h e g

Haute école de gestion
Genève

The effects of self-driving vehicles on the insurance industry

Bachelor Project submitted for the degree of

Bachelor of Science HES in International Business Management

by

Jérémy Karim VOITCHOVSKY

Bachelor Project Advisor:

Christophe COURBAGE, Professor at the Haute école de gestion de Genève

Geneva, June 3rd 2019

Haute école de gestion de Genève (HEG-GE)

International Business Management

Hes·so GENÈVE
Haute Ecole Spécialisée
de Suisse occidentale

Declaration

This Bachelor Project is submitted as part of the final examination requirements of the Haute école de gestion de Genève, for the Bachelor of Science HES-SO in International Business Management.

The student accepts the terms of the confidentiality agreement if one has been signed. The use of any conclusions or recommendations made in the Bachelor Project, with no prejudice to their value, engages neither the responsibility of the author, nor the adviser to the Bachelor Project, nor the jury members nor the HEG.

“I attest that I have personally authored this work without using any sources other than those cited in the bibliography. Furthermore, I have sent the final version of this document for analysis by the plagiarism detection software stipulated by the school and by my adviser”.

Geneva, the 3rd June of 2019

Jérémy Karim VOITCHOVSKY

Acknowledgements

I would like to thank all the persons, who contributed to this project by sharing their expertise and their opinions.

Firstly, I would like to express my gratitude to my advisor, Mr Christophe Courbage, for his information, his precious comments, his availability and for his moral supports.

Secondly, I would like to thank Mr Alexandre Nurock, who took an entire morning to answer many of my questions related to the insurance industry and its potential evolution. Moreover, I wish to express my appreciation to Mr Josué Voitchovsky and Mr Salman Farmanfarmaian, who kindly gave me the time to discuss this particular subject.

Finally, I wish to thank Mr Matile, Mr François Mutter, Mr Jürg Michel and Mr Olivier Raemy, who kindly took some of their time to answer my very specific questions.

Executive Summary

In a not too distant future, autonomous vehicles might be part of our life, offering us a new type of mobility with promising benefits. Nevertheless, they are also expected to disrupt our environment in all kind of manners and potentially threaten sectors related to transports and mobility. The main objective of this thesis was to understand and find out the different effects that those could have on the Swiss auto-insurance industry. Indeed, so far, many opinions related to the problematic were expressed, however very few were directly considering the Swiss environment with its different infrastructures, stakeholders and mentalities. Therefore, we wanted to understand how those vehicles still in development, would impact the Swiss insurance organisations, their internal activities and their products. We wanted to understand the general dynamism going behind their development and try to point out how the different stages of their evolutions would impact the operations of insurance companies.

This project revealed that because of the none-existence of adapted regulations, current self-driving systems were in fact considered as driving assistances to comply with the existing regulations as well as the Vienna Convention. As a consequence, the drivers are similarly liable and still required to subscribe a civil liability insurance policy. Findings were also reflecting the idea that until performances reach a certain level of reliability, regulations would not evolve and neither insurance products. It would only be at the time the legal framework is clearly established that insurance institutions would react. Depending on those evolutions, a new era of auto insurance services could arise. Indeed, insurance organisations might be evolving in a different environment, where mobility on demand would become prospering and corporations obliged to ensure their own vehicles, while the overall quantity of those might be significantly reduced. As a result, insurance institutions might have to deal with a different clientele, made of large corporations with strong bargaining power and a decreased quantity of individuals. Besides, autonomous vehicles will also implicate an evolution of the risks involved. Indeed, the risks related to driving could become irrelevant, while the ones emerging from cyber aspects could become particularly important.

In response to those different vehicles, those emerging risks and those different customers, insurance companies might have to reassess their know-how, the way they operate and potentially expand their areas of expertise, while developing new sets of skills allowing them to design innovative products meeting the needs of a different environment.

Contents

List of Figures

1. Introduction

1.1 Problem statement

Wherever we go, we find cars parked or driving around. It has become the ultimate way in our society to move individuals and goods. For some, “driving” became a professional activity, for others, a way to reach farther locations, giving access to life and professional opportunities. Switzerland, with well-developed road infrastructures and millions of vehicles [OFS 2018] represents an interesting market for automobile insurance companies.

But what would happen if we didn’t need to drive anymore? Autonomous vehicles (AVs) are now becoming a reality, the industry has announced their appearance in the following decade. And with it, a drastic decrease of car-accidents, deaths and injuries [H. Samuelsson 2018]. Additionally, mobility trends are also evolving, and car-ownership is supposed to decrease considerably over the following years [J. Harris 2017]. But, how will insurance companies respond to the projected drop in cars, accidents and the none-existence of a driver?

1.2 Literature review

In 2017, the FINMA and the OFAP (Office fédéral des assurances privées) published a report on the Swiss auto insurance industry, presenting a market of CHF 5.9 billion shaped by few large companies. A market secured by legal requirements (Loi sur la circulation routière) attesting that every vehicle matriculated should be insured to drive on public roads. (Art. 11 al. 1) (Art.63 al. 1). Moreover, they attest that in case of harms, death or material damages, the owner is legally responsible. (Art. 58 al.1 &4).

As of today, the automobile insurance services consist mainly in reimbursing costs resulting from vehicle accidents and unlucky events. Additionally, every contract is debated with and adapted to the customer and its vehicle(s). Those services include the mandatory civil responsibility that covers the eventual harms caused to others and other features depending on the needs of the client (for instance, casco partielle and casco complète).

The company AM. Best (2018) presented in its book the business model of the insurance industry as well as descriptions of its different stakeholders. They present the different steps of operations, key influences as well as others interesting facts, allowing the reader to understand the industry generally and to depict the value chain.

Additionally, Kevin L. Glaser (2014) presented in his book interesting general insights related to the operations and actors of the insurance sector. The different departments very specific to insurance companies are presented as well as their specific contributions. Moreover, he enables the lectors to understand the dynamic that runs insurance companies.

Lawrence D. Burns and Christopher Shulgan (2018) presented in their book the "upcoming disruptive revolution" that AVs might bring. More precisely, they present many interesting data, and figures related to their development, as well as the main actors, allowing the lector to understand the whole dynamism that goes behind the AVs.

Ernst & Young UK (2017), presented some of the issues that might face the insurance industry, such as a 90% - decrease of car accidents and a significant decrease in private car ownership as AVs sharing will keep growing (users might benefit to services similar to the ones currently provided by Uber, but with no driver behind the wheel.). So, we can ask ourselves: how insurance would evolve? As we said before, the driver is fully responsible in case of accident, but when it is fully autonomous, will we take responsibility for the manufacturer's mistake? There is yet to be proper literature related to potential market opportunities.

Deloitte center for Financial Services (2017), presented some interesting data and guidelines for Insurance Management suggesting that manufacturers themselves, thanks to the huge quantity of data they collected (ex: Waymo and Google map/Waze), could cover their own vehicles, which would be a considerable issue for insurances companies. However, they also suggested that AVs had more chances to be accepted in countries where people haven't developed driving habits, which means that country such as India or China would be more favourable to AVs than Switzerland.

1.3 Research objectives

As of today, insurance companies should already be elaborating potential strategies in response to cars becoming increasingly autonomous. Even though some literature has been published, we do not clearly know how tomorrow's insurance contracts will look like. How will we be covered? Would the manufacturers cover their own cars or contracts would be related to the users of the AV?

Along this thesis, we wish to find out how the Swiss automobile insurance industry might evolve over time with the development and the growth of AV. More precisely, we would try to figure out how these aspects might impact their current activities as well as their products. We would like to know, whether the current products would still be adequate and profitable. Finally, we would like to presume what type of product would be viable in the future by considering technological facts and the diverse environment influences.

1.4 The structure of the thesis

This project will be divided in different parts. First of all we are going to generally assess and present the insurance industry. We will introduce the business model as well as different aspects of the Swiss auto-insurance market.

Secondly, we will present the technology of autonomous vehicles. We will tackle the reasons of its development and why it might be interesting to consider its appearance. We will then present the current state of this technology and expose different angles of the Swiss macroenvironment that might impact their evolution. Last but not least, based on those studies, we will establish potential scenarios of evolutions.

The third part of this project will be firstly to identify the main issues and uncertainties brought by autonomous vehicles for the insurance companies. We will then elaborate hypothesis based on our researches and interviews, in the context of the scenarios of evolution established.

Finally, we will summarise and comment those findings and attempt to make recommendations, while maybe bring to light interesting thoughts deserving to be discussed.

2. Background

In order to fully understand the problematic and the different aspects related, it is essential to firstly analyse and present the two most concerned industries: the automobile insurance industry and the autonomous vehicles.

2.1 The auto insurance industry

To begin with, it is necessary to present the concept of insurance. There are many different definitions, however this following quote of best's guide to understanding the insurance industry, summarizes the concept very well.

> "*Insurance protects against the financial risks that are present at all stages of people's lives and businesses. Insurers protect against loss – of a car, a house, even a life – and pay the policy holder or designee a benefit in the event of that loss. Those who suffer the loss present a claim and request payment under the insurance coverage terms, which are outlined in a policy*." (p.03)

2.1.1 The business model

How does the insurance industry work? In a few words, insurance involves transferring the risks from one party to another in exchange for regular payments called a premium. To be more precise, one party accepts to cover the potential losses of the other, as long as they are part of the agreement and premiums are paid. [Courbage 2019]

To do so, insurance companies rely mainly on two concepts: risk pooling and the law of large numbers [A.M Best 2018]. The idea behind risk pooling, is that the insurer accumulates the premiums from its group of insured parties and uses part of the accumulated fund to compensate individual losses when these occur.

The law of large numbers implies that the statistical precision of the probable losses suffered by the insured group is improved as its size increases, assuming that each of the insured parties is subject to similar risks [Courbage 2019].

Based on that, insurance companies sell to individuals, a wide range of insurance policies covering different specific events. Events having a certain likelihood of occurring, which evolve with the profile of customers. Needless to say, that those companies heavily rely on data and statistics, that are essential to assess risks, to calculate probabilities and so, to create marketable insurance products.

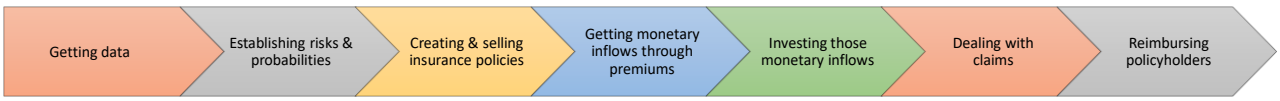
However, referring to our brief explanation of risks pooling, insurance companies actually maximize the use of this concept. By that, we mean that those are not only providing one type of contracts but diversifying themselves in all kind of ways and all kind of risks. Generally, the companies sell a wide array of products that can be organised in two categories: “Non-life insurance” (Property/Casualty) and “Life insurance”. Those are the main items of the insurance industry, even though we can find insurances for a wide range of situations.

Because of such activities, insurance companies are able to cumulate significant financial assets, which are of course used profitably. Indeed, those institutions produce most of their revenues by investing the accumulated premiums over different time perspectives (depending on the type insurance policy) with the aim of optimizing profits and dealing with claims of clients. Such activities explain why insurance companies are some of the biggest asset managers in our economy [Wikipedia 2019].

2.1.2 The value chain

If we would grossly illustrate the value chain of insurance companies, it would look as follows:

Figure 1 – The value chain of insurance organisations



Before presenting it, it is important to mention that insurance companies are complex and have many different activities and stakeholders. Therefore, the value chain that we will be presenting and describing will be summarised strictly to have the big picture in mind.

Getting data – the most precious input that insurances require are accurate and updated data, which are generally computed over the years and provided by the collaboration of reinsurance companies.

Assessing risks – as soon as the insuring company owns a sufficient set of data, they will be able to process them in order to assess risks, probabilities and financial exposure to certain types of events.

Creating and selling insurance policies – this step of the value-chain incorporates most of the departments of an insurance company, which all bring specific added-value enabling the company to sell adapted and profitable products. We could begin with, the **underwriting** and the **actuary** departments, who's roles are to analyse and compile the statistics used to create the products and to assess their accuracy over the time. They identify risk categories, the acceptable financial exposures and the adequate pricing. In a certain way, they establish the statistical bases used to develop the insurance products.

These two departments collaborate closely with the influential **marketing** department, which continuously analyses the environment, the competition and the general products of the market, allowing them to manage the distribution channels (policies are generally sold through three channels: independent agencies that sell products from different companies, "captive agents" that are paid for selling exclusively the products of one company, and official agencies), to provide internal and external marketing efforts as well as suggesting the creation of new products. A task that would be then handled by the **product development** departments as well as the **legal** and the **policy services** ones. Those ensure diverse legal aspects related as well as all the administrative works required to produce insurance policies.

It is interesting to mention that all those tasks require solid IT systems, which are in a way the backbone of the value chain, enabling its actors to fully collaborate and share their contributions with one another. Therefore, the role of the **IT** department is crucial. Furthermore, there are support departments such as **high management** that decide the strategic direction of the company or the **audit** department that evaluates the accuracy of policies as well as the efficiency of the internal activities. Last but not least, insurance companies in a similar manner, subscribe insurance policies as well. Of course, they are very specific and much more expensive.

