MANCHESTER SCHOOL OF ARCHITECTURE

Manchester Metropolitan University

CPU

# Work Package 7: Urban Simulation & Modelling

## D7.2 Discourse Analysis Autonomous Vehicles Concerns:

## Content Analysis of public sources

Solon Solomou, Sigita Zigure, Ulysses Sengupta, Iannis Kotsiopoulos, Rob Hyde

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# Aims and Objectives

This report aims to understand the concerns surrounding the implementation of Connected Autonomous Vehicles on public roads.

Key Objectives:

Identify concerns discourse surrounding CAVs.

Identify group profile bias in the discourse.

Ground the research using interviews and workshops with different groups.

Expand on the concerns found to explore why they may exist as concerns in the discourse.

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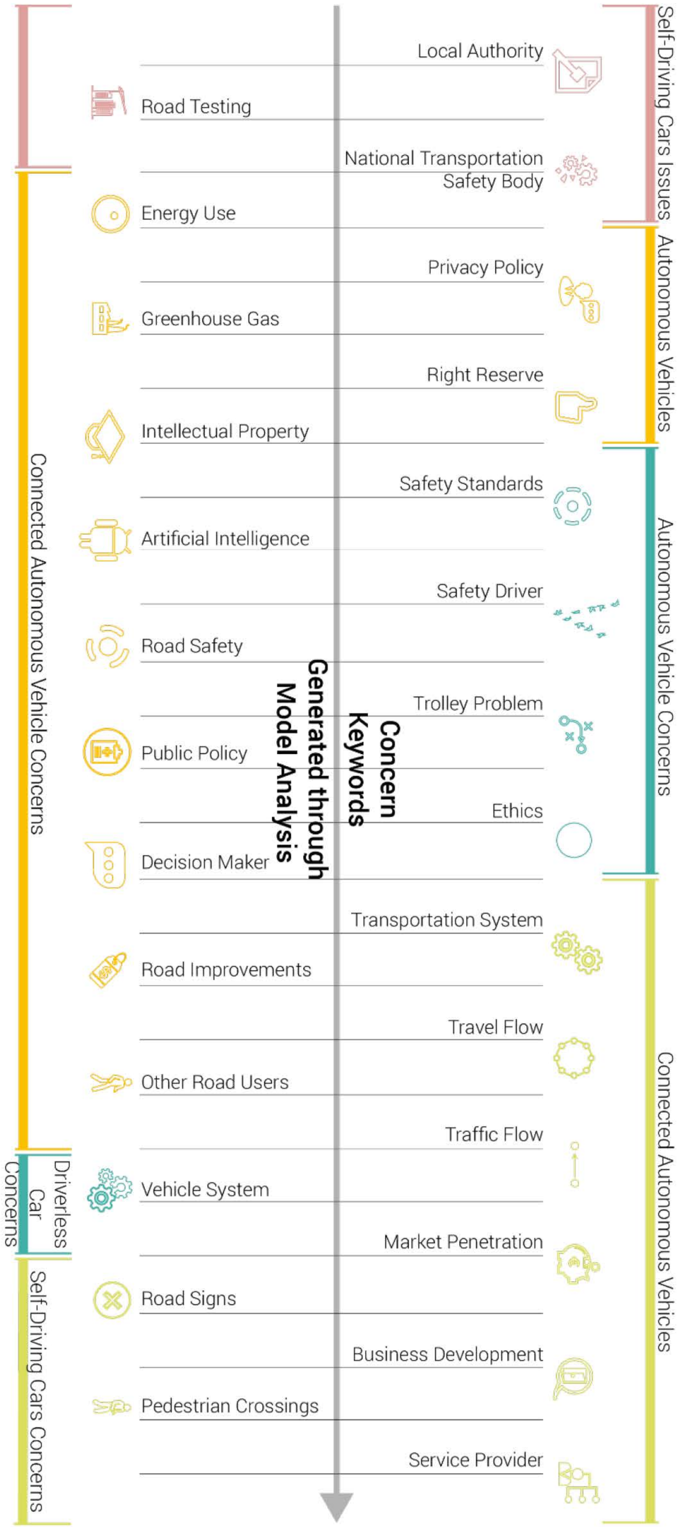
**Centre for Complexity Planning & Urbanism**

Report prepared by S.Solomou and S.Zigure

email:
s.solomou@mmu.ac.uk
s.zigure@mmu.ac.uk

Manchester School of Architecture
MMU
Room 7.14
Chatham Building, Cavendish Street, Manchester
M15 6BR, United Kingdom

# Executive Summary




Using specific terms as search criteria in the web, a collection of 682 sources were analysed to distil a number of specific words relating to concerns surrounding the implementation of CAVs on public roads. These are displayed in the diagram on the left. From this analysis, 10 concerns have been identified as the dominants in the written discourse. These concerns are as follows:

1) Travel Time
2) Personal Data / Privacy Policy
3) Travel Flow
4) Road Safety / Public Policy
5) Vehicle Safety Standards
6) Ethics / Decision Making for AV
7) Market Uptake of Technology
8) Changing Transportation System
9) Energy Use
10) Infrastructure Improvements

These concerns have been reinforced as well as debated using real-world interviews with specific groups as well as results from workshops conducted in an international conference. The result of this study identifies the concerns found in the discourse as valid when going forward with a CAV dominated future mobility system. At the same time, not enough mention on the transition of the technology exists within the discourse with concerns focused on the end result rather than the journey.

# 1. Introduction

## 1.1. What are CAV?

CAV stands for Connected and Autonomous Vehicle(s). Connected and autonomous vehicles is a term commonly used by the UK government which refers to a type of vehicles that are either highly or fully autonomous or connected, or both, connected and autonomous (The House of Lords Science and Technology Committee, 2017).

## 1.2. Autonomous Vehicles

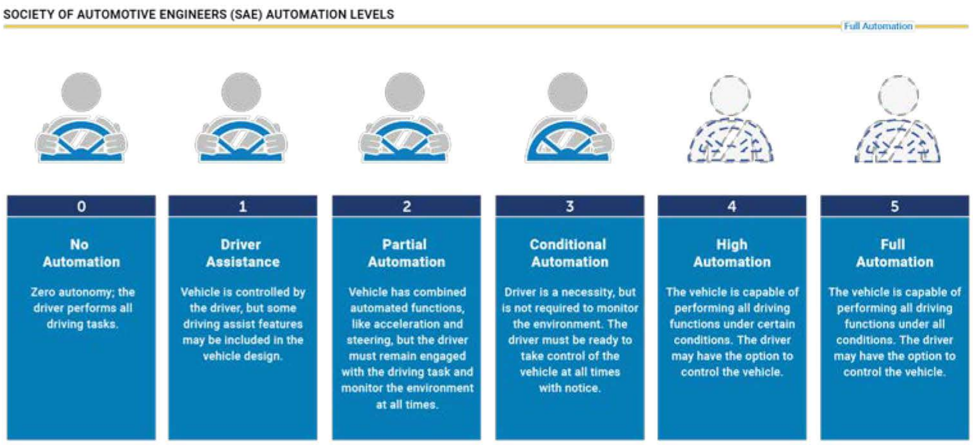



Figure 1 SAE Levels of automation, source: *https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety*

Autonomous driving implies a technology that is capable of performing driving without human presence. In literature, there is no clear indication of precise terminology when it comes to autonomous driving. In industry, the most commonly used classification is by SAE International (Society of Automotive Engineers) identifying six different levels of autonomy. Figure 1 summarizes the SAE classification. However, the level of autonomy is not always specified (especially, in media), which can result in unsubstantial assumptions of technology and its capabilities.

Earlier discourses about the future of autonomous driving saw the phasing in of the levels of autonomy as steps in a logical progression. However, more recent research has shown that Level 2 and Level 3 autonomy might not be safe enough to be introduced in the market. In a study performed by National Highway Traffic Safety Administration (US) on partial automation revealed that it takes up to 17 seconds for the driver to obtain full control of the vehicle and cognition of surroundings, due to lack of attention paid to the road while in autonomous mode (Blanco et al., 2015). Therefore, in order to avoid compromising road traffic safety, the mainstream self-driving vehicles that will be introduced on the roads will most likely be Level 4 or Level 5. Even though Level 4 has the option for the driver to take control, the vehicle is capable of performing driving in assigned situation and does not require human monitoring. For example, such vehicle might not be able to fully perform in a street traffic situation but can operate independently in an airport setting in known surroundings.

## *1.3. Connected Vehicles*

Connected refers to a vehicle equipped with communication technology allowing it to communicate to the infrastructure (V2I), to other vehicles (V2V), to cloud (V2C), to pedestrian (V2P) and other communications. Opposed to the levels of automation, there is no clear international or governmental classification of communication technology embedded in vehicles (or lack of them). It is important to note that automated driving does not require communication technology to perform the driving tasks, however, novel services such as Mobility-as-a-Service (MaaS) as well as other vehicle sharing and ride-hailing operations require vehicles to be connected, and they have often been brought up in discussions about the future of mobility (Jittrapirom et al., 2017; Sprei, 2018) and the future of autonomous vehicles (Gruel and Stanford, 2016).

## *1.4. Issues with Term Usage*

As per definition, CAV can mean three types of vehicle: connected vehicle, autonomous vehicle, or connected and autonomous vehicle. If not specified, this can result in confusion and misunderstanding in communication. Furthermore, most commonly used terms ‘autonomous car/bus/vehicle’, ‘self-driving car’, ‘driverless car’, ‘connected and autonomous vehicle’, ‘autonomous driving technology’, ‘automated driving’ very often do not specify the type of vehicle they refer to. This can lead to misconceptions about the capabilites of the technology, especially in media and when addressing non-experts.

## 1.5. Technology Progress

The first attempt towards driverless vehicles dates back to early 1920s (Marc Weber, 2014). It gathered momentum in the 1980s when researchers managed to develop automated highway systems (Ioannou, 1997). This paved the way for semiautonomous and autonomous vehicles to be connected to the highway infrastructure. Pioneer pilots of AVs were largely made in Germany and the U.S. during 1980 to 2000.

More recently, in 2000s The US Government funded three military efforts: Demo I (US Army), Demo II (DARPA), and Demo III (US Army). Demo III (2001), that demonstrated the ability of unmanned ground vehicles to navigate difficult off-road terrain, avoiding obstacles such as rocks and trees.

In the UK in 2006, the Intelligent Infrastructure Futures Project report predicted autonomous cars un UK roads. 2017 Autumn budget set out the government's objective to see first fully autonomous cars on UK roads by 2021. To achieve this objective multiple level funding and innovation schemes have been launched.

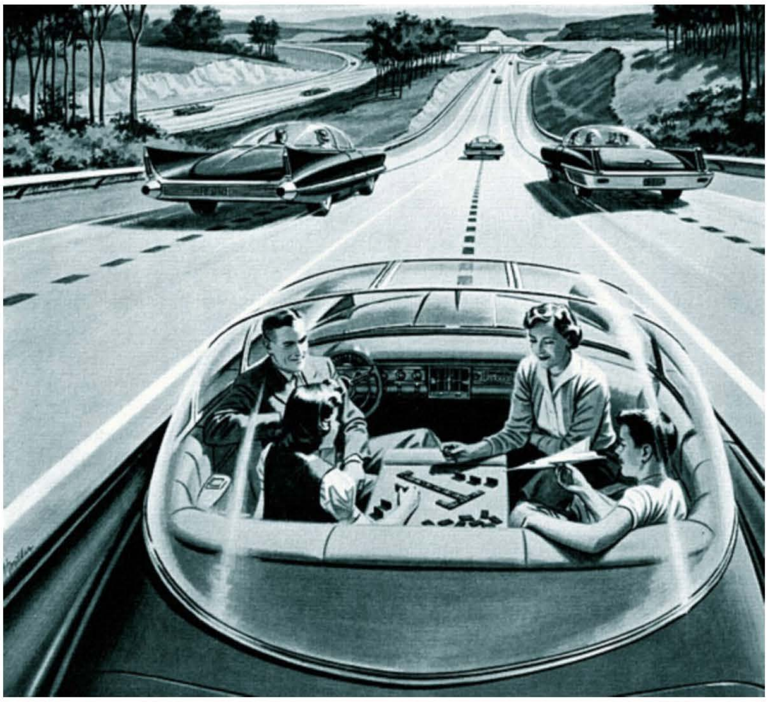


*Figure 2. America's Power Companies' advertisement from 1956 depicting a future with autonomous cars. Source: https://www.engineering.com/PLMERP/ArticleID/12665/The-Road-to-Driverless-Cars-1925--2025.aspx*

## 1.6. Focus of Report

In this report, the focus will primarily be on the written language found in the following types of literature:

1) News Articles

2) News Blogs

3) Open-Access Academic literature

4) Public Reports

The dominant discourse on Autonomous Vehicles revolves around their potential and the positive changes they can bring to current transportation system. The various companies that develop the technology enforce this. At the same time, they generate more discourse that is positive. The concerns discourse is mostly generate through two specific groups, the government and the public. Academia does have a role in this discourse but it is not often available for the public as it mainly comes in the form of academic papers that are only accessible by institutions. For the purpose of this report, only publicly accessible documents will be considered, as they are the ones dominating the current discourse resonating with the average person.

## 1.7. Group Profiles

It is worth profiling the two main groups that are responsible for the majority of the discourse available in the public realm, the government and the public. The aim is to show their connection and interest to the autonomous vehicle technology. For governments, AV's are a new type of transportation that requires a completely new approach in terms of regulating and policy writing. Governments are also concerned with the infrastructural needs of the technology. Primarily, what is required for its successful deployment? As any change in infrastructures requires a significant investment by the government, the technology will need to compromise with the demands of the government in order for it to be granted regulatory approval. On the other hand, the government needs to consider the greater good for the public, with issues around public safety and economic impact being an essential consideration for this group.

## Government Profile

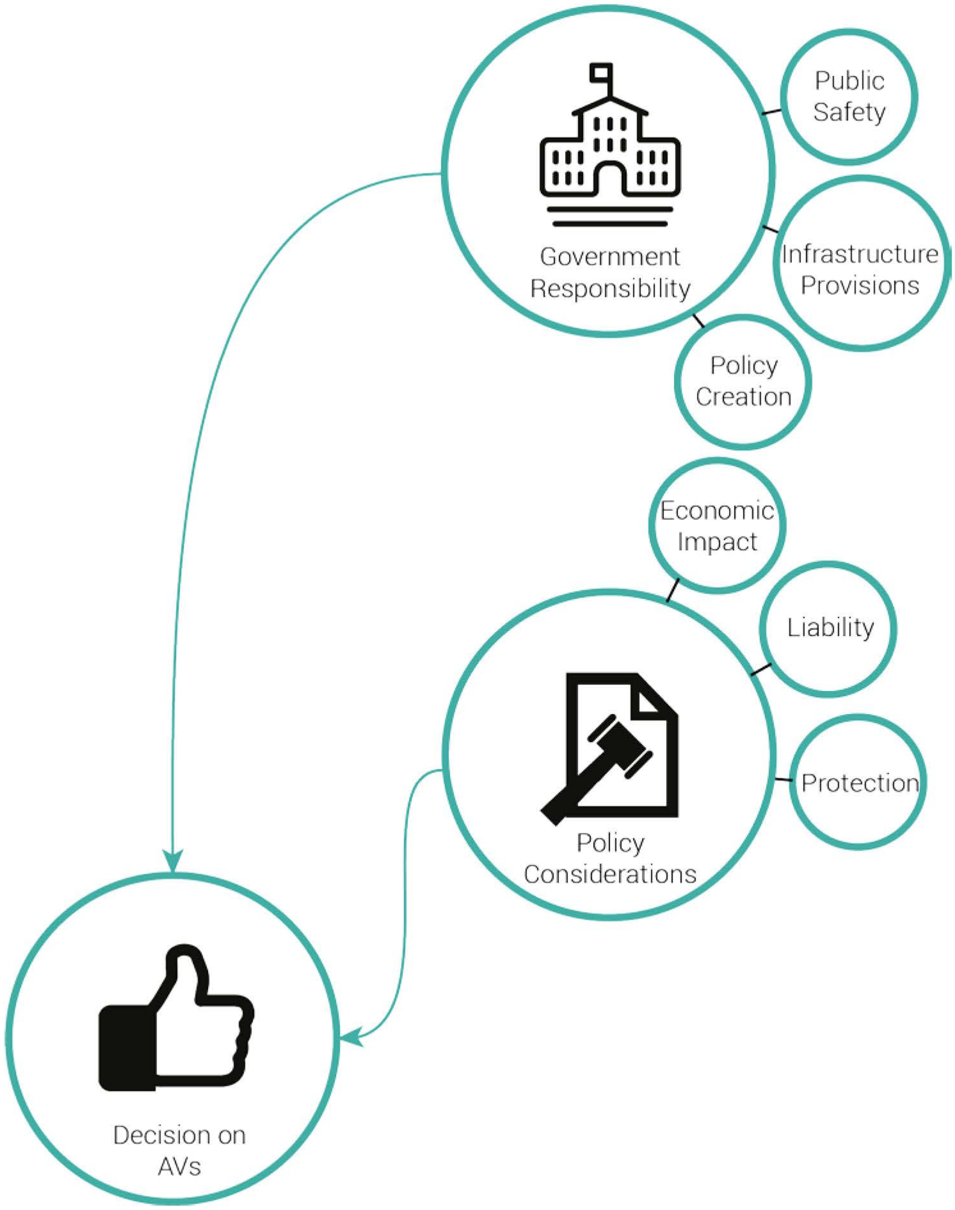



*Figure 3: The figure shows the profile of the government in terms of their responsibility and policy considerations*

The public forms the second group within this discourse analysis. Autonomous Vehicles will impact the public in three major ways. The first is in the job sector. With driverless vehicles, some jobs such as taxi drivers may become redundant. On the other hand, the rise of a new industry with the huge potential of AV, allows for the creation of new types of labor posts. The public will also need to adjust to a new infrastructure being implemented as part of AV requirements. These changes include new road signage, potential removal of traffic lights and smart highways that constantly change the lanes for traffic flows. These changes amongst others require a new level of understanding for the average driver and they can change the fundamental way the public interacts with roads / infrastructure. Another consideration for the public will be the new mobility model that may come with the introduction of AVs. This includes questions on vehicle ownership, liability and insurance. AVs have been discussed as a replacement for public transport and private vehicles due to their ability to service people independent of their owner. This allows for a shared ownership model for people located near each other. It does however raise issues with liability and insurance. Who is to blame for a crash? Who does the insurance pay out to? Questions like these are expected to be answered before implementation of a new system and problems arise. It will require an overhaul of the current system and the public's interaction and perception will have to change.

