	30.00%	18	20.00%	12	23.33%	14	25.00%	15	1.67%	1	60
2	evaluators/testers	28.33%	17	28.33%	17	35.00%	21	8.33%	5	0.00%	0	60
3	independent influencers	28.33%	17	25.00%	15	8.33%	5	35.00%	21	3.33%	2	60
4	technology providers	11.67%	7	26.67%	16	26.67%	16	30.00%	18	5.00%	3	60
5	other	1.67%	1	0.00%	0	6.67%	4	1.67%	1	90.00%	54	60

Q22 - I will recommend SAE L4/L5 vehicles to people who seek my advice

Table 41: Survey Q22 Responses

#	ANSWER	%	COUNT
1	Yes	32.31%	21
2	Maybe	50.77%	33
3	No	16.92%	11
	Total	100%	65

Q23 - I will encourage friends and relatives to consider the benefits of SAE L4/L5 vehicles

Table 42: Survey Q23 Responses

#	ANSWER	%	COUNT
1	Yes	41.54%	27
2	Maybe	43.08%	28
3	No	15.38%	10
	Total	100%	65

Q24 - SAE L4/L5 vehicles include technologies which will make them more expensive to use/lease/purchase than traditional vehicles

Table 43: Survey Q24 Responses

#	ANSWER	%	COUNT
1	Definitely yes	59.02%	36
2	Probably yes	36.07%	22
3	Probably not	4.92%	3
4	Definitely not	0.00%	0
	Total	100%	61

Q25 - Compared to an average new vehicle - $38,638 (Kelly Blue Book, 2020) - how much more will consumers likely pay for SAE L4/L5 vehicles?

Table 44: Survey Q25 Responses

#	ANSWER	%	COUNT
220	Nothing/$0	5.00%	3
221	Less than $5,000	28.33%	17
222	$5,000 > $10,000	43.33%	26
223	More than $10,000	23.33%	14
	Total	100%	60

Q26 - If SAE L4/L5 vehicles are more expensive than traditional vehicles, the additional cost (price) will be worth it

Table 45: Survey Q26 Responses

#	ANSWER	%	COUNT
1	Yes	22.58%	14
2	Maybe	64.52%	40
3	No	12.90%	8
	Total	100%	62

Q27 - Considering the anticipated cost to purchase SAE L4/L5 vehicles, how will consumers use these vehicles? Drag to rank order uses

Table 46: Survey Q27 Responses

#	QUESTION	1		2		3		4		TOTAL
1	private ownership	33.33%	19	15.79%	9	24.56%	14	26.32%	15	57
2	ride hailing services	33.33%	19	40.35%	23	22.81%	13	3.51%	2	57
3	subscriptions	7.02%	4	21.05%	12	29.82%	17	42.11%	24	57
4	public transit	26.32%	15	22.81%	13	22.81%	13	28.07%	16	57

Q28 - SAE L4/L5 vehicles will change the way residential and commercial areas are developed

Table 47: Survey Q28 Responses

#	ANSWER	%	COUNT
1	Definitely yes	30.65%	19
2	Probably yes	41.94%	26
3	Probably not	25.81%	16
4	Definitely not	1.61%	1
	Total	100%	62

Q29 - List 2 aspects of urban environments most likely to change with the advent of SAE L4/L5 vehicles

Table 48: Survey Q29 Responses

List 2 aspects of urban environments most likely to change with the advent of SAE L4/L5 vehicles
Car parks and town centres
Parking lots, curb regulation, accessibility
redesign of intersections and crosswalks and bike lanes; repurposing of parking areas; use of others as caches for on-demand vehicles
density, safety
Less parking lots
Smart connected infrastructure and mixed use lanes supporting vulnerable road users
Traffic control devices, pedestrian control
Dedicated corridors for L4/L5 vehicles, better space utilization (e.g. elimination of parking lots)
infrastruction maintenance and upgrade. Parking lots off site from downtown
Road lane designations, Curbing inc. pick-up/drop-off zones

Table 48 (cont'd)