Getting premiums – once the insurance policies have been sold, the insurance company will punctually receive premiums paid by the policyholders. Those will accumulate and represent a certain amount of capital that will cover all future claims of clients and be invested profitably.

Investing capitals – Indeed, investing those capitals in various asset classes are key activities of insurance organisations and a major source of their revenues. Nevertheless, those activities are very regulated to ensure that institutions fulfil their commitments in any situation.

Dealing with claims – of course, the insurance company will receive claims from policyholders that will be carefully examined by different departments depending on the situation. The first being the **claim** departments, whose roles are to decide if the events that occurred are covered by the policies and so require financial compensations. Depending on whether those are covered or not, claim adjusters would establish the adapted amounts to be paid to the policyholders. It is interesting to mention that the claim adjusters are not always part of the insurance company and can be external or independent. The second department concerned is the **legal** one, in addition to its expertise related to the creation of products, it also decides cases that should be fought and dealt with in court. Lastly, there is the **subrogation** department, which is in charge of getting money from people having debts towards the company.

Reimbursing policyholders – The last part of the value chain is the payment of the claims towards the policyholders. It is important to mention that the data related would then be implemented to the statistics as well as added to the profile of the client, what may increase its tariffs.

2.1.3 The SWOT analysis of the value chain

This model is certainly not perfect and in order to better identify consequences of AVs on it, we will present the different strengths, weaknesses, opportunities and threats related.

Strengths

One of the most significant strengths of insurance companies is their core ability to manage risk and financial exposure. Indeed, they are experts in pooling risks, analysing data and producing statistics that allow to produce and sell profitable insurance policies. Moreover, they increase their profitability by diversifying and providing coverage for a wide range of events and environments.

Insurance companies have also access to considerable resources. Firstly, they are usually multinational companies managing enormous amounts of financial assets and thus having solid financial means. Additionally, these economic empires own a wide range of precious know-how allowing them to adapt and to overcome most of situations.

Another strength of the insurance industry is the environment in which they are operating. Indeed, these companies are evolving in relatively stable and traditional markets, where products don't radically evolve over the years and where demand is constant and somewhat secured by the lobbies present in the political sphere.

Additionally, another asset is the strong relationship they usually build with their clients. Most of the time, customers have a well-known agent that advices, sells and responds to their requests. Besides, we could also say that the specific mentality and situation of our society largely satisfies the interests of insurance organisations.

Weaknesses

Even though, insurance companies have a well-oiled business model, it does have weak points. The first one being their heavy dependency on data, directly related to their activities and generally provided by the reinsurance partners. Without it, they couldn't proceed to any risk and statistics analysis, and so neither produce nor sell insurance policies. Such dependency can be a serious issue as many innovative activities are emerging and data is not always available. Additionally, insurance companies are critically dependent on the data providers and the accuracy of the data base.

As in many markets, there are affecting factors that insurance institutions cannot always influence. The first being the legal basis that regulate their operations; a slight change could result in serious externalities. Besides, those organisations are some of the first concerned by climatic hazards, even though those are included in their calculations, because of climate change, environmental disasters are more frequent and still have dramatic impacts. Similarly, as insurance companies are financial institutions, they are also sensitive to the evolutions of the stock-market and financial crises. As an example, we could mention the results of the sub-primes crisis on the insurance industry.

Another key element to consider is the market itself and the type of products being sold. Despite a relatively high competition, there is very little differentiation between products, therefore they require a significant engagement with customers during all steps of the lifecycle. Because those products might seem complex and represent serious investments, very often the clients prefer having a personal intermediary that would inform, advise and sell them a specific policy. Consequently, solid customers relationship skills and systems are required, and many resources might be spent to close a deal.

Unfortunately, another weakness is the biased relationships resulting from this model. Indeed, insurance companies and their representatives sell coverages that are supposed to be in the clients 'interests, and because of the strong relationships that those organisations maintain, clients very often consider the agents as their personal partners being somehow in their favour. However, the reality is quite different, people tend to forget that those organisations exist to make profits.

Consequently, they sell products, which are in their own interests and remunerate their agents depending on different criteria such as the quantity of products sold and the level of profitability of those. A reality that often does not match the one of their clients as well as their expectations.

Opportunities

Nowadays, our environment is evolving so fast, projects emerge, and others die. Despite an environment always more unstable, there are still opportunities that might be interesting for insurance institutions. The first one being the internet, even though it appeared decades ago, e-businesses have boomed recently. Insurance companies might want to integrate it even more and optimize their activities by, for instance, selling some of their policies online without insurance agents. Moreover, the internet brought the era of “big-data”, where data is collected online, which could represent an advantage for such organisations relying on information. Furthermore, we have seen those playing an important role in the general prevention of risks. Insurance companies have launched many sensitization campaigns in order to prevent hazards, campaigns that could be even more impactful with the effective use of internet opportunities. Last but not least, as said before our world has never been evolving so fast, everyday technology-levels increase and with it, the business possibilities. By considering the resources owned by insurance organisations they are fully capable of taking advantage of those opportunities.

Threats

Even though this fast-changing environment represents opportunities, it also involves serious threats. There are many areas where technology is so disruptive that insurance companies do not own sufficient data to efficiently propose insurance policies (as it would be partly the case for autonomous vehicle’s technology). In the same manner, our environment is always more automated, some expect that almost 50% of the job market will be automated in the future [C. Benedikt Frey & Michael A. Osborne 2013]. So, it is interesting to assess just how threatening these changes can be. Lastly, another threat for insurance companies would be the appearance of competitors bringing down prices. An event that can potentially happen due to the low differentiation and the high competition of the market.

2.1.4 The Swiss market

Now that we have the general functioning of insurance companies in mind, let's shift our focus on the Swiss environment. The Swiss auto insurance market is a place where dozens of insurance companies are operating, those are either stock-market companies or mutual ones. However, the market is mainly shaped by seven influential companies: *AXA, Zurich, La Mobilière, Allianz, Helvetia, Basler, and Generalli*. These main players, often being part of multinational organisations, have their hands on 99% of the market and collected by 2017, a total amount of premiums reaching CHF 5'998'777'610. Even though those numbers are high, it is interesting to mention that they did not stop increasing since 2009 [ASA 2019]. As highlighted by the total of premiums, the value of this market is considerable, but it is also segmented in different categories. We can find insurance coverages for different vehicles with different utilities such as heavy goods vehicles or cars of tourism. In our case, the vehicles of tourism amounted to more than 4.6 million of matriculated vehicles in 2018 [OFS 2019]. The products sold by insurance companies on the Swiss markets are relatively similar and commonly provided by companies. We could arrange them in four categories of conditional coverages that slightly evolve depending on the emitting company, the vehicles and the drivers. However, even if most of them are commonly provided, some features and specialities might be specific to companies.

The RC insurance

The most common one is called the "responsabilité civile" (RC), this insurance "liability "policy has the specificity to be a requirement for matriculating any vehicle. Indeed, this condition is part of the set of laws structuring the road infrastructures [LCR Art. 11 al. 1/ Art.63 al. 1], which has as an objective to ensure that in the case of an accident the resulting financial costs will be effectively covered, and the victims compensated [Assurance-info.ch, 2018].

The partial CASCO

This second type of insurance policy is called the "CASCO partielle", it is sold to ensure the coverage of a vehicle to a certain extent. This insurance product is supposed to ensure the policyholder, in a situation where his or her vehicle is damaged by external forces. Even though the policies vary depending on the insurance company, it generally covers damages resulting from theft, vandalism or natural catastrophes.

The collision/complete CASCO

This type of insurance product is another extension of coverage, which has the particularity to cover the damages of the vehicle resulting from the own action(s) of the policyholders. This includes for instance, parking incidents or loss of control.

The additional insurance products

Lastly, this fourth category has the specificity to be totally shaped by the consumer. The previous categories were a sort of general coverage packages. This last category combines additional features specifically requested by the consumer. For example, we can find different specifics covering the financial costs of passengers caused by an accident, damages that have occurred in parking, coverage for specific items in/of the vehicle, local and international assistance, guarantee of full coverage in case of serious offense of the law, or even stable premium prices despite the accident. In conclusion, this category represents precise coverage requests that may not interest everyone.

The pricing

But how is the pricing done? For a better understanding of our problematic, it is important to mention how the premiums are calculated. As mentioned before, the prices of premiums are based on the information and statistics that have been analysed and computed over time, as well as the products requested. The insurance agents then gather all kind of information to clearly identified the profile of the customers and the risks exposures related, based on those, they will submit price-offers. All kind of information are asked such as the drivers experience, previous events such as accidents, the vehicles driven, the place they live, the main drivers, their age, etc. However, there are other factors that influence prices. Some companies might be more specialised in some types of coverage and thus provide different prices. Additionally, the policy sellers can also impact their prices depending on what the insurance company expects from its distribution.

With that general introduction, we can now understand different aspects of this major economical actor, which is the insurance industry. An industry that accounts for the most sensible and attentive organisations. Indeed, even with solid business models and well-established markets, these institutions remain very sensitive to their environment and thus are continuously studying and assessing their “ecosystem”. What brings us on the following part of this project, a technology which is at the present time, a serious concern for insurance companies.

2.2 The Autonomous vehicles

One of the first thing that comes to our mind when we think about autonomous vehicles is “scepticism”. Some believe that it is a technology that would never appear, as others are inclined to think that it would take decades before we might actually see self-driving vehicles on public roads.

The first thing we should define is the term “AV”, which refers to a vehicle having the ability, to locate itself, to analyse and cope with its surrounding environment, while transiting safely to an established destination without any human intervention.

Creating those vehicles is a colossal engineering challenge, where scientists and engineers need to think about numerous questions such as how to operate among human drivers and other AVs, how to deal with a continuously changing environment, how to create a decision-making system or even how to set up a “fail-safe mechanism” that allows the passengers to stay safe in case of system-failures.

There are many different opinions about this topic. On one hand, we can read articles and reports claiming that before being able to provide fully autonomous driving vehicles, engineers must overcome a considerable amount of issues. And on the other hand, we can hear companies making revolutionary-promises, where we would not need to drive anymore and could get off the car at our destination without even caring about parking.

At the present time, more than fifty companies are working and developing AVs. Among them, some are cars manufacturers, giants of the tech industry or even start-ups. But to understand a bit more the dynamism that goes behind the development of these vehicles and the assumptions we will base this thesis on, we should focus on the current issues that the automobile industry is facing and what could eventually be solved by the proliferation of such a technology.

2.2.1 The societal issues encouraging the AV’s development

Nowadays, human society is confronted to significant changes and social issues. Earth’s population is becoming larger, countries’ economies are emerging and with it, their increasing need for resources. As the economies grow, individuals enjoy a rising purchasing power, giving them access to new services and goods as well as mobility and cars. However, even though some governments are trying to discourage their use, vehicles have considerable implications.

The first one being the pollution. Indeed, the CO2 emitted by road vehicles amounted in 2016 to 18.5% of the total world CO2 emissions [IEA 2018]. A serious externality damaging public health and causing thousands of deaths annually [WHO 2019] in addition to global warming. This negative externality is amplified by traffic congestion, a phenomenon caused by the increase of urban concentration, which also impacts our economy. INRIX, a company founded in 2005 specialised in managing traffic through data collection and analyses, estimated that Boston drivers were respectively spending 164 hours annually in traffic congestion, which represented a financial loss of USD 2'291 per individual and amounted to an estimated national loss of USD 87 billion for the American society. Despite those huge numbers, Switzerland is also concerned as drivers of Zurich and Geneva, were respectively wasting 156 and 142 hours per year [INRIX 2019]. If we would extrapolate and assume that those hours could be used for professional activities in Geneva, it would represent a theoretical loss of CHF 567'449'265 for the local economy. (By simply taking the median hour-salary (CHF 40.6 [OFS 2018]), the quantity of regular commuting (98'427 commuting drivers [OFS/Hussain 2018] and the time wasted.

Beside that significant loss, we might also consider the use of resources required to store our vehicles, as we not only sacrifice a part of our revenues but also a considerable amount of our lands (64 km2 in 2009, [OFS 2009]). The Swiss monthly median costs of parking in the workplace was estimated to CHF 60 [OFS 2010], while a monthly rent for a unique spot in Zurich was oscillating between CHF 80 and CHF 170 [Habitat à stationement réduit 2010]. Due to these numbers, we understand the necessity of reassessing how we visualize cars. Over the past century, cars have been representing freedom and social status and used not only to travel or commute, but also as a required condition to integrate the active society.

As Lawrence D. Burns presented in his book "Autonomy", despite cars becoming a concentrate of technology drastically impacting our day to day lives, their main concept remains unchanged: – four wheels, gas-fuelled, a windshield protecting passengers and 4 doors. The same components than the Ford T, which appeared more than a hundred years ago.

Additionally, the same author presented the idea that vehicles were incredibly inefficient, because of their energic efficiency, their weight, the quantity of their occupant(s) and their actual usage (said to be unused 95% of their time.) Indeed, the best engines used for automobile are reaching an efficiency rate of 36% for gasoline and 42% for diesel [Wikipedia 2019].

