Implementation of Usage Based Insurance

within the car insurance industry

5/29/2017

J. Kerckhaert

BACHELOR THESIS IT & MANAGEMENT

TILBURG SCHOOL OF ECONOMICS AND MANAGEMENT

Implementation of Usage Based Insurance within the car insurance industry

Jordi Kerckhaert

ANR 873651

May 29, 2017

Bachelor Thesis IT & Management

Supervisor: Dr. J. Hulstijn

Faculty Information Management

Department of Management

Tilburg School of Economics and Management

Management Summary

As a result of digital business transformation, car insurance companies are trying to implement a new insurance policy, called “Usage Based Insurance” (UBI). By using communication- and information technologies, the insurance company is able to measure individual driving behavior and exposure characteristics. This carries out a more realistic estimation of the corresponding risk of each driver in comparison to the lump-sum car insurance of today, which results in several benefits for the different parties involved. However, the implementation of UBI seems to be a sharp shift from today’s policy. The aim of this study is to concentrate on the technological and business content of UBI to determine all main factors that could affect the implementation of usage based insurance. To this end, the research question covers: *What are the positive and negative factors that have influence on the implementation of Usage Based Insurance into the car insurance business of today?* The research question is answered through a literature review which focuses on the advantages and limitations of UBI for each stakeholder, regarding security, privacy, society, environment and business. The literature review showed that a lower insurance premium is the most important incentive for drivers to switch to a usage based insurance. When the monetary benefits are high enough, drivers are willing to share their driving data and privacy fears will disappear. However, the insurance companies need to deal with these costs in combination with uncertain demand and big investment costs. This leads to financial uncertainty for the insurance companies and can be seen as the most important limitation for the implementation of usage based insurance in the car insurance market of today.

Table of Contents

1 Introduction

1.1. Problem Indication

Over the last ten years, the automotive industry is strongly affected by a digital business transformation, due to communication- and information technologies (Koushik & Mehl, 2015). As a result of digital transformation, a lot of new technological opportunities have arisen for different parties in this industry. One big opportunity for the insurance industry is to perform insurance policies based on vehicle use (Usage Based Insurance or otherwise UBI), consisting of two main components. By using telematics, companies can analyse their customers' driving behaviour. Knowing this behaviour, the insurance company can do a realistic estimation of the corresponding risk of the driver and define an insurance-premium based on this risk (Tselentis, Yannis, & Vlahogianni, 2016). This way of determining car insurance premiums is also called the 'Pay-how-you-drive' (PHYD) system. The other component of UBI is more known as a 'Pay-as-you-drive' (PAYD) system. The PAYD system is charging premiums based on total exposure characteristics such as mileage and road network used, while PHYD is based on individual driving behaviour measuring parameters such as speed, harsh acceleration, hard braking etc. (Tselentis et al., 2016) . A recent example of an insurance company who is already selling the PHYD-insurances is the ANWB, a Dutch insurance company. Consumers receive a stick small device which can be plugged into a car to analyse its driving behaviour. When being a safe driver, you could get a discount of 30 % (ANWB, 2017).

According to performed research on PHYD schemes so far (Husnjak, Peraković, Forenbacher, & Mumdziev, 2015), this new method presents many potential and appears to have many benefits. Studies have shown several advantages of using PHYD, both for the drivers and for the insurance-companies themselves. A small-scale study on the use of UBI resulted on in a reduction of 38% of parameters with direct and indirect relation to the risk of accidents. Additionally, the study found that 70% of the participants indicate positive impact on their driving score (Husnjak et al., 2015).

However, even if one believes PHYD is the best way to rate a user's driving and estimate his crash risk, it still remains a sharp shift from today's lump sum policy where everybody is paying the same premium. The current pricing policy of motor insurance companies around the world is called unfair and inefficient (Tselentis et al., 2016).With regards to the PAYD-system, drivers with similar characteristics such as age, gender and location pay the same premiums, no matter if they drive five or fifty thousand kilometres a year. Regarding to the PHYD-system, the current system does not punish aggressive driving behaviour and on the other hand, it does not

encourage safe driving behaviour (Butler, Butler, & Williams, 1988). However, when you look at this so-called unfairness from a broader social perspective, solidarity could also play a significant role on the decision between paying less or the same than someone with a higher accident probability. For example, the healthcare sector use the same principal: younger healthier patients pay as much as the older more frequently ill patients, because the older ones were young once too. Furthermore, the fact that the United States has a Patent on the "motor vehicle monitoring system for determining a cost of insurance" since 1998, can be described as remarkable (Dean, Moreland, Ohio, & Heinen, 1998). This means that after 19 years there still are some constraints to fully implement the UBI. The reasons for that will be investigated in this research.

