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A SMART MOVE? 24 ESSENTIALS OF A SWOT ANALYSIS POLICYMAKERS NEED TO CONSIDER

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Regulators and policymakers are increasingly involved in making important decisions about the governance of automated vehicles (AVs). Policymakers need to design comprehensive policies to deliver the benefits of AVs and to foresee and address potential unintended consequences; however, this is not an easy task. Especially given the complexity of the technology, AVs require a sophisticated analysis: beyond the apparent safety and security issues, AVs have significant potential to affect issues related to privacy, accessibility, the environment, and land management.

Understanding and balancing the potential benefits of AVs against their challenges would help with the problem of delivering comprehensive policies on AVs. In addition, leveraging governments' strengths and identifying their weaknesses would help also with the problem of delivering more effective AV policies, influencing the ways in which this technology is adopted, and at what pace.

This policy primer explores governments' most relevant strengths, weaknesses, opportunities, and threats (SWOT) in relation to AVs in the form of a SWOT analysis, which may expand policymakers' governance toolbox and help them design comprehensive policies to proactively address the unintended consequences of AVs. It intends to inform regulators and policymakers, bridging information asymmetries between policymakers and technologists. It also aims at expanding policymakers' governance toolbox to help them create more effective policies and regulations.

AVs have the potential to generate both benefits to society and undesirable consequences. The final output of the technology will very much depend on the public policies and regulations that are put in place to shape the deployment of AVs. The effectiveness of this deployment is dependent on governments' leveraging the strengths of AVs and mitigating their weaknesses.

Although traditional SWOT analyses are organized by their strengths, weaknesses, opportunities and threats, respectively, this policy primer presents a unique flow to the traditional order. In the following sections, we will be introducing the analysis of the opportunities, threats, strengths, and weaknesses of governments with respect to AVs, an analysis that aims at expanding policymakers' governance toolbox.

OPPORTUNITIES

What are the key opportunities presented by AVs?

1 Road Safety And Social Costs

AVs can be a catalyst for improving road safety. The World Health Organization estimates that there are 1.3 million casualties in highway accidents per year.[1] In the US, about 30,000 people die in traffic collisions every year, and 40,000 in Europe.[2] Human errors are believed to be responsible for over 90% of these accidents, primarily due to causes like distracted driving, speeding, reckless driving, and driving under the influence, among others.[3] If 90% of passenger vehicles in the US were autonomous, traffic fatalities could be reduced by nearly two-thirds.[4] In addition to saving lives, the reduction in traffic accidents will decrease the social costs related to accident prevention and management and related healthcare services. In the US during 2016 alone, motor-vehicle fatalities, injuries, and property damage cost more than $432 billion, a 7% increase from 2015.[5]

2 Increased Mobility And Accessibility

At the same time, AVs can serve as a more convenient mode of transportation (point-to-point), especially for those populations unable to operate a vehicle manually (including youth, people with certain disabilities, and the elderly). In the US, only two-thirds of the population have a driver's license, and between 5-10 million people cannot drive due to disabilities.[6] On a global scale, the number of people who are 85 and older is estimated to increase by 351% between 2010 and 2050.[7] In Japan, for example, 35% of the population will be over the age of 65 by 2100.[8] Also, the number of elderly people living alone is growing in most countries, further limiting the mobility of this population. In some European countries, more than 40% of women aged 65 years or older live alone.[9]

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1 World Health Organization, *10 facts on global road safety,* (2017), http://www.who.int/features/factfiles/roadsafety/en/.

2 Business insider, *Advantages of Self-driving cars,* (2016), http://www.businessinsider.com/advantages-of-driverless-cars-2016-6/#roads-will-be-safer-1.

3 US Department of Transportation, *2045 Beyond Traffic: Trends and Choices,* https://cms.dot.gov/sites/dot.gov/files/docs/Draft_Beyond_Traffic_Framework.pdf, 102.

4 Business insider, *Advantages of Self-driving cars,* (2016), http://www.businessinsider.com/advantages-of-driverless-cars-2016-6/#roads-will-be-safer-1.