By that, we mean the mechanical power perceived by the fuel explosions happening inside the engine, all the rest is wasted in heat, sound or used to power accessories of the car. So if we think about the weight of a vehicle varying from 900 kg for a Smart [Smart, 2019] to 2000 kg for a Volvo SUV [Volvo 2019], with an average occupancy varying from ~1.45 person in Europe [European Environment Agency 2005] and 1.67 person in the U.S [Office of E.E & RE 2018], the quantity of fuel used to move the passenger itself is ludicrous. Beside those points, road users are also exposed to health risks, (annually 1.35 million people are killed in road accidents [WTO 2018]) and legal liabilities that considerably affect the life of the individuals are involved, as we've seen the severity of some laws such as VIA SICURA in Switzerland.

Because of the issues of our time, our mobility model (based essentially on habits and social culture) should be totally reshaped as it is totally inefficient and involves environmental pollution, health risks, financial costs and a considerable waste of our resources. The development of the AVs in addition to be a disruptive technology, gives us the opportunity to rethink our mobility and thus to transform the "culture of the car" of the last decades.

2.2.2 How AVs could solve some of our issues

AVs are likely to bring many strong improvements, the most obvious benefit would be the reduction of the opportunity cost of driving. Indeed, the main advantage of that technology is that the driver would not have to be attentive to the road nor need to be in continuous control of the vehicle. And so, the driver would have the possibility to dedicate his time to other tasks that might bring value to his life.

Secondly, self-driving technology could bring radical changes to our mobility model. We could eventually experience the expansion of car-sharing companies having fleets of AVs operating -24/7 [BCG 2018] and therefore, strongly reduces the overall cost per kilometre [Patrick M. Bosch, Felix Becker, Henrik Becker, Kay W. Axhausen 2018], while providing to everyone, including the elderly or disabled individuals, the access to mobility. In addition, it could stimulate the development of different concepts, a car that would be more energy efficient and specially adapted to its operating-environment [Lawrence D. Burns 2018].

Furthermore, such mobility models would lead to higher degrees of use of the vehicles and thus drastically decrease their quantity on the roads (it is estimated that 15% of the current vehicles fleet would be enough to provide shuttles to the population [Lawrence D. Burns 2018]). Besides, it could also allow us to use differently the resources that were usually dedicated to vehicles such as land, energy, finances, etc.

Finally, AVs would provide safer journeys. Nowadays engineers are developing AVs able to drive on open public roads thanks to efficient tools such as radars, sensors, cameras, A.I, highly-detailed mapping and other technologies allowing them to scan the entire surrounding environment to a distance of up to 250m and so to predict the actions of road users [Waymo 2018]. Of course, the designs of system vary depending on companies, however they all share a common vision: to produce a “chauffeur” that is sharp and never distracted, providing the safest driving experience to this date.

2.2.3 Why we should consider their development

In addition of those potential benefits, our society is also experiencing changes that may help to set the scene for self-driving vehicles. First of all, the mentality of people is evolving thanks to social, technological and political changes. For past generations, having a driving license and owning a car was considered a necessary life-achievement, giving access to freedom and autonomy. Nowadays, this is still the case, but people develop different opinions, especially Millennials, who grew up with global warming awareness measures, the development of transport alternatives and technologies such as computers and smartphones. On top of that, the evolvement of tendencies such as studying longer, leaving the parental home later in life as well as a higher interest for urban areas are also an influencing factor [Police 2019].

Furthermore, the appearance of smartphones completely changed our lives. They gave us a constant access to the internet improving the experience of public transports’ users and opening doors for alternatives solutions such as car sharing or Uber (whose operating model might be applied to AVs and which, somehow offers a “smooth transition” to the autonomous vehicle.) Along with smartphones came some strong technological improvements that would ease AV’s appearance. For instance, mapping or the street view used regularly by millions of users might be used by AVs to locate themselves and improve their environment analyses. Furthermore, artificial intelligence is also playing an essential role as it is used to compute and analyse thousands of data entries to shape the safest driving system known to date [Lawrence D. Burns 2018].

Another factor that might impact the future of AV would be the development of the 5G. This last generation of cellular communication would provide a high data rate, reduce latency and provide massive device connectivity [Wikipedia 2019]. Beyond those features, it would give AVs the possibility to share data much faster, while allowing them to emit and collect essential environmental information [Bijan Khosravi 2018].

Last but not least, changes in local politics show evolutions of mentality as we notice the rising empowerment of “green” parties and a tendency to favour environmental laws [Votation cantonale GE 2016– Loi pour une mobilité cohérente et équilibrée], resulting in the willingness to discourage and reduce the access to cars, while developing an eco-friendly mobility. Besides those societal evolutions, the market of autonomous vehicle represents a significant business opportunity that was estimated at USD 4 trillion by Lawrence D. Burns, which justifies the billions that have been invested in the development of such technologies. For all those reasons, it would so far not be senseless to predict their appearance and to consider the repercussions they might bring on the related industries.

2.2.4 The AVs’ technology in 2019

This engineering challenge started 15 years ago with the 2004 DARPA challenge, organised to stimulate the development of self-driving technologies for military use. Since then, many things have changed as the technology evolved and achievements were realised. To briefly introduce the technology, there as six levels of autonomy (going from zero to five [figure 2].) The level 0 consisting in absolutely no autonomation and requiring the human driver to undertake all the driving, while, the level 5 is fully autonomous, as the system manages all aspects of dynamic driving under all conditions.

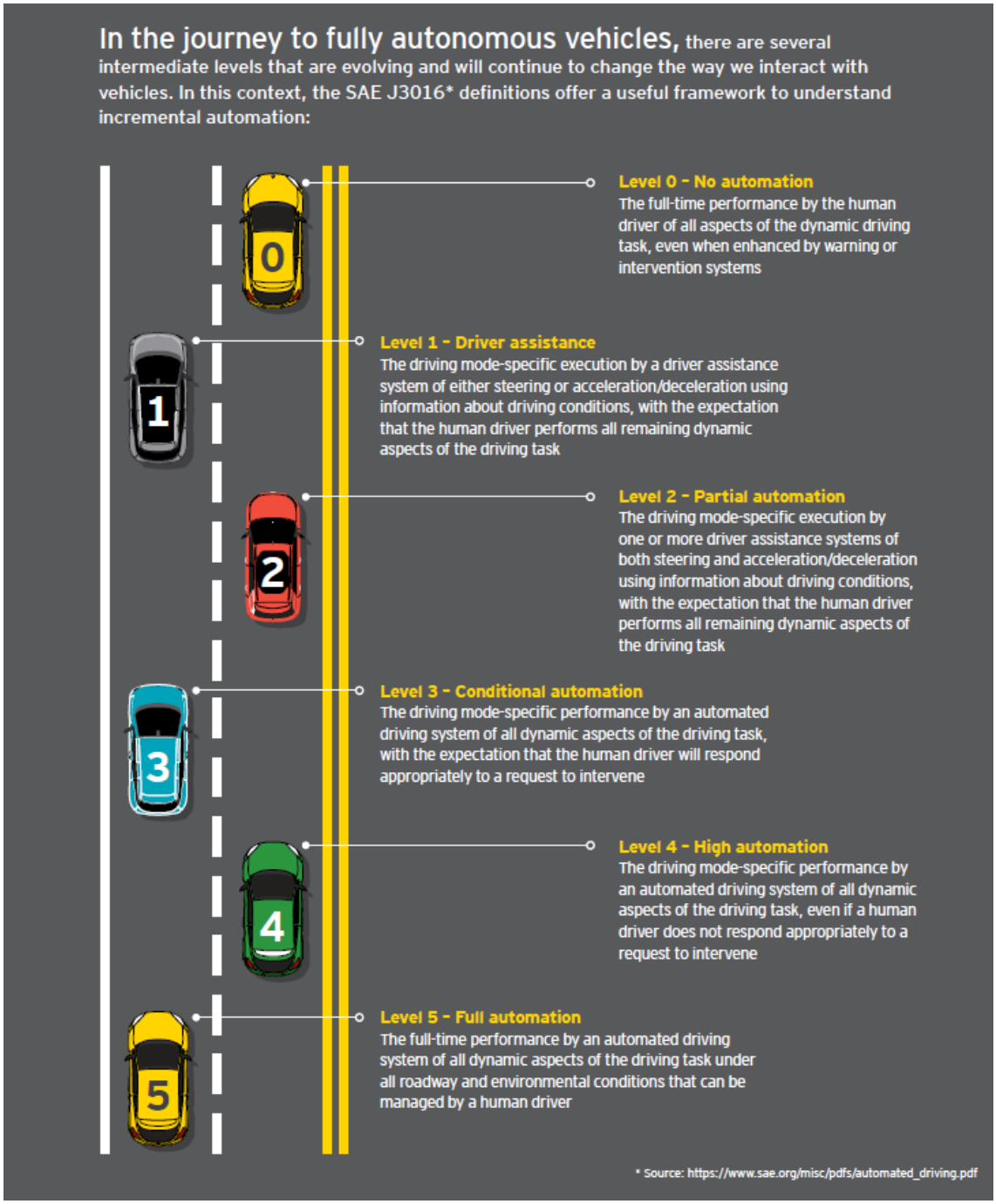
As of today, many companies are working on AVs, but only 20 of them are competitive players investing massively in development. These are mainly automakers, high-tech companies such as Google or Microsoft or partnerships [ReportLinker 2018]. Additionally, as just mentioned, it is interesting to consider that car manufacturers are not always the direct developers of self-driving systems, sometimes those are collaborating with independent high-tech companies, which are in fact the real designers of the self-driving systems that are then adapted on traditional vehicles, as it is the case with Volvo and Uber [Newcomb 2017], or Waymo and the group Fiat-Chrysler Automobiles [Market mad house 2017]. As a consequence, we could see the car market evolve in the same direction than the ones of computers or smartphones, where manufacturers are licensing the operating systems of their devices.

Nowadays, the most advanced “tourism” cars of the market (for instance, the Tesla model S) are only reaching the level 3, meaning that the automated system can drive but expects the driver to respond in case of requests. Even though the analysts expect the technology to reach the level four by 2022 [Mckinsey 2017], the general evolution is going much quicker and already causes polemics because of their involvement in crashes and deadly accidents (what could be affiliated to wrong and risky corporate strategy.) Despite those unfortunate events, companies still obtain authorisations for testing on public roads [Conger 2018]. In California by October 2018, 60 companies were testing nearly 300 autonomous vehicles, some being fully autonomous and not having any steering wheels nor foot pedals [Andrew J. Hawkins 2018].

In 2018, the company Waymo started to test fully self-driving vehicles (level 5) and agreed to increase its fleet with 20’000 supplementary AVs [Waymo 2019], in addition of the existing project involving the purchase and testing of 62’000 AVs (level 4) [Boudette 2018]. All that tough and rigorous testing is the reason for the continuous incremental improvements, which at this stage allow to reach an unbelievable performance with a ratio of one driver’s intervention per 14’432 km driven [Lawrence D. Burns 2018]. However, one of the big difficulties remains in introducing that technology in our infrastructures, which is not designed for such vehicles and where we could find unpredictability, irrationality and many uncertainties. Furthermore, if we want to welcome AVs on a large scale, some assume that logically all vehicles should be able to communicate between them at a really high speed, which might only be achieved with the 5G but would remain impossible until the automatic share of data between vehicles, becomes a legal requirements [Bijan Khosravi 2018].

To conclude, we would say that technology is evolving fast, but it is hard to predict when it would be available to the public. However, people and the industry are now understanding its importance as demonstrated through their engagement and their spending. This technology seems to have a bright future, but there are still a lot of influencing factors such as culture, politics and laws which could affect its evolution. Last but not least, this industry is really fragile and can heavily suffer from the actions of others. Moreover, it is important to mention that not all companies share the same approach of engineering and not all of them are reaching the same level of development. Additionally, if we consider that they all have their own strategy and vision of responsibility, the lack of standardization makes the industry even more fragile and vulnerable to actions of others.

Figure 2 – The different levels of autonomy



(Ernst & Young 2017)

2.2.5 The Swiss macroenvironment analysis

There are many factors that may affect the development of such products, in order to create relevant predictions on their development, it is important to analyse the forces that will affect it.

Political

The Swiss political system being a direct democracy, things can go in two opposite directions: politics and the public can either promote or reject AV's development. From a political point of view, it does not really go against the identity of any party. However, some can be more conservative and frightened by their impact or just not believing in them, which could result in a negative campaign. Furthermore, what might really affect the industry, could be associations such as Touring Club Suisse with 1.5 million of members [TCS 2019] or the lobby of insurance companies that would see AVs as a serious threat to their profitability and might try to slow them down. Thus, we would say that politics are likely to be an influential factor that may limit the expansion of the AV industry. However, as of today the Swiss confederation explicitly demonstrates its interest for the AV's technology, as the federal council has already allowed different pilot-projects and mandated the OFROU to study and assess the different strategies to welcome them in the following decade, while keeping tracks on international levels [OFROU 2018]. Additionally, some politicians are already putting some pressure to stimulate their development by adapting the current laws. By December 2017, a "motion" was submitted and adopted by the national council in order to limit the legal obstacles of AVs and allowing insurance organisations to confront manufacturers' liability in case of unfortunate events [Le Parlement Suisse 2017].