parking areas will be collocated into few big parking garages instead of having parking lots all over the place; urban streets will require less lanes leaving more space for green areas or pedestrian areas
Parking facilities; traffic management systems
drop off/pick up points, remote parking, compact parking areas, more congestion
Fewer parking garages and street parking spaces; More ridehailing locations
Public Transport, fewer crashes
Less area and facilities devoted to parking
More centralized parking decks, less surface lots
Greater suburban spread
public transport will move to this offering.
None
availability of set routing public transport that is automated
Autonomous lanes, more parking
Changes to curb management and access; Changes to parking and use of curb space
If adoption occurs and makes long commutes more bearable, urban centers will continue to empty out and people will seek suburban, exurban respites. It is possible that these displace other forms of mass transit like bussing, light-rail, or ride hailing.
parking & drop off/pick up areas
Street Layouts and safety regulations
Depending on how L4/L5 systems are deployed, they may either reduce congestion and improve the quality and reliability of public transit in urban areas, or, if mass-deployed by ridehailing providers or similar businesses, roving robotaxis will dramatically worsen congestion.
Roads
Streets will become more dangerous to pedestrians and cyclists.
Parking
Street planning, crosswalk security
City planning strategies impacted in all areas of planning, parking infrastructure development
Dedicated autonomous lanes and adjustment in traffic routing (more one-way streets, etc.). Likely investments in infrastructure, too.
pavement, access to business
Number of privately held vehicles may be reduced; May manage 'rush hour' better
Not sure
Parking and fewer or no stop signs or stop lights.
Less accidents & More productivity due to not as much traffic

Table 48 (cont'd)

HOV designation
traffic congestion, parking
Less traffic lights and more roundabouts
public transportation will be an early mover to this technology when there are established repeatable routes.
Road layouts. Parking garages
Parking Lots and Automated Car Lanes
Less private ownership and more ridesharing/public transit. Cities will probably become less congested and allow more space for walking and biking.
Places like New York and Houston were congestion may be reduced through better wider flow on the streets and public transit possibly even less vehicle owners. Including possibly more parking availability due to dialed parking from autonomous capabilities.
Less congestion and less pedestrian strikes by cars.
public transportation structure, parking lots
public transit
Traffic flow, ride sharing
Congestion will likely be reduced, and the number of cars on the street will also be reduced.
Parking lots will shrink, mass car storage buildings will become the new norm
parking lots go away,

Q30 - List 2 aspects of suburban environments most likely to change with the advent of SAE L4/L5 vehicles

Table 49: Survey Q30 Responses

List 2 aspects of suburban environments most likely to change with the advent of SAE L4/L5 vehicles
Noise levels and traffic
Low speed shuttles for first mile last mile and robot delivery vehicles and perhaps trash removal
use of parking lots (schools, etc.) as caches for on-demand vehicles
density, distance
None

Table 49 (cont'd)

More roundabouts due to V2V connectivity and lanes supporting VRUs
Traffic control devices, pedestrian control
no need for garages and driveways, lower congestion
shipping of goods (amazon, groceries, etc).
Road lane designations, Parking
I don't see too much change to happen in suburban environments
Traffic management; access to buildings
Lower speed travel, less congestion, improved traffic flow
More suburban sprawl; ewer detached homes with garages (or at least smaller garages)
improved services for the elderly and special populations; fewer crashes
Further out suburbs.
Fewer traffic lights and more traffic circles.
NA
Public transport will move to this offering.
None
Ride hailing usage of this technology for local transport
None
Possibly re-purposing of garages; more congestion
Inner ring suburbs will lose favor to more exurban areas; an outward migration will continue - it is possible that outward extensions of train lines/light rail to suburban centers is reduced and/or displaced
Basing of fleet services & loitering areas
Same as above
L4/L5 systems may improve connections of suburbs to central cities. They will also improve the quality of life of suburban residents who do not or cannot drive, given suburban development patterns necessitate vehicle ownership and use.
More sprawl
Unexpected maneuvers by automated vehicles will cause driving confusion.
Charging/return stations, more bus stops
Running errands, gas stations locations
Consolidation of trips to the grocery store, to pickup the kids, get Starbucks, etc.
pavement, cameras/markers

Table 49 (cont'd)

Ditto Q29
Not Sure
Fewer roads or roads that are more narrow (ie: single lane, like a one way)
Less accidents & productivity increase
More commuters and ride sharing.
Less stop signs
Can offer connectivity for people without transport to access essential services.
Road layouts. Street/garage parking
Automated Car Lanes
Neighborhoods will be more tightly packed since people will not need garages or places to keep cars. People will commute from suburbs to cities in ridesharing programs, jumping from one car or bus to the next like trains.
Suburban environments may see change in flow such as the urban areas but also more public transit
Less congestion and better commute time.
charging stations, parking
public transit
Fences to prevent children and pets from running into the streets, more stop signs
People might be willing to live farther from cities and their jobs if they can also do other things on their commute. Congestion will be reduced.
Reduction in curbside parking, optional garages
smaller garages

Q31 - List 2 aspects of rural environments most likely to change with the advent of SAE L4/L5 vehicles