Based on the facts mentioned above, the outstaying success of the usage based insurance is a relevant and interesting issue for companies as well as for researchers, both on a technological as on an ethical way. It should be highlighted that only a handful of studies have included behavioural characteristics in their models. So far, only a few insurance companies are exploiting behavioural information to assess drivers and estimate their charges. Except in highly developed markets such as the United Kingdom (Aviva.co.uk, 2012) and the United States of America (Privat, 2012), UBI has not been widely adopted by the insurance market (Masseran, Parreiras, Maria, Antunes, & Lowe, 2013).

1.2. Problem statement

This literature review focuses on the integration of a new car insurance policy based on mileages driven and driving behaviour and the reasons for the lack of success of this policy so far. This research and literature review leads to the following problem statement:

What are the positive and negative factors that have influence on the implementation of Usage Based Insurance into the car insurance market of today?

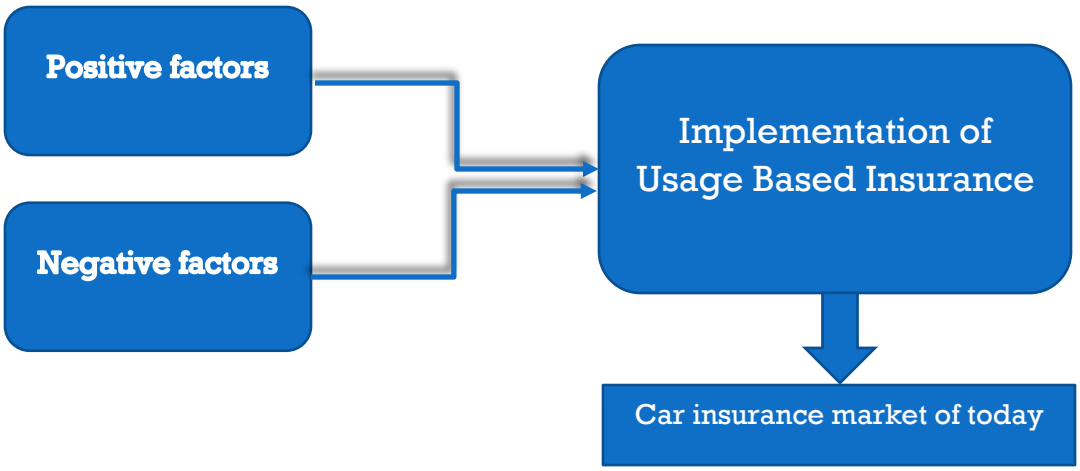

Figure 1*: Conceptual model*

1.3. Research questions

In order to address this problem statement in a proper manner, it is possible to divide it into a number of research questions. These questions define more specific problems and will structure the research process of the study.

This resulted into four research questions:

1. What is usage based insurance and what are the differences with a lump-sum insurance?
2. How is data being obtained from the vehicle and what are the security constraints?
3. What are the privacy constraints on UBI?
4. What are the most important advantages and disadvantages for using an UBI for the different parties involved?

These research questions will be discussed in Chapter 2 until Chapter 4, followed by Chapter 5 which discusses the Conclusion and Recommendations.

1.4. Research design and data collection

The approach for this bachelor thesis will be a literature review, in which secondary data from other relevant studies is used. The studies used will identify the main concepts, factors and variables to fulfil the demands of this research objective. Based on the literature review, the key factors of this research are: information technologies through data-analysing, risk selection, policy implementation and adoption of new insurance-systems by society.