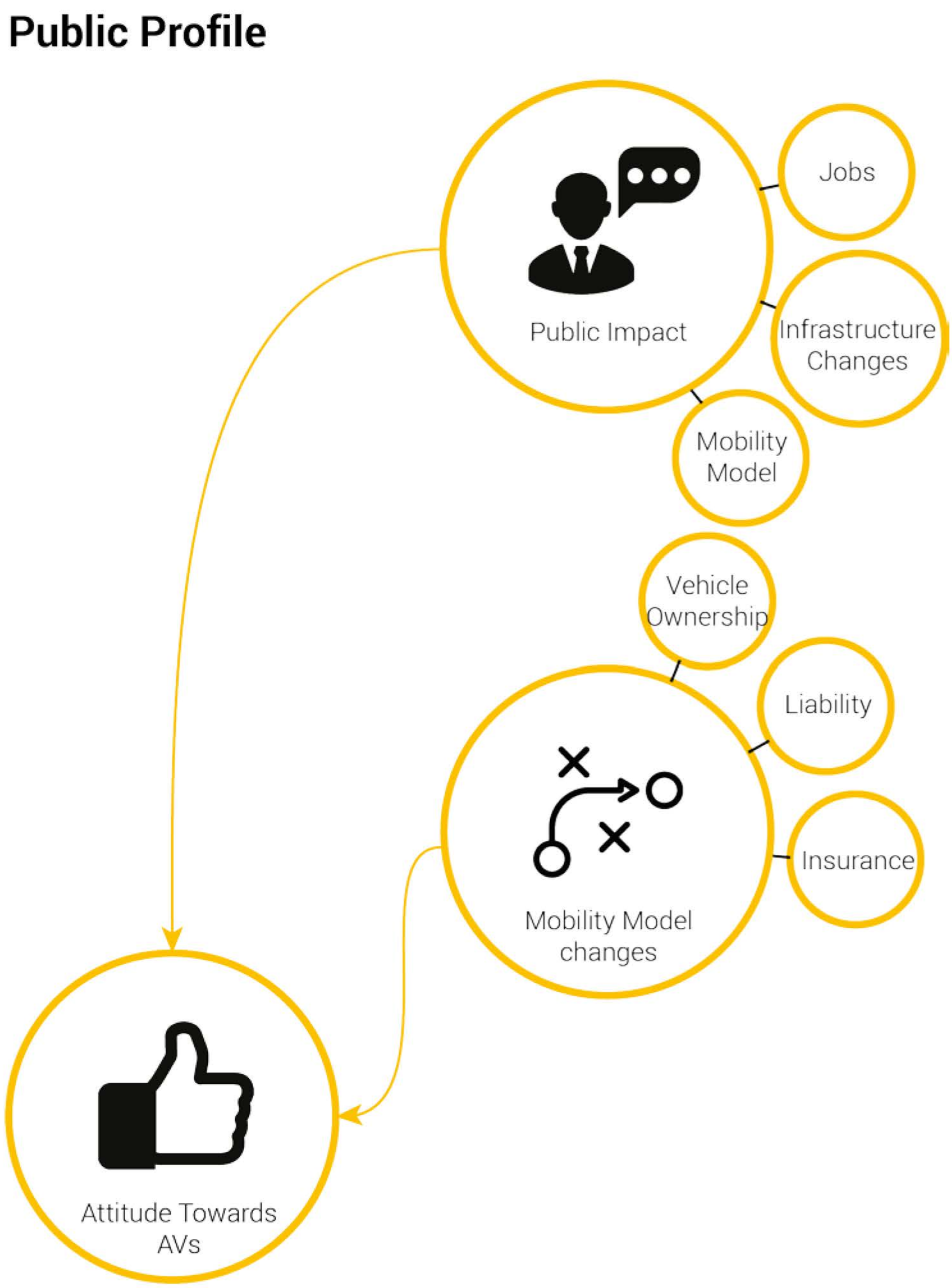



*Figure 4: The figure shows the public profile in terms of the impact on the public, the introduction of AVs will have*

# 2. Concerns Found Through Key Terms

The raw data output from the LDA model used to analyse the documents can be viewed in the appendix. The analysis to follow takes the words interpreted by the model, identifies the ones associated with possible concerns / issues and groups them together in relation to that specific search term. The results for each search term are listed below.

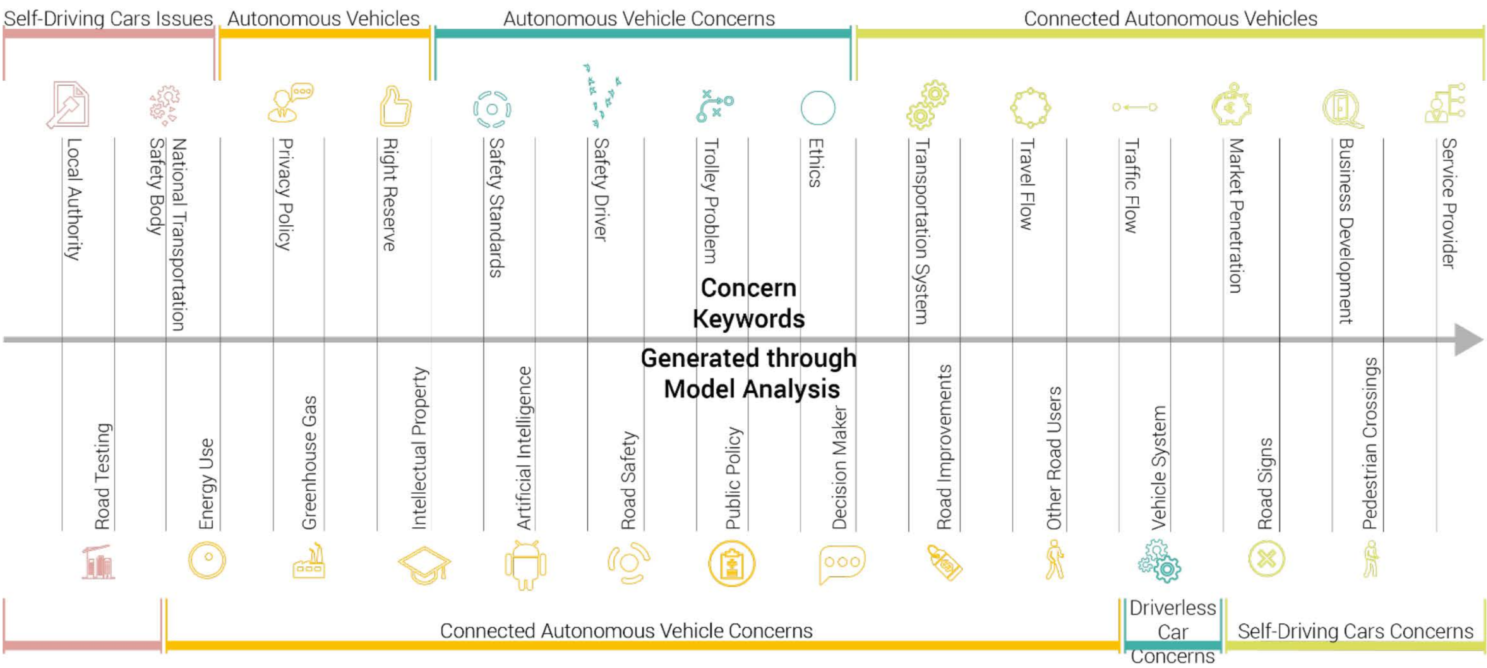



*Figure 5: Breakdown of model results / words generated from each search term*

1) Autonomous Vehicles
    a. Privacy Policy
    b. Right Reserve
2) Autonomous Vehicle Concerns
    a. Safety Standards
    b. Safety Driver
    c. Trolley Problem

   d. Ethics
3) Connected Autonomous Vehicles
   a. Transportation System
   b. Travel Time
   c. Traffic flow
   d. Market Penetration
   e. Business Development
   f. Service Provider
4) Connected Autonomous Vehicles Concerns
   a. Energy Use
   b. Greenhouse Gas
   c. Intellectual Property
   d. Artificial Intelligence
   e. Road Safety
   f. Public Policy
   g. Decision Maker
   h. Road Improvements
   i. Other Road Users
5) Driverless Cars Concerns
   a. Vehicle System
6) Self-Driving Cars Concerns
   a. Ethics
   b. Trolley Problem
   c. Road Signs
   d. Pedestrian Crossings
7) Self-Driving Cars Issues
   a. National Transportation Safety Body
   b. Stop Sign
   c. Local Authority
   d. Road Testing

After having narrowed down the words relevant to the discourse that this report is interested in investigating, the next step is to explore possible patterns that arise throughout different term searches. It is interesting to point out that term searches with autonomous vehicles featured more concern words surrounding the actual vehicle (safety standards and ethical thinking) versus searches with connected autonomous vehicles that yielded issues with the wider network surrounding the car. Some words are repeated in different searches but in general, each search had a specific set of concerns discourse keywords that explored a different aspect of autonomous vehicles. From the pattern analysis 10 concerns have been identified as dominant in the discourse. These concerns are as follows:

1) Travel Time
2) Personal Data / Privacy Policy
3) Travel Flow
4) Road Safety / Public Policy
5) Vehicle Safety Standards
6) Ethics / Decision Making for AV
7) Market uptake of Technology
8) Changing Transportation System
9) Energy Use
10) Infrastructure Improvements

These ten themes are the findings of this report as the dominant concerns in the Autonomous Vehicle discourse. It is worth noting that these findings are representative of the sources that are made-up of mostly news articles and government reports. The academic and commercial groups are not well represented in this search due to the nature of the data collection process. This is not an issue for the purpose of this report as public and government opinions are the aims of this investigation in identifying the dominant concerns discourse, which is generally associated with the majority population's view. In this case, the public and the government that represents them form the majority population.

## 2.1. Travel Time

### *2.1.1. Will AVs cut down on travel time?*

The issue with travel can be viewed from three different perspectives, congestion time, waiting time and speed of travel. The AV discourse explores all three of these issues and tries to predict how AVs will help in these matters.

Congestion time refers to the amount of time spend waiting in traffic. In order to understand how AVs can help in this area there needs to be a clear understanding of how traffic jams occur. In many ways, it is a result of human driving style. The common misconception with traffic jams is that the number of vehicles on the road, car breakdowns, accidents and roadworks all contribute to this phenomenon. The real contributor to traffic jams however is the sudden fluctuations in speed. When drivers travel at a constant rate, the flow of traffic is synchronised and efficient. If a driver slows down, the vehicle behind him has to reduce speed as to avoid a collision. This means that all vehicles, following that initial driver's lead of decelerating, will have to slow down when the car in front of them does. When the change in speed is not that drastic, travel flow is restored relatively fast, however when the rate of acceleration after slowdown is less than the rate of deceleration from the cars behind, traffic starts to build up. This phenomenon is also known as ghost traffic. AVs have the ability to accelerate and decelerate at the same rate as the car in front of them negating the possibility of traffic build up.

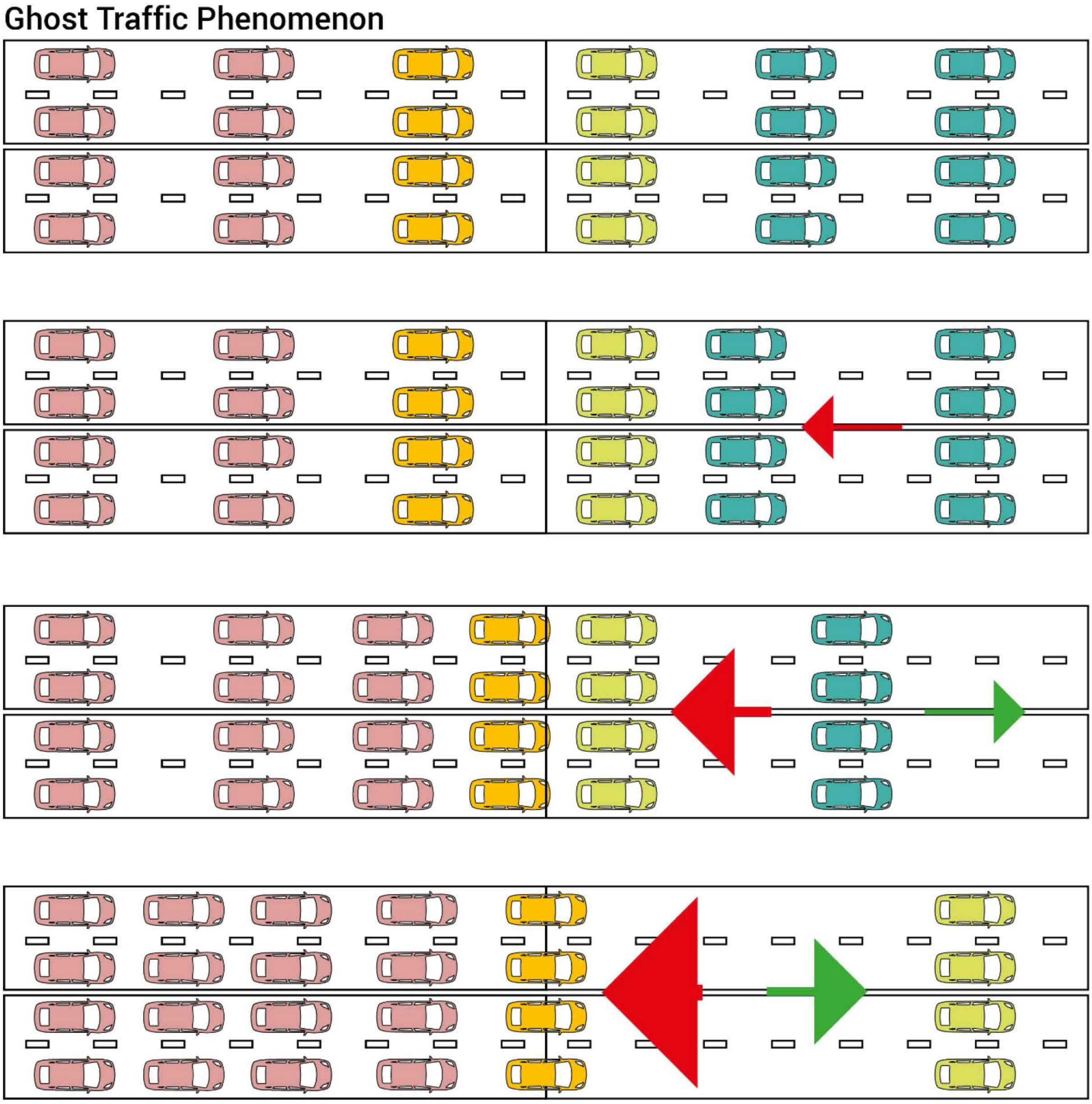



*Figure 6: Diagram indicates the ghost traffic phenomenon. Traffic is build up due to the fluctuations on speed and imbalance between acceleration and deceleration.*

Waiting time refers to the wait for pick up. If you own your own vehicle, the wait time is zero. However, AVs are marketed alongside this new shared mobility system where cars are requested through some medium and not necessarily readily available in everyone's driveway. This gives rise to the concern of long waiting times for a journey.

The last perspective, speed is another concern facing AVs. Theoretically speaking, with a computer driving, the speed of travel will be close to what is physically possible and not restricted to various speed limits. However, this may only be true on highways, roads that share usage with pedestrians or have sidewalks require a specific speed limit. With AVs, the thinking time is minimal compared to humans, so an argument can be put forward that AVs can travel at greater speeds and have the same safety standards as regular drivers. This kind of thinking is sadly contradictory to current testing and usage of the technology as it shares the road with other human driven vehicles. In fact, the average speed of an AV is set lower than a human driver who often defies the road speed limit. This gives rise to the concern of slower moving vehicles.

## *2.2. Personal Data / Privacy Policy*

### *2.2.1. Privacy issues and GDPR*

A shared mobility system, a connected vehicle that shares real-time data with the cloud and a shared ownership system all raise the question of personal data protection. Who gets to view the data generated by a person's vehicle? Who gets to own that data? What kind of data does the AV store / use? How private is that data? Will it know the journey I make every day? Will it allow third parties to monitor my movements?

All these questions and more come up when the subject of data and AVs arise. On top of the privacy aspect, the new GDPR laws set by the EU create a new type of problem. If connected AVs require the constant feeding of real time data from one another as well as the road network, would that be allowed under GDPR? If the data is classified as private and the answer is no then AVs will have a harder time to function in the real world. At the same time, if data sharing is allowed between cars and infrastructure, what measures of protection are there for the collection / usage of the data and what kind of data is shared in this system?

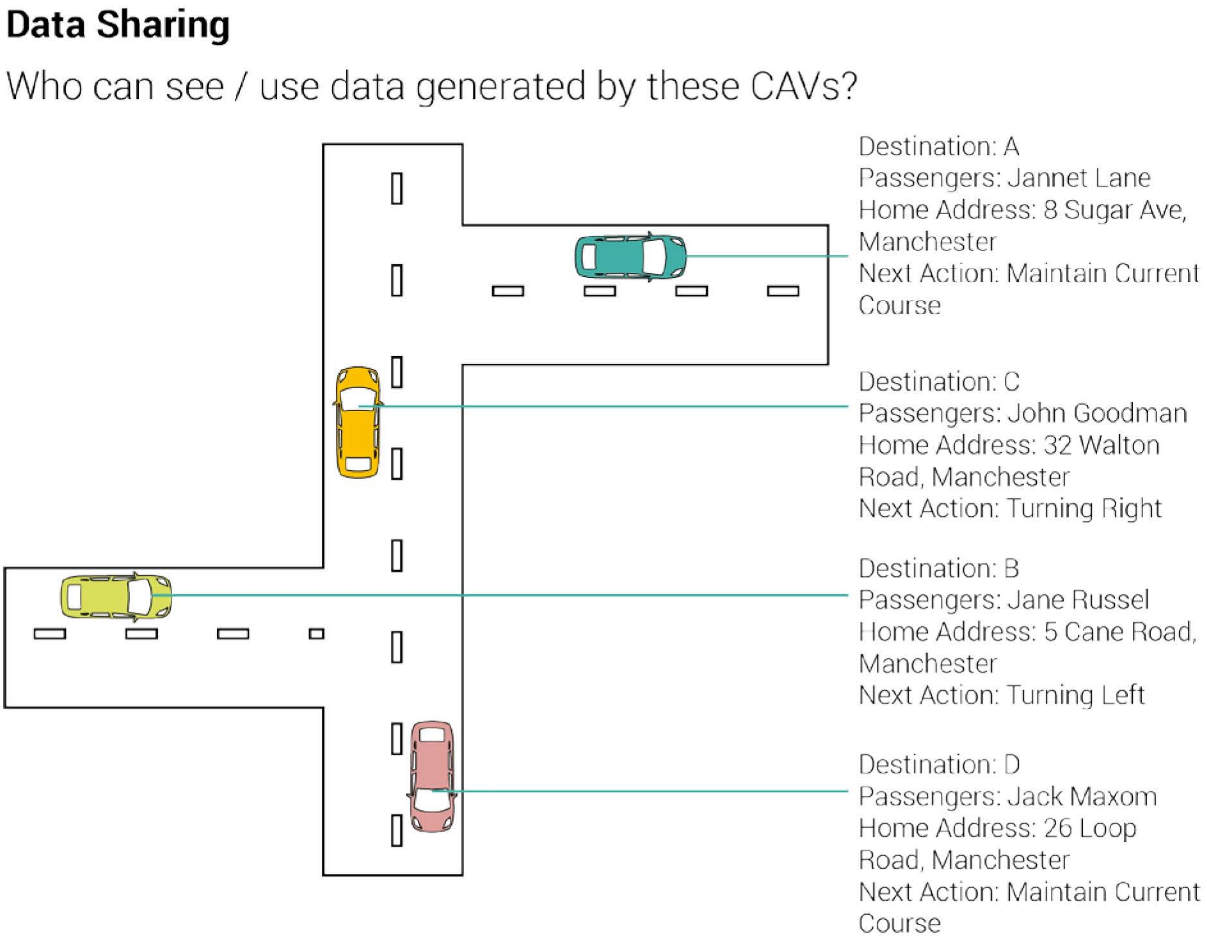



*Figure 7: Shows the generation of data from the vehicles and poses the question on their usage.*

## *2.3. Travel Flow*

### *2.3.1. What would be the effect of an AV dominated urban mobility system on the flow of traffic?*

Traffic build up, as mentioned before, is not just the effect of road collisions but the sudden change in speed between cars heading in the same direction. Therefore, the solution to traffic is coordination not cars. Connected Autonomous Vehicles offer an inhuman level of coordination which would ultimately solve major traffic congestion issues. An example of this coordination issue can be seen at traffic lights. When the traffic light is red a row of cars waits patiently for the light to go green. Once the light grows green, the driver of the first car starts accelerating while the rest of the road keeps waiting patiently. After a set distance is achieved between the first and second car, the driver of the second car starts accelerating. This effect continues; one by one, cars start accelerating; all the while, the cars in the back of the road remain stationary. The end result being, there is time for only a limited number of cars to pass.