Table 50: Survey Q31 Responses

List 2 aspects of rural environments most likely to change with the advent of SAE L4/L5 vehicles
Wider roads and road markings
Access to health care services
unlikely
none
None
N/A
Traffic control devices, pedestrian control
better access to services (esp for seniors), lower cost of connectivity to urban centers
farm equipment running autonomously.
Little to none
road infrastructure may have to be improved (road surface, road markings, etc.) to allow for more robust operation of SAE L4/L5 vehicles
Road maintenance; charter buses
Installation/improvement of traffic control devices, improved traffic flow
Increased population; fewer detached homes with garages (or at least smaller garages)
Minimal - fewer crashes
Autonomous agriculture; high speed limits on better-built roads.
Not much change
NA
I think rural will see very little impact as it will not be cost effective to deploy.
None
This area I think will see the lowest impact.
None
Become more populated

Table 50 (cont'd)

Rural farmers are already used to this type of technology via autonomous farm equipment; depending upon barriers to adopting similar technology for street vehicles, rural areas may be the first to adopt the technology
Road standardization & basing of fleet services
Better commumications and, efficient farming
Household-owned L4/L5 autonomous vehicles will increase the number of "super commuters" - people traveling extreme distances to/from work, and facilitate further distancing of home from work (provided remote work such as we've done during the pandemic does not cement this by itself). This will encourage new development into currently rural areas / lead to more sprawl.
Difficulty
Paved/roads taken care of to be more clear to autodrive tech, manufacturing may take over farmland
Trucking, Farming efficiencies
more working from home / further from work; can sleep in the car when you go to the office
Won't, unless it's an autonomous tractor.
cameras/markers
Ditto Q29
Not Sure
Fewer or no passing lanes, higher speed limits.
Less deer accidents & less reckless driving
None
Higher speed limits
Can offer connectivity for people without transport to access essential services.
Road layouts. Street/garage parking
None
Overall road conditions will need to be updated, less unpaved roads etc. People may be even more spread out since they can now commute while distracted.
Rural environments I believe are less likely to experience any change due to lower and wider spread population.
Potentially weak signals, so that could require additional automotive plants around rural areas. Perhaps more people would live in rural areas since they could possibly sleep on long drives into urban environments for work
dirt roads
private transit or self-driving machinery
Unsure
Rural communities will likely be the slowest to change. More people might move into rural countryside and taxi services might be more accessible for rural residents.
Speed limits will increase, all roads will need to be paved

Table 50 (cont'd)

more crashes

Q32 - What is your current age?

Table 51: Survey Q32 Responses

#	ANSWER	%	COUNT
1	Under 18	0.00%	0
2	18 - 24	24.59%	15
3	25 - 34	8.20%	5
4	35 - 44	14.75%	9
5	45 - 54	19.67%	12
6	55 - 64	13.11%	8
7	65 - 74	11.48%	7
8	75 - 84	6.56%	4
9	85 or older	1.64%	1
	Total	100%	61

Q33 - In which country are you a resident?

Table 52: Survey Q33 Responses

In which country are you a resident?
UK
United States
United States
US

Table 52 (cont'd)

United States
USA
United States
United States
usa
USA
Germany
United States
US
United States
USA
U.S.
USA
US
USA
USA
USA
United States
US
Canada
usa
US
USA
USA
USA
USA
United States
Usa

Table 52 (cont'd)

USA
Slovakia
United States
United States
U.S
United States
USA
US
US
USA
United States
United States
United States
USA
USA
USA
United States
United States of America
United States
United States
United States
America
USA
USA
USA
United States
United States of America
USA

Q34 - What is your gender?

Table 53: Survey Q34 Responses

#	ANSWER	%	COUNT
1	Male	86.89%	53
2	Female	13.11%	8
3	Non-binary / third gender	0.00%	0
4	Prefer not to say	0.00%	0
	Total	100%	61

Q35 - In which mobility/automotive/transportation domain are you engaged?

Table 54: Survey Q35 Responses

#	ANSWER	%	COUNT
1	Research	24.59%	15
2	Testing	18.03%	11
3	Manufacturing	16.39%	10
4	Marketing	8.20%	5
5	Sales	3.28%	2
6	After-sales	0.00%	0
7	Regulatory	1.64%	1
8	Education	6.56%	4
9	Other	21.31%	13
	Total	100%	61

Q36 - Is there anything else you would like to share?