Environment

The Swiss geography is diverse, we can find mountains, plains and different weather conditions. Most of the population is living in the "plateau" where we can find the bigger cities. In our situation, AVs could operate in those, but would remain hardly adapted and unsuitable for delicate road-conditions typical from certain parts of our territory[1]. Besides, the real issue would be our road-infrastructures, which might need to be adapted to the potential evolutions of such technology. (For instance, would it be necessary to create roads only for AVs so they can drive safely?)

[1] Interview with Mr Josué Voitchovsky - Qualified engineer from EPFL, Geneva, 3rd April 2019

To welcome such disruptive vehicles, our infrastructure and environment would have to be adapted to a certain extent, which could compromise their spreading.

Technological

On technological aspects, Switzerland is more or less in line with other developed countries and might have the technology level required to welcome AVs and car-sharing businesses. As 92% of the adult population owns a Smartphone [Deloitte 2018] and 85.7 % of the population older than 14 years use regularly internet [OFS 2018]. Moreover, virtual maps are regularly updated and available on systems such Google, Apple and others.

However, as said before the continuous sharing of data between vehicles (autonomous or not) is likely to be a critical factor, which can be achieved only with the 5G guaranteeing a lower latency in the transfer of data [Edwards 2019]. However, there are some polemics regarding the negative health-impacts and its access is not yet entirely certain (a Swiss petition against it reached 50'000 signatures). Moreover, if we expect a fleet of AVs owned by a car-sharing company, it would mean an IT server compiling the geographical information of the AVs and the consumers, which might cause confidentiality issues.

Lastly, another critical factor might be the safety of such systems against hacking, which would result in losing the control of the vehicles or data of consumers. Indeed, we live in an environment where organisations are very often the subject of cyber-attacks and in our case, unless AV companies can guaranty a solid IT protection, their future is compromised.

Social

The culture of driving in Switzerland is strong as it became a common habit more than 50 years ago. Even though mentality is changing, many people appreciate driving and might not trust this new technology and so oppose its evolution. It is important to note that the general population of Switzerland is aging as 51.9 % of the population is between 40 years old and older [OFS 2018]. Consequently, AV could be a solution for the increasing quantity of people unable to drive or reluctant to use public transports, even though some might be afraid to use them. Furthermore, an interesting factor to consider is that generally people tend to resist change. Our case being so disruptive, it might need a certain time to be accepted and trusted. Lastly, this technology is very likely to cause the confidentiality issues we presented before. Even more in a time where people are getting sensitive and concerned with data leaks and privacy.

Economic

The economical angle of AVs is one of the most significant. As presented before, they represent considerable business opportunities, however, they are also very likely to threaten or negatively impacts other related sectors. For instance, it would not only harm the insurance industry, but also the whole car industry, the petrol stations or private drivers such as taxis. Nevertheless, if we focus on individual point of views, the economic situation of Switzerland would certainly allow the development of those modern vehicles, as investors and potential consumers are likely to be found.

Legal

The legal aspects will be key factors and must be considered attentively as they could literally drive or sink the development of AVs in Switzerland. The first thing to (re)mention is that Swiss drivers are subject to LCR (Lois sur la circulation routière), which as of today, do not authorise fully autonomous vehicles on public roads, unless they are part of regulated pilot-tests specially authorised by the federal counsel [LCR art.106 al. 5]. However, “semi-autonomous” vehicles are still accepted on public roads with the condition that the driver remain alert and in control of the system, as he remains as responsible as with a traditional car, a condition that allows Switzerland to stay in line with the Vienna Convention. Additionally, it is important to mention that the LCR still attests that every vehicle must be insured.

Therefore, we could assume that those laws would be, at least for a while, equally applied to AVs and would protect insurance companies to a certain extent until laws evolve or are changed. However, it is still required to adapt or create legal basis to establish safety standards and limits of liability in AVs accidents [OFROU 2019]. Switzerland, not being part of the EU, sets up its own standards and norms, resulting somehow in a certain type of protectionism. The government could easily set up norms limiting the import of AVs, if they consider them more of a risk than an opportunity.

Besides those details, in the last years Swiss citizen have seen a toughening of LCR with the Via Sicura adjustments with heavier sanctions (prison sentences and significant fines in a case of “délits de chauffard” [LCR art. 90]). What could turn into another incentive for some people to opt for AV’s technology.

3. Analysis

3.1 The research methodology

To properly complete this task of research, we will consider different periods related to the AV's evolution, which will define our context of analyses. Depending on those, we will try to point out the potential influences on the Swiss insurance industry.

To do so, we will firstly present the explicit uncertainties related to AVs and insurance companies that we will then treat individually, in the context of those periods. Finally, we will make comments and attempt to establish accurate hypothesis, based on the information we gathered through research and interviews.

3.2 The establishment of the scope of analysis

After having studied the technology and the Swiss environment, we realised that the concepts of cars as we know them, are so present that somehow most of our society's infrastructures are shaped accordingly. In addition, we understood that AVs are strongly related to their environment and considering the disruptive change they might bring, it might have to be greatly modified to accommodate them.

On a factual basis, the technology is likely to be functional and available sooner than we think. But before having fully autonomous vehicles operating on our roads, we would have to change our environment as well as our mentality. To a certain extent, we might not wait for the technology, the technology might have to wait on us. However, before the days of a fully autonomous mobility arrive, we will go through a transition period that will impact the insurance industry as well.

In order to answer the problematic accordingly, we will present and analyse, from the perspectives of an insurance company, two periods involving different scenarios: one period considering the transition phase leading to full autonomy, while the other would cover scenarios based on full autonomy.

Transition period: Autonomous vehicles between level 3 and 5

In this first part, we will approach a not-too-distant future and will focus on the transition period leading to full autonomy. We will project different perspectives in a context of AVs being continuously improved until reaching a level of full autonomy. The vehicles of this period would be automated to a level being between 3 and 5 (figure 2), which would mean that the performances would vary from a technology being able to operate only on specific roads as it is today, to performances reaching practically full autonomy. Nevertheless, systems would be considered as driving assistances and could still be switched-off manually, what would make it theoretically allowed on Swiss public roads. Additionally, the vehicles would still include the usual driver-assistance with emergency breaking, crossing-line alert as well as all kind of cameras and sensors. Finally, as we imagine that those vehicles would transit through on public roads and would be driven by an individual, we assume that it would still require usual insurance coverages.

Period of full autonomy

In view of this second part, we would imagine vehicles marking the end of this period of transition. We will try to assess the consequences of fully autonomous systems (level 5), which would be able to undertake all the aspects of driving and parking, while being able to operate even without any passenger inside. Those AVs would be able to transit on most roads including on highways, urban areas and country roads.

Additionally, we would explore another possibility that may be created by autonomous vehicles. This time, we would not analyse personal vehicles, but a fleet of AVs owned by a car-sharing company providing “mobility on demand”. Indeed, such outcome has always been part of the AVs’ philosophy and was one of the ultimate objectives related to this great engineering challenge. This eventuality would have the main advantage of strongly improving the urban mobility, while maximizing the use of vehicles and resources.

In such situation, we would assume that vehicles would have been designed differently to be totally in line with urban mobility. Consequently, we would imagine that those would be small fully autonomous cars (level 5) having a low weight and being limited to a certain speed as well as to a specific length of journey. Those vehicles would have the specificity to not require any human intervention once the destination is established and would be continuously operating, by providing lifts depending on the customers’ current location.

3.3 Definition and analysis of related uncertainties

3.3.1 Liability

The first issue is to determine who would be legally and financially liable in situations where AV(s) are involved in accidents, and how such situations could be solved. Indeed, as it was presented previously, there is currently no legal basis adapted to autonomous vehicles in Switzerland. Nevertheless, in the context of our scenarios, we believe that such aspect could evolve as follow.

Transition period:

It is important to mention that until now, the systems found in the vehicles were exclusively considered as driving-assistances and so, required the entire driver's attention by requesting a constant contact with the steering wheel[2]. In addition, manufacturers such as Tesla explicitly say that the self-driving systems require human-supervision and that the driver remains responsible for instantaneously retrieving control if needed. This detail would have a significant impact as it would not only allow the vehicles to legally transit on public roads (as it respects the Vienna convention), but it would also require that the driver of the vehicle would remain completely liable in case of unfortunate events.

Based on an interview[3], we assume that until the environment got a certain amount of experience with AVs, there will be no specific regulation established and that current laws would still be applied. Therefore, we are inclined to think that even though performances would be continuously improved, until systems reach a level of full autonomy, those would still have to fall into the category of driving-assistance to legally drive on public roads.

Consequently, we assume that drivers would be as liable as of today and that civil responsibility (RC) products would still be mandatory. For insurance companies, this specific aspect is very important as it would ensure the adequacy of the current products.

[2] RAEMY, Olivier, 2019. *Re: Mémoire de bachelor* [email]. 27th May 2019

[3] Interview with Mr Nurock – Corporate/ private senior customer, Geneva, 1st May 2019

Period of full autonomy:

In a context of full autonomy, liability is source of many questions and debates. However, what is certain, is that the legal frameworks will be very influential factors. We were told that before having fully autonomous vehicles operating, legal bases would be implemented and would enable insurance companies to react and adapt their products, depending on the level of liability carried by the different stakeholders[4].

Nevertheless, an important thing to mention is that some self-driving systems onboarded might have been developed independently, in the same manners than Android or Windows, which are in fact licensed operating systems set up on different devices from different brands [Wikipedia, 2019]. So, we could expect similar situations as some of the developing companies are none other than Microsoft and Google (which owns Waymo and Android.)

For this reason, the liability could be differently devolved to three stakeholders[5]: the owner of the vehicle, the car manufacturer and the developer of the self-driving system.

As of today, only two of them are concerned, the car manufacturers that are liable to a certain extend for the proper functioning of their vehicles, and their final owners for the damages potentially caused by their own vehicles and actions. Nevertheless, in a situation where the self-driving systems are designed by another entity, the latter could assume a certain responsibility as their systems might play a major role.

During this project, we were unable to obtain concrete answers concerning the future level of liability of those three stakeholders. Nevertheless, we suppose that authorities could assign responsibility as following:

- A liability fully assumed by the owners of the vehicles.
- A liability fully assumed by the car manufacturers.
- A liability jointly assumed by the manufacturers and the owners of vehicles.
- A liability jointly assumed by the manufacturers and the developers of the self-driving system.
- A liability jointly assumed by the owners, the car manufacturers and the self-driving system developers.

[4] Interview with Mr Nurock – Corporate/ private senior customer, Geneva, 1st May 2019

[5] Interview with Mr Matile – HEG Lecturer / Attorney at law, Geneva, 9th May 2019

Indeed, we tend to think that all those possibilities could eventually be valid as all those stakeholders have an impact on the vehicle. Our thinking considered that the owners were somehow responsible for the maintenance of their goods, while the manufacturers were supposed to sell through their distribution's channels reliable and safe vehicles.

Finally, in a situation, where a company is licensing products to other partners, they are obliged to provide products with certain requirements, which would be in our case safety. (It is also possible that the car manufacturer remains the main developer of the self-driving system.) It is important to mention that those presented eventualities would only concern the liability insurance products and not the casco products, as we do not believe that the manufacturers would assume damages in case of events caused by external forces. As of today, we don't know exactly what form of obligations those stakeholders could face. Nevertheless, we were confirmed by TPG[6] and CarPostal[7], two organisations involved in projects with the *Navya* shuttles (self-driving shuttles), as well as by the OFROU[8], that insurance liability policies were still relevant and required for those projects and situations. Therefore, we are inclined to think that authorities might still require liability policies in the future, but the question would be who would take charge of it.

From the insurance organisations' perspectives, this detail could be very influential as they might deal with different types of clients having different specificities and needs. Indeed, we could imagine manufacturers and system developers approaching insurance organisations to establish partnerships to ensure themselves, their vehicles and the costs related to accidents.

Such a situation could force insurance organisations to adapt to "Business to Business" activities, by modifying the business model that we have seen earlier in this thesis. More precisely, we could imagine that the value chain might have to evolve in function of a situation, where needs, products, clients and risks would be different. As consequences, it strongly modifies the products and pricings, how they are sold, how risks are assessed and how claims are handled. Naturally, we can also expect that the authorities maintain the same regulations that we follow nowadays, with the same liability-endorsement of the owners, similar but adapted products and the same value chain. This could ensure a certain stability for the Swiss auto insurance industry.

[6] MUTTER, Francois, 2019. *Re: Mémoire de bachelor* [email]. 22th May 2019

[7] MICHEL, Jürg, 2019. *Re: Mémoire de bachelor* [email]. 23th May 2019

[8] RAEMY, Olivier, 2019. *Re: Mémoire de bachelor* [email].27th May 2019

Last but not least, it is essential to mention that those are only hypothesis and that the finality could be totally different.

3.3.2 Risk assessment

The second uncertainty would concern the operating model of insurance companies. As we know, those heavily rely on statistics built over the years, to assess risks and estimate probabilities. With the appearance of autonomous vehicles, insurance institutions could face a situation where they would suffer from a considerable lack of data, threatening their ability to evaluate risks and so, to offer adapted contracts. A risk that could be exacerbated by the continuous updates of AVs and algorithms.