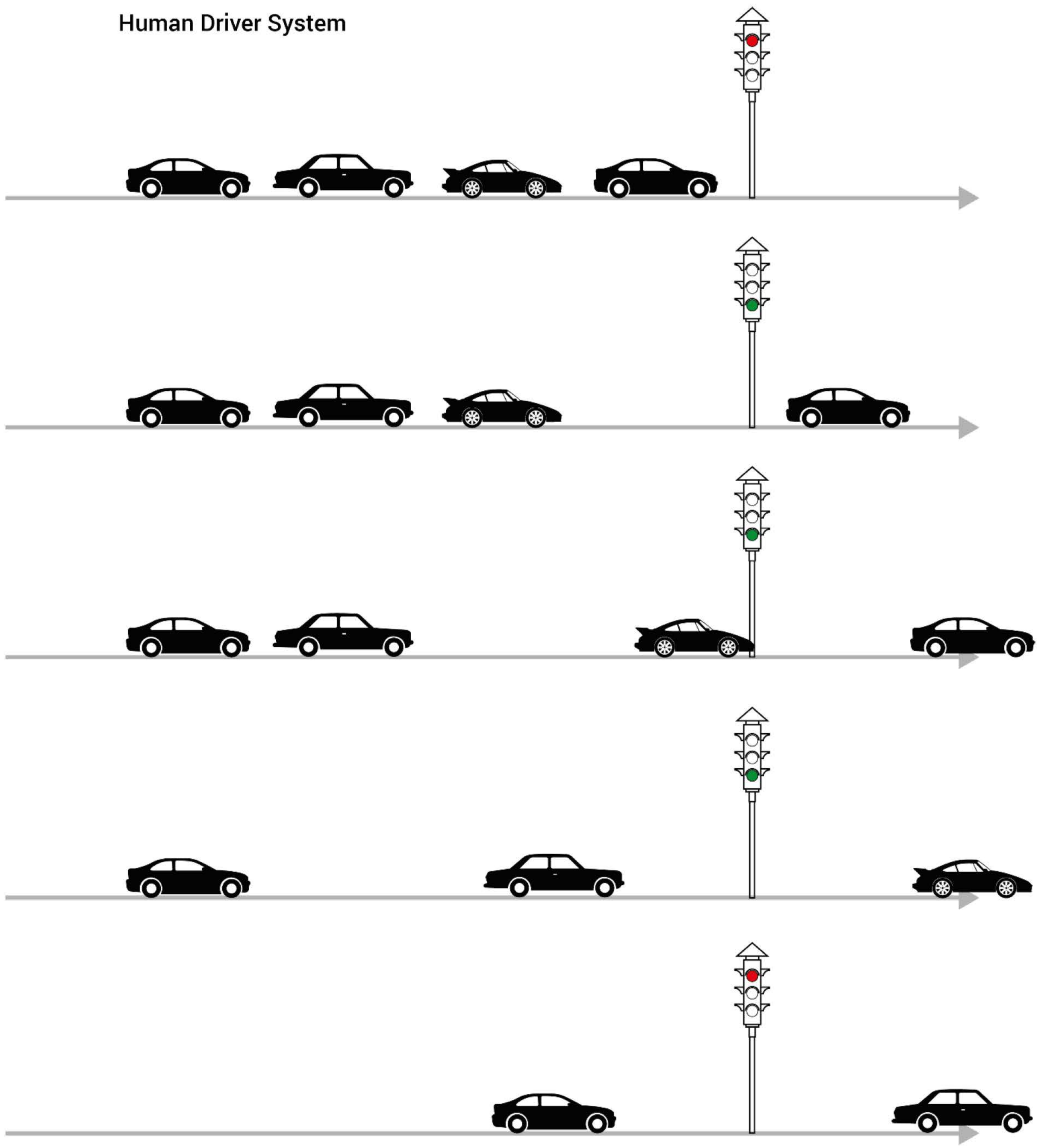



*Figure 8: Human Driver System, with cars accelerating one by one.*

In an AV dominated mobility system, this phenomenon would not occur due to the connectedness between the vehicles and absolute knowledge of each-others actions. Cars would all accelerate at the same rate and decelerate at the same rate mimicking train carriages. Though not physically connected, one would not be able to tell the difference.

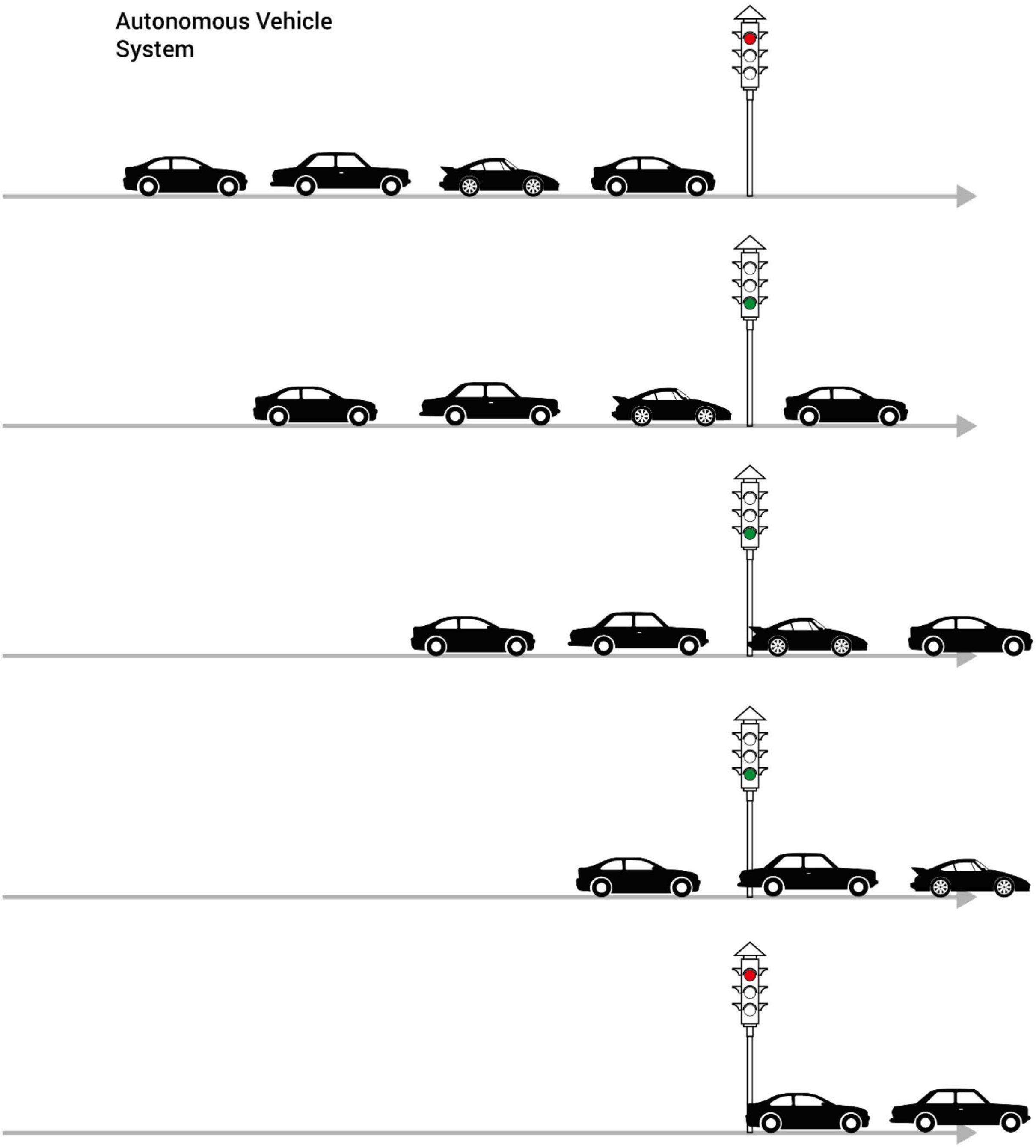



*Figure 9: Autonomous Vehicle system with instant same time acceleration.*

## 2.4. Road Safety / Public Policy

### 2.4.1. Are AVs safe?

Every new technology that includes public interaction generates concern around safety. For AVs, road safety concerns stem from two types of interaction. Interaction with pedestrians and interaction with other cars.

Pedestrian are concerned about their own safety when crossing the road or riding their bike next to an AV. This concern has gained some popularity lately due to some high profile road incidents when testing the technology. Perhaps the most famous incident, that caused the death of one person, is the one in Tempe, Arizona with an Uber car. It illustrated the failure of an AV to slow down before hitting a woman walking her bike across the street. It raised questions on the AV's decision-making system and the ability to identify potential pedestrians.

Drivers have also raised concern on AV safety. Interviews with taxi drivers in New York, show the distrust on the technology to cope with the amount of vehicles as well as foot traffic in the busy Manhattan streets. Mentions of erratic and complex behaviour from other drivers and pedestrians alike create an issue for AV's coded systems to understand, predict and deal with. Workshops with government officials indicated a lack of knowledge on the possible issues with transition of the system from a human-driven to AV. Essentially, public policy has no clear direction with AVs and cannot, at the moment, cope with their introduction on public roads. This raises a major point of concern amongst government officials as well as insurance companies that have no way of quantifying the risk surrounding the technology.

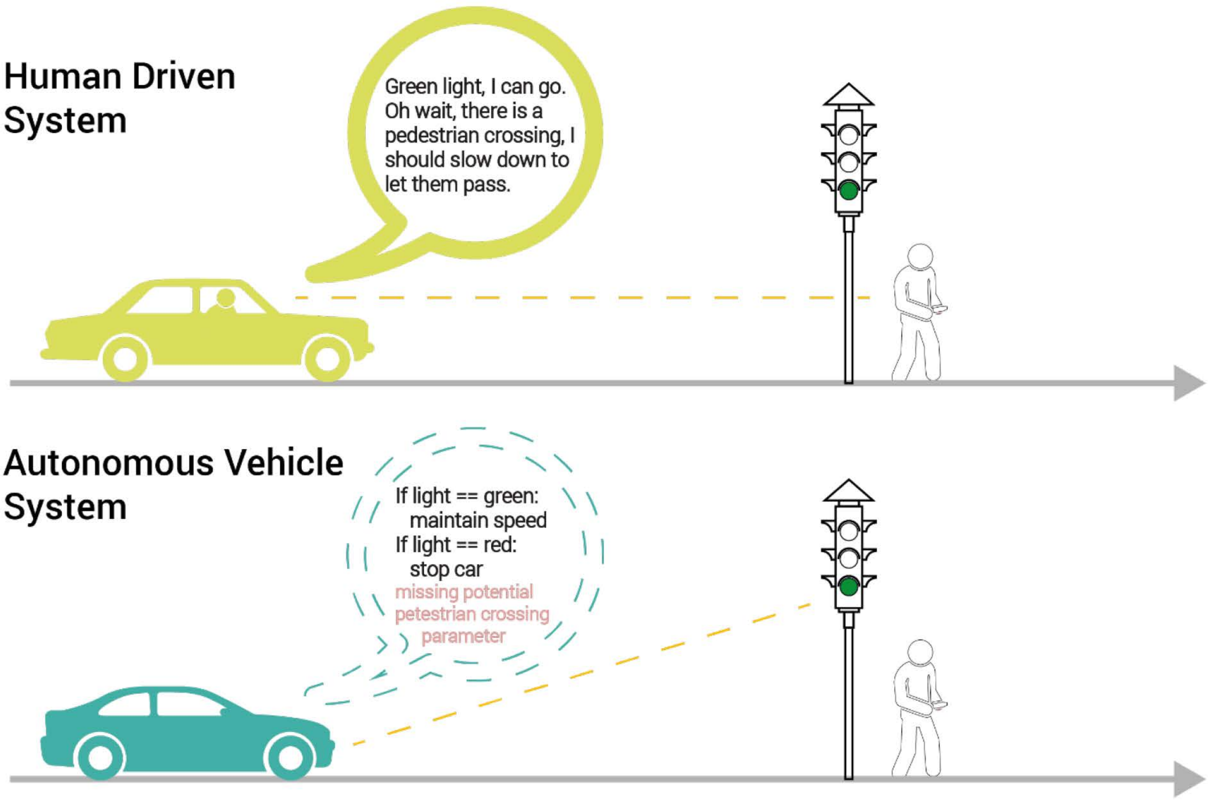



*Figure 10: Diagram illustrates the difference in thinking between humans and machine drivers*

## 2.5. Vehicle Safety Standards

### *2.5.1. Do AVs need a different safety Standard?*

A driver can sense by the way a car handles, if there is something wrong with the suspension, if there is not enough air in the tires, if there is something wrong with the engine and so on. Mechanics make a living out of identifying as well as solving issues with cars. What happens when there is no driver? When an AV misses a turn due to a faulty tire or broken suspension, who is to blame? Should AVs have different vehicle safety standards that include sensors that indicate the status of everything on the car?

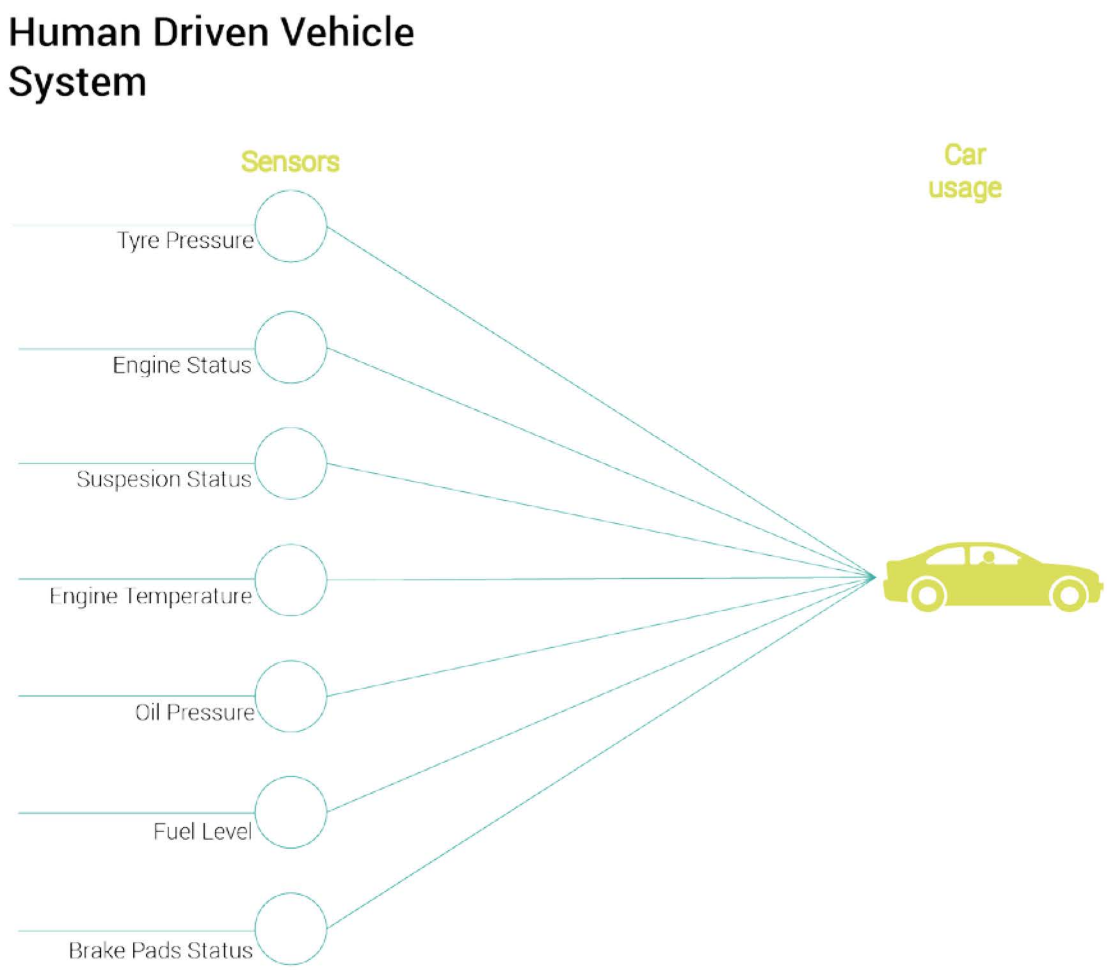



*Figure 11: Illustrates the sensors work on the car as an indication of various microsystems*

Modern vehicles have advanced sensor technologies that enable self-diagnostics on many of these issues but they are mainly indicative. They do not stop the driver from using the car in any particular way even if something may be wrong. In the case of AVs, such sensors may need to be connected to the working parameters of the car in order to allow for the limitation of speed or even usage of the car. These decisions need to be embraced universally across all manufacturers, which means that they need to be implemented through government policy.

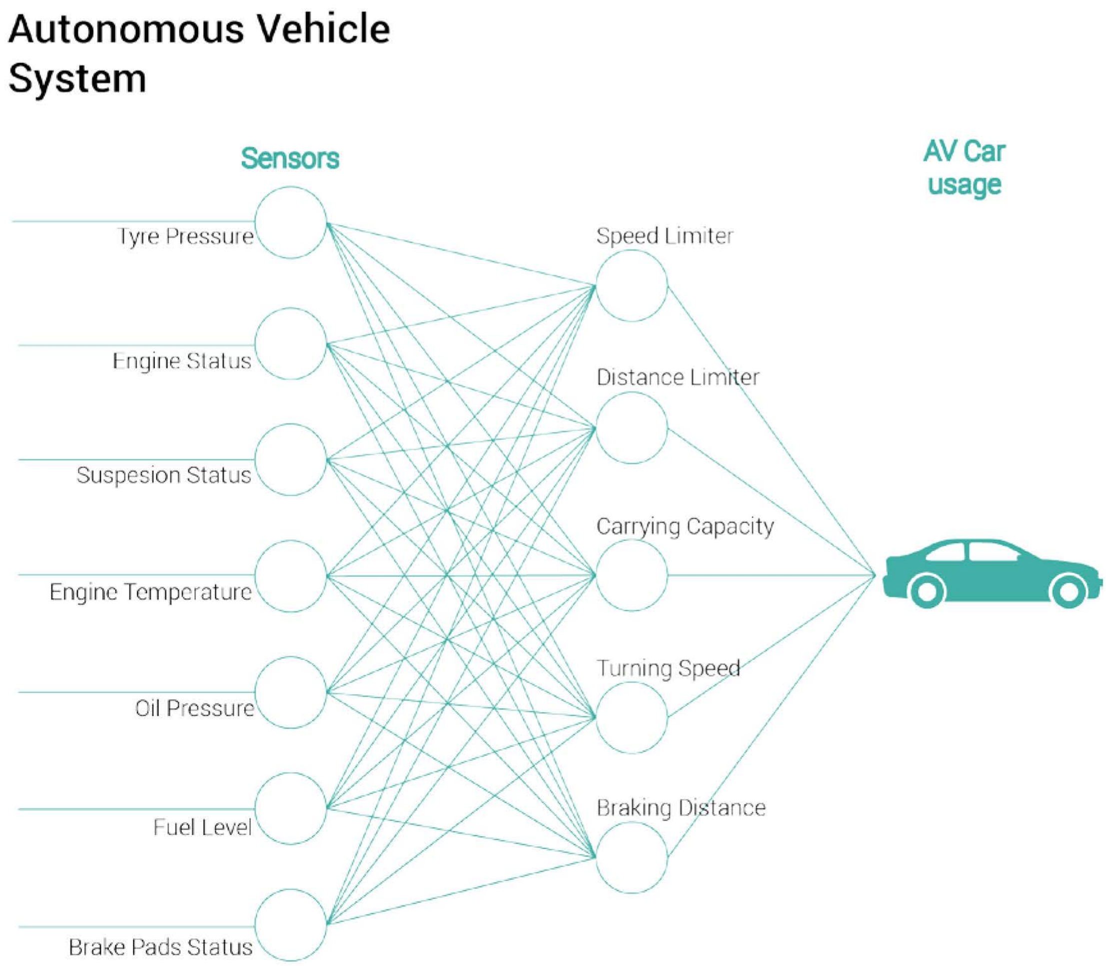



*Figure 12: Illustrates how in an AV, sensors could be connected to Car functions that may limit Car usage for safety reasons*

## *2.6. Ethics / Decision Making for AV*

Can we trust a machine to make driving decisions?

The ethics concern for AVs is associated with so called ‘trolley problem’. It is often mentioned as one of the most controversial issues regarding AV deployment on public roads. It is implied that either the government, the manufacturers or the insurance companies should govern the rules of how the AVs will behave in situations when collision is unavoidable. The questions usually are: should the vehicle aim to save the driver’s life or act to save most lives? What decision would the car-owners prefer? What decision would the public prefer? Who should be in charge of making such decision?

The ethical discussion about any decision-making process associated with AI is controversial also because the ethics dilemmas have no clear ‘right answer’. Experts have pointed out that over 90% of car accidents are due to driver error. Therefore, those situations described in ethics discussions are highly unlikely to happen on roads. Also, despite AVs having arguably more sensing power and higher reaction speeds than humans, accidents where loss of life occurs can still happen.