In order to gather high-quality data about these factors, the search engines TiU Library, Science Direct, Web of Science and Google Scholar are used. Attention will be paid to the reliability and validity of the resources. Besides, there will be the possibility to do an interview with Allianz, one of the Dutch insurance companies who is trying to implement the PHYD system. The purpose of this interview is to add extra value to this research through gathering primary data and the possibility to ask specific questions which are hard to be answered based on only literature. The following search terms are used to gather relevant information for this literature review: *Pay-as-you-drive, Pay-how-you-drive, Usage Based Insurance, Implementation of usage based insurance, influence of age on driving accidents, location based services, (Automotive)Telematics insurance, risk based pricing insurance, data protection usage based insurance.*

2.UBI explained and the differences regarding lump-sum

2.1 Lump-sum car insurance

The most popular pricing policy for car insurance companies nowadays is still a lump sum for each user (Butler et al. 1988). This means that each consumer pays a fixed price for his or her car insurance, on an annual, semi-annual or quarterly basis. To define this premium, the insurer needs to calculate your risk getting involved in an accident or your car being stolen. The risk is based on some unchangeable factors like age, gender and marital status. A study with a sample of over 3000 accident cases showed that young drivers, especially males, have relatively more accidents than other drivers. (Clarke, Ward, Bartle, & Truman, 2006). Another study showed that married drivers have the lowest probability (0,78%) of being involved in a fatal or severe accident, while separated and widowed have the highest(1.18%) – a gap of about 50%(Factor, Mahalel, & Yair, 2008). Referring to the outcome of the studies mentioned above, it can be concluded that the indicated factors have a significant influence on a driver's risk and so indirectly also on the chance of an accident. In addition to the factors mentioned above, some changeable factors like your residence, driving record, type of vehicle and accident claims are taken into account when defining the insurance premium (Bian, 2005). According to these facts, it is reasonable to take the factors mentioned above into account when defining a consumer's premium. However, due to the technological developments of the last decades, other significant factors can be added as determinants in the insurance pricing-system. In this manner, the usage based insurance is created.

2.2 Usage Based Insurance

In contrast to the lump-sum insurance, a Usage-Based Insurance (UBI) is based on a dynamic premium with a lot more changeable factors of influence. UBI considers a much broader variety and more objective of variables than self-reported data. Prior researchers have done some meaningful works on exposing these variables as a substitute for established rate factors in insurance (T. Litman, 2005) As mentioned in the problem indication, UBI can be divided into two main charging systems: Pay-as-you-drive and Pay-how-you-drive.

2.2.1 Pay-as-you-drive

Pay-As-You-Drive (also called Distance-Based, Mileage-Based, Per Mile, Usage-Based, and Cent-Per-Mile) pricing means that a vehicle's insurance premiums are based directly on how much it is driven during the policy term. It changes vehicle insurance from a fixed cost into a variable cost. The more you drive the more you pay and the less you drive the more you save. This is done by changing the unit of exposure from the vehicle-year to the vehicle-mile, vehicle-kilometre, or vehicle-minute (T. A. Litman, 2011). Other standard rating factors as mentioned before are incorporated so lower-risk motorists pay less, and higher-risk motorists pay more per unit of travel. According to the literature, variable of mileage should be one of the most relevant factors for predicting accident risk and be proven by researchers (Chipman et al. 1993) (Bian, 2005).

> "Basic PAYD premiums are calculated by dividing existing premiums by a vehicle's rate class average annual miles. For example, a $250 annual premium for a 10,000 annual mile vehicle class becomes 2.5¢ per mile, and a $1,800 annual premium for a 15,000 annual mile vehicle class becomes 12¢ per mile" (T. Litman, 2005).

At the moment there are still two general ways of obtaining the relevant data. The first one is simply contacting your insurance company and forwarding the amount of miles you drove. The second and more innovative one is exchanging the relevant data through the use of information systems like GPS, OBD or external devices installed in the car.

2.2.2 Pay-how-you-drive

Instead of focusing on how much is driven when defining the insurance premium, PHYD is concentrating on the behavioural aspects of the driver. Properties like speed, sharp parking, sudden acceleration, seatbelt use and hard breaking are measured to collect real-time data. After this information is processed, based on rating information provided by the insurer, the risk factor of interest for each driver can be generated (Tselentis et al., 2016). Taking these risk factors into account together will result in behaviour-based insurance premiums. The "safe drivers" will be separated from the "more aggressive drivers". So it holds that the riskier you drive the more you pay and the safer you drive the more you save.