5 National Safety Council, *Motor Vehicle Fatality Estimates 2016,* http://www.nsc.org/NewsDocuments/2017/12-month-estimates.pdf.

6 US Department of Transportation, *2045 Beyond Traffic: Trends and Choices*, https://cms.dot.gov/sites/dot.gov/files/docs/Draft_Beyond_Traffic_Framework.pdf, 105.

7 WHO, *Global Health and Aging report*, http://www.who.int/ageing/publications/global_health.pdf, 8.

8 Rosamond Hutt, Japan's population is shrinking: What does it mean for the economy?, (2016), https://www.weforum.org/agenda/2016/02/japans-population-is-shrinking-what-does-it-mean-for-the-economy/

9 WHO, *Global Health and Aging report*, http://www.who.int/ageing/publications/global_health.pdf, 22.

3 Environmental Sustainability

AVs can help to improve environmental sustainability and could reduce CO_2 emissions by 300 million tons per year.[10] AVs will reduce traffic congestion, specifically by reducing the number of collisions, which—in the United States—"account for about one-third of all delays due to traffic congestion."[11] AVs will also optimize braking and acceleration, which are vehicle functions that, when done inefficiently, result in increased CO_2 emissions.[12] It has been estimated that optimized driving could reduce CO_2 emissions by 60%.[13]

Additionally, sharing schemes for AVs could lessen the environmental impact of passenger vehicles by decreasing the number of vehicles on the road. In effect, AV sharing schemes would foster the use of on-demand vehicle services, reducing the need for individuals to own a car[14] and provide last-mile services, which—combined with other transportation methods, such as trains—promote the use of more sustainable transportation systems.[15]

4 More Profitable Use Of Resources

Automation could help drivers reclaim the time they spend commuting, enabling them to use their time in more productive ways. Researchers have suggested that AVs may increase worker productivity by 10-15%[16] and save around 1 billion hours every day.[17] For example, in the US, drivers spend almost an hour driving each day[18] and 40 hours in traffic jams each year, which is estimated to cost $121 billion.[19]

It is also estimated that automated driving could generate 5 billion euros in digital media revenues per year for every extra minute that AV users dedicate to checking social media and producing content.[20]

Ride-sharing could also reduce the time individuals spend searching for parking spaces; today, "up to 30% of traffic in metropolitan areas is due to drivers circling business districts in order to find a nearby parking space."[21] Furthermore, by reducing the overall demand for parking spaces,

10 Business insider, *The 3 biggest ways self-driving cars will improve our lives,* (June 2016), http://www.businessinsider.com/advantages-of-driverless-cars-2016-6/#traffic-and-fuel-efficiency-will-greatly-improve-2.

11 US Department of Transportation, *2045 Beyond Traffic: Trends and Choices,* https://cms.dot.gov/sites/dot.gov/files/docs/Draft_Beyond_Traffic_Framework.pdf, 102.

12 *Id.*,102.

13 McKinsey, *Ten ways in which autonomous driving could redefine the automotive world*, (2015), https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/ten-ways-autonomous-driving-could-redefine-the-automotive-world.

14 *Id.*,103.

15 *Id.*, 103.

16 Digital Transformation Monitor, *Autonomous cars: a big opportunity for European Industry*, (2017), https://ec.europa.eu/growth/tools-databases/dem/monitor/sites/default/files/DTM_Autonomous%20cars%20v1.pdf, 5.

17 *Id.*

18 US Department of Transportation, *2045 Beyond Traffic: Trends and Choices*, https://cms.dot.gov/sites/dot.gov/files/docs/Draft_Beyond_Traffic_Framework.pdf, 105.

19 *Id.*, 13-14.

20 *Id.*

21 Darrell M. West, *Moving forward: self-driving vehicles in China, Europe, Japan, Korea, and the US*, Center for Technology Innovation at Brookings (2016), https://www.brookings.edu/wp-content/uploads/2016/09/driverless-cars-3-ed.pdf, 10, citing research done by Donald Shoup.