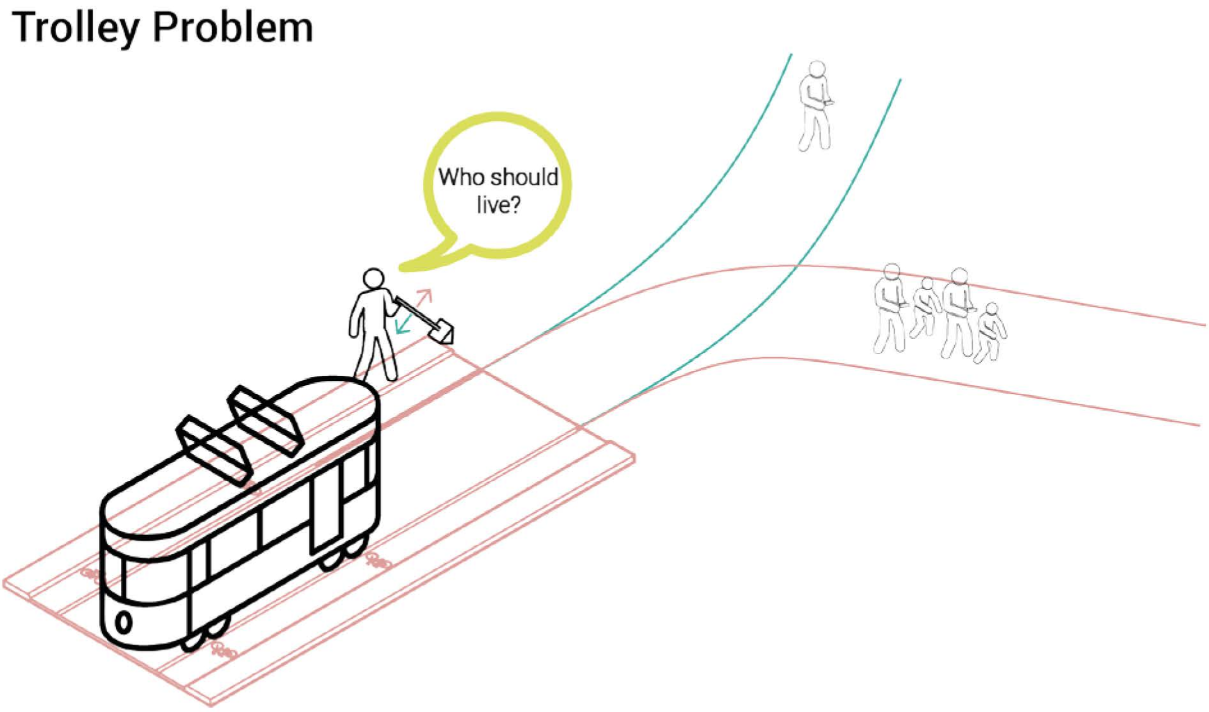



*Figure 13: Illustration of the Trolley Problem. Will you choose to kill one person or many?*

## 2.7. Market uptake of Technology

Would AVs really catch on?

As with every new technology and innovation, the consumer reaction can be unpredictable. In the case with AVs there is no clear understanding on how consumers would react to their introduction in the market. Surveys have shown that people most enthusiastic about AVs are young people, people who can't drive or those who don't enjoy driving.

Some people and governments see AVs as a threat to jobs and are therefore take measures to prevent that from happening. For example, India introduced a ban on AVs in 2017.

This will also be affected by the ownership model of the AVs. Many major cities are actively looking for ways to reduce car traffic in urban areas because of health and environmental damage. Shared on-demand modes of transport are seen as a modern individual-oriented solution to rising public transport issues. However, the question of whether people would give up car ownership is still unclear.

## Private Ownership System

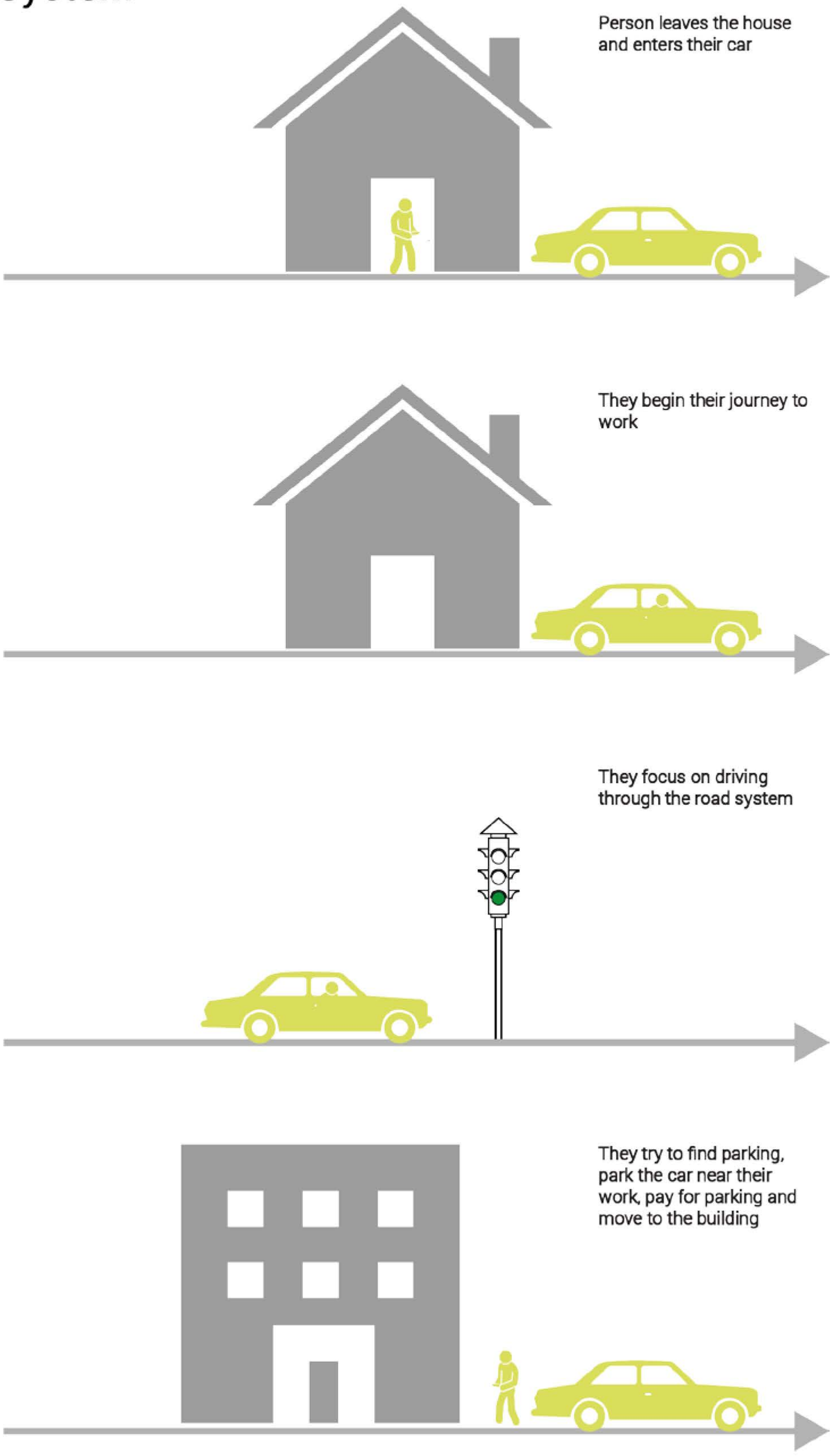



*Figure 14: Illustrates the current private car ownership system*

## Shared Ownership System

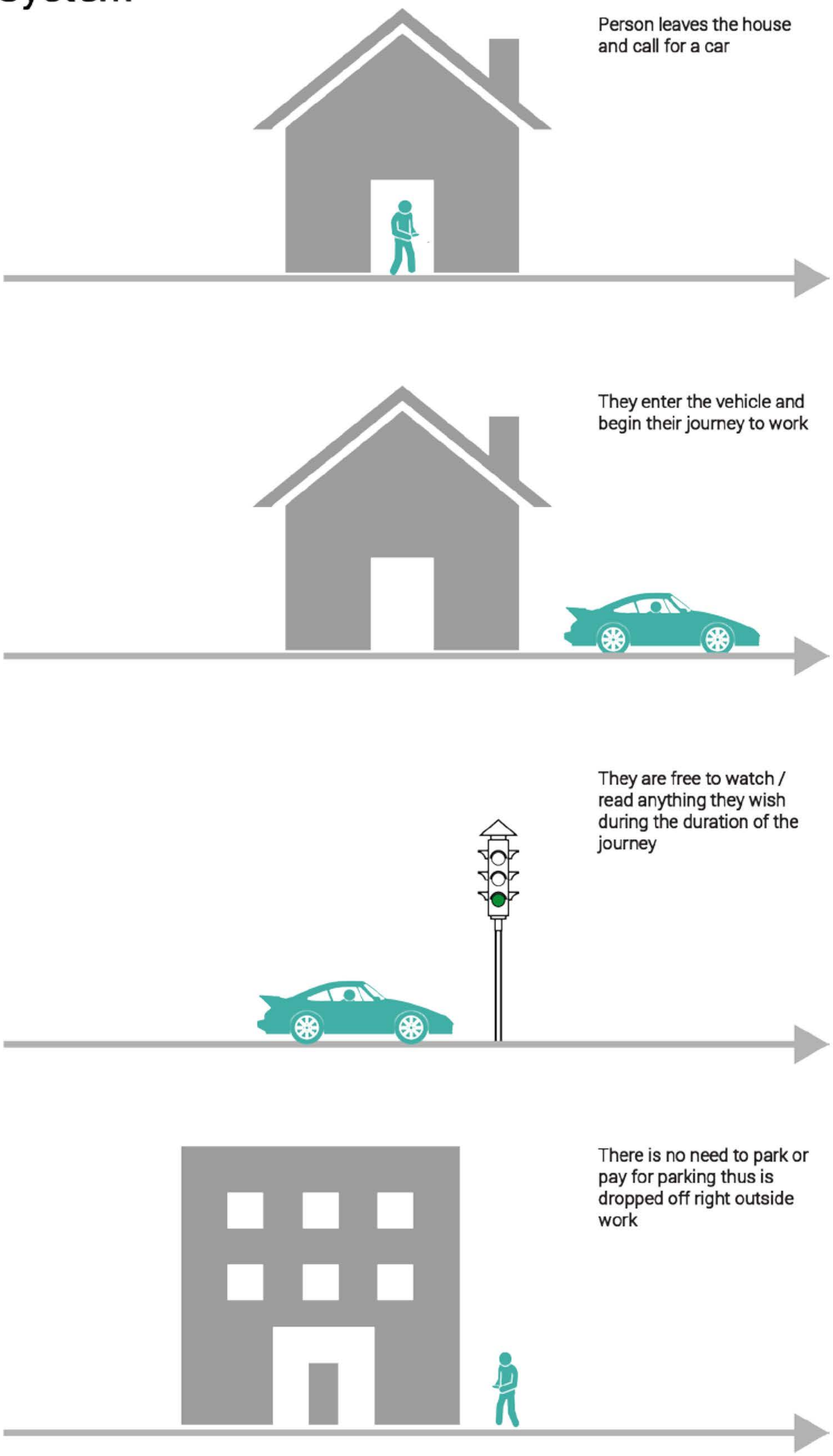



*Figure 15: Illustrates an AV shared mobility system*

## *2.8. Changing Transportation System*

Would AVs bring about a Transportation System overhaul?

This is a very vague and wide concern. The anticipated change to transport systems can come in various ways:

- MaaS and shared mobility competing with traditional/existing public transport. This should be governed in a way that provides societal good and doesn't cause further social inequality for transport accessibility.
- Fleet size increase due to more access to vehicles and people choosing to live further away from work because of travel time becoming useful for other purposes.
- Behaviours that can bring about infrastructure change:
  - Pedestrians assuming that AVs will always stop and walking in front of AVs causing the need to be separated.
  - AVs needing to be separated from the rest of the traffic.
  - Communication infrastructure to support full range of AV functions and capabilities.
  - If AVs become the primary type of vehicle on roads this would suggest a more fundamental infrastructural change, for example, traffic lights and signs becoming redundant.

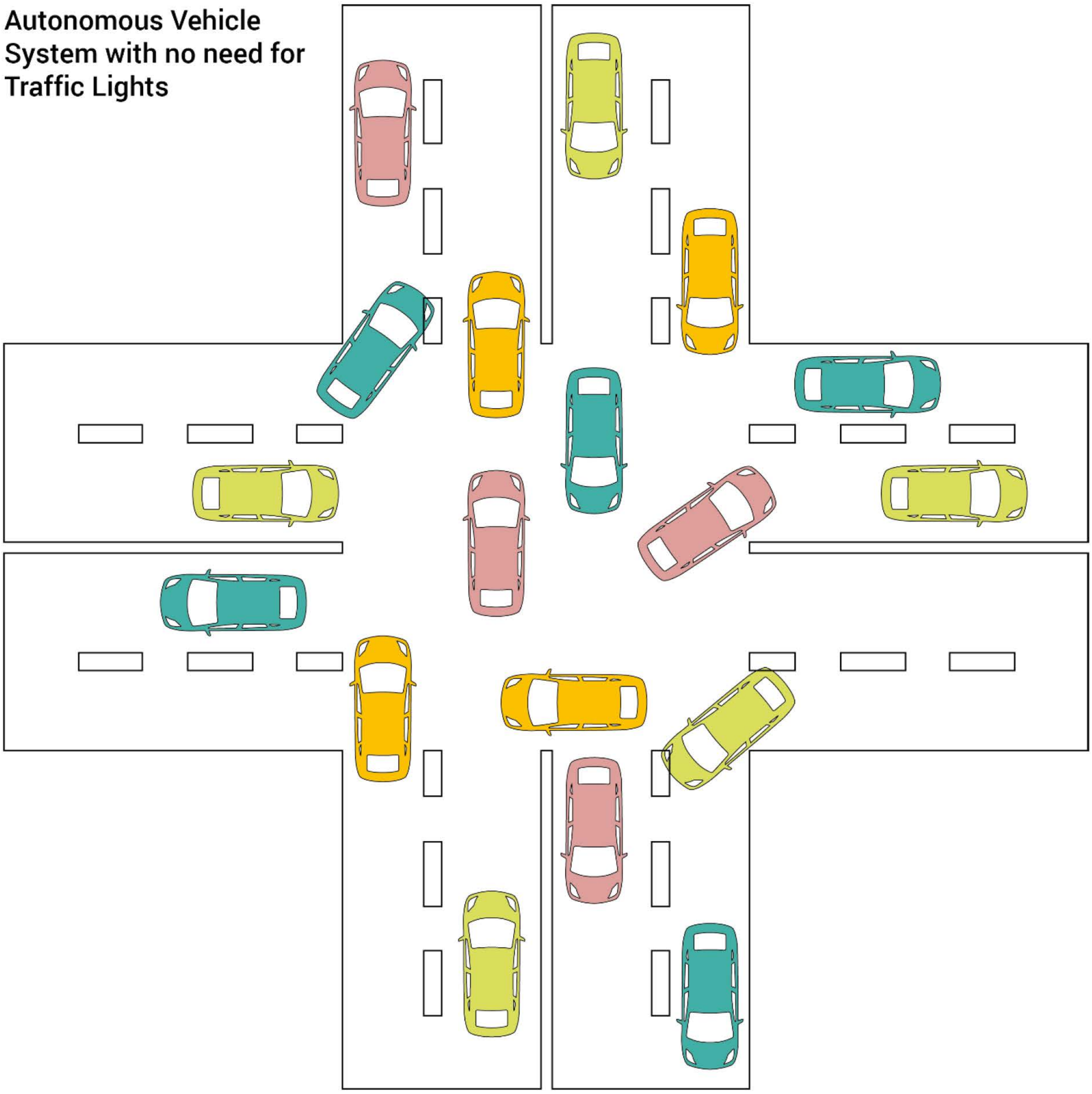



*Figure 16: In a fully intergraded AV transportation system, traffic lights will become redundant*

## *2.9. Energy Use*

Should AVs help reduce energy usage in the transport sector?

Energy use is closely linked with the travel distance and miles travelled. So far the findings in literature are inconclusive – depending on parameters such as consumer demand, route planning, fleet sizing and others the results vary from showing energy saving as well as increased energy use in AV simulations. This is strongly linked to consumer behaviour.

It is assumed that most AVs will be electric vehicles. Electric vehicles are beneficial to the environment because they reduce noise and emissions, contributing positively towards more sustainable transportation systems. However, the electricity sources should be considered as well. If non-renewable energy is used, it reduces the potential positive effects of electrification. Another consideration is the production of batteries for electric vehicles. In order to produce lithium batteries, graphite, cobalt and lithium is necessary. A lot of the materials are sourced in developing countries in unethical and life-threatening conditions. Furthermore, mining requires vast environmental resources, such as water. Therefore, global system-wide considerations and measures need to be in place in order to provide more environmentally sustainable vehicles and energy.

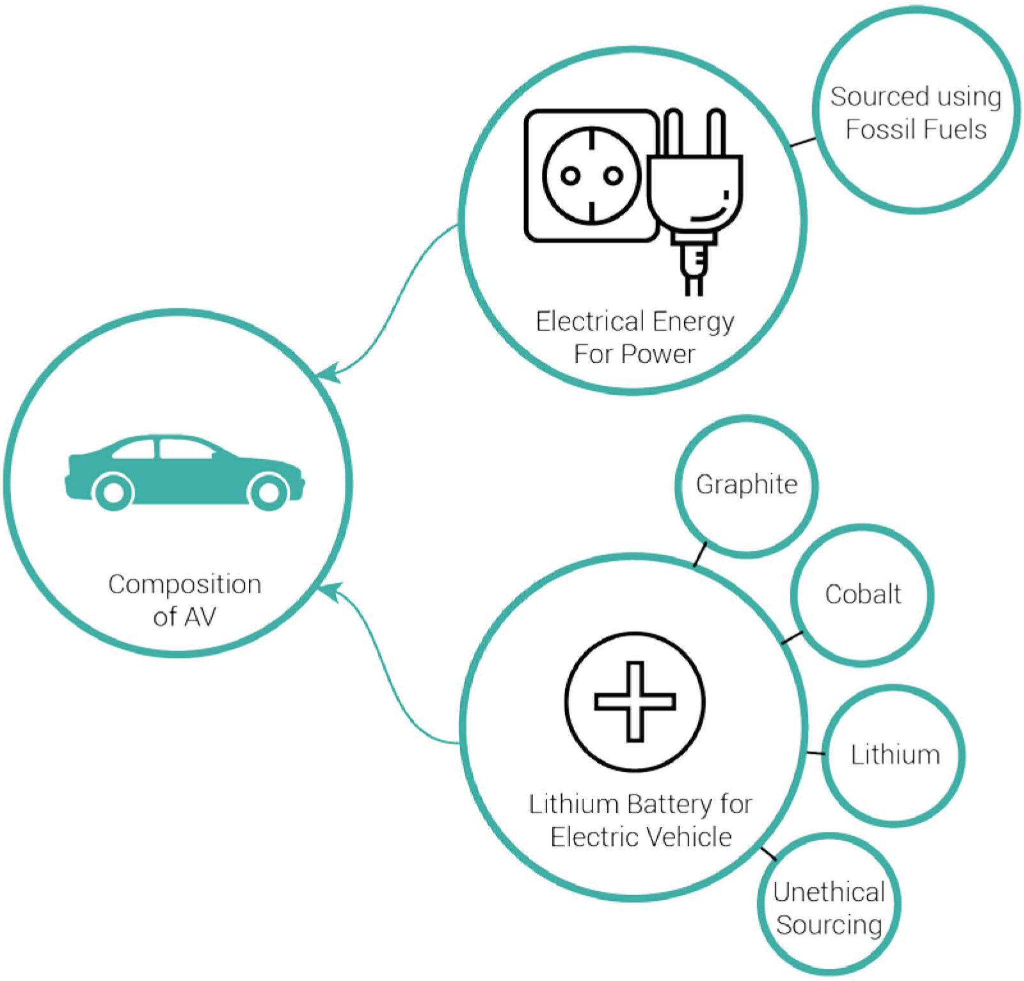



*Figure 17: Energy use concerns surrounding AVs primarily focus on the provision of electrical energy and the battery manufacturing method*

## 2.10. Infrastructure Improvements

What are the infrastructure changes that need to occur in order to accommodate for AVs?

This is primarily transport providers' and city planners' concern, because AV technology requires certain infrastructure provisions and changes. Infrastructure upgrades often require time, resources and extensive planning. This needs to be in pace with AV development to deploy them successfully and in a timely manner. This includes power (for example for charging) and communications (such as fiber). Another consideration is data collection. In order to make use of the full potential of the technology, real-time data access is vital, which requires technology (for example, microcells, or picocells, or connected-vehicle radios, or bluetooth beacons) installed on roads. Signage, traffic lights and intersection management systems also need to be considered for the needs and capabilities of AVs.