Table 55: Survey Q36 Responses

Is there anything else you would like to share?
Why do you use the term “autonomous “? The vehicles will not have agency. That’s why SAE established the terminology.
Public transit will lead the way in the adoption and advancement of AVs.
There need to be unified/consistent message from all vehicle/tech developers relating to ADS. The current propaganda is confusing and misleading and as a result the trust of the public is low.
The major issues: 1) cost of automated vehicles, 2) the range (assuming all electric is likely), 3) the longevity of ownership - we keep our vehicles 10-15 years, 4) repair cost for Automated vehicles may become prohibitive for seniors on a reduced income.
Autonomous vehicles will lead to ubiquitous autonomous robots of all kinds in all sectors of the economy.
Self driving technology is being developed with no basic understanding of consumers. Unless this industry starts truly understanding consumer attitude, behavior and emotion self driving vehicles will have limited appeal.
Until full V2X is in place and the vision systems have subsystems ensuring clear vision for critical sensors is addressed these systems will cause a lot of lives, thus affecting consumer confidence and market penetration
It's ironic that autonomous vehicles strip people of their autonomy
I would be interested in the practicality of autonomous vehicles in rural areas where traffic conditions are lighter and machine learning perhaps less invariable; curious as to the adoption curve/acceptance curve of rural farmers using autonomous farm equipment and the willingness to consider similar technology in private vehicles to make long, rural drives to towns or cities more accommodating.
I answered the last question because of my experience with state legislation and state& federal standards. First the L4/5 delineations are confusing to the public generally. These should be redefined as simply 1) driver assisted safety driving features; 2) self-steering capabilities for part-time hands-off the steering wheel; and, 3) full-time hands-off driving. That's all. Secondly, we're a VERY long ways off from commercialization. For reasons too complex for this venue.
The phrasing of several questions and prompts implies the author is assuming from the start that L4/L5 will become commercially viable and the benefits marketers and hypesters continuously promise will manifest. Both of these assumptions require consideration. As a specific example, while L4/L5 autonomous vehicles may provide environmental benefits, that is only one possible - and unlikely - outcome. AVs will be more energy-intense due to the power requirements of onboard computers, sensors, and other electronics - likely doubling the amount of energy consumed per mile traveled. Likewise, for a subscription or ridehail AV to be profitable, extremely high utilization rates are needed. A vehicle with extremely high annual VMT both will wear out faster, dramatically increasing the pace of fleet turnover and increasing vehicle production related environmental damage. For an example of on-the-record comments: Connie Loizos. "Ford says its autonomous cars will last just four years." TechCrunch. August 26, 2019. https://techcrunch.com/2019/08/26/ford-says-its-autonomous-cars-will-last-just-four-years/
Difficult to apply in rural areas
N/A
Hopefully my feedback helps :)
No
Given the exponential rate of tech evolution and average life cycle of 16M driver-driven US SAAR, there could be a future where autonomous passenger drones 500 to 1000 feet up mapped over existing roads surpass number of AVs on the road. No congestion.

Table 55 (cont'd)

no
I really like the format of this survey and feel that it is very well done.
I am retired.
Have a good day!
N/A
I work in the trucking industry.

BIBLIOGRAPHY

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Abraham, H., Seppelt, B., Mehler, B., & Reimer, B. (2017, September). What's in a name: Vehicle technology branding & consumer expectations for automation. In Proceedings of the 9th international conference on automotive user interfaces and interactive vehicular applications (pp. 226-234).

Abuelsamid, S. “Guidehouse Market Data AVs Q2 2021.” Accessed November 12, 2021. https://guidehouseinsights.com/reports/market-data-automated-vehicles.

Al-Qaysi, N., Mohamad-Nordin, N., & Al-Emran, M. (2020). Employing the Technology Acceptance Model in Social Media: A Systematic Review. Education and Information Technologies, 25(6), 4961-5002.

Albino, V., Berardi, U., & Dangelico, R. M. (2015). Smart cities: Definitions, dimensions, performance, and initiatives. Journal of urban technology, 22(1), 3-21.

Anania, E. C., Rice, S., Walters, N. W., Pierce, M., Winter, S. R., & Milner, M. N. (2018). The effects of positive and negative information on consumers’ willingness to ride in a driverless vehicle. Transport policy, 72, 218-224.

Baltic, T., Cappy, A., Hensley, R., Pfaff, N. (2019). The Future of mobility is at our doorstep. McKinsey Center for Future Mobility.

Bansal, P., & Kockelman, K. M. (2017). Forecasting Americans’ long-term adoption of connected and autonomous vehicle technologies. Transportation Research Part A: Policy and Practice, 95, 49-63.

Bansal, P., & Kockelman, K. M. (2018). Are we ready to embrace connected and self-driving vehicles? A case study of Texans. Transportation, 45(2), 641-675.

Barbour, N., Menon, N., Zhang, Y., & Mannering, F. (2019). Shared automated vehicles: A statistical analysis of consumer use likelihoods and concerns. Transport Policy, 80, 86-93.

Bel Geddes, N. (1940). Magic motorways. Random House.

Bennett, R., Kottasz, R., & Shaw, S. (2016). Factors potentially affecting the successful promotion of electric vehicles. Journal of Social Marketing.