2.2.3 Distinction between PAYD and PHYD

To make assumptions about the implementation of UBI in the car insurance, it is essential to make a clear deviation between the two UBI-models considered. It is important to distinguish the meaning of terms, since they depend on the usage level of telematics solution, and are determined based on the user data collected (Husnjak et al., 2015). "Telematics is referring to

the integrated use of communications and information technology to transmit, store and receive information from telecommunications devices to remote objects over a network" (Rouse, 2017)**.**

The relationship between the different systems is depicted in Figure 2. The horizontal axis shows the amount of information available on the vehicle and driving style itself, while the vertical axis shows the amount of information available on the driver himself (Husnjak et al., 2015)**.** Figure 1 shows a clear distinction between the current lump-sum insurance, self-reporting (miles) insurance, PAYD model and PHYD model. The blue box indicates the three innovative insurance systems which are currently on the market, in comparison with the lump-sum insurance which is depicted in the lower left corner of the figure.

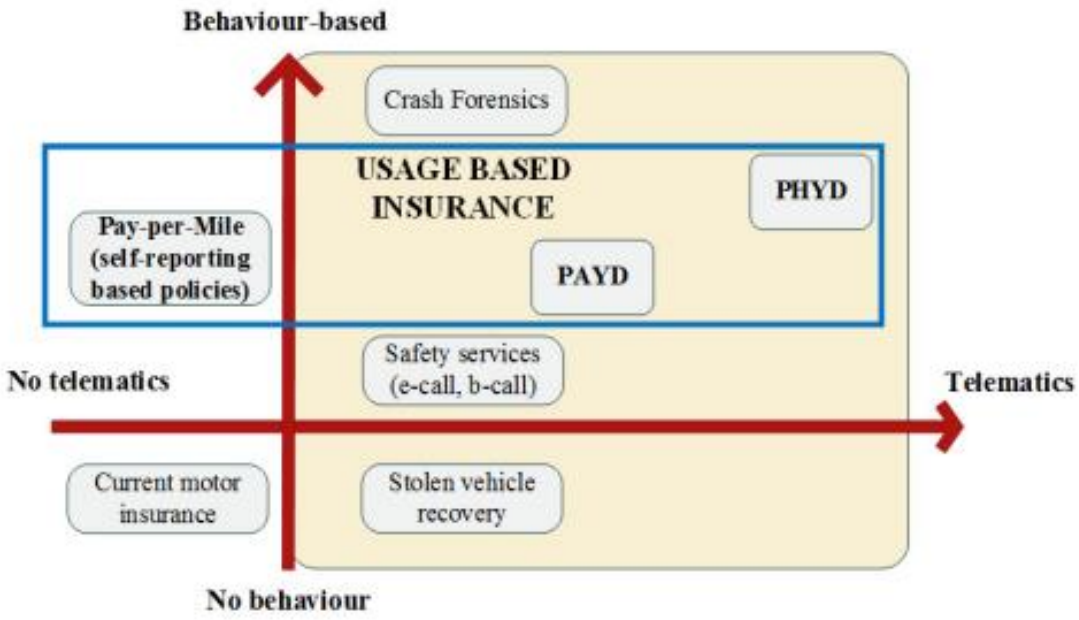

Figure 2: The variety of terms related to telematics solutions of car insurance (] Ptolemus Consulting Group, Usage-Based Insurance (Global Study), Free Abstract, 2013)

As can be seen from the graph, the PHYD model collects the most information about the vehicle and driving style, as well as about the driver himself. It includes the most parameters of importance to define a driver's risk, which produces the most information as a result. The PAYD model is situated in the semi-behaviour-based area of the figure, because it only takes into account the basic characteristics of the driver, including mileages, but without any influence of real-life driving behaviour. That is why PAYD and the self-reporting insurance are vertically on the same level, they both include mileages. Regarding the telematics axis, PAYD is depicted in the middle, because it only affects the information available on the vehicle including the amount

of miles driven. The information concerning the driving style is missing, which causes the gap on the horizontal axis between PAYD and PHYD.