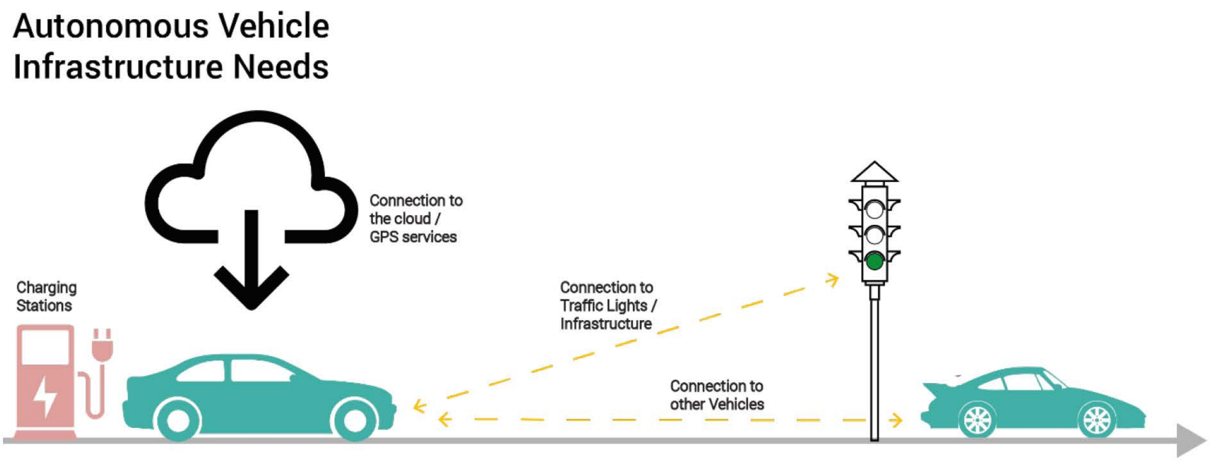
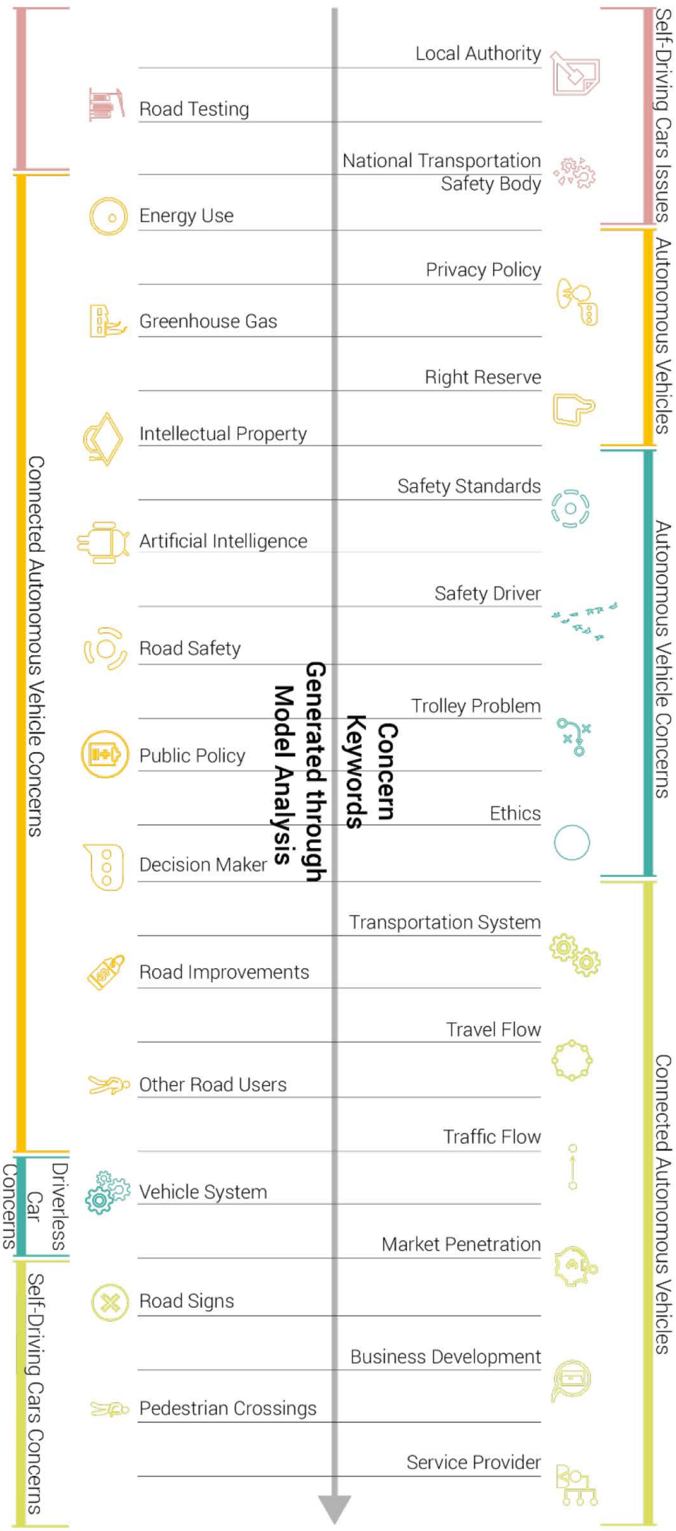



*Figure 18: CAVs will require infrastructure that supports Vehicle to infrastructure connection, Vehicle to Vehicle connection, Vehicle to Cloud connection as well us sufficient amount of charging stations*

# 3. Conclusions




Using specific terms as search criteria in the web, a collection of 682 sources were analysed to distil a number of specific words relating to concerns surrounding the implementation of CAVs on public roads. These are displayed in the diagram on the left. From this analysis, 10 concerns have been identified as those dominant in the written discourse. These are as follows:

11) Travel Time
12) Personal Data / Privacy Policy
13) Travel Flow
14) Road Safety / Public Policy
15) Vehicle Safety Standards
16) Ethics / Decision Making for AV
17) Market Uptake of Technology
18) Changing Transportation System
19) Energy Use
20)Infrastructure Improvements

Interviews were contacted with taxi drivers in New York City, who recently gave approval to cruise automation to begin AV testing in the streets of Manhattan, in order to enhance our findings.

Comparing them to the written literature concerns, it is interesting to find that only 5 out of the 10 concerns exist in both the spoken and written findings. These are road safety, travel flow, infrastructure, market uptake of technology and the changing transportation system. In fact, taxi drivers raised more concerns focused on the transition of the technology while many finding it unthinkable for AVs to function in Manhattan. This transition issue is an aspect not explored enough in the written literature. It is nevertheless a very important subject as any technological introduction that will cause a total shift in the system requires a carefully planned transition period.

Another attempt to reinforce our findings came with the hosting of a workshop at the Autonomy conference in Paris. The expert panel of attendees provided a good opportunity to get input into our discourse results. Using our pre-identified list of concerns, taken from the written literature with the use of an LDA model, we asked participants to rank them in terms of importance from 1-10, 1 being the highest and 10 the lowest. We also allowed for additional concerts to be placed by the participants and a question and answer session in order to identify potential shortcoming of previous findings generated by the LDA model. The result of this study identifies the concerns found in the discourse as valid when going forward with a CAV-dominated future mobility system. At the same time, not enough mention on the transition of the technology exists within the discourse with concerns focused on the end result rather than the journey.

# 4. References

Blanco, M., Atwood, J., Vasquez, H. M., Trimble, T. E., Fitchett, V. L., Radlbeck, J., Fitch, G. M., Russell, S. M., Green, C. A., Cullinane, B. and Morgan, J. F. (2015) *Human Factors Evaluation of Level 2 and Level 3 Automated Driving Concepts. (Report No. DOT HS 812 182).* Washington, DC.

Fairclough, N. (1995) *Critical Discourse Analysis: The Critical Study of Language. Longman Group Limited.*

Gruel, W. and Stanford, J. M. (2016) 'Assessing the Long-term Effects of Autonomous Vehicles: A Speculative Approach.' *Transportation Research Procedia*. Elsevier B.V., 13 pp. 18–29.

Ioannou, P. A. (1997) *Automated Highway Systems*. Springer US.

Jelodar, H., Wang, Y., Yuan, C. and Feng, X. (2012) 'Latent Dirichlet Allocation (LDA) and Topic modeling: models, applications, a survey' p. 2012.

Jittrapirom, P., Caiati, V., Feneri, A.-M., Ebrahimigharehbaghi, S., González, M. J. A. and Narayan, J. (2017) 'D4 Mobility as a Service: A Critical Review of Definitions, Assessments of Schemes, and Key Challenges.' *Urban Planning*, 2(2) pp. 13–25.

Marc Weber (2014) *Where to? A History of Autonomous Vehicles | @CHM Blog | Computer History Museum*. [Online] [Accessed on 26th October 2018] http://www.computerhistory.org/atchm/where-to-a-history-of-autonomous-vehicles/.

Sprei, F. (2018) 'Disrupting mobility.' *Energy Research & Social Science*. Elsevier, 37(October) pp. 238–242.

The House of Lords Science and Technology Committee (2017) *Connected and Autonomous Vehicles: The future? - Science and Technology Committee. 2nd Report of Session 2016–17.*

Vazifeh, M. M., Santi, P., Resta, G., Strogatz, S. H. and Ratti, C. (2018) 'Addressing the minimum fleet problem in on-demand urban mobility.' *Nature*, 557(7706) pp. 534–538.

Wodak, R. and Meyer, M. (2001) *Methods of Critical Discourse Analysis. Introducing qualitative methods*. SAGE Publications Ltd.

# 5. Appendices

## *5.1. Methodology*

The method can be broken down in two parts:

1) Data collection;
2) Data (content) analysis.

### *5.1.1. Data Collecting – Web Crawling Google Search Pages*

In order to run context analysis, a substantial amount of source material is needed. For this purpose we used Google Search API python based library for searching google (https://github.com/abenassi/Google-Search-API).

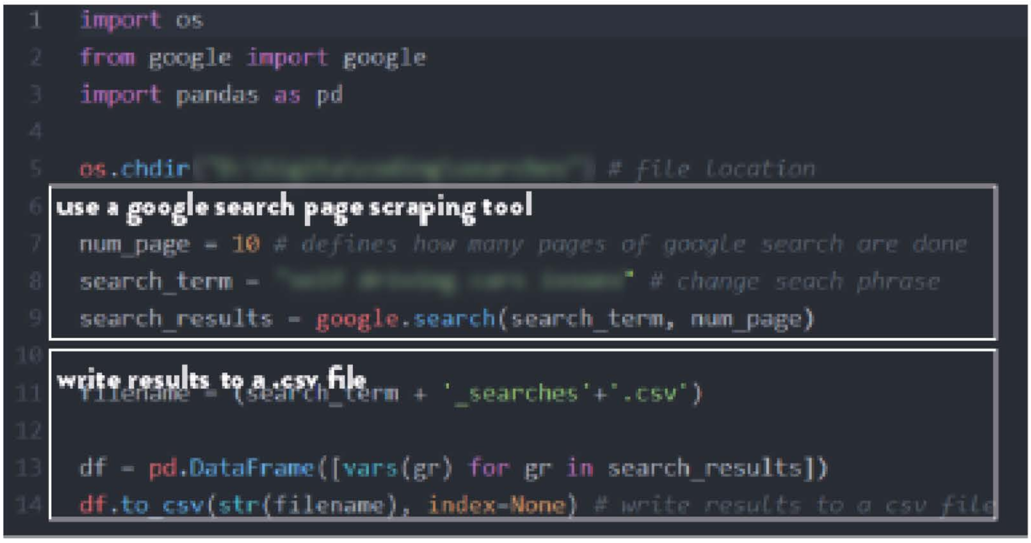



*Figure 19 Sample code of searching the web and saving search results to a csv file.*

This tool scrapes google search pages based on specific search terms. It records the link, its index (where it appeared in search results), and a short description (the first couple of lines of text as seen on google search page). For overview and further analysis, we then outputted the results to a .csv file (Figure 20).

In order to run the content analysis, we used the Python *requests* libary and the *beautifulsoup* library. The script iterates through the list of links (that have been prepared in .csv format previously) and extracts all html paragraph content from the webpages. The content is then saved to text files that are used in the next part of the analysis.

### Limitations of the search and data collection method

This search method is limited to searching only for the current time results, meaning that the results could be different if searched on a different day. The searches can also be impacted by the search history of the user. This could be eliminated and/or improved by using a paid service such as the Google custom search json API service by google. For the purposes of this report we focused on current concerns only, therefore specific search parameters were not required.

Another issue that might affect the final analysis is the text content that is extracted from the web pages. Because the scipt has to iterate through different sites, there are build differences in their html structure. Sometimes this can lead to the scraper not capturing the whole extent of the content. Additionally, text encoding may vary between diffeent websites, which can lead to text not being recognised and/or captured.

For certain keywords another issue could be the repetition of the same source/website which could add bias to the final result.

### *5.1.2. Text Analysis – Latent dirichlet allocation (LDA) Topic Model*

| description | index | link | name | r |
|---|---|---|---|---|
| 23 Oct 2017 - The Many Problems With Autonomous Vehicles. Optimists predict that autonomous vehicles will be a transportation panacea, but there are good reasons to be skeptical. They may create as many problems as they solve. There are many optimistic predictions for autonomous vehicle impacts and their potential benefits. | 0 | https://www.planetizen.com/blogs/95445-many-problems-autonomous-vehicles | The Many Problems With Autonomous Vehicles - Blogs \| Planetizenhttps://www.planetizen.com/blogs/95445-many-problems-autonomous-vehicles | |
| Autonomous and unmanned vehicle technology has already achieved a high .... One major area of autonomous vehicle development concerns an area whereÂ ... | 1 | https://www.lloyds.com/~/media/lloyds/reports/-emerging-risk-reports/autonomous-vehicles-final.pdf | Autonomous Vehicles - Lloyd's of Londonhttps://www.lloyds.com/~/media/lloyds/reports/-.../autonomous-vehicles-final.pdf | |
| 4 Jan 2018 - Unless self-driving cars can dramatically reduce fatalities, the public ... be worried about riding in an autonomous vehicle due to concerns overÂ ... | 2 | https://www.citylab.com/transportation/2018/01/autonomous-vehicles-consumer-backlash/549650/ | Drivers Aren't Ready for Self-Driving Cars - CityLabhttps://www.citylab.com/transportation/2018/01/autonomous-vehicles.../549650/ | |
| 27 Mar 2018 - The biggest ethical challenges for self-driving cars arise in mundane ... The ethical problems deepen when you attend to the conflicts of interestÂ ... | 3 | http://theconversation.com/the-everyday-ethical-challenges-of-self-driving-cars-92710 | The everyday ethical challenges of self-driving carstheconversation.com/the-everyday-ethical-challenges-of-self-driving-cars-92710 | |
| 13 Feb 2018 - Self-driving cars are going to broadcast a lot of information. What if the wrong people are listening? | 4 | https://blogs.thomsonreuters.com/answerson/privacy-concerns-self-driving-cars-ready-autonomous-vehicles/ | Privacy concerns and self-driving cars: Are we ready for autonomous ...https://blogs.thomsonreuters.com/.../privacy-concerns-self-driving-cars-ready-autono... | |
| 31 May 2018 - But the technology of self-driving cars is one of only very few technologies where safety issues are inherently the primary focus of development. | 5 | http://www.driverless-future.com/?cat=32 | Safety issues \| Driverless car market watchwww.driverless-future.com/?cat=32 | |
| 20 Mar 2018 - The biggest challenge facing the development of autonomous cars is not money or technology, but legal and ethical concerns, Morgan StanleyÂ ... | 6 | https://www.cnbc.com/2018/03/20/ethical-legal-worries-form-biggest-barrier-to-autonomous-vehicles-analyst-says.html | Ethical, legal worries form biggest barrier to autonomous vehicles ...https://www.cnbc.com/.../ethical-legal-worries-form-biggest-barrier-to-autonomous-ve... | |
| electric vehicles, autonomous cars and smart cities. Autonomous and connected vehicles: navigating the legal issues. â€œthere will be 21 million autonomousÂ ... | 7 | http://www.allenovery.com/SiteCollectionDocuments/Autonomous-and-connected-vehicles.pdf | Autonomous and connected vehicles: navigating the legal issueswww.allenovery.com/.../Autonomous-and-connected-vehicles.pdf | |
| 20 Mar 2018 - Unsurprisingly, safety and the ability of self-driving cars to avoid mistakes are among the biggest concerns of people opposed to autonomousÂ ... | 8 | https://www.statista.com/chart/5950/concerns-about-self-driving-cars/ | â€¢ Chart: Consumer Concerns About Self-Driving Cars \| Statistahttps://www.statista.com â€º Topics â€º Autonomous Vehicle Technology | |
| 1 Feb 2018 - Those are "relatively trivial to optimize for," he said, and they are "solved problems right now" for autonomous vehicles. But, teaching theÂ ... | 9 | https://www.zdnet.com/article/the-obstacles-to-autonomous-vehicles-liability-societal-acceptance-and-disaster-stories/ | The obstacles to autonomous vehicles: Liability, societal acceptance ...https://www.zdnet.com/.../the-obstacles-to-autonomous-vehicles-liability-societal-acce... | |

*Figure 20 Sample search results in .csv file*

Part of the methodology for analyzing the sources, includes a model that gathers all text literature and looks at how they are related through shared topics and words. This type of model is called an LDA Model. In order to explain this type of model, it is best to use an example from a magazine website.

When you read an online article, it is common practice for the website to suggest other content you may be interested in. Understanding what the reader would choose to read next poses an interesting challenge for the website. It must understand the underlying theme for the article and then connect it to other articles with similar content / themes. For humans, this is an easy task. We can quickly glance through the article's front cover and recognize that it belongs to a specific category such as food recipe. Because of our brains we can answer questions on the article such as what is it about; what it is related t; what it feels like; what it means. This comes down to us linking the article to our overall knowledge about the world. Knowing what a car is, when our birthday is and what feels to be happy help us understand and contextualize things. We are also very good at adjusting to changing context quickly and choosing the right level of abstraction in order to make sense of things. An example of that is our ability to know that a word can have many meanings depending on the context it is used in. The word 'red', for example, can be used to describe many different colours when combined with other words such as red hair, red wine, red skin, red book all of which contain the same word but have a completely different colour. Overall we have this amazing ability to learn and understand different topics based on the words appearing in various contexts.

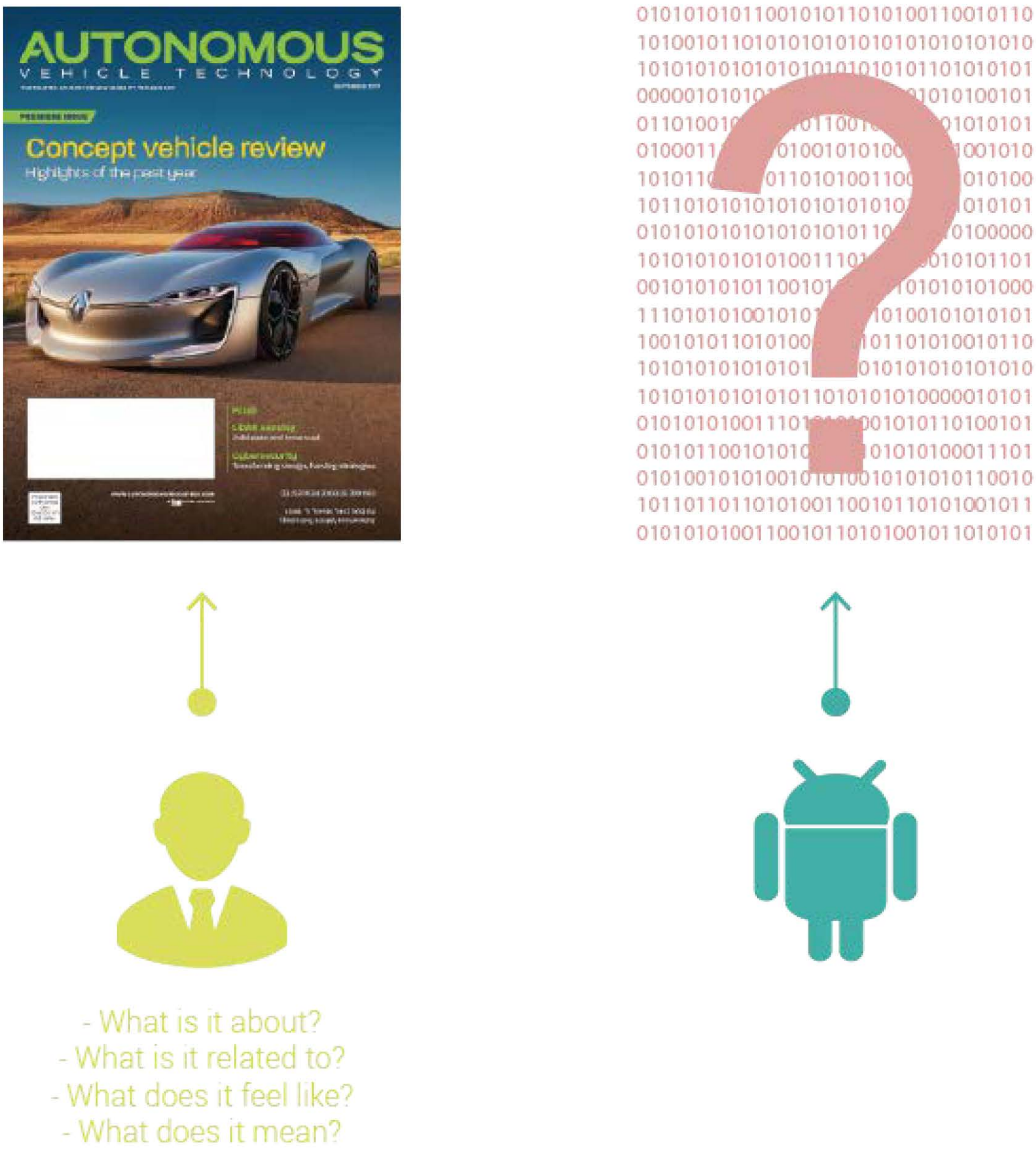



*Figure 21: Shows the differences between a computer and human understanding of read literature*

The interesting question is how to place all this knowledge and thinking capacity into a machine in order to automate finding similar articles and make its recommendations feel human like. To begin this process we need the three things listed below:

1) Context: Give the machine all the knowledge we can by making it "read" many things.