Bergh, B. G. V., Krugman, D. M., & Salwen, M. B. (1983). The temptation to puff: Puffery in automotive advertising, 1930 to 1980. Journalism Quarterly, 60(4), 700-769.

Bonnefon, J. F. (2021). The Car That Knew Too Much: Can a Machine Be Moral?. MIT Press.

Bower, J. L., & Christensen, C. M. (1995). Disruptive technologies: catching the wave.

Brosius, H. B., & Weimann, G. (1996). Who sets the agenda: Agenda-setting as a two-step flow. Communication Research, 23(5), 561-580.

Burns, R., Ferrell, J., & Orrick, E. (2005). False Advertising, Suggestive Persuasion, and Automobile Safety: Assessing Advertising Practices in the Automobile Industry. Southwest Journal of Criminal Justice, 2(2).

Burns, R. G., & Lynch, M. J. (2003). A space for safety: the transformation of automobile safety advertising in response to NHTSA crash test implementation, 1977 and 1981. The Social Science Journal, 40(4), 635-641.

Campbell, Mark, Magnus Egerstedt, Jonathan P. How, and Richard M. Murray. "Autonomous Driving in Urban Environments: Approaches, Lessons and Challenges." Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, October 13, 2010. https://doi.org/10.1098/rsta.2010.0110.

Choi, J. K., & Ji, Y. G. (2015). Investigating the importance of trust on adopting an autonomous vehicle. International Journal of Human-Computer Interaction, 31(10), 692-702.

Chu, S. C., & Kim, Y. (2011). Determinants of consumer engagement in electronic word-of-mouth (eWOM) in social networking sites. International journal of Advertising, 30(1), 47-75.

Chuttur, M. Y. (2009). Overview of the technology acceptance model: Origins, developments and future directions. Working Papers on Information Systems, 9(37), 9-37.

Coleman, J., Katz, E., & Menzel, H. (1957). The diffusion of an innovation among physicians. Sociometry, 20(4), 253-270.

Creswell, J. W., & Creswell, J. D. (2018). Research design: Qualitative, quantitative, and mixed methods approaches. Sage publications.

Davis, F. D. (1985). A technology acceptance model for empirically testing new end-user information systems: Theory and results (Doctoral dissertation, Massachusetts Institute of Technology).

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS quarterly, 319-340.

Eastman, J. W. (1984). Styling vs. Safety. The American Automobile Industry and the Development of Automotive Safety, 1900-1966 (No. HS-036 634).

Epting, S. (2019). Automated vehicles and transportation justice. Philosophy & Technology, 32(3), 389-403.

Faber, K., & van Lierop, D. (2020). How will older adults use automated vehicles? Assessing the role of AVs in overcoming perceived mobility barriers. Transportation research part A: policy and practice, 133, 353-363.

Fagnant, D. J., & Kockelman, K. M. (2014). The travel and environmental implications of shared autonomous vehicles, using agent-based model scenarios. Transportation Research Part C: Emerging Technologies, 40, 1-13.

Fagnant, D. J., & Kockelman, K. (2015). Preparing a nation for autonomous vehicles: opportunities, barriers and policy recommendations. Transportation Research Part A: Policy and Practice, 77, 167-181.

Faisal, A., Kamruzzaman, M., Yigitcanlar, T., & Currie, G. (2019). Understanding autonomous vehicles. Journal of transport and land use, 12(1), 45-72.

Faisal, A., Yigitcanlar, T., Kamruzzaman, M., & Paz, A. (2021). Mapping two decades of autonomous vehicle research: A systematic scientometric analysis. Journal of Urban Technology, 28(3-4), 45-74.

Ferguson, S. A., Hardy, A. P., & Williams, A. F. (2003). Content analysis of television advertising for cars and minivans: 1983–1998. Accident Analysis & Prevention, 35(6), 825-831.

Fraedrich, E., & Lenz, B. (2016). Societal and individual acceptance of autonomous driving. In Autonomous driving (pp. 621-640). Springer, Berlin, Heidelberg.

Fuller, B. (2016). Cautious optimism about driverless cars and land use in American metropolitan areas. Cityscape, 18(3), 181-184.

Ghasri, M., & Vij, A. (2021). The potential impact of media commentary and social influence on consumer preferences for driverless cars. Transportation Research Part C: Emerging Technologies, 127, 103132.

Gheorghe, I. (2012). Word-of-Mouth communication: a theoretical review. Маркетинг і менеджмент інновацій, (1), 132-139.