AVs could free up nearly 5.7 billion square meters of land that is currently used in the US for parking[22]— land that could instead be used for housing, greenspaces, or otherwise enhancing neighborhood livability.

5 Reduced Operational Costs And Improved Logistics

Automated driving could reduce the operational costs associated with commercial trucking by 30%.[23] A report of the International Transport Forum (ITF)[24] highlights several factors, such as reductions in labor costs (which in Europe account for 35-45% of transportation costs), and reduced fuel consumption resulting from the optimization of vehicle operations (e.g. efficient acceleration and braking) and the improved aerodynamics achieved through "platooning."

Platooning is defined by the European Automobile Association as "the linking of two or more trucks in convoy, using connectivity technology and automatized support systems."[25] Additionally, because computers are not limited by the resting requirements of human drivers, AVs could enhance productivity by increasing the number of hours that the vehicles are in operation, which would create the opportunity to decrease fleet size.[26] Other services made possible by AVs could include automated delivery, load pick up, and fleet management.[27]

6 Lower Litigation Costs

Extant technologies, such as Event Data Recorders (EDR), are being used by the NHTSA to investigate crashes and clarify civil liabilities earlier, which may reduce litigation costs.[28] By helping to prevent collisions, AVs could also decrease the number of torts claims. However, in the case of an accident occurring, AVs—as EDR—will help to provide insight into the event and clarify civil liability.

22 McKinsey, *Ten ways in which autonomous driving could redefine the automotive world,* (2015), https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/ten-ways-autonomous-driving-could-redefine-the-automotive-world.

23 International Transport Forum/OECD, *Managing the Transition to Driverless Road Freight Transport,* (2017), https://www.itf-oecd.org/sites/default/files/docs/managing-transition-driverless-road-freight-transport.pdf.

24 *Id.*

25 European Automobile Manufacturers Association, *Truck Platooning Roadmap*, http://www.acea.be/uploads/publications/Platooning_roadmap.pdf

26 International Transport Forum/OECD, *Managing the Transition to Driverless Road Freight Transport,* (2017), https://www.itf-oecd.org/sites/default/files/docs/managing-transition-driverless-road-freight-transport.pdf.

27 Digital Transformation Monitor, *Autonomous cars: a big opportunity for European Industry,* (2017), https://ec.europa.eu/growth/tools-databases/dem/monitor/sites/default/files/DTM_Autonomous%20cars%20v1.pdf, 4.

28 NHTSA, *Event Data Recorder,* https://www.nhtsa.gov/research-data/event-data-recorder.

7 Adjacent Industry Transformation[29]

"Some plug-in hybrid cars generate 25 GB of data in just one hour."[30] This supply of data can create new possibilities for automakers, such as facilitating predictive maintenance (which could reduce repair frequencies and global maintenance costs), reducing insurance premiums (which could enable insurance models to charge based on distance, place, and type of care, for instance) and expand car sharing and pooling mobility services.[31] Revenue from AVs is expected to rise to 147 billion euros from 2015 to 2022. [32]

8 Learning Experience

AVs also provide the opportunity for regulators to gain policymaking experience from emerging artificial intelligence (AI) technologies, which could inform approaches to future regulations and decision-making processes in regard to other AI-based technologies. The insights gathered through case studies of AVs may be reutilized for other AI systems.

29 Digital Transformation Monitor, *Autonomous cars: a big opportunity for European Industry,* (2017), https://ec.europa.eu/growth/tools-databases/dem/monitor/sites/default/files/DTM_Autonomous%20cars%20v1.pdf, 3-4.

30 *Id.,* 3.

31 *Id.,* 3-4.

32 *Id.,* 3.

THREATS

What are the main threats that AVs pose to society?