2) Words: There is a need to be careful with the key words used, as they are the features that carry the information.

3) Topic: Information needs to be split in appropriate chunks, since that will determine the context in which words will connect.

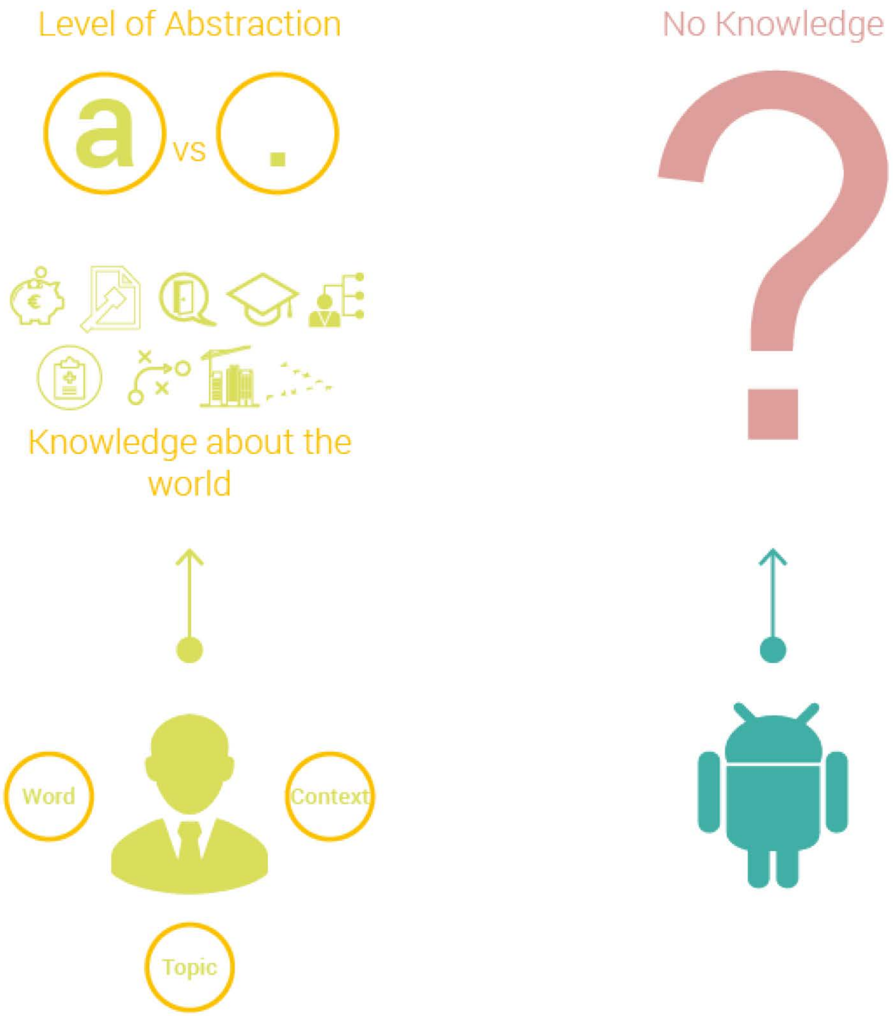



*Figure 22: Shows a person's knowledge level and cognitive capability vs a computer*

As in many models there is a process that needs to be followed in order to create an LDA model that can mimic human thinking in such a way. The diagram below shows the process. The first step is the preprocess that gathers the data / knowledge. The second step is to train the model to understand and contextualise the data. The third step is to be able to apply the model on some new data and finally evaluate its performance. Once all this is achieved, we can have a machine able to understand what the user is reading and suggest related articles on the topic. This is where our example ends and where our usage of the LDA model begins.

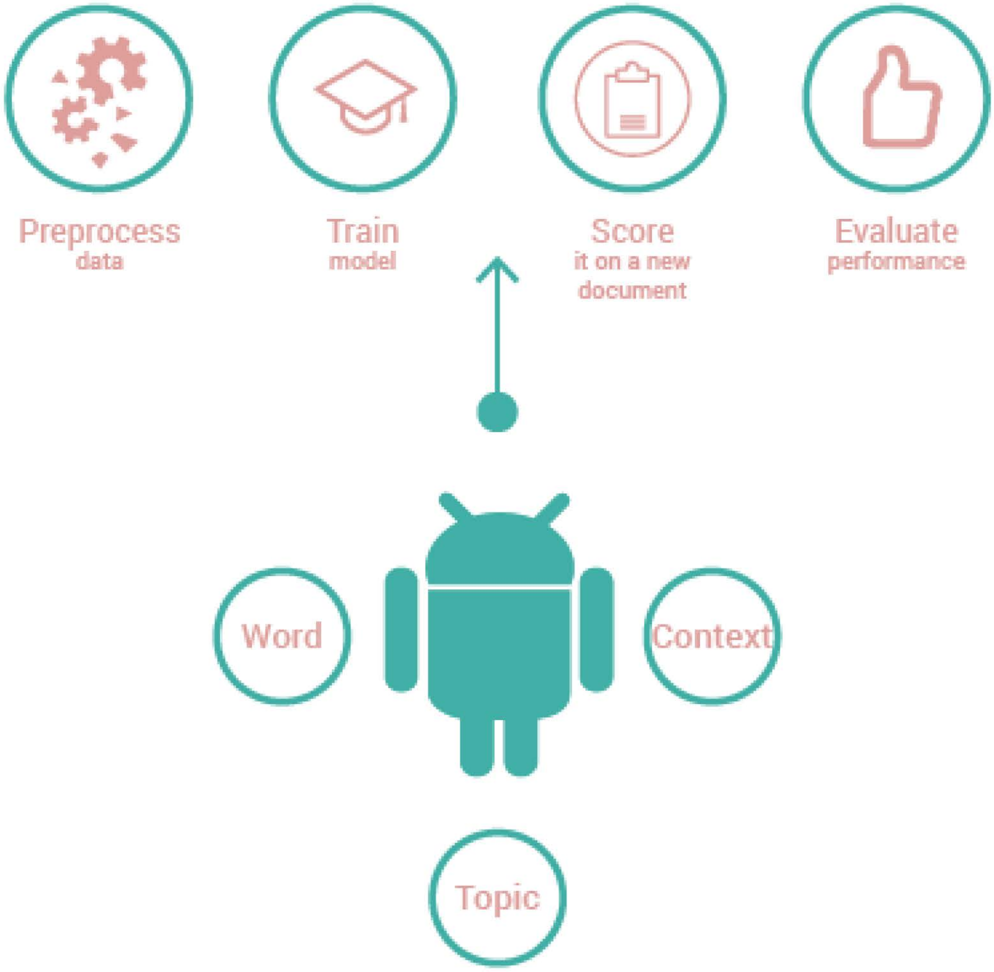



*Figure 23: Explains the process of creating a model that can understand context and topics*

The LDA model was developed by David Blei, Andrew Ng and Michael Jordan in 2003 and its purpose is to identify topics presented in any given document by observing all the words in it and producing a topic distribution (Jelodar et al., 2012). It therefore looks at all the words in a document, the topics for those words and the range of topics in relation to other documents. It combines all the three things stated above, i.e. topic, word and context. What the model does is run through a collection of documents containing a plethora of words. It then arranges those words in a logical way that best describes the range of topics. This is done through two given model parameters, namely how many topics and how those topics are assigned to a document. By placing those parameters to the LDA model, it categorises recurring words to their assigned topic and calculates the number of times these words are used in the given topic.

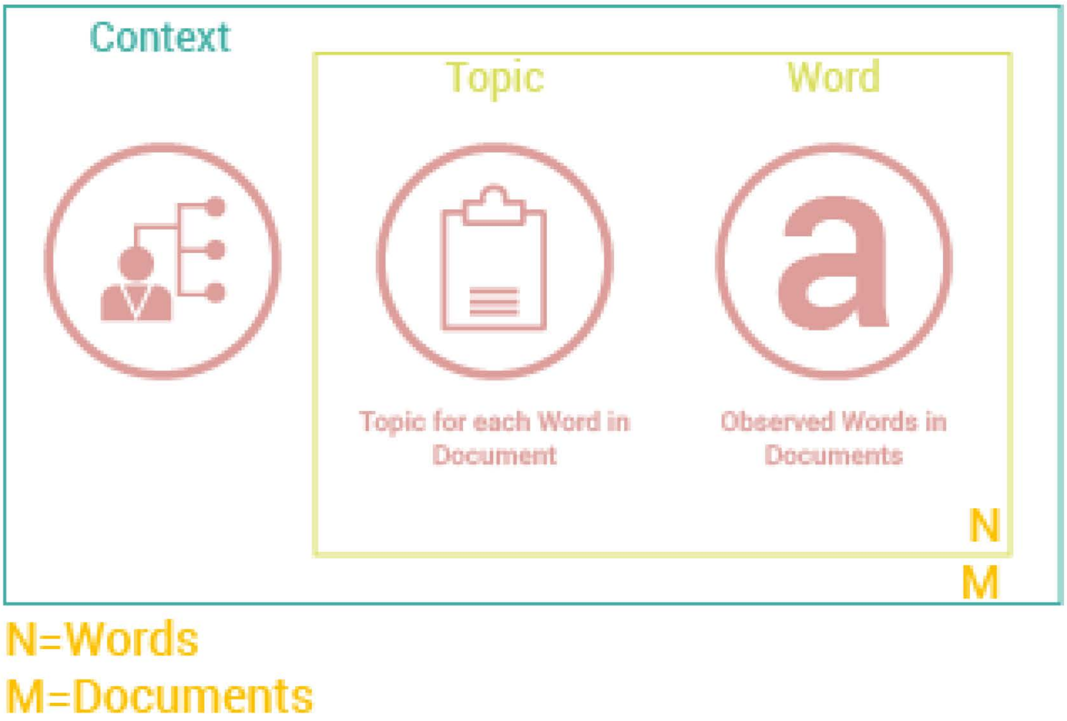



*Figure 24: An overall breakdown of context to topic and words from documents for the LDA model*

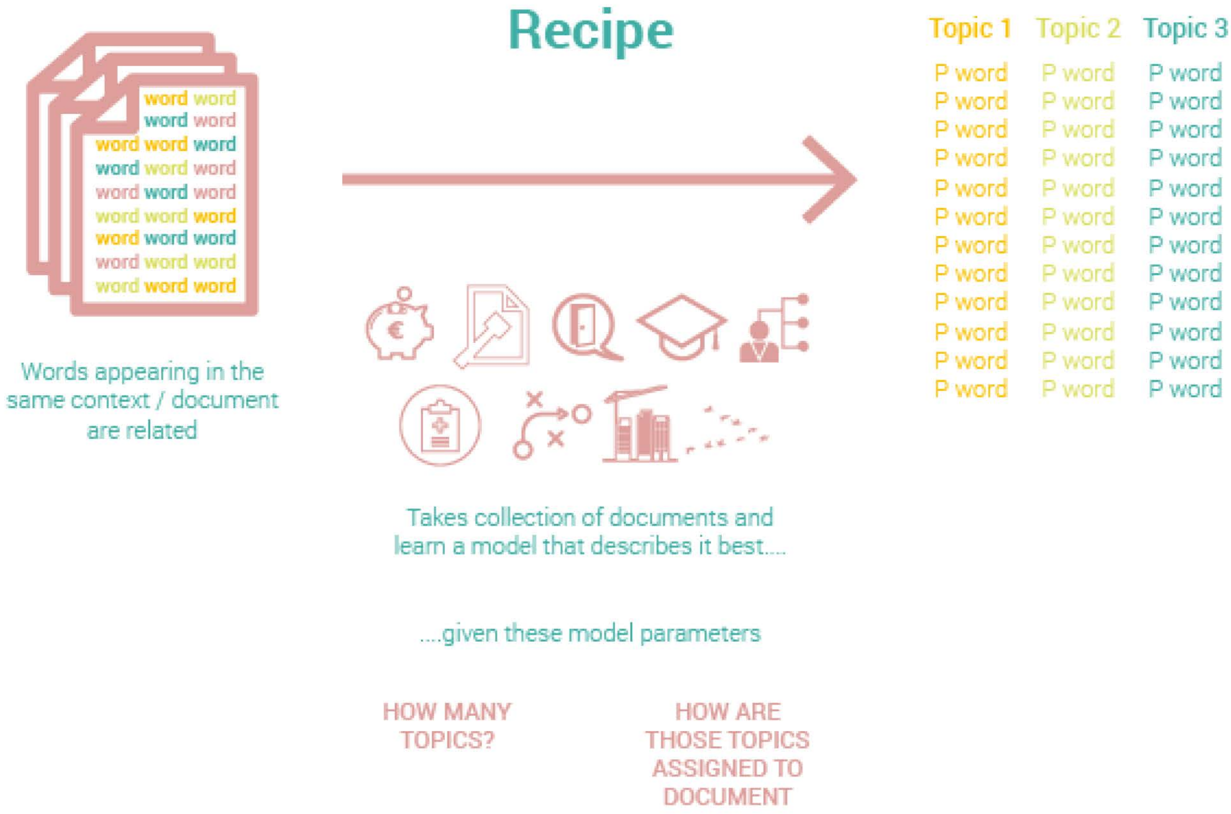



*Figure 25: Breakdown of the process made by our LDA model in analysing articles on AVs*

Using this method, we can analyse a range of sources generated through different key words much faster than manual analysis and can allow for the expansion of the theme to other topics and other keywords.

## *5.2. Searches Generated*

We used 7 keywords for searches. To gather results for analysis, we used various search terms to reflect the inconsistent use of terms associated with autonomous driving technology. Additionally, more generic search terms 'autonomous vehicles' and 'connected and autonomous vehicles' were used to evaluate how adding 'concerns' to search term affects the results.

| Search term | Sources obtained |
|---|---|
| autonomous vehicles concerns | 98 |
| Self driving cars concerns | 101 |
| **Connected and autonomous vehicles** | 91 |
| Connected and autonomous vehicles concerns | 93 |
| Driverless cars concerns | 98 |
| **Autonomous vehicles** | 100 |
| Self driving cars issues | 100 |
| | |

Out of 683 search results in total, 330 were unique hits (only found once). The rest of sources duplicated at least one in different search terms. In total, there were 462 unique links.

## *5.3. Keyword Analysis Results*

Search tem ‘autonomous vehicles’

Search tem ‘autonomous vehicles concerns’

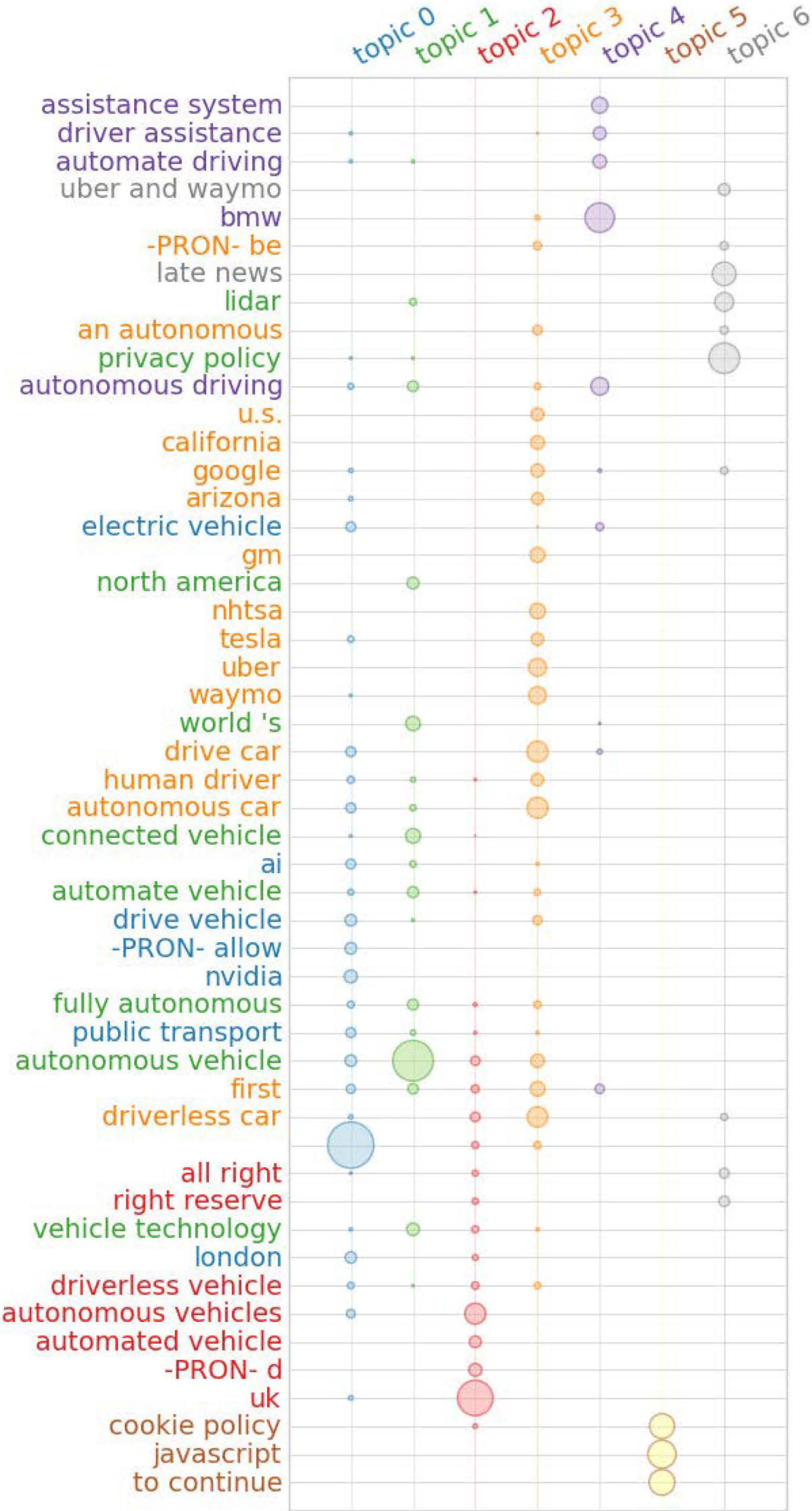
Search tem ‘connected and autonomous vehicles’