Griggs, T., & Wakabayashi, D., (2018). How a Self-Driving Uber Killed a Pedestrian in Arizona, https://www.nytimes.com/interactive/2018/03/20/us/self-driving-uber-pedestrian-killed.html?action=click&module=RelatedLinks&pgtype=Article

Guerra, E. (2016). Planning for cars that drive themselves: Metropolitan planning organizations, regional transportation plans, and autonomous vehicles. Journal of Planning Education and Research, 36(2), 210-224.

Hohenberger, C., Spörrle, M., & Welpe, I. M. (2016). How and why do men and women differ in their willingness to use automated cars? The influence of emotions across different age groups. Transportation Research Part A: Policy and Practice, 94, 374-385.

Höltl, A., & Trommer, S. (2013). Driver assistance systems for transport system efficiency: Influencing factors on user acceptance. Journal of Intelligent Transportation Systems, 17(3), 245-254.

Huang, T. (2021). Research on the use intention of potential designers of unmanned cars based on technology acceptance model. PLoS one, 16(8), e0256570.

Hulse, L. M., Xie, H., & Galea, E. R. (2018). Perceptions of autonomous vehicles: Relationships with road users, risk, gender and age. Safety science, 102, 1-13.

Jing, P., Xu, G., Chen, Y., Shi, Y., & Zhan, F. (2020). The determinants behind the acceptance of autonomous vehicles: A systematic review. Sustainability, 12(5), 1719.

Kalra, Nidhi, and Susan M. Paddock. “Driving to Safety: How Many Miles of Driving Would It Take to Demonstrate Autonomous Vehicle Reliability?” Transportation Research Part A: Policy and Practice 94 (December 2016): 182–93. https://doi.org/10.1016/j.tra.2016.09.010.

Kassens-Noor, E. (2022), Lecture on Disruptive Technology. Class - Urban Planning 868, Michigan State University.

Kassens-Noor, E., Cai, M., Kotval-Karamchandani, Z., & Dexaminid, T. (2021). Autonomous vehicles and mobility for people with special needs. Transportation research part A: policy and practice, 150, 385-397.

Kassens-Noor, E., Dake, D., Decaminada, T., Kotval-K, Z., Qu, T., Wilson, M., & Pentland, B. (2020). Sociomobility of the 21st century: Autonomous vehicles, planning, and the future city. Transport Policy, 99, 329-335.

Kassens-Noor, E., Kotval-Karamchandani, Z., & Cai, M. (2020). Willingness to ride and perceptions of autonomous public transit. Transportation Research Part A: Policy and Practice, 138, 92-104.

Kassens-Noor, E., Wilson, M., Cai, M., Durst, N., & Dexaminid, T. (2020). Autonomous vs. Self-Driving Vehicles: The Power of Language to Shape Public Perceptions. Journal of Urban Technology, 1-20.

Kassens-Noor, E., Wilson, M., & Yigitcanlar, T. (2021). Where Are Autonomous Vehicles Taking Us?. Journal of Urban Technology, 28(3-4), 1-4.

Katz, E., & Lazarsfeld, P. F. (2017). Personal influence: The part played by people in the flow of mass communications. Routledge.

Katz, E. (1957). The two-step flow of communication: An up-to-date report on an hypothesis. Public opinion quarterly, 21(1), 61-78.

Katz, E. (1987). Communications research since Lazarsfeld. The Public Opinion Quarterly, 51, S25-S45.

Kontokosta, C. E. (2021). Urban informatics in the science and practice of planning. Journal of Planning Education and Research, 41(4), 382-395.

Streetsblog USA. “The 94% Error: We Need to Understand the True Cause of Crashes,” October 14, 2020. https://usa.streetsblog.org/2020/10/14/the-94-solution-we-need-to-understand-the-causes-of-crashes/.

Koul, S., & Eydgahi, A. (2018). Utilizing technology acceptance model (TAM) for driverless car technology adoption. Journal of technology management & innovation, 13(4), 37-46.

Krueger, R., Rashidi, T. H., & Rose, J. M. (2016). Preferences for shared autonomous vehicles. Transportation research part C: emerging technologies, 69, 343-355.

Kyriakidis, M., Happee, R., & de Winter, J. C. (2015). Public opinion on automated driving: Results of an international questionnaire among 5000 respondents. Transportation research part F: traffic psychology and behavior, 32, 127-140.

Lah, U., Lewis, J. R., & Šumak, B. (2020). Perceived usability and the modified technology acceptance model. International Journal of Human–Computer Interaction, 36(13), 1216-1230.

Lai, A. W. (1995). Consumer values, product benefits and customer value: a consumption behavior approach. ACR North American Advances.

Lazarsfeld, P. F., Berelson, B., & Gaudet, H. (1968). The people’s choice. Columbia University Press.

Lee, M., & Youn, S. (2009). Electronic word of mouth (eWOM) How eWOM platforms influence consumer product judgement. International journal of advertising, 28(3), 473-499.