Transition period:

In the context of this transition period leading to full autonomy, insurance companies would have to be particularly cautious about how they assess risks and probabilities. The main uncertainty remains on the self-driving system itself. Indeed, as the technology is relatively new, related data remain limited. A situation which is aggravated by manufacturers and system developers being not always transparent about the limits of their technology and playing somehow on communication (as example, the Tesla's driving assistance called "Autopilot") [Tesla 2019]. Consequently, insurance companies might have to carefully interpret the accessible data and include margin in their calculations as technology would be continuously evolving, and additional risks might be emerging with time.

Nevertheless, they would not face a critical situation, as they could still rely on most of their data for the main reason that the vehicles would still be operating on a known environment with well-known forces. Additionally, because insurance organisations continuously yield information, they already have data on some of the onboard material, as traditional vehicles have been increasingly assisted and share many common points with AVs[9].

Parallelly, we might imagine that covering such vehicles, while having a driver supposedly attentive on the roads, who would react in case of system-failures, could somehow allow (re)insurance companies to gather related data on larger scale, while making profits relatively safely.

[9] Interview with Mr Nurock – Corporate/ private senior customer, Geneva, 1st May 2019

Period of full autonomy:

We are inclined to think that reaching such level of autonomy might take some time. Therefore, we believe that insurance companies would have had the opportunity to sharpen their risk assessment, by financing their own tests and continuously updating their data. Additionally, depending on partnerships, they might have access to key-information allowing them to perform even more effectively.

However, we tend to believe that such vehicles could drastically change the risks assessment activities of insurance organisations. Indeed, we believe that with such technology onboard, insurance institutions might have access to real time data enabling them to assess risks and prices even more effectively. As consequences, we could imagine that premiums would not be calculated depending on the drivers anymore, but on the self-driving system of the vehicle.

Additionally, we are inclined to think that such technology might still involves unknown risks related to cybersecurity. Consequently, we believe that insurance organisations might have to actively adapt their activities to fully consider those, as well as the systemic risks that could threaten self-driving systems. A threat that could become even more critical in a context of “mobility on demand” as one technological deficiency could impact not one individual vehicle, but an entire company and its fleet.

For those reasons, we believe that such vehicles might force insurance organisations to strongly evolve and mainly to expand their expertise on cyber aspects to be able to understand and consider the risks, which might be not only related to driving any longer, but to computer science.

3.3.3 Cybersecurity

As mentioned in the previous paragraphs, another raising question is the vulnerability of autonomous vehicles to cyber risks. An article published by the Blick [Heierli 2019] was already informing about how modern vehicles were exposed to cyber-attacks. Indeed, modern vehicles are complex objects where many components are interconnected or connected to the internet. A fact even more relevant for AVs, which must be continuously in network and so, are very sensitive to hackers. Some research indicate that such vehicles might be the victims of many types of attacks (Figure 3), from targeting components of one vehicle, to targeting fleets of many, resulting in different issues from traffic disturbance to accidents or system failures [J. Petit & S. E. Shladover 2014].

So, the questions thus remain how: exposed those vehicles would be and how could it impact insurance institutions.

Transition period:

This issue remains one of the hardest to determine as it is difficult to make relevant cyber security hypothesis on none-existing vehicles.

Based on different studies and experts' testimonials, traditional and autonomous vehicles could be sensible to hacking attacks, so we could reasonably assume that it would also be the case for the vehicles of this period. However, the question would be: who is liable in case of events resulting from a hacking attack? Logically, the self-driving system developers might assume this responsibility. Until now, manufacturers are responsible for the safety of their vehicles and must comply with specific ISO norms warrantying a certain safety for the users [ISO 2012], as we already heard about large-scale recall actions from manufacturers [TCS 2016]. But in our situation, is there yet any existing standards related to autonomous vehicles? Standards which might quickly be outdated considering how fast computer science evolves. Thus, the question would remain particularly difficult to answer, as precise legal bases and standards need to be written and defined. Nevertheless, if we base ourselves on the existing legal frameworks, manufacturers must ensure the well-functioning of their vehicles and are obliged to react in case of known weaknesses of their vehicles.

Thus, we could assume that such responsibility would devolve to the creators of system. Nevertheless, because of how impactful cyberattacks and cyber-terrorism could be, engineers might develop solid solutions as it could greatly threaten the development of the autonomous vehicles.

Beyond how dramatic those aspects could be, we tend to think that such risks could eventually represent opportunities for insurance organisations, which may consider developing adapted products. However, in such case, they would need to reorganise their internal operations to consider new domain of activities that were so far relatively unusual for auto insurance organisations.

Period of full autonomy:

As mentioned before, it is complex to define the cyber-security of vehicles that have yet not appeared. However, as of today, we are already able to understand how critical this criterion is. We are inclined to think that cyber-protection would be essential as passengers would not intervene in the driving and might not pay attention to the roads. In such context, cyber-attacks altering the system could be dramatic in terms of casualties and reputation. Therefore, we would assume that such detail would be a top-priority for the system-designers and that they would spend important resources to guarantee a certain safety-level against cyber-criminality or cyber-terrorism. Last but not least, we would not omit to mention the idea that because those are significant threats that could critically impact the exposed stakeholders, system designers could subscribe specific insurance policy covering potential consequences.

In a context of “mobility on demand”, cyber-security would be even more critical than in the previous ones, as in a context of public AVs and mobility on demand, many additional risks would be involved. As we have seen previously, the first type of risks would concern the driving ability of the AVs which could suffer from malwares threatening the perfect functioning of the driving systems and so, endanger the passengers [figure 3]. The second issue would concern the control of the AVs. It might sound extreme and bizarre, but experts considered the idea that such vehicles could be hijacked [La voiture autonome 2019]. In a situation, where only one empty vehicle is stolen, the finality wouldn’t be so severe unless the event becomes public. But in case of an entire fleet being hijacked, the consequences would be a dramatic disaster. Indeed, such outcomes could open the doors to new types of cyber-criminality and cyber-terrorism, where people could be kidnapped by their own AVs and fleets could be hijacked for terrorism purposes.

Lastly, if people start commuting with those vehicles, a solid IT structure would be required to guaranty a constant localisation of AVs, the identification and location of the customers, its banking data, the history of its journey and so on. Such needs involve many risks and uncertainties. Those companies would have access to many sensitive data, for which they would have to guarantee a certain protection and confidentiality.

Therefore, we imagine that the general operation could also be altered by a cyber-attack or an IT problem.

To conclude, we could say that those risks may represent some of the undefined risks emerging that auto insurance industry would have to consider as they might shape the insurance needs of tomorrow. Because of the seriousness of those threats and how impactful they could be on “mobility on demand” and AV-manufacturing companies, we are inclined to think that such risks may, in fact, represent opportunities for insurance companies, noticing a rise of needs for adapted cyber insurance policies.

Figure 3 – Attack surfaces in autonomous automated vehicle

Target	Means	Feasibility of the attack	Physical access	Ease of detection by driver	Ease of detection by system	Probability of success	Direct consequence(s)	Hazard created	Mitigation technique
Infrastructure sign	change sign (fake, irrelevant)	low	n/a	high	low	low-medium	false reaction	traffic disturbance	harden infrastructure sign change; map database of sign in-vehicle; driver reporting
	alter (change speed), make it unreadable	high	n/a	high	low	low-medium	false/no reaction	traffic disturbance	harden infrastructure sign change; map database; driver reporting
	remove (e.g. stop sign)	high	n/a	high	low	low-medium	no reaction	traffic disturbance	harden infrastructure sign change; map database; driver reporting
Machine vision	blind (only source of information)	high	no	medium	high	high	degraded mode	driver disturbance	multiple cameras with different angle
	blind (other source of information available)	high	no	medium	high	high	turn off the camera	none	n/a
	fake picture/emergency brake light (only source of information)	low	no	medium	low	medium	false reaction	driver disturbance	other source of data
	fake picture/emergency brake light (other source of information available)	low	no	medium	low	medium	false reaction	driver disturbance	n/a
GPS	spoofing	high	no	low	medium	high	wrong positioning	traffic disturbance or crash hazard	authentication
	jamming	high	no	low	medium to high	high	no accurate positioning information available	need to stop vehicle unless other location info sources available	Anti-Jam GPS techniques, high-quality IMU
In-vehicle devices	inject malware	medium	yes for USB, no for others	low	medium	medium	depends on malware's capability	depends on malware's capability	Separation infotainment/safety buses; Intrusion Detection System/Anti-virus/Firewall
	head unit attack	medium	yes	high*	medium	medium	display unexpected information	driver disturbance	Protection of display of safety status information
Acoustic sensor	interference (electromagnetic, loud sound, inaudible)	medium	no	low to medium	low	low	turn off the sensor	n/a	filter; spectrum analysis
	fake crash sound	high	no	low to medium	low	low	false reaction	traffic disturbance	other source of data (e.g. radar)
	fake ultrasonic reflection	medium	no	low	low	low	false positive or false negative obstacle detection	traffic disturbance or low-speed crash	other source of data (e.g. lidar)
Radar	chaff	medium	no	medium	high	medium	degraded mode	traffic disturbance	filter; other source of data
	smart material (non reflective surface, invisible object)	low	no	medium	low	medium	no detection of surroundings	collision	other source of data
	jamming (saturation with noise)	high	no	low	high	medium	turn off radar/degraded mode	traffic disturbance	filter; other source of data
	ghost vehicle (signal repeater)	high	no	medium*	medium	medium	false detection	traffic disturbance	filter; other source of data
Lidar	jamming	high	no	low	high	medium	turn off lidar/degraded mode	loss of situation awareness by vehicle	filter; other source of data
	smart material (absorbent, reflective)	high	no	medium*	medium	medium	false detection (e.g. fake delineation)	traffic disturbance	filter; other source of data

(SHLADOVER, Steven E. and PETIT, Jonathan, 2014)

3.3.4 Evolution of the market (new competitors)

Another uncertainty brought by AVs concerns directly the evolutions of the market competition. Indeed, insurance organisations could also see the appearance of external competitors that might perceive opportunities, or manufacturers willing to somehow cover their own vehicles. As an example, Waymo (Google) claims having computed with their AVs a vertiginous quantity of kilometres in testing (approximately 16 million of km on real roads and 11 billion in simulation) and if we consider the financial situation of companies such as Google, it wouldn't be senseless to consider the possibility that they cover their own vehicles.

Transition period:

In a context where self-driving systems are considered as driving assistances and the liability remains the drivers' issue, we do not expect any drastic change in competition as the environment and the laws would remain identic to those of today. Indeed, as the insurance market involves low differentiation and intense competition, entrances of new competitors are unlikely. Additionally, because the technology is not completely reliable and that the drivers would still undertake some aspects of the driving, manufacturers are not expected to cover their own vehicles. Nonetheless, because of this lack of data, partnerships are likely to be established, as it is already the case between the Zurich insurance and Tesla [Tesla 2019]. Indeed, both manufacturers and insurance companies would have interest in collaborating.

One might have access to some exclusive data, providing serious advantages over competitors and bringing additional clients, while the other could benefit from premiums adapted to its vehicles and so, stimulating its sales. However, such partnerships could also represent a double-edged sword for companies having to compete in those situations.

Period of full autonomy:

With the appearance of fully autonomous vehicles, we are inclined to think that the market of auto insurance could be the subject of many changes. The first influence could be the need for a different know-how. Indeed, as we have seen in the parts linked to risk assessment and cybersecurity, insurance organisations might have to develop effective expertise in cyber-security and cyber-risks.

Even though we believe that such know-how could be transferred internally, from departments having different activities such as cyber cover insurance, we tend to think that it could also come from external companies active in other niche markets. Therefore, we assume that insurance organisations could seek partnerships with external actors.

Regardless of liability aspects, we believe that same situations could happen with manufacturers or system developers. Indeed, we are inclined to think that insurance organisations could have, to a certain extent, interest in collaborating and developing partnerships, in manners to obtain precious information about their vehicles, to close significant deals to cover large fleets of vehicles, or to get the most of a situation where manufacturers could insure their own vehicles.

3.3.5 Environment reaction

Another interrogation would concern the reaction of stakeholders regarding the technology. How could they react and how could it change the environment where insurance organisations are operating? We will try to analyse the potential reactions of the environment in function of our scenarios.

Transition period:

In the context of this period of transition, we tend to believe that, at the beginning, the environment shouldn't evolve much as the vehicles would not be radically different from the AVs already existing. In addition, the none-modification of the LCR and the grey-area that surrounds the AV's performances could support this assumption.

However, we are inclined to think that such vehicles would attract the public attention and might cause controversy, while encouraging people to question the current infrastructure and regulations, which could stimulate the potential elaboration of laws. Nonetheless, we suppose that the general situation would allow insurance organisations to operate normally, while not having to radically change their products.

However, we are inclined to believe that when AVs would have reached a relatively high level of performance, the period that follows would deeply influence their future. Indeed, we expect people and authorities to have been exposed enough to have opinions towards the technology. People might either trust or doubt, while authorities might have enough information to start legislating the related legal frameworks. Such details could indirectly but heavily impact insurance organisations as it might shape the mobility of tomorrow.

The environment might accept or refuse the idea that one day, fully autonomous vehicles might be operating and start considering the possibilities and opportunities related, such as mobility on demand. Beyond those points, people might also start reassessing the validity of insurance products, which might force such organisations to react and respond. For those reasons, we believe that the period when technology would reach this level, insurance organisations would have to effectively set up strategies to adapt and respond, while considering regulations and the public's opinion.