2.3 UBI compared with traditional Lump-sum

When comparing the Lump-sum charging system with the UBI's, clear differences appear. In general, each driver could be assigned a probability of accident involvement based on his driving behaviour. Charging all drivers the same premium, could lead to the assumption that the accident probability is equal across the entire population of drivers. Evidently, this does not from a user optimum and socially equitable approach, as drivers with lower accident risk are forced to "subsidize" those with higher. In other words, safer drivers are forced to "buy" higher probability of accident risk than actually exists, unlike dangerous drivers who "buy" less. (Tselentis et al., 2016) Traditional insurance approach does not consider the exposure of a vehicle or the behaviour of a user and assigns to a specific vehicle and driver an "average premium" that corresponds to the "average driver" and consequently to an "average accident probability".

On the other hand, UBI is based on users driving behaviour evaluation and degree of exposure leading to a realistic estimation of the corresponding risk. The PHYD model incorporates a large number of parameters allowing the accurate estimation of the driving risk. The final outcome of the PHYD model can be an individual risk indicator that will depict the risk associated with the driving behaviour of a user (Tselentis et al., 2016). The same holds for the PAYD model, where the unit of exposure is changed into a variable one that reflects the number of miles driven. This also leads to a more realistic prediction of the corresponding risk instead of only focusing on the basic characteristics of the driver and his car.

However, when looking at this comparison from a broader point of view, where an insurance in general should act as a collective utility, a paradox could arise. The assumption that the accident probability is equal in case of a lump-sum system is made up from an individual perspective. From a social collective perspective, it could also be explained as a norm where the impact of accidents is shared among all drivers on an equal basis. A clear example of such a norm can also be found in the healthcare sector. In contrast with the lump sum theory explained above, the underlying idea in this case is to let the people with lower risks pay the same premium as the people with higher risks. That is because, the lower risk people, which are in that case the younger healthier people, once will also become older and will therefore be more frequently ill (higher risks). So in this case the "average premium" is not based on an "average probability", but on solidarity and reciprocity between age groups. Exactly the same principle could hold in case of the lump-sum car insurance, where the older safer drivers are

willing to subsidize the younger riskier drivers, because they know they may have been risky drivers too. It is imaginable this principle could influence the implementation of the UBI's and the acceptance by society. However, no research is done yet on the question whether this influence really exists.

On the other hand, an issue that arises concerning the notion of solidarity in this case is the amount of risk-indicating factors that you have influence on by yourself. Except from age, it is complicated to predict if someone has a high risk of getting ill. However as mentioned earlier, in the car insurance industry many more critical factors that are controllable, including usage-based ones, exist and can be measured. The question is if it is right to use these factors and determine a "fair" premium, or to hang onto the healthcare principle. So on one hand you could compare the healthcare insurance with the car insurance system, when defending the lump-sum premium. On the other hand it is doubtful whether this comparison should be based on one shared factor.

3. Data collection and constraints regarding security and privacy

3.1 Data obtainment

The most important component of the UBI model is the collection of driving data, simply because without this data it would not be possible to estimate a driver's behaviour on the road. Although the data is an unmissable factor, it should also be handled carefully with regards to the privacy of the customers. To retrieve possible constraints for the safety of the customers' privacy and consequently also for the implementation of the UBI, a detailed review is done on the data-collection of the relevant parameters.

In terms of the data collection process in the matter of UBI, data in most studies are recorded either by the vehicle's on-board diagnostics (OBD) or user's smartphone and transmitted to a central database for central processing and analysis (Boquete et al., 2010). According to a research of Ernst and Young, that is a global leader in assurance, tax, transaction and advisory services, the most reliable and secure offering is a black box. This contains a professionally-installed device that is permanently affixed to the insured vehicle. Another method mentioned in this study is information exchange through a Dongle, a device which is installed in the car by the insurer itself (EY, 2016), using the car's own sensors for measurement. So concisely there are four UBI technology offerings applicable.