Lee, Y., Kozar, K. A., & Larsen, K. R. (2003). The technology acceptance model: Past, present, and future. Communications of the Association for information systems, 12(1), 50.

Legacy, C., Ashmore, D., Scheurer, J., Stone, J., & Curtis, C. (2019). Planning the driverless city. Transport reviews, 39(1), 84-102.

Motor Trend. “Elon Musk Says Tesla Robotaxis Will Be Ready This Year,” April 16, 2020. https://www.motortrend.com/news/tesla-robotaxis-will-ready-2020-elon-musk-says/.

Lipson, H., & Kurman, M. (2016). Driverless: intelligent cars and the road ahead. MIT Press.

Litman, T. (2020). Autonomous vehicle implementation predictions: Implications for transport planning.

Liu, W., Sidhu, A., Beacom, A. M., & Valente, T. W. (2017). Social network theory. The international encyclopedia of media effects, 1-12.

Liu, P., Yang, R., & Xu, Z. (2019). Public acceptance of fully automated driving: Effects of social trust and risk/benefit perceptions. Risk Analysis, 39(2), 326-341.

Luke, J. O., & Vessels, C. M. (2004). Implications of two-sided advertising in the automotive industry (Doctoral dissertation, Massachusetts Institute of Technology).

Marangunić, N., & Granić, A. (2015). Technology acceptance model: a literature review from 1986 to 2013. Universal access in the information society, 14(1), 81-95.

Maxwell, J. A. (2016). Expanding the history and range of mixed methods research. Journal of mixed methods research, 10(1), 12-27.

May, K. R., Noah, B. E., & Walker, B. N. (2017, September). Driving acceptance: Applying structural equation modeling to in-vehicle automation acceptance. In Proceedings of the 9th International Conference on Automotive User Interfaces and Interactive Vehicular Applications Adjunct (pp. 190-194).

Menon, N., Barbour, N., Zhang, Y., Pinjari, A. R., & Mannering, F. (2019). Shared autonomous vehicles and their potential impacts on household vehicle ownership: An exploratory empirical assessment. International Journal of Sustainable Transportation, 13(2), 111-122.

Menon, N., Zhang, Y., Rawoof Pinjari, A., & Mannering, F. (2020). A statistical analysis of consumer perceptions towards automated vehicles and their intended adoption. Transportation planning and technology, 43(3), 253-278.

Milakis, D., Van Arem, B., & Van Wee, B. (2017). Policy and society related implications of automated driving: A review of literature and directions for future research. Journal of Intelligent Transportation Systems, 21(4), 324-348.

Millard-Ball, A. (2018). Pedestrians, autonomous vehicles, and cities. Journal of planning education and research, 38(1), 6-12.

Mladenovic, M. N., & McPherson, T. (2016). Engineering social justice into traffic control for self-driving vehicles?. Science and engineering ethics, 22(4), 1131-1149.

National Association of City Transportation Officials. “Blueprint for Autonomous Urbanism: Second Edition,” September 5, 2019. https://nacto.org/publication/bau2.

Nordhoff, S., De Winter, J., Kyriakidis, M., Van Arem, B., & Happee, R. (2018). Acceptance of driverless vehicles: Results from a large cross-national questionnaire study. Journal of Advanced Transportation, 2018.

Norton, P. D. (2011). Fighting traffic: the dawn of the motor age in the American city. MIT Press.

Norton, P. (2021). Autonorama: The Illusory Promise of High-Tech Driving. Island Press.

Noyes, D., (2020). Driver in Fatal 2018 Mountain View Tesla Crash Was Playing Video Game, NTSB Says. https://abc7news.com/tesla-autopilot-crash-car/5966601/

Packard, V. (1957). The hidden persuaders (p. 240). New York: Pocket Books.

Panagiotopoulos, I., & Dimitrakopoulos, G. (2018). An empirical investigation on consumers' intentions towards autonomous driving. Transportation research part C: emerging technologies, 95, 773-784.

Patel, N. & Hawkins, A., J. (2022, January 6). Pete Buttigieg Is Racing To Keep Up With Self-Driving Cars. The Verge. https://www.theverge.com/22869190/pete-buttigieg-self-driving-cars-electric-tesla-decoder

Pavlou, P. A. (2003). Consumer acceptance of electronic commerce: Integrating trust and risk with the technology acceptance model. International journal of electronic commerce, 7(3), 101-134.

Penmetsa, P., Sheinidashtegol, P., Musaev, A., Adanu, E. K., & Hudnall, M. (2021). Effects of the autonomous vehicle crashes on public perception of the technology. IATSS Research.