9 Ethical Dilemmas

Determining how AVs should react under an imminent, unavoidable accident raises ethical questions. An example often invoked is the well-known trolley problem,[33] introduced by Philippa Foot and analyzed by Judith Thomson back in the 1970s and 1980s. The dilemma involves a situation in which an accident is about to occur, and the AV has to decide between two deadly scenarios. The simplified options are: (1) doing nothing, that is, not modifying the trajectory of the vehicle, which could result in a number of casualties; and (2) modifying the trajectory of the vehicle to reduce the number of potential casualties, either by making a movement that could end up with collateral casualties or actively choosing to kill a person in order to save others.

Deciding to modify the vehicle's trajectory requires an analysis of the situation and a consideration for potential casualties based on pre-established criteria, such as number of people saved versus potential casualties, physical conditions, age, illegality of actions (jay walking, for example), or protective measures (wearing a helmet versus not). This raises other concerns with respect to the traditional rights to life and dignity.

In this context, each option—doing nothing and discriminating between potential casualties—raises difficult ethical questions. For example, what values should we consider in the decision? Who should be entitled to make those decisions? Would it matter if the vehicle is publicly owned, like a bus?[34] Who should be liable for the outcome of the vehicle's decisions?

10 Cyber Vulnerabilities

AVs also present new types of vulnerabilities and technical uncertainties. First, as objects connected to the Internet of Things, AVs will be connected to a network and thus more exposed to cybersecurity threats—such as vehicular systems hacking—resulting in safety vulnerabilities. In 2015 and 2016, two hackers remotely hijacked a Jeep Cherokee, showing how the systems can be remotely hacked over the Internet.[35]

In November of 2017, the UNECE's group on AVs identified 86 threats to cybersecurity that could affect the safe operation of AVs, data in-

33 Judith Jarvis Thomson, The Yale Law Journal, Vol. 94, No. 6, *The Trolley Problem,* (1985), https://www.jstor.org/stable/796133?seq=1#page_scan_tab_contents

34 Patrick Lin, *Why Ethics Matter for Autonomous Cars, (2016),* https://link.springer.com/content/pdf/10.1007%2F978-3-662-48847-8_4.pdf, 80.

35 Wired, *Hackers remotely kill a Jeep on the highway—with me in it*, (2015), https://www.wired.com/2015/07/hackers-remotely-kill-jeep-highway/ and Wired, *The Jeep hackers are back to prove car hacking can get much worse,*(2016), https://www.wired.com/2016/08/jeep-hackers-return-high-speed-steering-acceleration-hacks/.

tegrity, and software updates.[36] The threats include transmission of false data to other vehicles, malicious remote instructions and control of the system, the use of vehicle-vehicle communication to compromise other vehicle systems, the use of vehicle-infrastructure communications to attack infrastructure systems, or interception of sensitive information.[37] The UN has realized that the digitalization of transportation requires additional safety requirements to continue protecting the rights and liberties of citizens and transport users.[38]

11 Increased Road Traffic/Inefficiency Of Uncoordinated Traffic

The opportunities AVs offer for enhancing accessibility and convenience may cause users to prefer AV transportation over public buses or subways, potentially increasing the numbers of vehicles on the road. AVs might also be able to drive more closely together than traditional vehicles, which could potentially increase highway capacity by 5-fold and, consequently, the amount of traffic.[39] In addition, AVs may decrease the efficiency of traffic flow if traffic is not externally controlled, because every vehicle would be programmed to optimize its own route with the information provided by other vehicles and infrastructure (microlevel traffic management) rather than considering overall traffic benefit (macrolevel traffic management).[40]

12 Job Displacement

Automated driving would also have a significant impact on certain job sectors, particularly the trucking and taxi industries. In a recent study, it is estimated that AVs will translate into 300,000 job losses per year in the US alone.[41] The ITF reported that 70% of truck driving jobs could be eliminated by 2030. Because 70% of truck drivers in the US and 60% in Europe have not studied beyond the high school level, they might have difficulty being retrained or finding new jobs.[42]

36 UNECE, *12th AV informal group meeting* (2017), https://wiki.unece.org/pages/viewpage.action?pageId=54427891&preview=/54427891/54428639/(ITS_AD-13-02)%20Major%20results%20and%20action%20items%20of%20the%2012th%20meeting%20of%20Informal%20Group.pdf.