Period of full autonomy:

As we tend to think that legislation should be slowly put in places during the period surrounding the appearance of fully autonomous vehicles, we believe that the uncertainties related to the environment would mainly concern the confidence of the public towards such vehicles, which would be directly influenced by the effective performances of the latter. However, we suppose that in a situation where owners must still subscribe policies and that those vehicles are effectively safer and operating properly, the public could manifest the opinion that insurance products are inadequate and create influential debates.

Besides, from insurance organisations' perspectives, the reaction of the environment towards mobility on demand is going to be decisive. Indeed, in a situation where AVs are functioning effectively and safely, we are inclined to believe that people would get confident and that car-sharing companies are likely to become prosperous, by offering an attracting substitute to private vehicles and changing the mobility as we know it [Harris 2017].

Such synopsis could heavily impact the insurance industry as the general quantity of vehicles as well as the probability of accidents would decrease significantly. As a consequence, activities of auto-insurance companies could be severely altered, as they would find themselves in need to adapt their activities to deal with different risks and much different and fewer clients.

3.3.6 Profitability

Another critical question would be the remaining profitability of the segment. In the last years, insurance companies have seen a decrease of direct profits made through the automobile industry because of the increasing level of technology, significantly affecting repair costs[10]. So, we can wonder what consequences even more sophisticated vehicles would have on their margins, while also taking into consideration that the overall number of vehicles is expected to decrease in the following decades.

Transition period:

The question of profitability remains a key-element, which is hard to determine for external individuals. Unfortunately, no percentage of profit has been found. A sure thing is that such organisations operate to be a minimum profitable, what inclines us to think that the current policies offered remain somehow profitable and would not exist unless they are. However, we also know that autonomous vehicles remain expensive nowadays, as the components onboard such as LIDAR (light detection and ranging) [Wikipedia, 2019], cameras, radars and onboard computers are particularly costly materials. Nevertheless, we suppose that with time, the competition and mass-productions, the prices of the technology and of those components should become cheaper, as it was generally the case for past technologies. Until then, the profitability of AVs for insurance companies have not been defined.

Additionally, in the cases of our scenarios, it would be interesting to consider the ideas that thanks to a driver remaining in principle alert and the increased quantity of driving-assistance tools, the overall risks of damages should decrease, while because of the complexity of the onboarded material and increased quantity of data generated, the quantity of fraud could decrease, what might influence the financial results of insurance companies.

Period of full autonomy:

As it was presented in the previous part, it is hard to establish the level of profitability related to future AVs. Nevertheless, there are common influential factors that we could consider. Indeed, the first being, in theory, a drastic decrease of driving accident, as 90% of them are caused by human actions and that such vehicles would not operate unless they are effectively reliable.

[10] Interview with Ms Van De Ven – Australian Insurance officer, Geneva, 18th February 2019

Nevertheless, the vehicles would still be exposed to external forces, and therefore might still require usual casco products. A situation even more relevant for a fleet of AVs which would be open to the public and operating intensively.

Furthermore, as we have seen in the previous parts, some emerging risks might appear and might as well impacts the risk assessments and financial results of insurance institutions.

In addition to those points, a critical factor that may evolve would be the type and the bargaining power of the customers[11], which insurance organisations would be dealing with. Indeed, depending on who would assume the liability, insurance companies could face a situation where few clients would bring major parts of their revenues. Therefore, they would have to adapt to deal, not only with private customers anymore, but corporations benefiting from a much stronger bargaining power. Nevertheless, in a case where mobility companies would grow, insurance organisations might have to face a similar situation, while dealing with a significant reduction of demand for insurance policies, which could put them in difficult position.

[11] Interview with Mr Farmanfarmaian – Venture capitalist, Geneva, 15th May 2019

4. Discussion

4.1 Main findings

To begin with, our different sources confirmed that the auto-manufacturing industry has realised the potential and the importance of autonomous vehicles, driving them to invest massively in their development to close the gap that has been created between the giant Google (Waymo) and them. Such situation had, as benefits, to strongly raise the overall quantity of developers and to stimulate interdisciplinary collaborations. In such circumstances, the overall level of performances has drastically increased, leading to encouraging testing sessions, where empty AVs are transiting on public roads as well as the appearance of always more advanced AVs [Hawkins 2018]. Despite those improvements and those important resources, autonomous vehicles must still overcome significant challenges, such as anticipating irrational behaviours and dealing with all types of roads infrastructures. In top of that, different research illustrated that AVs could be the victims of cyber-attacks, opening the door to new types of criminality and terrorism. For those reasons, even though the future seems to be promising, predictions are delicate to establish.

Similarly to other countries, Switzerland has not yet adapted its regulations to AVs [Synced/OFROU 2018]. Regulations have been established in respect of the Vienna Convention, which requires a human driver to remain in continuous control of the vehicle. For this reason, fully autonomous vehicles are forbidden on the Swiss public roads unless they are part of pilot-projects authorised by the Federal Council itself. As a result, the self-driving systems available on the market are considered as driving assistances.

Despite that legal situation, different public reports demonstrated that Swiss politics have realised the potential benefits of AVs for the Swiss society, and so explicitly declared the willingness to adapt regulations accordingly, as long as safety is guaranteed [Grosjean 2019]. An enthusiasm confirmed by the approval of a related motion by the Swiss Parliament and by the validations of those different pilot-projects by the Federal Council. Moreover, the OFROU (Office Fédéral des Routes) was mandated by the national authorities to study and present different ways to welcome AVs on the Swiss roads. Not only by keeping an eye on the international scene, but also by defining the eventual structure required.

Last but not least, the Swiss environment has so far seemed to be receptive to AV's technology as thousands of Tesla have been matriculated [Seydtaghia 2019], and a law encouraging alternative mobility has been voted (loi cantonale sur la mobilité douce) [République et Canton de Genève 2016].

However, even though interesting steps have been taken by authorities, they would still have to legally define the level of responsibility of the concerned stakeholders. A task that appears to be complex as it should allow authorities to solve legal cases of accident, while considering all influences and all degrees of involvement. Without such regulations, it would be complicated to expect fully autonomous vehicles on Swiss public roads.

From the insurance's perspectives, such laws would not only impact civil liability products, but also the complete value chain of insurance organisations. Indeed, depending on the attribution of the responsibilities, those might not deal with individuals anymore, but large corporations. Therefore, insurance organisations might have to adapt to meet the needs of a different type of clients having a much stronger bargaining power. As consequences, those might find themselves in the need to revise how they operate and potentially modify aspects such as risk assessment, distribution channels, products, prices and so on.

Nevertheless, findings were supporting the idea that until the legal basis evolves, insurance products would not change much. Indeed, as the existing self-driving systems are considered as driving assistances, the liability remains on the drivers' shoulders and justifies the validity of current products. Therefore, it might only be at the time liabilities are legally defined that insurance firms would develop new types of liability policies and adapt their activities. That being said, it is important to mention that those potential changes might mainly impact the liability products. Indeed, we are inclined to think that since vehicles would still be exposed to external forces, the casco products should remain adapted and attractive regardless of the type of client.

Besides those influences and facts, we found out along this report that the evolution of technology itself is likely to influence even more the activities of insurance organisations. Indeed, as we presented in this report, autonomous vehicles, while theoretically decreasing the quantity of accident, would also involve different types of risks (such as cyber risks), which were until now not concerning the traditional vehicles and neither the auto-insurance industry. For this reason, we are inclined to believe that they would have to expend their knowledge and adapt some of their activities accordingly, to face the needs related to those vehicles as well as the ones of their future clients.

Nevertheless, insurance organisations remain very proactive and have already started to collect data by insuring vehicles that are increasingly autonomous. Moreover, they also finance their own tests as the MAIF foundation did [MAIF Fondation 2018], or developed partnerships with manufacturers, in the same manners than the Zurich insurance and Tesla.

As a result, even though risk assessment departments might have to evolve, interpret and make suppositions, they are likely to have access to an increasing quantity of data allowing them to shape their calculations and to better assess risks.

Because of this proficiency, competitions might evolve as well. As presented, the auto insurance market involves intense competition due to low-products differentiation. We therefore suppose that partnerships between AV's developers and insurance organisations could appear to obtain strategic benefits, which could represent potential threats for other actors of the market. We were told during this project that such situations could be conceivable, unlike the appearance of an insurance organisation owned by car manufacturers, as financial requirements are significant and the activities far from their core-business.

In retrospect, we suppose that insurance institutions could in fact benefit from this "transition" period presented in this report, which would last until fully autonomous vehicles are regulated and operating. Until then, because insurance products would still be saleable, they would make profits, while collecting precious information that could enable them to eventually react and adapt when it will be needed. Nevertheless, it is pertinent to mention that profitability of auto insurance products remains a grey-area of this work, as no precise information were obtained. However, we were told that such organisations were excellent calculators and for this reason, we assume that as long as needs for auto-insurance policies would be demonstrated and deals closed, those would somehow remain profitable.

Besides, a decisive factor would be the reaction of the environment, which would be largely influenced by the performances of the AVs. Depending on those and how trustful people become, we could see the emergence of companies offering "mobility on demand". Considering the direction that our society is taking and the growth of car-sharing, it would not be senseless to consider that perspective. Nevertheless, such eventuality could heavily impact the auto insurance industry, which could face a situation, where the quantity of clients would decrease and the ones remaining would have a considerable bargaining power. In addition of that, even though new risks might emerge, the vehicles involved could allegedly drown the risks of accidents.

As a result, insurance companies could face the need to deeply reorganise their operations and products in response to a decreased level of activities involving fewer and different risks, while dealing in business-to-business manners.

To conclude, we would say that we realised during this project that the actual threat for insurance companies isn't AVs directly, but the evolution of the mobility on longer-terms, which might involve fewer cars, fewer accidents and so, fewer needs for insurance policy. Nevertheless, we also realised that even though the overall risks are supposed to diminish, there is also a part of unknown risks related to autonomous vehicles which might emerge, what could represent an interesting opportunity for insurance organisations.

4.2 Recommendations

Along the research and the writing of this thesis, we developed different opinions related to this problematic. To start with, we are inclined to think that the Swiss auto insurance industry will remain spared for another decade, as the technology still needs to be developed and trusted, while people tend to hold their vehicles, in average, seven years [Gillies 2017]. However, we believe that in other countries such vehicles could appear much sooner because of the significant mobility issues they face and their different mentalities [Canaan 2017]. A situation that would surely influence somehow the Swiss environment. Additionally, we believe that even though authorities might start elaborating regulations, those are very likely to be deeply influenced by international agreements such as the Vienna Convention.

In terms of liability, by pragmatism, we believe that regulations would not change drastically and that owners of autonomous vehicles would still be required to subscribe liability policies. Nevertheless, we are convinced that new laws would be established in order to engage the responsibility of car manufacturers and self-driving system's developers, even though it might be complex to prosecute international organisations because of local accidents. Such legal framework would have the advantage of guaranteeing a certain economic and legal stability. Indeed, authorities wouldn't have to completely change the existing legislation, but eventually only deepen certain legal aspects. In addition, it would also protect national insurance organisations against disruptive changes of the environment.

Regarding the evolution of insurance institutions, we believe that those would have to adapt their whole activities to the increasing presence of cyber aspects.

Indeed, we believe that on longer terms, risks would not be related to driving habits, irrational behaviours or human actions anymore, but deeply correlated with cyber aspects and technology. For this reason, we believe that insurance organisations, in order to remain effective and profitable, would have to become experts in such fields.

In addition to those points, we developed the opinion that even though we expect changes or not in the legal infrastructures, the mobility as we know it, is going to evolve to deal with the different societal issues of our time. We tend to think that with the evolution of urban areas, where the population is always more concentrated, private vehicles could become inappropriate, a situation that could be even more exacerbated by “mobility on demand” solutions.

Therefore, we believe that on longer-terms, insurance institutions might find themselves trapped in a reduced market driving much smaller revenues.

Nevertheless, we are inclined to think that apart from those relatively dramatic perspectives, the future still involves opportunities. We believe that because of those many changes and uncertainties, a new market dynamism could emerge giving the chance to institutions to differentiate themselves from competitors. We believe that because of those changes, insurance companies would reassess and reinvent their activities, leading to innovation and products adapted to the business environment of tomorrow.

Because of this belief, the only recommendations we could make would be to continuously analyse the business environment, the technology and the legal infrastructures, to ensure a certain proficiency and fully exploit the opportunities of tomorrow’s mobility.

5. Conclusion

As we have seen along this thesis, the future involves many uncertainties and a significant part of unknown. We believe that the best way to deal with such situation is to remain as proactive and objective as possible. We are inclined to think that insurance organisations would have a strong interest in keeping in mind a long-term vision, while cautiously scanning and understanding every aspects of their environment in order to be able to consider and anticipate any potential scenario. Finally, we tend to think in such situation, that building solid partnerships might be a potential way to take as much advantage of such circumstances.