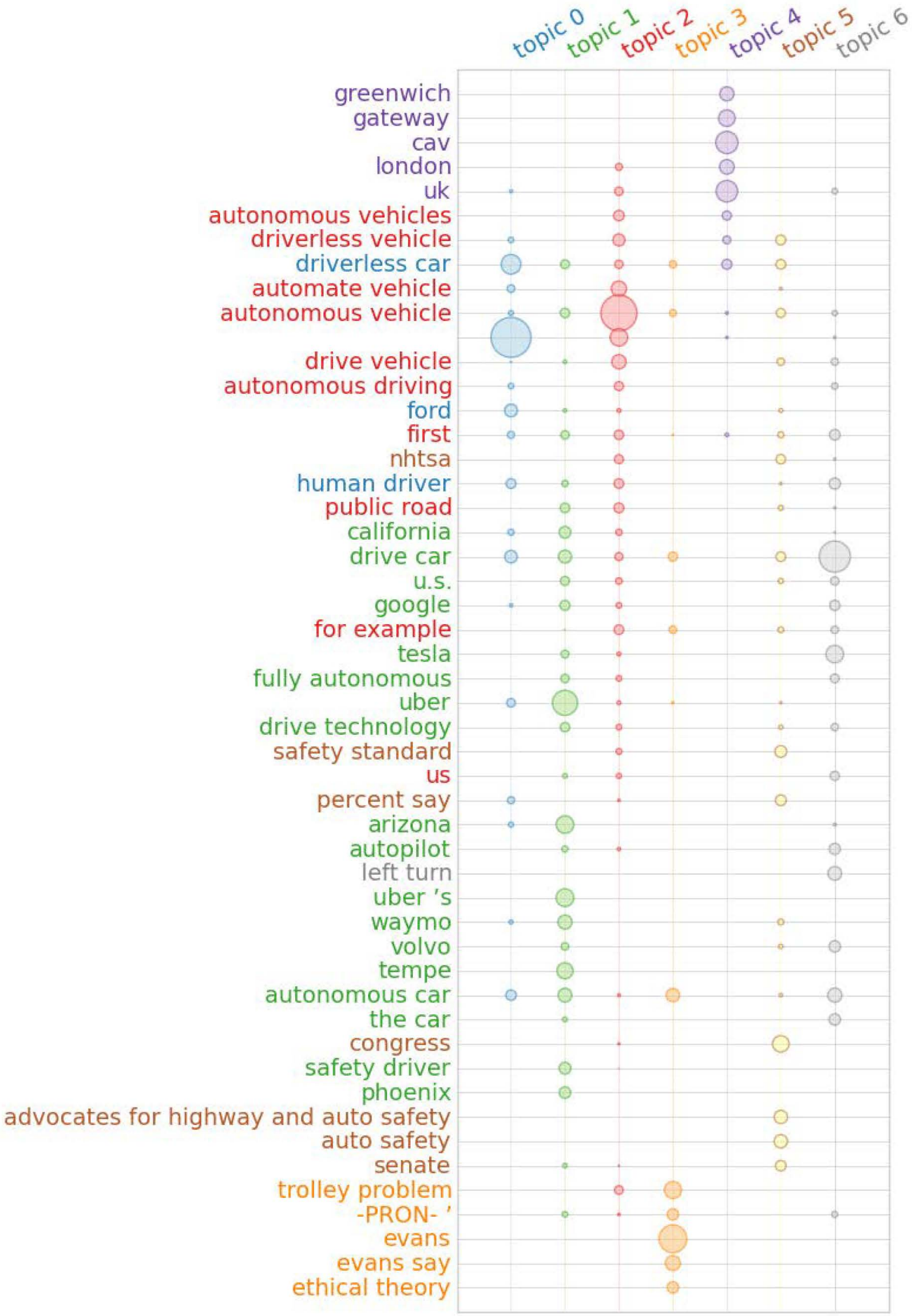
Search tem ‘connected and autonomous vehicles concerns’

Search tem ‘driverless cars concerns’

Search tem ‘self driving cars concerns’

Search tem ‘self driving cars issues’


topic 0
topic 1
topic 2
topic 3
topic 4
topic 5
topic 6
assistance system
driver assistance
automate driving
uber and waymo
bmw
-PRON- be
late news
lidar
an autonomous
privacy policy
autonomous driving
u.s.
california
google
arizona
electric vehicle
gm
north america
nhtsa
tesla
uber
waymo
world 's
drive car
human driver
autonomous car
connected vehicle
ai
automate vehicle
drive vehicle
-PRON- allow
nvidia
fully autonomous
public transport
autonomous vehicle
first
driverless car
all right
right reserve
vehicle technology
london
driverless vehicle
autonomous vehicles
automated vehicle
-PRON- d
uk
cookie policy
javascript
to continue


topic 0
topic 1
topic 2
topic 3
topic 4
topic 5
topic 6
greenwich
gateway
cav
london
uk
autonomous vehicles
driverless vehicle
driverless car
automate vehicle
autonomous vehicle
drive vehicle
autonomous driving
ford
first
nhtsa
human driver
public road
california
drive car
u.s.
google
for example
tesla
fully autonomous
uber
drive technology
safety standard
us
percent say
arizona
autopilot
left turn
uber 's
waymo
volvo
tempe
autonomous car
the car
congress
safety driver
phoenix
advocates for highway and auto safety
auto safety
senate
trolley problem
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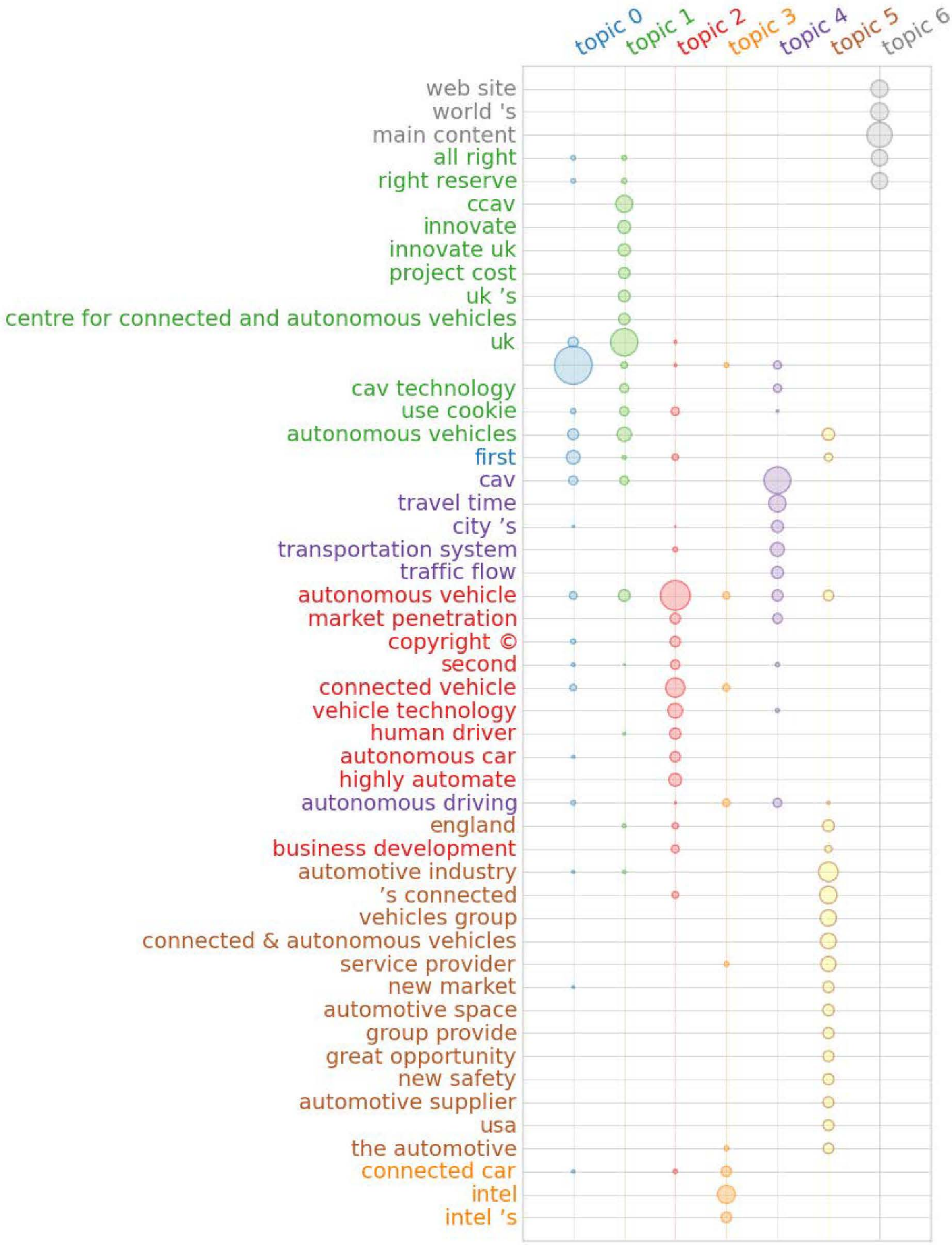
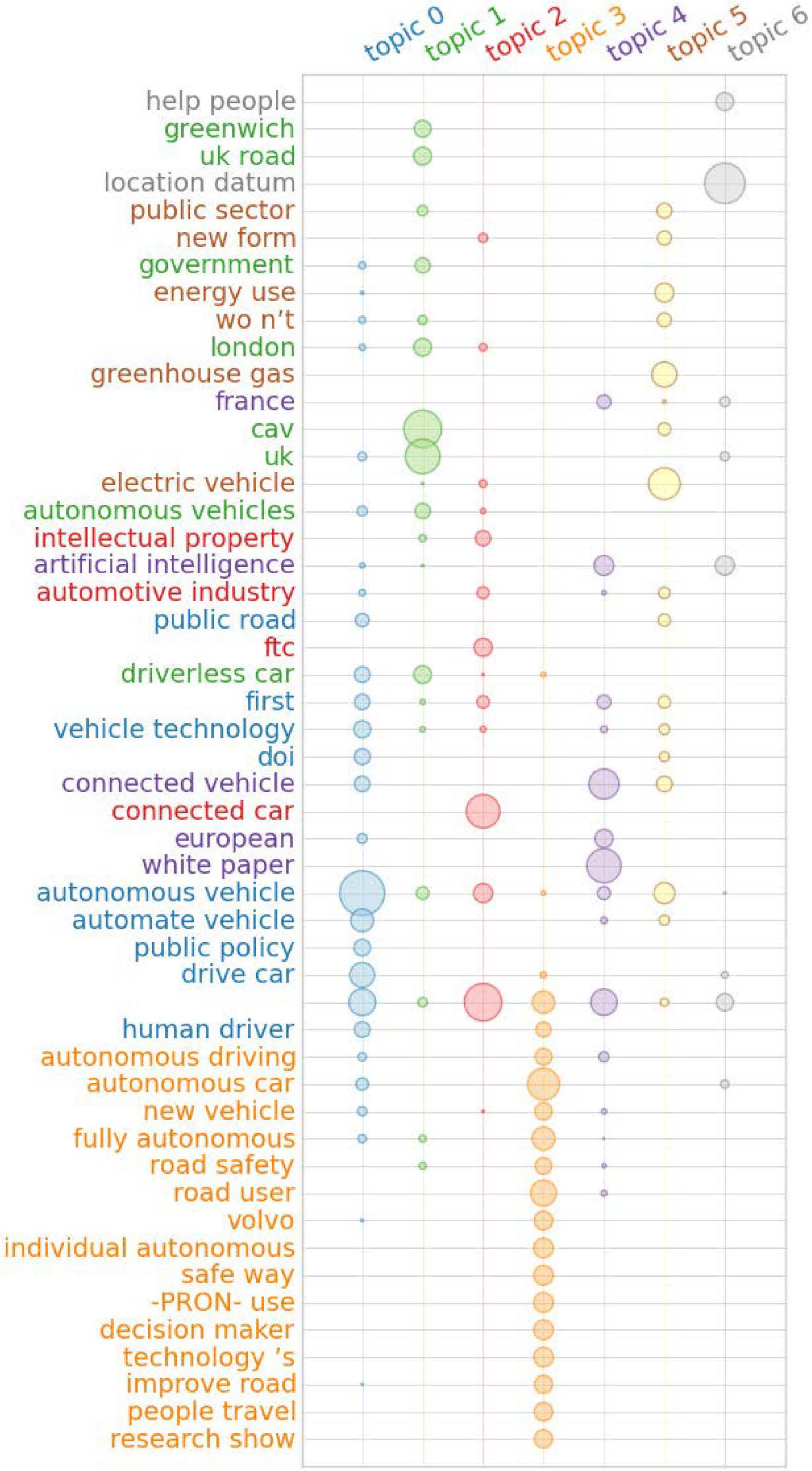
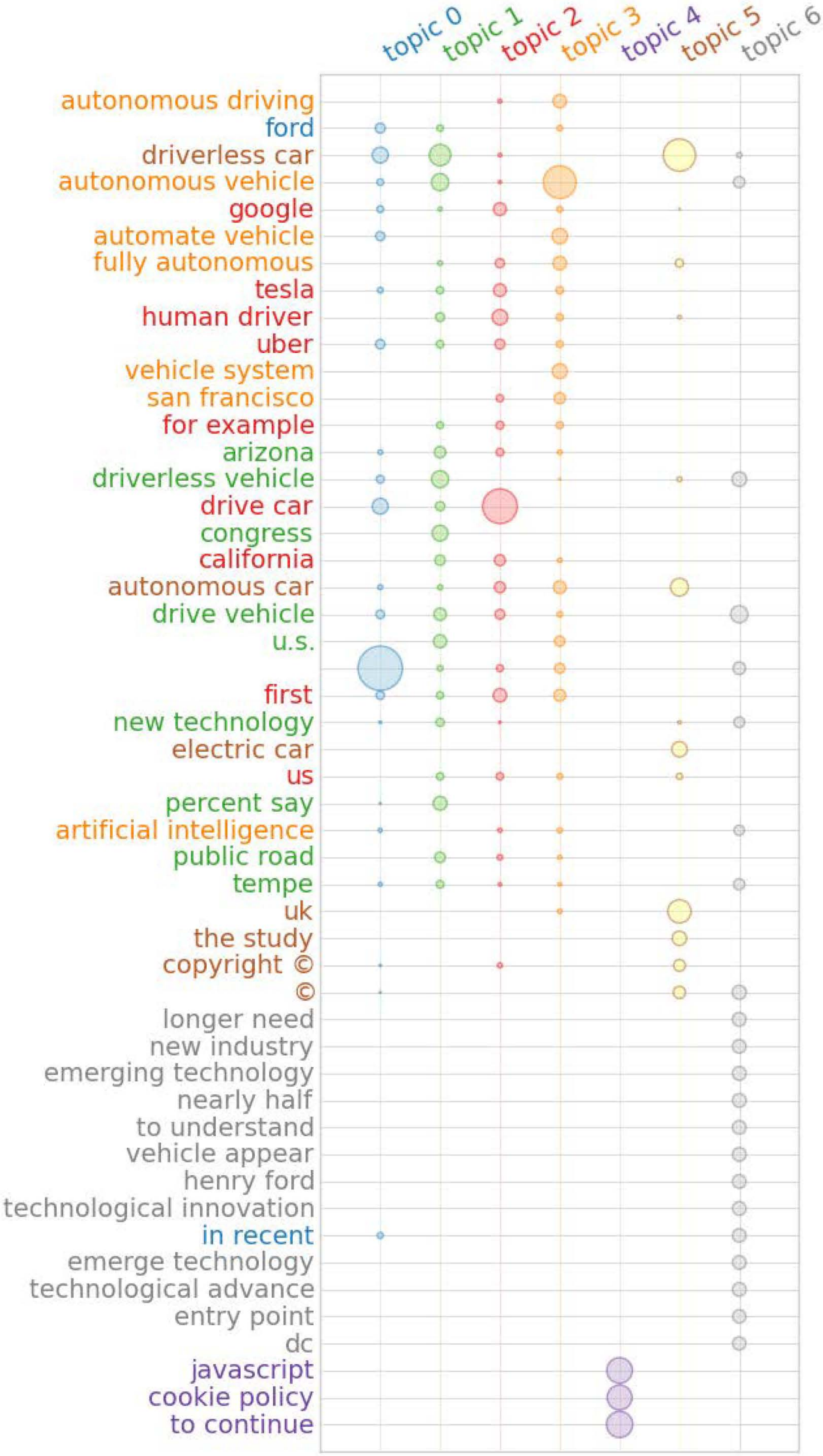
evans
evans say
ethical theory


topic 0
topic 1
topic 2
topic 3
topic 4
topic 5
topic 6
web site
world 's
main content
all right
right reserve
ccav
innovate
innovate uk
project cost
uk 's
centre for connected and autonomous vehicles
uk
cav technology
use cookie
autonomous vehicles
first
cav
travel time
city 's
transportation system
traffic flow
autonomous vehicle
market penetration
copyright ©
second
connected vehicle
vehicle technology
human driver
autonomous car
highly automate
autonomous driving
england
business development
automotive industry
's connected
vehicles group
connected & autonomous vehicles
service provider
new market
automotive space
group provide
great opportunity
new safety
automotive supplier
usa
the automotive
connected car
intel
intel 's


topic 0
topic 1
topic 2
topic 3
topic 4
topic 5
topic 6
help people
greenwich
uk road
location datum
public sector
new form
government
energy use
wo n't
london
greenhouse gas
france
cav
uk
electric vehicle
autonomous vehicles
intellectual property
artificial intelligence
automotive industry
public road
ftc
driverless car
first
vehicle technology
doi
connected vehicle
connected car
european
white paper
autonomous vehicle
automate vehicle
public policy
drive car
human driver
autonomous driving
autonomous car
new vehicle
fully autonomous
road safety
road user
volvo
individual autonomous
safe way
-PRON- use
decision maker
technology 's
improve road
people travel
research show


topic 0
topic 1
topic 2
topic 3
topic 4
topic 5
topic 6
autonomous driving
ford
driverless car
autonomous vehicle
google
automate vehicle
fully autonomous
tesla
human driver
uber
vehicle system
san francisco
for example
arizona
driverless vehicle
drive car
congress
california
autonomous car
drive vehicle
u.s.
first
new technology
electric car
us
percent say
artificial intelligence
public road
tempe
uk
the study
copyright ©
©
longer need
new industry
emerging technology
nearly half
to understand
vehicle appear
henry ford
technological innovation
in recent
emerge technology
technological advance
entry point
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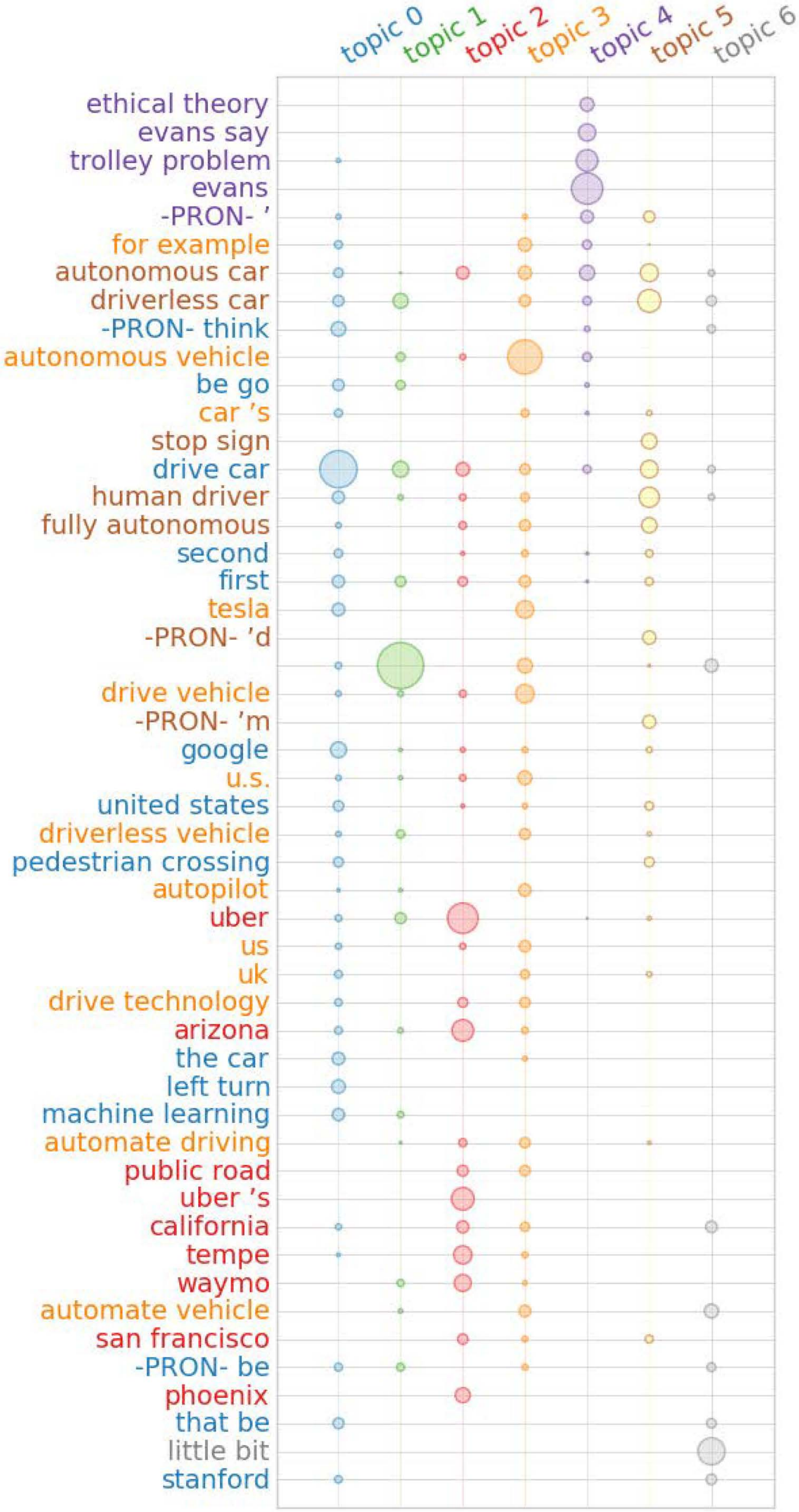
cookie policy
to continue