37 UNECE, *Table on Cyber Security Threats,* https://wiki.unece.org/pages/worddav/preview.action?fileName=TFCS-ahT-02e+%28OICA%29+Table+on+CS+-Threats.xlsx&pageId=43778091.

38 UNECE, Press Release on Updating International Convention, https://www.unece.org/info/media/presscurrent-press-h/transport/2016/unece-paves-the-way-for-automated-driving-by-updating-un-international-convention/doc.html

39 US Department of Transportation, *2045 Beyond Traffic: Trends and Choices*, https://cms.dot.gov/sites/dot.gov/files/docs/Draft_Beyond_Traffic_Framework.pdf, 103.

40 International Transport Forum (ITF), *Automation of the Driving Task: Some possible consequences and governance challenges*, (2017), https://www.itf-oecd.org/automation-driving-task-possible-consequences-governance-challenges, 21.

41 CNBC, *Self-driving cars could cost America's professional drivers up to 25,000 jobs a month, Goldman Sachs says,* (22 May 2017), https://www.cnbc.com/2017/05/22/goldman-sachs-analysis-of-autonomous-vehicle-job-loss.html.

42 International Transport Forum (ITF), *Managing the Transition to Driverless Road Freight Transport,* (2017), https://www.itf-oecd.org/sites/default/files/docs/managing-transition-driverless-road-freight-transport.pdf, 45.

13 Privacy And Data Security

Concerns about privacy of personal data and data security in AVs are generally two-fold. The first relates to potential government access to information about vehicle records, which could be seen as a way to monitor or surveil citizens. For instance, regulations that allow governmental access to AV data may enable law enforcement to track lawbreakers' locations.[43] This new capacity, and its potential for abuse, raises questions about the role of the state, surveillance powers, and civil liberties.[44]

The second concern relates to the commercial use of data. For instance, AV systems could be designed to follow routes that pass by certain businesses,[45] compromising the control of the driver or passengers using the AV. AVs could record a user's visits to psychiatry clinics, doctors, or liquor stores. AVs will store location information, external information from cameras and sensors, biometric information for user recognition systems, as well as troves of data from inside the vehicle through microphones or cameras.[46] Who owns this data, who has access to it, and how it is accessed are all critical questions about privacy for AV users, as well as insurance companies, employers, and many other parties who could use this information.

43 European Commission, Final Report on *Public support measures for connected and automated driving,* (2013), http://edz.bib.uni-mannheim.de/daten/edz-h/gdb/17/CAD%20-%20Final%20Report%202017.05.31.pdf, 60.

44 *Id.* at 72.

45 W. Kohler and A. Colbert-Taylor, *Current Law and Potential Legal Issues Pertaining to Automated, Autonomous and Connected Vehicles* (Santa Clara High Technology Law Journal, 2015), 31(1): 99-138

46 National Automobile Dealers Association and the Future of Privacy Forum, *Personal Data in your car*; https://fpf.org/wp-content/uploads/2017/01/consumerguide.pdf, 5.

STRENGTHS

What strengths do governments have in attempting to deliver the benefits of AVs while minimizing the risks they pose?

14 Capacity To Promote The Technology To Deliver Its Benefits Faster

Policymakers have the power to support the deployment of and investment in AV technology, which could accelerate its adoption and more quickly deliver its benefits to society. Governments have the capacity to act as customers of AV companies: governments in the United States, for example, maintain a fleet of roughly four million publicly-owned vehicles, replaced at a rate of about 10% each year.[47] Thus, governments could invest in the development of a public AV transit network. Governments also have the capability to fund cutting-edge research programs on AVs in universities or through public-private partnerships that accelerate the technological development process and foster an understanding of how autonomous technologies will change our social systems. Finally, governments can help the industry attract talent and private investments via special tax programs and visa quotas.[48]

15 Ability To Incentivize Av Makers To Embed Values Into The Technology And Make Avs More Harmonious With Human Values

Governments have the capacity to fund AV research programs that seek to incorporate social values into the technology and promote AV technologies that are safer, more accountable, and more transparent by purchasing vehicles from companies that use best practices in privacy, security, and cyber-security. Governments can encourage AVs to comply with standards and best practices that facilitate transparency and privacy and demand that AVs avoid any discrimination that could lead to ethical issues.