Below in figure 2 the information flow of the data-collection process is depicted. Devices installed in the vehicle via OBD Interface, or professionally installed telematics devices, can collect data on driver behaviour as well as miles driven, and send them directly to motor insurance billing service providers. Collected data are generally transmitted to the central server where additional data on driving behaviour are being extrapolated. In the context of motor insurance billing based on usage, segmentation of existing technical solutions is needed (Husnjak et al., 2015). Thereafter, the information is sent to the insurance company that uses it to calculate the customer's insurance premium. At the same time the customer receives feedback on his or her driving behaviour from the datacentre. This could be an incentive for the driver to change or keep the way he or she is driving, depending on the kind of feedback.

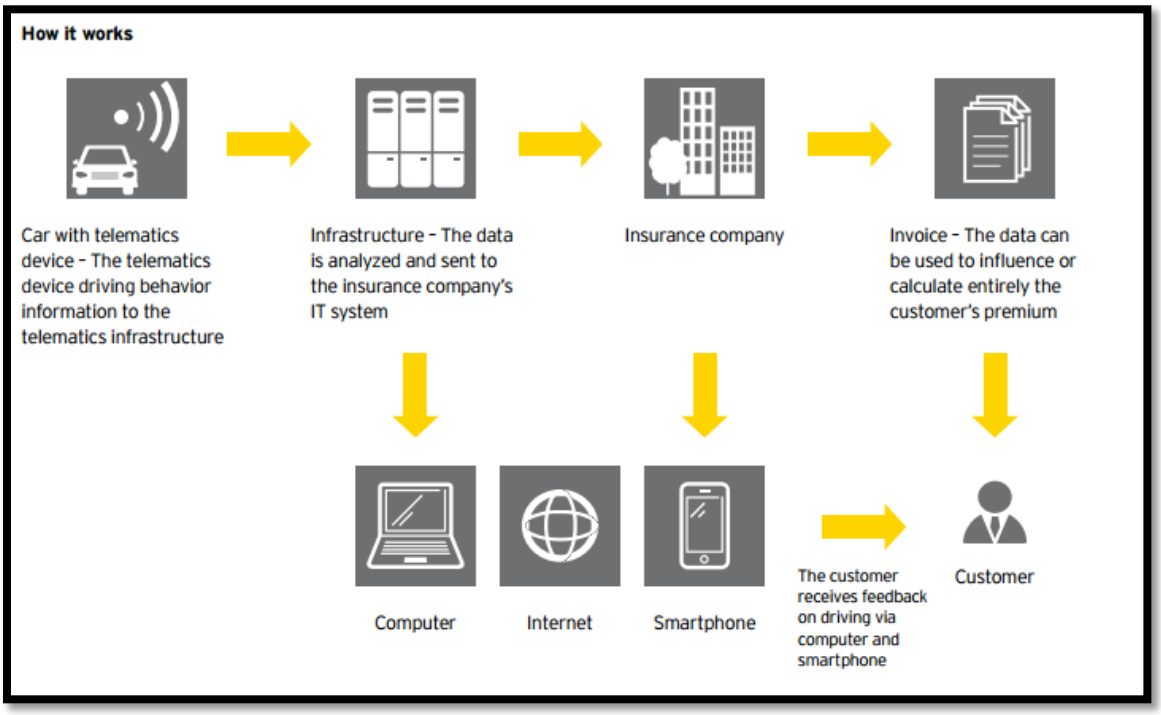

Fig. 2. The information flow of Usage Based Insurance (EY. (2016). *Introducing " Pay How You Drive " (PHYD) Insurance*.)

Because the biggest threats to confidentiality could be found at the external parties of the information chain, the architecture of the insurance company's IT system will be explained. To scoop out the processing architecture of the model, Figure 3 of a patent on the "System and method for automated risk-based pricing of a vehicle warranty insurance policy" is used.

Fig. 3 shows a block diagram of the processing architecture of the automated risk-based pricing system. The description linked to the figure of the patent is cited below. The numbers are referring to the different components of the architecture that have influence on the performance of the system.