topic 0
topic 1
topic 2
topic 3
topic 4
topic 5
topic 6
ethical theory
evans say
trolley problem
evans
-PRON- ’
for example
autonomous car
driverless car
-PRON- think
autonomous vehicle
be go
car ’s
stop sign
drive car
human driver
fully autonomous
second
first
tesla
-PRON- ’d
drive vehicle
-PRON- ’m
google
u.s.
united states
driverless vehicle
pedestrian crossing
autopilot
uber
us
uk
drive technology
arizona
the car
left turn
machine learning
automate driving
public road
uber ’s
california
tempe
waymo
automate vehicle
san francisco
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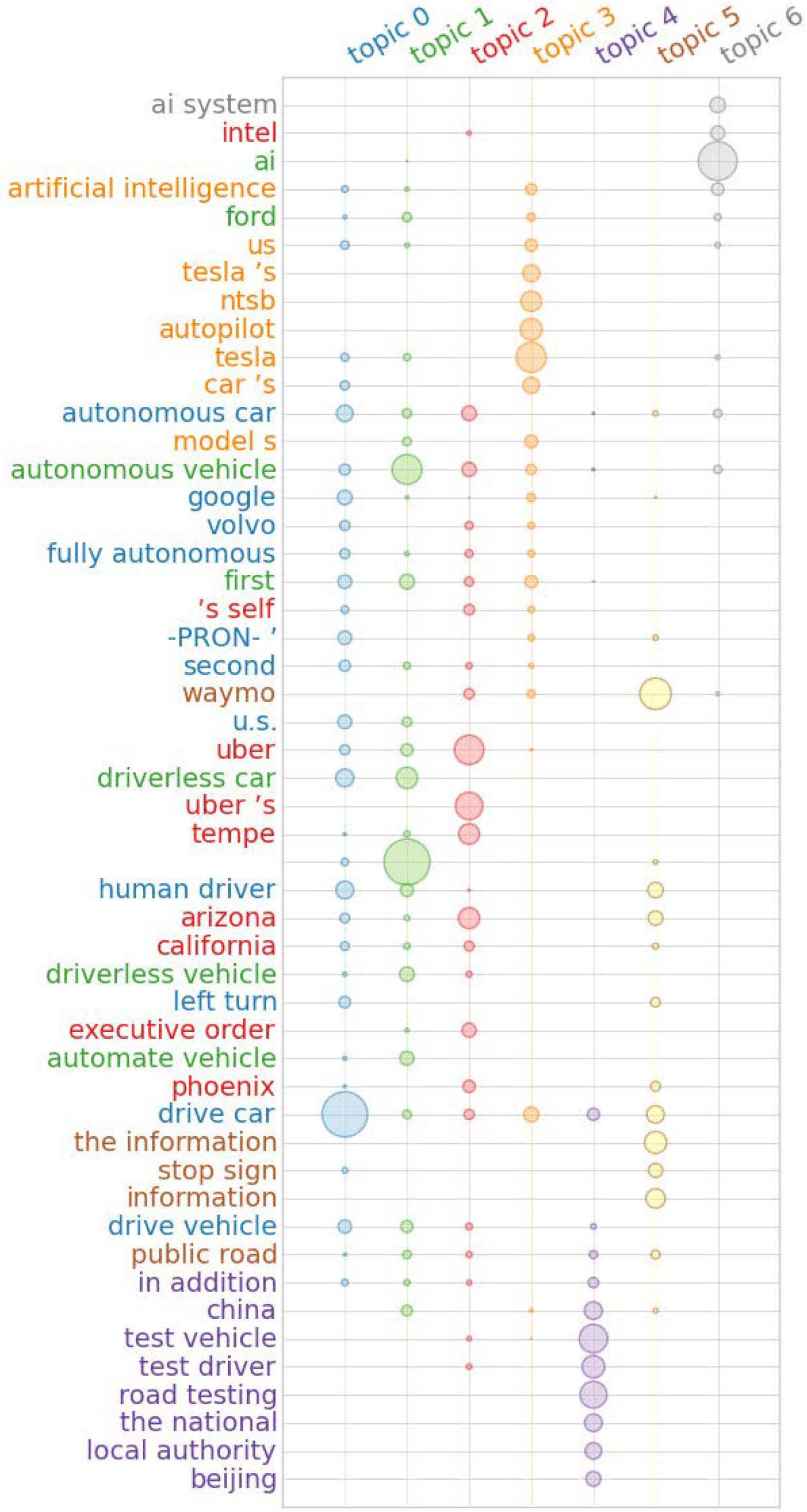
phoenix
that be
little bit
stanford


topic 0
topic 1
topic 2
topic 3
topic 4
topic 5
topic 6
ai system
intel
ai
artificial intelligence
ford
us
tesla 's
ntsb
autopilot
tesla
car 's
autonomous car
model s
autonomous vehicle
google
volvo
fully autonomous
first
's self
-PRON- '
second
waymo
u.s.
uber
driverless car
uber 's
tempe
human driver
arizona
california
driverless vehicle
left turn
executive order
automate vehicle
phoenix
drive car
the information
stop sign
information
drive vehicle
public road
in addition
china
test vehicle
test driver
road testing
the national
local authority
beijing

## 5.4. Interviews / Discussions

We have conducted interviews / had discussions with two different groups. One group was the New York City taxi drivers and the second was academics from Boston MIT. The results are explained and their findings listed below.

### 5.4.1. New York Taxi Drivers

The first group of people were taxi drivers in New York City. Cruise automation, an autonomous vehicle branch of General Motors has recently been granted permission to operate AV tests in Manhattan. This resembles the first step to operate AVs in a busy city centre. The ambition is to embed the technology in the city's mobility model making them a direct competitor to existing modes of on-demand transportation such as the famous New York taxis. That being the case, it forms an interesting opportunity to get the opinions of the members of the public whose jobs / livelihood are in direct competition to this rising technology.

Throughout our journey in New York we have taken taxi trips with different drivers and engaged in discussions with them around a predetermined set of questions. It was an attempt to see if, firstly, they were keeping up with current discussions in the matter, secondly, they had any strong beliefs in the matter. The questions were as follows:

1) What do you think of the driverless car-testing going on in the US now?
2) Do you believe that they will implement driverless cars on normal roads with other cars?
3) Do you think there are any safety issues with allowing driverless cars on public roads?
4) Do you think it will affect taxis and taxi services, taking away jobs and creating a new economic model?
5) Do you think that the future lies in self-driving cars or in better technology for human driver cars?
6) What technologies do you think exist?

The results of these interviews varied from driver to driver. Some drivers avoided answering some of the questions due to disinterest. Other answers showed a lack of knowledge in the subject and thus lack of opinion by some drivers. Overall, we conducted 10 valid interviews (some drivers did not wish to talk / engage in conversation thus rendering the interview as invalid). The results / opinions arising from the interviews are outlined below:

1) Welcome of the new invention
2) Safety issue with introduction to current road conditions. City is too crowded, too many people that may have an impact on their possible testing.
3) Worried about losing their job but confident that another job market will be created for them.
4) The safest option between AV and better technology for human drivers will prevail.
5) If you could choose in an Uber app to travel with a human driven vehicle vs a driverless car, which would you choose? It is the human interaction aspect like talking to the driver that will be lost.
6) Capitalism will find a way; the most profitable way will succeed.
7) Too many human-driven cars in Manhattan to test AVs in this environment.
8) Self-driving flying pods might be more likely / viable.
9) Self-driving cars are too dangerous. It is about life. Driving is a skill and a machine cannot have the same skill.
10) I do not believe it is going to happen. It is too stressful to even think about. It is a concept out of a movie and that is where it should stay.
11) Technology today does not care whether we like it. If it works and is safe and cheap it will be implemented.

The above statements form the summary of concerns raised through the interviews. Comparing them to the written literature concerns, it is interesting to find that only 5 out of the 10 concerns exist in both the spoken and written findings. These five are road safety, travel flow, infrastructure, market uptake of technology and changing transportation systems. In fact, taxi drivers raised concerns more focused on the transition to the technology with many finding it unthinkable for AVs to function in Manhattan. This issue with transition is an aspect not explored enough in the written literature. It is nevertheless a very important subject as any technological introduction causing a total shift in the system will require a carefully planned transition period.

### *5.4.2. MIT – Senseable City Lab Discussion*

While planning our interview work in New York City, MIT's Senseable City Lab published an article in Nature with the title "Addressing the minimum fleet problem in on-demand urban mobility" (Vazifeh et al., 2018). It is an attempt to create a scalable minimum fleet solution for on-demand mobility systems. The research is a response to two distinctive trends arising, autonomous / connected vehicles and the rise of the concept of shared mobility. Furthermore, the data and setting for the solution is in Manhattan, New York City using taxi ride data. It provided a distinct possibility to complement our research with taxi drivers and to have a discussion with the researchers about this work.

As it was explained to us, this is an attempt to optimise the efficiency of autonomous on-demand mobility. It is a network-based online vehicle-dispatching model. Their network-based optimisation, when compared to the taxi operations of New York City, shows that there could be as much 40% reduction in taxis on the road serving the same number of fairs. The impressive aspect is that this reduction causes no further delay to the customer.

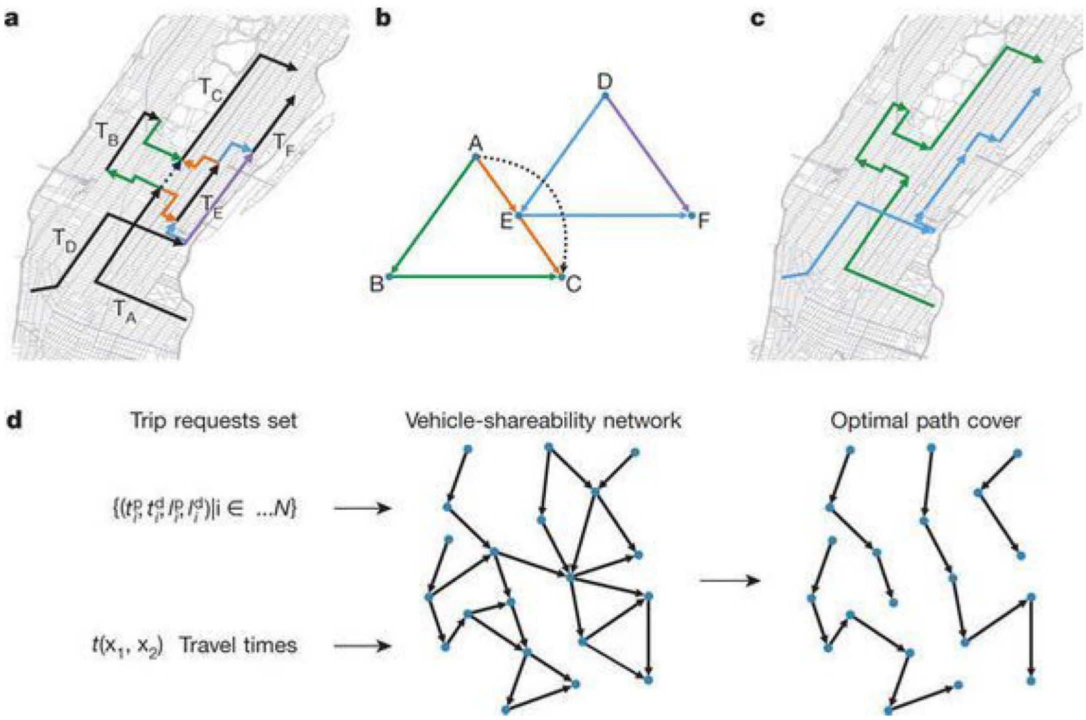



*Figure 26: Image from "Addressing the minimum fleet problem in on-demand urban mobility" journal article, outlining the network-based model*

The importance of MIT's research to our report revolves around three of the concerns we previously identified in the written literature (traffic flow, travel time and changing transportation system) and one identified in the taxi driver interviews. This research looks at how concerns surrounding the first two can be addressed through a change in the system and a move to an autonomous on-demand mobility system. Though change in the system is itself a found concern, in this case, it serves as a solution to two other concerns of travel time and traffic flow with the use of connected autonomous vehicles. On the other hand, taxi driver concerns on job loss may be valid. Simulations show that there is a smaller need for taxis with the possibility of the whole system becoming fully autonomous.

## ***5.5. Workshop***

In an attempt to improve our analysis, we have held a workshop at the annual Autonomy Conference in Paris on the 18th of October 2018. The aim of the workshop was to understand and discuss concerns regarding the deployment of Connected Autonomous Vehicles on public roads. The conference was primarily made-up of government, public and commercial sectors coming together to discuss changing technologies in transportation systems, in effect, autonomous vehicles and their introduction.

The expert panel of attendees provided a good opportunity to provide input to our discourse results. Using our pre-identified list of concerns, taken from literature with the use of an LDA model, we asked participants to rank them in terms of importance from 1-10. 1 being the highest and 10 the lowest. We also allowed for additional concerns to be placed by the participants and a question and answer session in order to identify potential shortcomings of the previous findings / LDA model approach. All participants were asked to provide their job title and organisation so as to take into account the bias introduced by the sector they worked in. An example of the workshop leaflet and information sheet can be found in the appendix.

The findings of the research can be viewed on the table below. Some of the additional concerts raised by the participants were as follows:

1) Immediacy - "At-the-Moment" Spontaneous use of movement especially in rural areas.
2) Impact on the workforce (drivers).
3) How to manage a 2-speed transition:
    a. Phase-in level 3 AV into current road layout.
    b. Challenge of a gradual shift in road layout.
4) AV interaction with non AV vehicles
5) Acceptance by People
6) Mixed fleet in urban area. Travel growth / Road use increase
7) Transition and cost for people
8) Co-habitation of AV and normal vehicles

| Profile | Travel Time | Personal Data / Privacy | Travel Flow | Road Safety / Public Policy | Vehicle Safety Standards | Ethics / AV Decision Making | Market Uptake of | Changing Transportation | Energy Use | Infrastructure | Additional Concerns |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Commercial | 7 | 1 | 6 | 10 | 8 | 3 | 4 | 5 | 2 | 9 | Immetiacy - "In-the-Moment" Spontanious use of movement especially in rural areas |
| Commercial | 3 | 5 | 7 | 9 | 10 | 4 | 8 | 2 | 6 | 1 | n/a |
| Government | 9 | 8 | 4 | 1 | 2 | 5 | 7 | 6 | 10 | 3 | n/a |
| Commercial | 3 | 6 | 4 | 9 | 7 | 10 | 2 | 8 | 1 | 5 | n/a |
| Commercial | 10 | 9 | 5 | 1 | 8 | 7 | 6 | 2 | 4 | 3 | Impact on the workforce (drivers) |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Government | 3 | 10 | 2 | 8 | 4 | 9 | 7 | 1 | 5 | 6 | n/a |
| Government | 8 | 5 | 9 | 9 | 8 | 6 | 3 | 10 | 2 | 9 | How to manage a 2-speed transition: 1) phase-in level 3 AV into current road layout. 2) Challenge of a gradual shift in road layout. |
| Government | 10 | 8 | 9 | 7 | 7 | 3 | 6 | 5 | 3 | 7 | n/a |
| Commercial | 8 | 5 | 8 | 3 | 3 | 3 | 5 | 5 | 0 | 0 | AV interaction with non AV vehicles |
| Commercial | 2 | 4 | 8 | 6 | 7 | 3 | 5 | 10 | 9 | 1 | Interaction between users and AV |
| Commercial | 4 | 6 | 7 | 3 | 2 | 1 | 8 | 9 | 0 | 5 | n/a |
| Commercial | 10 | 4 | 6 | 1 | 3 | 8 | 8 | 7 | 9 | 2 | n/a |
| Government | 7 | 3 | 8 | 1 | 9 | 4 | 10 | 5 | 6 | 2 | n/a |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Commercial | 4 | 6 | 5 | 2 | 1 | 3 | 7 | 8 | 9 | 10 | Acceptance by People |
| Government | 6 | 1 | 5 | 2 | 7 | 10 | 9 | 3 | 8 | 4 | Mixed fleet in urban area. Travel growth / Road use increase |
| Government | 5 | 6 | 8 | 2 | 10 | 4 | 9 | 1 | 3 | 7 | n/a |
| Public | 10 | 5 | 8 | 1 | 4 | 2 | 9 | 3 | 7 | 6 | Transition and cost for people |
| Government | 7 | 2 | 5 | 1 | 3 | 4 | 8 | 9 | 6 | 10 | Co-habitation of AV and normal vehicles |
| Government | 7 | 6 | 8 | 1 | 2 | 3 | 10 | 9 | 4 | 5 | n/a |
| Government | 8 | 1 | 8 | 4 | 4 | 8 | 2 | 8 | 4 | 7 | n/a |
| Commercial | 1 | 4 | 6 | 5 | 10 | 9 | 7 | 2 | 3 | 8 | n/a |

Some of the additional concerns arising from the workshop are in line with the interviews conducted with New York City taxi drivers: acceptance of the technology by people, the cost for people, impact on the workforce and co-habitation of CAVs and human driven vehicles on the same road. These concerns take a more human perspective at the issue and engage with questions surrounding the transition period between the fully AV implemented system and the current one. This is an important question that needs answering and it is currently not mentioned as much in the written literature.

From the workshop the following results can be obtained in terms of ranking the concerns found through the LDA model:

| | Travel Time | Personal Data / Privacy Policy | Travel Flow | Road Safety / Public Policy | Vehicle Safety Standards | Ethics / AV Decision Making | Market Uptake of Technology | Changing Transportation System | Energy Use | Infrastructure Improvements |
|---|---|---|---|---|---|---|---|---|---|---|
| Median | 7 | 5 | 7 | 3 | 7 | 4 | 7 | 5 | 4 | 5 |

It is clear that on the average the biggest concern from the written literature is Road Safety and Public Policy. This may be due to the nature of the conference with a many government officials attending thus having a bias towards public well-being. Surprisingly Ethics / AV Decision Making and Energy Use were the second highest concerns. It would appear that electrical energy versus combustible engines and the overall sustainability umbrella with both its environmental and social sides rank highly in the concerns of the participants.

Through the question and answer part it was pointed out by some participants that some of the concerns are described using generic words. They do not cover the specific issues neither do they point out to specific answers. This is due to the ambiguity of the written literature. It is evident that many of the articles included in the “knowledge of the world” for the LDA model have been written with very generic terms, offering no particular solutions. This can be attributed to a number of things. For the news article section of the initial dataset, the authors are not engineers or policy writers. They are journalists mostly reporting on current events and thus use a language that is easy for people to follow with no depth of knowledge to offer. The important finding appears when we consider the public policy part of the dataset. Government documents surrounding AVs are at the moment written in a manner than offers very little depth in solutions for policy issues and regulations. Participants argued that governments do not yet possess knowledge on how to transition from this current human-led transportation system to an autonomous one. Technology is moving faster than government knowledge; this may lead to a chaotic introduction of AVs in public roads with no proper policy regulation and sub-par infrastructure to accommodate a disruptive change.

## *5.6. Appendix C*

Paris Workshop sheet

MANCHESTER SCHOOL OF ARCHITECTURE

Manchester Metropolitan University

CPU

# Agreement to participate in a recorded workshop

Title of Project: **Project Synergy**

Name of Researcher: **Sigita Zigure, Solon Solomou**

Please, tick each box

1. I confirm that I have read and understood the information sheet dated 18/10/2018 for the above project and have had the opportunity to ask questions about the workshop procedure. ☐
2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason to the researcher. ☐
3. I understand that my responses will be recorded and used for analysis for this research project. ☐
4. I give/do not give permission for my workshop recording to be archived as part of this research project, making it available to future researchers. ☐
5. I understand that my responses will remain anonymous. ☐
6. I agree to take part in the above research project. ☐
7. I understand that at my request a transcript of my responses can be made available to me. ☐

| | | |
|---|---|---|
| ------------------- | 18/10/2018 | ------------- |
| Name of Participant | Date | Signature |
| S. Zigure | | ------------- |
| S. Solomou | 18/10/2018 | ------------- |
| Researcher | Date | Signature |

*To be signed and dated in presence of the participant*

MANCHESTER SCHOOL OF ARCHITECTURE

Manchester Metropolitan University

CPU

# Workshop 18/10/2018

# Autonomy, Paris

Job Title: ……………………………..

Name of Organisation: ……………………………..

## Please rank the following concerns on the implementation of Autonomous Vehicles on public roads

Please, rank from 1 -10 with 1 being the highest

- Travel Time ☐
- Personal Data / Privacy Policy ☐
- Travel Flow ☐
- Road Safety / Public Policy ☐
- Vehicle Safety Standards ☐
- Ethics / Decision Making for AV ☐
- Market uptake of Technology ☐
- Changing Transportation System ☐
- Energy Use ☐
- Infrastructure Improvements ☐

Any Additional Concerns: ……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………