16 Capacity To Facilitate The Training Of Workers To Minimize The Negative Impact Of Avs On Employment

Governments can promote a better alignment of academic programs and jobs of the future, equipping workers with the skills necessary for transitioning from an "analog" job to a digital one. Governments have the ability to create and/or fund academic that support the retraining workers who may be displaced by AV technology, thereby mitigating the potential negative impacts that AVs may have on employment.

47 The US federal government together with the states, counties, and municipalities owns around 4.15 million of motor vehicles (https://www.fhwa.dot.gov/policyinformation/statistics/2016/mv7.cfm). Bryant Walker Smith compares these figures with the Tesla sales, showing that with a turnover rate of the public owned fleets of a 10% each year, that amount would be 5 times more than Tesla has sold in its entire existence (https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2749375 (page 23)).

48 McKinsey Global Institute, *AI: The next Digital Frontier?*, (2017), https://www.mckinsey.com/~/media/McKinsey/Industries/Advanced%20Electronics/Our%20Insights/How%20artificial%20intelligence%20can%20deliver%20real%20value%20to%20companies/MGI-Artificial-Intelligence-Discussion-paper.ashx.

17 Capacity To Bring Together Different Stakeholders To Develop Shared Solutions To Av Challenges

Governments have the ability to mobilize different groups of stakeholders and facilitate dialogue between them. These dialogues can generate solutions to complex issues that AVs raise for various stakeholders. Government convened dialogues may help stakeholders perceive certain solutions as more fair and trustworthy.

For example, the Virtual Farmers Market,[49] developed under the Forum on Science, Technology, and Innovation in promotion of the Sustainable Goals of UNECE, was created by smallholder farmers and buyers and facilitated by an e-platform that connected both parties to openly negotiate fair prices. The resulting prices were perceived by both sides as more trustworthy. This is an example of how interested stakeholders can be mobilized to help governments address complex problems, and how stakeholders can contribute to developing solutions.

18 Capacity To Influence Public Trust In Avs To Facilitate The Use Of Av Technology And Spread Av Benefits

Governments can promote trust and acceptance of AV technologies by educating the public about the technology: how to use it safely, its limits and possibilities, and how to seize its benefits. Governments can also facilitate a smooth integration of AVs into society by allowing the public to interact with AVs—for example, by permitting testing on public roads, or mandating that governmental vehicles must be autonomous.

Finally, governments can issue safety standards and develop procedures for safety certification that could increase public trust in the safety of AVs. This move could garner broad public support—a recent poll in the US revealed that 73% of the respondents supported "the DOT developing safety standards for new features related to the operation of driverless cars," [50] and 81% supported the DOT "issuing cybersecurity rules to protect against hacking of cars that are being operated by computer."[51]

49 United Nations, *Global Innovation Exchange: Virtual Farmers Market initiative*, https://www.globalinnovationexchange.org/innovations/virtual-farmers-market.

50 Advocates for Highway & Auto Safety, *CARAVAN Public Opinion Poll: Driverless Cars* (2018), http://saferoads.org/wp-content/uploads/2018/01/AV-Poll-Report-January-2018-FINAL.pdf, 5.

51 Advocates for Highway & Auto Safety, *CARAVAN Public Opinion Poll: Driverless Cars*(2018), http://saferoads.org/wp-content/uploads/2018/01/AV-Poll-Report-January-2018-FINAL.pdf, 11.

19 Ability To Promote Open Environments Of Innovation And Open Data To Foster Interoperability And Safer Systems

Governments also have the ability to encourage the sharing of industry data and to generate open data standards for AVs. Governments are also able to promote the creation of open data platforms, where users can share training data and learn collectively from one another's experiences. This openness to contributions allows a more robust software, increasing safety, and a shared learning experience. This saves a great amount of time to developers, moving the innovation process much faster than traditional proprietary systems.