Bibliography

1. A.M. BEST, 2018. *Best's guide to understanding the insurance industry.* 2018 edition. Oldwick, NJ: A.M. Best. ISBN:9781729526941
2. GLASER, Kevin L., 2014. *Inside the insurance industry*. 3rd edition. Wisconsin: Right Side Creations LLC. ISBN:9780991038817
3. BURNS. Lawrence D. and Christopher Shulgan, 2018. *Autonomy.* 1st edition. New York: HarperCollins. ISBN 9780062661128fo
4. Ernst & Young UK, 2017. "The evolution in self-driving vehicles – Trends and implications for the insurance industry". [PDF file].
5. Canaan Michelle, 2017. "CloserLook | "To be or not to be" is no longer the question: Insurers confront the "when" and "how" of uneven transition as mobility preferences and capabilities evolve. [PDF file] Deloitte Center for Financial Services / Deloitte Canada.
6. COURBAGE, Christophe, 2007. *Chapter 5 – arrangements and risks sharing* [PowerPoint file]. Course support : Cours "Risk Management », Haute école de gestion de Genève, filière International Business Management, année 2007-2019
7. COURBAGE, Christophe, 2007. *Chapter 6 – the nature and role of insurance in risk management* [PowerPoint file]. Course support : Cours "Risk Management », Haute école de gestion de Genève, filière International Business Management, année 2007-2019
8. MCCLINTOCK, Leslie, 2019. What is Risk Pooling. *Zacks* [online]. 13th April 2019. [Consulted on the 30th March 2019]. Available from: https://finance.zacks.com/risk-pooling-insurance-1890.html
9. Allianz. Wikipédia: l'encyclopédie libre [online]. Last updates on the 25th April 2019. [Consulted on the 4th April 2019]. Available from: https://fr.wikipedia.org/w/index.php?title=Allianz&oldid=157653924
10. ASSOCIATION SUISSE DES ASSURANCES, 2018. RC, véhicules automobiles et transport. *Svv.ch* [online]. 3rd August 2018. [Consulted on the 13th April 2019]. Available from: https://www.svv.ch/fr/secteur/chiffres-et-faits/assurance-de-dommages/rc-vehicules-automobiles-et-transport
11. OFFICE FÉDÉRAL DE LA STATISTIQUE, 2019. « Véhicules routiers- parc, taux de motorisation ». *bfs.admin.ch* [online]. 2019. [Consulted on the 13th April 2019]. Available from: https://www.bfs.admin.ch/bfs/fr/home/statistiken/mobilitaet-verkehr/verkehrsinfrastruktur-fahrzeuge/fahrzeuge/strassenfahrzeuge-bestand-motorisierungsgrad.html
12. ASSURANCE-INFO.CH, 2018. *ASSURANCE RESPONSABILITE CIVILE VEHICULE* [online]. 2018. [Consulted on the 13th April 2019]. Available from: https://www.assurance-info.ch/assurance-responsabilite-civile-voiture-auto-vehicule-rc/
13. INTERNATIONAL ENERGY AGENCY, 2019. *"*CO2 Emissions Statistics – An essential tool for analysts and policy makers"*. IEA* [online] 2019. [Consulted on the 17th March 2019]. Available from: https://www.iea.org/statistics/co2emissions/

14. WORLD HEALTH ORGANISATION, 2015. Health and sustainable development – Climate impacts. *who.int* [online]. 2015. [Consulted on the 17th March 2019]. Available from: https://www.who.int/sustainable-development/transport/health-risks/climate-impacts/en/

15. INRIX, 2019. *INRIX 2018 Global Traffic Scorecard* [online]. 2018. [Consulted on the 3rd March 2019]. Available from: http://inrix.com/scorecard-city/

16. OFFICE FÉDÉRAL DE LA STATISTIQUE, 2018. « Enquête suisse sur le niveau et la structure des salaires 2016 ». *bfs.admin.ch* [online]. 2018. [consulted on the 7th March 2019]. Available from :https://www.bfs.admin.ch/bfs/fr/home/statistiques/catalogues-banques-donnees/communiques-presse.assetdetail.5226937.html

17. HUSSAIN, Mouna, 2018. " Le trajet des pendulaires toujours plus long pour se rendre au travail". *RTS Info* [online]. 31st January 2018. [Consulted on the 7th March 2019]. Available from: https://www.rts.ch/info/suisse/9295329-le-trajet-des-pendulaires-toujours-plus-long-pour-se-rendre-au-travail.html

18. OFFICE FÉDÉRAL DE LA STATISTIQUE, 2018. « Population résidante, personnes actives occupées, personnes en formation : pendulaires par canton ». *bfs.admin.ch* [online]. 2018. [Consulted on the 7th March 2019]. Available from: https://www.bfs.admin.ch/bfs/fr/home/statistiques/catalogues-banques-donnees/tableaux.assetdetail.7226471.html

19. OFFICE FÉDÉRAL DE LA STATISTIQUE, 2018. « Infrastructure et longueur des réseaux ». *bfs.admin.ch* [online]. 2018. [Consulted on the 7th March 2019]. Available from: https://www.bfs.admin.ch/bfs/fr/home/statistiques/mobilite-transports/infrastructures-transport-vehicules/longueur-reseaux.html

20. Office fédéral de la statistique, 2018. « Coût mensuel moyen pour la place de stationnement au lieu de travail ». *bfs.admin.ch* [online]. 2018. [Consulted on the 7th March 2019]. Available from: https://www.bfs.admin.ch/bfs/fr/home/statistiques/catalogues-banques-donnees/tableaux.assetdetail.293546.html

21. HABITAT A STATIONEMENT REDUIT, 2010. Chiffres et faits. *habitat-mobilitedurable.ch*. 2015. [Consulted on the 7th March 2019]. Available from: https://habitat-mobilitedurable.ch/contexte/chiffres-et-faits/?L=1

22. Rendement d'un moteur à explosion. Wikipédia: l'encyclopédie libre [online]. Last updates on the 29th May 2019. [Consulted on the 4th March 2019]. Available from: https://fr.wikipedia.org/wiki/Rendement_d%27un_moteur_à_explosion

23. SMART, 2019. *Caractéristiques techniques* [online]. 2019. [Consulted on the 28th February 2019]. Available from: https://www.smart.com/ch/fr/index/smart-fortwo-453/technical-data.html

24. VOLVO, 2019. *Caractéristiques techniques* [online]. 2019. [Consulted on the 28th February 2019]. Available from: https://www.volvocars.com/fr-ch/modeles/nous-modeles/xc90/caractéristiques-techniques/moteurs

25. EUROPEAN ENVIRONMENT AGENCY, 2016. "Occupancy rates of passenger vehicles". *EEA* [online]. 16th December 2008. 19th April 2016. [Consulted on the 28th February 2019]. Available from: https://www.eea.europa.eu/data-and-maps/indicators/occupancy-rates-of-passenger-vehicles/occupancy-rates-of-passenger-vehicles

26. OFFICE OF ENERGY EFFICIENCY & RENEWABLE ENERGY, 2018. *Average Vehicle Occupancy Remain Unchanged From 2009 to 2017* [online]. 30thJuly 2018. [Consulted on the 28th February 2019]. Available from: https://www.energy.gov/eere/vehicles/articles/fotw-1040-july-30-2018-average-vehicle-occupancy-remains-unchanged-2009-2017

27. WORLD HEALTH ORGANISATION, 2018. Road traffic injuries. *who.int* [online]. 7th December 2018. [Consulted on the 20th March 2019]. Available from: https://www.who.int/news-room/fact-sheets/detail/road-traffic-injuries

28. BOSTON CONSULTING GROUP, 2019. Self-Driving Vehicles, Car Sharing, and the Urban Mobility Revolution. *bcg.com* [online]. [Consulted on the 24th March 2019]. Available from: https://www.bcg.com/industries/automotive/self-driving-vehicles-car-sharing.aspx

29. BOSH, Patrick M, BECKER, Felix, BECKER Henrik, AXHAUSEN, Kay W., 2018. Cost-based analysis of autonomous mobility services. *Science Direct* [online]. May 2018. [Consulted on the 23rd March 2019]. Available from: https://www.sciencedirect.com/science/article/pii/S0967070X17300811?via%3Dihub

30. BURNS. Lawrence D., 2018. *Autonomy.* 1st edition. New York: HarperCollins. ISBN 9780062661128fo

31. WAYMO, 2018. Waymo 360° Experience: A Fully Self-Driving Journey [video file] *Youtube* [online]. 28th February 2019 [Consulted on the 30th January 2019]. Available from: https://www.youtube.com/watch?v=B8R148hFxPw

32. POLICE, Marion, 2019. « La voiture, intouchable utopie adolescente ». *Le Temps* [online]. 12th March 2019. Consulted on the 24th March 2019]. Available from: https://www.letemps.ch/societe/voiture-intouchable-utopie-adolescente

33. BURNS. Lawrence D., 2018. *Autonomy.* 1st edition. New York: HarperCollins. ISBN 9780062661128fo

34. KHOSRAVI, Bijan, 2018. “Autonomous Cars Won't Work - Until We Have 5G”. *Forbes* [online]. 25th March 2018. [Consulted on the 26th March 2019]. Available from: https://www.forbes.com/sites/bijankhosravi/2018/03/25/autonomous-cars-wont-work-until-we-have-5g/#197f8752437e

35. Loi cantonale of the 5th June 2016, “Loi pour une mobilité cohérente et équilibrée”. *République et canton de Genève* [online]. 2016. [Consulted on the 28th February 2019]. Available from: https://www.ge.ch/dossier/loi-mobilite-coherente-equilibree

36. REPORT LINKER, 2018. Top 20 Companies Developing Autonomous Vehicles (AV) Technologies 2018. *Reportlinker.com* [online]. October 2018. [Consulted on the 28th March 2019]. Available from: https://www.reportlinker.com/p04194710/Top-20-Companies-Developing-Autonomous-Vehicles-AV-Technologies.html

37. NEWCOMB, Doug, 2017. “Interview: Head Of Volvo R&D On Uber Collaboration And Automaker's Autonomous Vehicle Plans”. *Forbes* [online]. 28th December 2017. [Consulted on the 26th May 2019]. Available from: https://www.forbes.com/sites/dougnewcomb/2017/12/28/interview-head-of-volvo-rd-on-uber-collaboration-and-automakers-autonomous-vehicle-plans/#3ec2d2a619bc

38. MARKET MAD HOUSE, 2018. “Will Waymo boost Fiat Chrysler Automobiles (FCAU)?”. *Medium* [online]. 26th December 2018. [Consulted on the 26th May 2019]. Available from: https://medium.com/@MarketMadhouse/will-waymo-boost-fiat-chrysler-automobiles-fcau-537c52ed9db7

39. HEINEKE Kersten, AMPSHOFF, Philipp K, MKRTCHYAN, Armen, SHAO, Emily, 2017. Self-driving car technology: When will the robots hit the road? McKinsey.com[online]. May 2017. [Consulted on the 23rd October 2018 Available from:https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/self-driving-car-technology-when-will-the-robots-hit-the-road

40. CONGER, Kate, 2018. Uber's Driverless Cars Return to the Road After Fatal Crash. *The New York Times* [online] 20th December 2018. [Consulted on the 28th March 2019]. Available from: https://www.nytimes.com/2018/12/20/technology/uber-driverless-cars-return.html

41. HAWKINS, Andrew J., 2018. Waymo gets the green light to test fully driverless cars in California. *The Verge* [online]. 30th October 2018. [Consulted on the 30th March 2019]. Available from: https://www.theverge.com/2018/10/30/18044670/waymo-fully-driverless-car-permit-california-dmv

42. WAYMO, 2018. What's Next. *Waymo.com* [online]. 2018. [Consulted on the 28th March 2019]. Available from: https://waymo.com/whats-next/

43. BOUDETTE, Neal E., 2018. Waymo to Buy Up to 62,000 Chrysler Minivans for Ride-Hailing Service. The New York Times [online] 31st May 2018. [Consulted on the 28th March 2019]. Available from: https://www.nytimes.com/2018/05/31/business/waymo-chrysler-minivans.html

44. KHOSRAVI, Bijan, 2018. "Autonomous Cars Won't Work - Until We Have 5G". *Forbes* [online]. 25th March 2018. [Consulted on the 26th March 2019]. Available from: https://www.forbes.com/sites/bijankhosravi/2018/03/25/autonomous-cars-wont-work-until-we-have-5g/#197f8752437e

45. BURNS. Lawrence D., 2018. *Autonomy.* 1st edition. New York: HarperCollins. ISBN 9780062661128fo

46. OFFICE FÉDÉRAL DES ROUTES, 2018. « Etudes et rapports sur la mobilité intelligente et la conduite automatisée ». *astra.admin.ch* [online]. 2018. [consulted on the 23th April 2019]. Available from : https://www.astra.admin.ch/astra/fr/home/themen/intelligente-mobilitaet/studien-und-berichte.html

47. Parliamentary motion 17.4039 « Véhicules autonomes. Suppression des obstacles juridiques » submitted on the 7th December 2017 by GROUPE VERT'LIBÉRAL. L'assemblée fédérale – Le Parlement Suisse. [Consulted on the 7th May 2019]. Available from : https://www.parlament.ch/en/ratsbetrieb/suche-curia-vista/geschaeft?AffairId=20174039