Prendergast, G., Ko, D., & Siu Yin, V. Y. (2010). Online word of mouth and consumer purchase intentions. International journal of advertising, 29(5), 687-708.

Raj, A., Kumar, J. A., & Bansal, P. (2020). A multicriteria decision making approach to study barriers to the adoption of autonomous vehicles. Transportation research part A: policy and practice, 133, 122-137.

Ram, S., & Sheth, J. N. (1989). Consumer resistance to innovations: the marketing problem and its solutions. Journal of consumer marketing.

Ruvio, A., Bagozzi, R. P., Hult, G. T. M., & Spreng, R. (2020). Consumer arrogance and word-of-mouth. Journal of the Academy of Marketing Science, 48(6), 1116-1137.

SAE International. "SAE J3016," April 2021.

Şahin, A., TURHAN, L., & ZEHİR, A. (2013). Building behavioral intentions in automotive industry: Brand experience, satisfaction, trust, direct mail communication and attitudes toward advertising. Business Management Dynamics, 3(4), 45.

Schoettle, B., & Sivak, M. (2014). A survey of public opinion about autonomous and self-driving vehicles in the US, the UK, and Australia. University of Michigan, Ann Arbor, Transportation Research Institute.

Schoettle, B., & Sivak, M. (2015). Potential impact of self-driving vehicles on household vehicle demand and usage. University of Michigan, Ann Arbor, Transportation Research Institute.

Shabanpour, R., Shamshiripour, A., & Mohammadian, A. (2018). Modeling adoption timing of autonomous vehicles: innovation diffusion approach. Transportation, 45(6), 1607-1621.

Statisitca (2021). Number of employees in U.S. automotive industry by sector 2010-2021

Stilgoe, J., & Cohen, T. (2021). Rejecting acceptance: learning from public dialogue on self-driving vehicles. Science and Public Policy.

Sultan, N. (2013). Knowledge management in the age of cloud computing and Web 2.0: Experiencing the power of disruptive innovations. International journal of information management, 33(1), 160-165.

Talebian, A., & Mishra, S. (2018). Predicting the adoption of connected autonomous vehicles: A new approach based on the theory of diffusion of innovations. Transportation Research Part C: Emerging Technologies, 95, 363-380.

Threlfall, Richard. “Autonomous Vehicles Readiness Index (AVRI) - KPMG Global.” KPMG, October 6, 2020. https://home.kpmg/xx/en/home/insights/2020/06/autonomous-vehicles-readiness-index.html.

Townsend, A. M. (2020). Ghost Road: Beyond the Driverless Car. WW Norton & Company.

Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. Management science, 46(2), 186-204.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. MIS quarterly, 425-478.

Ward, C., Raue, M., Lee, C., D’Ambrosio, L., & Coughlin, J. F. (2017, July). Acceptance of automated driving across generations: The role of risk and benefit perception, knowledge, and trust. In International Conference on Human-Computer Interaction (pp. 254-266). Springer, Cham.

Watson, L., Lavack, A. M., Rudin-Brown, C., Burns, P., & Mintz, J. H. (2010). Message content in Canadian automotive advertising: a role for regulation?. Canadian Public Policy, 36(Supplement 1), S49-S67.

Westenberg, B., Georgieva, T., Kolodge, K., & Boor, L. (2018) Automated Vehicles: Liability Crash Course. J. D. Power & Miller Canfield.

Yigitcanlar, T., Wilson, M., & Kamruzzaman, M. (2019). Disruptive impacts of automated driving systems on the built environment and land use: An urban planner's perspective. Journal of open innovation: Technology, market, and complexity, 5(2), 24.

Yuen, K. F., Cai, L., Qi, G., & Wang, X. (2021). Factors influencing autonomous vehicle adoption: An application of the technology acceptance model and innovation diffusion theory. Technology Analysis & Strategic Management, 33(5), 505-519.

Yuen, K. F., Wong, Y. D., Ma, F., & Wang, X. (2020). The determinants of public acceptance of autonomous vehicles: An innovation diffusion perspective. Journal of Cleaner Production, 270, 121904.

Zakharenko, R. (2016). Self-driving cars will change cities. Regional science and urban economics, 61, 26-37.

Zhang, K. Z., & Benyoucef, M. (2016). Consumer behavior in social commerce: A literature review. Decision Support Systems, 86, 95-108.

Zhao, H., Dimovitz, K., Staveland, B., & Medsker, L. (2016, September). Responding to challenges in the design of moral autonomous vehicles. In 2016 AAAI Fall Symposium Series.

Zhu, G., Chen, Y., & Zheng, J. (2020). Modelling the acceptance of fully autonomous vehicles: a media-based perception and adoption model. Transportation research part F: traffic psychology and behavior, 73, 80-91.