Open data refers to both training data and the systems themselves. Governments have the ability to promote an open environment of innovation to avoid closed proprietary systems that could hamper the interoperability of AV technology.

WEAKNESSES

What are the weaknesses that governments must overcome in seizing the benefits of AVs?

20 Lack Of Specialized Knowledge

AVs are multifaceted systems that combine a number of complex technologies, such as artificial intelligence, computer vision, IoTs, Big Data, and transportation technologies. This combination of complex technologies will have a broad range of impacts on society, from employment to accessibility to safety to the environment. Given this complexity, establishing effective policies—such as safety standards and certification procedures—will require that policymakers have the specialized knowledge needed to understand how the technologies function and their potential impact on society.

The lack of technical expertise is a weakness that has been highlighted respect to AI generally, but the arguments can also be applied to AVs as a specific application of AI. It has been argued that governments need to advance their understanding of the technologies and their applications;[52] create new advisory bodies that specialize in a topic and offer regulatory advice;[53] and hire personnel with different perspectives on the current state of the technology.[54]

21 Lack Of Coordination Within And Between Governing Entities

AVs impact multiple sectors and test the competencies of different governmental agencies at the national, regional, and local levels, which often regulate in isolation. A lack of coordination among government entities often results in inefficiencies and unnecessary consumption of public resources.

In addition, a lack of coordination among governmental bodies may result in incoherent AV policies. This inconsistency will add more barriers to the adoption of the technology, as it generates uncertainty with regard to the industry with which it has to comply.

Again, AI literature has highlighted as a weakness the lack of coordination among different governing bodies responsible for the sectoral impacts of the technology. The White House, for instance, realized that better coordination was necessary to develop a national strategy, and consequently

52 Bryant Walker Smith, *How Governments Can Promote Automated Driving, New Mexico Law Review, (2016),* https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2749375, 17.

53 The European Parliament and experts on Robotics Law as Prof. Ryan Calo have asked for the creation of a specialized agency to offer regulatory advice to governments. *See European Parliament Report with recommendations to the Commission on Civil Law Rules on Robotics, (2017),* http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+REPORT+A8-2017-0005+0+DOC+XML+V0//EN *and* Ryan Calo, *Artificial Intelligence Policy: A Primer and Roadmap, (2017),* https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3015350.

54 Executive Office of the President, National Science and Technology Council, Committee on Technology, *Preparing for the future of AI, (2016),* https://obamawhitehouse.archives.gov/sites/default/files/whitehouse_files/microsites/ostp/NSTC/preparing_for_the_future_of_ai.pdf.

encouraged coordination among departments to share challenges, strategies, standards and best practices when dealing with these technologies.[55]

22 Regulatory Processes That Cannot Keep Pace With The Fast Changes Of Av Innovation

While regulations are created through lengthy processes, technologies evolve and move quickly. Even if policymakers are able to enact effective laws or regulations applicable to a given technology, the policies will soon become obsolete if they are not revised iteratively. Because technology develops quickly—facilitating new uses and capabilities that could threaten safety, security, public health, or civil rights— the law that was once developed for it may become outdated and no longer comprehensive or effective.

23 Existing Regulations That Hamper The Deployment Of Avs

Other governmental weaknesses include extant legal frameworks and a lack of norm harmonization that inhibit the deployment of AVs. These legal and social barriers slow innovation and the realization of AVs' benefits.

Some legal constraints are harder to change than others. For example, international treaties such as the United Nations' Geneva[56] and Vienna Conventions on Road Safety[57] are more difficult to modify than state motor vehicle codes. Both types of regulations constrain the deployment of AVs and must be adapted. They were created under the assumption that human drivers would be in control of vehicles at all times, with steering wheels to manage. Thus, traditional concepts about the nature of the driver or what it means to be in control of the vehicle, as well as current policies surrounding licensing procedures, vehicle registration, safety tests, and assignment of liability, represent friction points with AVs that—if not addressed—will hamper the technology's deployment.