48. Parliamentary interpellation 18.3445 « Véhicules autonomes et responsabilité. A quand une adaptation de la législation helvétique ?» submitted on the 4th June 2018 by GROUPE PDC. L'assemblée fédérale – Le Parlement Suisse. [Consulted on the 23th May 2019]. Available from : https://www.parlament.ch/en/ratsbetrieb/suche-curia vista/geschaeft?AffairId=20183445

49. DELOITTE, 2018. Le smartphone est au coeur de nos vies – Seuls 8% de la population suisse n'en possèdent pas encore. *Deloitte.com* [online]. [Consulted on the 1st April 2019]. Available from: https://www2.deloitte.com/ch/fr/pages/press-releases/articles/deloitte-in-switzerland-smartphones-become-control-centre.html

50. OFFICE FÉDÉRAL DE LA STATISTIQUE, 2018. « Utilisation d'internet en Suisse ». *bfs.admin.ch* [online]. 5th December 2018. [Consulted on the 1st April 2019]. Available from: https://www.bfs.admin.ch/bfs/fr/home/statistiques/catalogues-banques-donnees/tableaux.assetdetail.6766512.html

51. EDWARDS, John, 2019. “5G versus 4G: How speed, latency and application support differ”. *Network World* [online]. 07th January 2019. [Consulted on the 4th April 2019]. Available from: https://www.networkworld.com/article/3330603/5g-versus-4g-how-speed-latency-and-application-support-differ.html

52. OFFICE FÉDÉRAL DE LA STATISTIQUE, 2018. « Age, état civil, nationalité ». *bfs.admin.ch* [online]. 2018. [consulted on the 1st April 2019]. Available from : https://www.bfs.admin.ch/bfs/fr/home/statistiken/bevoelkerung/stand-entwicklung/alter-zivilstand-staatsangehoerigkeit.html

53. OFFICE FÉDÉRAL DES ROUTES, 2018. « Etudes et rapports sur la mobilité intelligente et la conduite automatisée ». *astra.admin.ch* [online]. 2018. [consulted on the 23th April 2019]. Available from : https://www.astra.admin.ch/astra/fr/home/themen/intelligente-mobilitaet/studien-und-berichte.html

54. Android (operating system). Wikipédia: l’encyclopédie libre [online]. Last updates on the 31st May 2019. [Consulted on the 26th May 2019]. Available from: https://en.wikipedia.org/wiki/Android_(operating_system)#Licensing

55. TESLA, 2019. *Autopilot* [online]. 2019. [Consulted on the 25th April 2019]. Available from: https://www.tesla.com/autopilot

56. HEIERLI, Anian, 2019. «Neue Autos lassen sich fernsteuern und werden zur Waffe»- *Blick* [online]. 25th February 2019. [Consulted on the 23th April 2019]. Available from: https://www.blick.ch/news/schweiz/berner-it-spezialisten-zeigen-wie-ein-citroen-fremdgesteuert-werden-kann-so-einfach-laesst-sich-auch-ihr-auto-kapern-id15187765.html

57. SHLADOVER, Steven E. and PETIT, Jonathan, 2014. Potential Cyberattacks on Automated Vehicles. IEEE. *IEEE Transactions on Intelligent Transportation Systems*, 2014. IEEE, 2014. pp. 546-556. [Consulted on the 24th April 2019]. Available from: http://ieeexplore.ieee.org/lpdocs/epic03/wrapper.htm?arnumber=6899663

58. INTERNATIONAL ORGANIZATION FOR STANDARDIZATION, 2012. Road vehicles run on ISO standards. *Iso.org* [online]. 5th January 2012. [Consulted on the 25th April 2019]. Available from: https://www.iso.org/news/2012/01/Ref1498.html

59. TOURING CLUB SUISSE, 2016. *Rappels et défauts de véhicule* [online].2016. [Consulted on the 18th May 2019]. Available from: https://www.tcs.ch/fr/tests-conseils/conseils/controle-entretien/rappels-defauts-de-voiture.php

60. *La voiture autonome* [TV Documentary]. Science & Vie. 18th March 2019. [Consulted on the 30th March 2019].

61. TESLA, 2019. InsureMyTesla – Assurance automobile. *Tesla.com* [online]. 2019. [Consulted on the 25th April 2019]. Available from: https://www.tesla.com/fr_CH/support/insuremytesla

62. HARRIS, John, 2017.” Owning a car will soon be a thing of the past”. *The Guardian* [online]. 23rd October 2017. [Consulted on the 28th January 2019]. Available from: https://www.theguardian.com/commentisfree/2017/oct/23/owning-car-thing-of-the-past-cities-utopian-vision

63. Lidar. Wikipédia : l’encyclopédie libre [online]. Last updates on the 10th January 2019. [Consulted on the 25th April 2019]. Available from: https://fr.wikipedia.org/w/index.php?title=Lidar&oldid=155681276

64. HAWKINS, Andrew J., 2018. Waymo gets the green light to test fully driverless cars in California. *The Verge* [online]. 30th October 2018. [Consulted on the 30th March 2019]. Available from: https://www.theverge.com/2018/10/30/18044670/waymo-fully-driverless-car-permit-california-dmv

65. SYNCED, 2018. "Global Survey of Autonomous Vehicle Regulations". *Medium* [online]. 15th March 2018. [Consulted on the 18th May 2019]. Available from: https://medium.com/syncedreview/global-survey-of-autonomous-vehicle-regulations-6b8608f205f9

66. OFFICE FÉDÉRAL DES ROUTES, 2018. « Etudes et rapports sur la mobilité intelligente et la conduite automatisée ». *astra.admin.ch* [online]. 2018. [consulted on the 23th April 2019]. Available from : https://www.astra.admin.ch/astra/fr/home/themen/intelligente-mobilitaet/studien-und-berichte.html

67. GROSJEAN, Arthur, 2019. "Mobilité : Berne veut légaliser les voitures autonomes ». *La Tribune de Genève* [online]. 19th April 2019. [Consulted on the 19th April 2019]. Available from: https://www.tdg.ch/economie/berne-veut-legaliser-voitures-autonomes/story/31606019

68. SEYDTAGHIA, Anouch, 2019. « Le Model 3 de Tesla numéro un en Suisse en mars, toutes catégories ». *Le Temps* [online]. 11th April 2019. Consulted on the 20th May 2019]. Available from: https://www.letemps.ch/economie/model-3-tesla-numero-un-suisse-mars-toutes-categories

69. Loi cantonale of the 5th June 2016, "Loi pour une mobilité cohérente et équilibrée". *République et canton de Genève* [online]. 2016. [Consulted on the 28th February 2019]. Available from: https://www.ge.ch/dossier/loi-mobilite-coherente-equilibree

70. MAIF FONDATION, 2018. "Des véhicules encore loin d'être autonomes ». *MAIF Fondation* [online]. July 2018. [Consulted on the 8th May 2019]. Available from: https://www.fondation-maif.fr/pageArticle.php?rub=10&id=881

71. GILLIES, Trent, 2017. "Car owners are holding their vehicles for longer, which is both good and bad ". *CNBC* [online]. 28th May 2017. [Consulted on the 7th May 2019]. Available from: https://www.cnbc.com/2017/05/28/car-owners-are-holding-their-vehicles-for-longer-which-is-both-good-and-bad.html

72. Canaan Michelle, 2017. "CloserLook | "To be or not to be" is no longer the question: Insurers confront the "when" and "how" of uneven transition as mobility preferences and capabilities evolve. [PDF file] Deloitte Center for Financial Services / Deloitte Canada.

73. DAIMLER, 2019. *Automated and Autonomous Driving. Legal Framework* [online]. 2019. [Consulted on the 18th May 2019]. Available from: https://www.daimler.com/innovation/case/autonomous/legal-framework.html

74. DELAITE, Anne, 2018. "Blessé, un automobiliste suisse attaque Tesla en justice". *RTS Info* [online]. 18th December 2018. [Consulted on the 25th April 2019]. Available from: https://www.rts.ch/info/suisse/10080529-blesse-un-automobiliste-suisse-attaque-tesla-en-justice.html

75. ALLIANZ, 2019. Notre assurance auto. *Allianz.ch* [online]. 2019. [Consulted on the 13th April 2019]. Available from: https://www.allianz.ch/fr/clients-prives/vehicules-et-voyages/vehicules/assurance-auto/

76. OFFICE FÉDÉRAL DE LA STATISTIQUE, 2018. « Mobilité et transports : Rapport statistique 2018 ». *bfs.admin.ch* [online]. 2018. [Consulted on the 28th January 2019]. Available from: https://www.bfs.admin.ch/bfs/fr/home/statistiques/catalogues-banques-donnees/publications.assetdetail.6666757.html

77. REJDA, George E, 2011. Insurance and Risk; Introduction to Risk Management. *Principles of Risk Management and Insurance.* 11th – Global Edition. Pearson. 978-0-273-76508-0

78. ASSOCIATION SUISSE DES ASSURANCES, 2018. RC, véhicules automobiles et transport. *Svv.ch* [online]. 3rd August 2018. [Consulted on the 13th April 2019]. Available from: https://www.svv.ch/fr/secteur/chiffres-et-faits/assurance-de-dommages/rc-vehicules-automobiles-et-transport

79. TALOS, Christine, 2019. Les nouvelles voitures facilement piratables. *Le Matin.* [online]. 26th February 2019. [Consulted on the 23rd April 2019]. Available from: https://www.lematin.ch/suisse/Les-nouvelles-voitures-facilement-piratables/story/20981219

80. EUROPEAN AUTOMOBOLIE MANUFACTURERS ASSOCIATION, 2017. Vehicles Per Capita, by Country. *Acea.be* [online]. 2017. [Consulted on the 28th January 2019]. Available from: https://www.acea.be/statistics/tag/category/vehicles-per-capita-by-country

81. NAVYA, 2019. Autonom Shuttle. *Navya.tech* [online]. 2019. [Consulted on the 26th May 2019]. Available from: https://navya.tech/shuttle/

Appendix 1: Minute of the interview with Mr Nurock

Wednesday, 1st May 2019 – 09h30
Helvetia Assurances, rue François-Versonnex 7, 1207 Genève

Attendee: Mr Alexandre Nurock
Interviewers: Jérémy Voitchovsky

Agenda item: The effects of self-driving vehicles on the Swiss auto-insurance industry

Discussion:
Main points of the interview**:**
Validation of insurance issues resulting from autonomous vehicles and potential reactions resulting from specific scenarios.

Personal information:
Mr Alexandre Nurock, corporate/ private senior customer adviser

General findings:

Questions related to liability

- Insurance organisation are very likely to start acting only from the moment, legal basis is established by the government, as they would base their products on those laws.
- Until laws are established, drivers will be liable and so products won't change much.
- Expect that until standards and laws would be established, manufacturers would have to be liable for their vehicles but until such time, the driver would remain liable and so products would remain relatively unchanged.

Questions related to profitability

- Auto-insurance policies are still profitable and even though, monetary flows fluctuate much, these are still a large source of income.
- All risks are included in the premiums and policies are continuously assessed. Consequently, policies would remain profitable. When premiums are not profitable, prices are increased to improve profits or to push the clients out.
- Companies such as *Mobility* offering services of car-sharing, has adapted premiums and policies. Generally, those have the same status than UBER, taxis or vehicles with private chauffeurs, which involves more kilometres and risks for the insurance organisations. However, depending on the size of the fleet they are very likely to have specific tariffs.

Questions related to the environment reaction

- Even though, vehicles are autonomous, there will always be possibilities of accidents, due to human actions, which would maintain premiums existence. Thus, prices might decrease but only slightly.
- Extension of policy might be added.
- In a situation, where a fleet of light vehicles with low speed capacity were deployed, different categories of policies would be suggested including the policies called “casco-machine”, used generally for cable car or industrial machines.

Questions related to risk management

- Insurance companies already started to collect data with vehicles increasingly autonomous such as TESLA and others. So, they might be able to adapt their products to autonomous vehicles.
- Still possible for manufacturers to establish partnerships with insurance organisations by providing additional data in exchange of lower premiums for their vehicles.

Questions related to the potential new competitors

- Entering the insurance market remains complex as Swiss laws require specific rates of financial reserves to be allowed to sell insurance policies. However, companies could still acquire existing companies.
- Systems manufacturers might deal straight with the Reinsurance companies

Appendix 2: Minute of the interview with Mr Farmanfarmaian

Tuesday, 15th May 2019 – 18h00
Interviewee reached by phone

Attendee: Mr Salman Farmanfarmaian
Interviewers: Jérémy Voitchovsky

Agenda item: The effects of self-driving vehicles on the Swiss auto-insurance industry & The general development of autonomous vehicles

Discussion:
Main points of the interview**:**
Eventualities of AVs' development

Personal information:
Mr Salman Farmanfarmaian, Venture capitalist

General findings:

Questions related to the overall development and potential scenarios

- Car manufacturers and self-driving's system developers might be different organisations.
- To understand the dynamism, it is interesting to understand who has the strongest bargaining power, as well as the complete picture.
- Concerning the data accumulated, it would be interesting to consider the law of diminishing return, which could allow competitors to close the current gap between the leaders and them.
- In a dimension where network of operations such as UBER or DiDi would be operating, those would define how they perceive insurance covering. They could outsource and approach insurance organisations with strong bargaining power or even cover their own vehicles, as their financial means would allow it.
- Interesting to consider how rental car organisations ensure their vehicles.