> "In the processing architecture there is a vehicle warranty policy request input source (**26)** that receives the request for a vehicle warranty policy. The processor (**14)** receives the request from the input source (**26)** and uses a risk-based pricing algorithm obtained from an analytical tools unit (**28)** to determine a price for the request, as well as suggest terms and conditions for the priced policy. Using the risk-based pricing algorithm, the processor (**14)** partitions the vehicle listed in the request into a plurality of components that comprise its assembly. The processor (**14)** determines a correlation between the failure rates of each of the plurality of components and costs to repair the failed component with vehicle warranty related information contained in the plurality of databases (**16),** using various evaluation applications obtained from the

analytical tools unit (**28)**. As shown in Fig. 3, the databases comprise an environmental database (**30)** and a vehicle database (**32)**. The environmental database (**30)** contains environmental information for various geographic regions and the vehicle database (**32)** contains information on a variety of vehicles. The processor (**14)** uses each correlation to derive an expected cost of policy claims for the vehicle described in the request. The processor (**14)** uses tools from the analytical tools unit (**28)** to search a historical policy database (**34)** that contains a plurality of historical vehicle warranty policies for historical vehicle warranty policies that are substantially similar to the policy request. The processor (**14)** compares the derived expected cost of the policy request to the actual incurred costs of the similar historical vehicle warranty policies. If the expected cost is consistent with the historical data, then the processor (**14)** uses the derived expected cost. However, if the expected cost is not consistent with the historical data, then the processor (**14)** adjusts the derived expected cost to the historical policies. After checking the derived expected cost with the historical policies, the processor (**14)** then sets a policy proffer price along with suggested terms and conditions" (Osborn & Hershey, 2001, p.14).

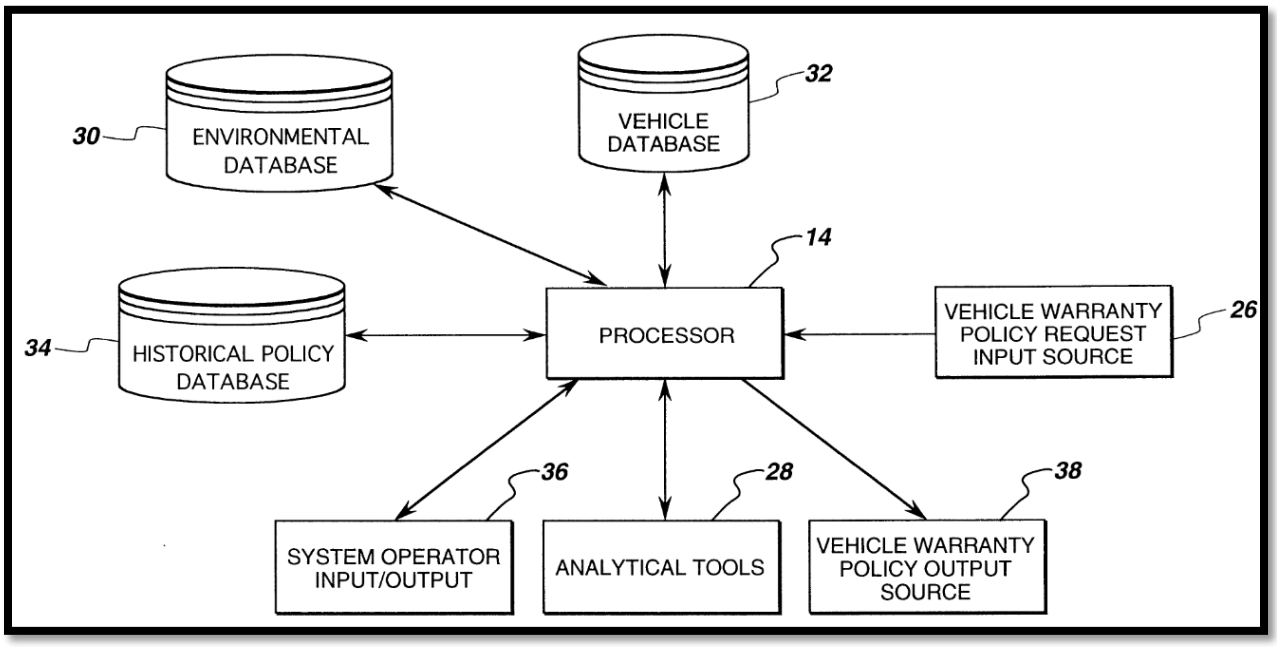

Fig. 3. The processing architecture of the automated risk-based pricing system (Osborn, B. E., & Hershey, J. E. (2001). (12) United States Patent.