In addition, a lack of harmonization in vehicle regulations increases the difficulty of adopting the technology. A prominent example is platooning. Different countries, and even states within the US, specify different minimum distances or times between vehicles (for example, France calls for a distance of 50 meters; Germany, Alaska and Utah each require two seconds; and the Netherlands specifies "a safe distance"). These varying standards complicate cross-border platooning, providing an example of how harmonizing regulations would be beneficial.

55 Executive Office of the President, National Science and Technology Council, Committee on Technology, *Preparing for the future of AI, (2016), https://obamawhitehouse.archives.gov/sites/default/files/whitehouse_files/microsites/ostp/NSTC/preparing_for_the_future_of_ai.pdf.*

56 United Nations Geneva Convention on Road Traffic, (1949),https://treaties.un.org/doc/Publication/UNTS/Volume%20125/v125.pdf, 22-101.

57 United Nations Vienna Convention on Road Traffic, (1968), https://www.unece.org/fileadmin/DAM/trans/conventn/crt1968e.pdf.

24 The Need To Invest In Infrastructure Maintenance And Adaptation To Allow Connected Vehicles

Finally, it is important that governments invest in preparing physical and digital infrastructure for AVs. This may include not only providing AVs with good roads and better mobile networks, but also changing traffic signals, curb and lane widths, and on-road information systems. It is also important that policymakers consider in advance urban planning needs, such as new parking schemes.

Updating infrastructure and conducting urban planning require a considerable amount of time. As a result, policymakers must anticipate future infrastructure needs to allow automated and connected vehicle operations to thrive. Failing to prepare the infrastructure needed for AVs will delay the deployment of the technology.

CONCLUDING REMARKS

Policymakers are investing considerable efforts toward realizing the anticipated benefits of AVs while mitigating risks. However, the complexity of the technology significantly complicates this mission.

This policy primer has explored governments' most relevant strengths, weaknesses, opportunities, and threats (SWOT) in relation to AVs in an attempt to expand the toolbox available to policymakers in developing a strategy to govern the technology. Governments can use AVs to deliver a range of potential benefits to society, such as safety, increased mobility, more efficient use of resources, and environmental sustainability, among others. However, AVs pose difficult challenges and risks that governments must consider, including ethical dilemmas, cyber vulnerabilities, increased road traffic, job displacement, and privacy and data security challenges.

To shape the technology and minimize its risks to society, governments can use some of their strengths, including their capacity to promote technology, incorporate values into the technology, train workers, bring together stakeholders, and influence public trust and acceptance of the technology. At the same time, governments will need to be cognizant of their weaknesses, particularly a lack of technical knowledge, poor coordination within and between governments, slow-paced regulatory processes, and existing limiting regulatory frameworks, among others.

This SWOT analysis can contribute to policymakers' governance toolbox and help to craft comprehensive public policies that will deliver the benefits created by AVs while minimizing the risks posed by the technology.

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ADDITIONAL READINGS

A permalink to this paper can be found here:

http://cyber.harvard.edu/publication/smart-move-24-essentials-swot-analysis-policymakers-need-consider

For further information about AVs and their technical issues, international trends in AV governance, and potential tools to address their regulatory challenges, regulators and policymakers can access the following complementary policy papers of the series:

Five Technological Factors Regulators and Policymakers Need to Know, which presents the basics of the technology and current policy discussions.

What Governments Across the Globe Are Doing to Seize the Benefits of Autonomous Vehicles, which introduces some of the strategies and initiatives that other governments are taking to navigate the challenges of AVs and to facilitate AVs reaching their full potential.

Three Practical Tools to Help Regulators Develop Better Laws and Policies, which analyzes some of the types of AV regulatory challenges and provides three practical tools that policymakers and regulators can use to develop better AV policies and expand their set of instruments to govern the technology: Legal Interfaces, Law Labs, and structured dialogues.