3.2 Security constraints

Proceeding from the architecture explained in section 3.1, one of the security constraints could be appointed to the data processor. This main component of the system exchanges data about the consumer's driving behaviour with different databases. A good solution would be to not exchange that data at all, but to calculate the scores in the car and only communicate the scores. However, the feasibility of this solution is doubtful, because no insurance companies yet use local calculations for their driving scores. So, to protect this big amount of data, the insurance company is responsible to include a safe environment on data exchange in the model. Regarding the data-flow between the processor and the databases, public key cryptography can be used for ensuring safe communication. All on board computing devices as well as the insurer entity have a public/private key pair. The public key of the insurer is used to send messages from the vehicle back to the insurer securely; this message is also digitally signed by the vehicles system for non-repudiation (Paper, Lim, & Lim, 2006).

Another threat concerning the total architecture depicted in Fig. 3 could be an outside attack. Particularly the location-based data is sensitive for abuse. Hackers can for example extract burglary-sensitive information and find out where a driver lives and whether he or she is at home. A solution for this privacy concerning threat could be an anonymous way of location-based data exchange. For example, a study of the department of computer science at a University in Singapore invented a "Location Diversity" concept, which focuses on the enhanced privacy protection in location based services. (Xue, Kalnis, & Pung, 2009)**.** However, research supported by the IBM Cyber Security Center of Excellence at the Ben-Gurion University of the Negev, showed that it is possible to gather personal data without using the drivers' location (American Associates, Ben-Gurion University of the Negev, 2017). So it can be stated, independent of using location-based data or not, the chance that private information will be uncovered when using connected vehicle networks will increase.

In addition, the third technical snare concerns the matching process between driver, data and car. In practice, where the data is automatically linked with the car because of the device installed, a connection between the car and its driver and so indirectly between the data and driver is missing. This means 5 different drivers can produce different behaviour based data in the same car for one insurance, without the system noticing it. With respect to the business aspect of UBI, this could lead to a serious decline of the target group for the UBI market. For example, the lease volume has doubled in the last five years, suggesting that the automotive market could be on the verge of a fundamental shift in consumer mind-set about the value of owning a new vehicle -- particularly when the purchase has to be financed (Edmunds, 2016). To

respond to such a transformation, insurance companies should include a flexible privacy policy with possibilities to link a usage based insurance to a driver instead of a car. Especially in the case of cars leased regarding business, one car can have multiple drivers in a relatively short period. Although it depends on who pays, the company of the employee itself, a possible solution would be a login-account for each user of the insurance. This will prevent external influence on someone's usage based premium.

3.3 Privacy constraints

When focusing on privacy, the definition of it according to Alan Westin could be kept in mind:

"Privacy is the claim of individuals, groups and institutions to determine for themselves, when, how and to what extent information about them is communicated to others" (Westin, 1967, p.1).

To successfully implement the UBI in the insurance market, it is not only important that the insurance companies know their system is reliable and safe themselves. The biggest challenge is to convince their possible customers from safety and prevent privacy fears. According to Westin's definition, they need to be aware of the amount and sort of data that will be shared with the insurance company. By law, every company is required to inform their customers about what sort of data is used to perform their business. For example the ANWB mentions on their webpage that they meet with the requirements stated in the Personal data protection act.

Partially the convincement can be reached through providing clear information about the procedure of the data-obtainment. Although, the customer should also place trust in the respective insurance-company. An attempt of winning this trust and actually explaining their requirements in a practical way, can also be found on a webpage of the ANWB. It describes exactly for which objectives a consumers' personal data is used for, but more important, it also explains the subjects your data will definitely not be used for. For example, it is stated that the ANWB will not use your data as a speeding camera and will not reject your insurance claim if you drove above the speed limit (ANWB, 2017).

So even though users of UBI could know to what extent information about them is communicated, customers could still see the UBI service as a violation of their privacy and therefore probably will not accept the insurance terms. The difficulty in this case, referring back to Westin's definition, is the fact that consumers cannot determine when, how and most importantly to what extent their information is communicated to others. So despite of being aware, determination is the missing value.

However, trust can still be seen as very subjective factor, which means it is hard to rely on concerning the performance of UBI. Several studies showed that the determination Westin is referring to, which causes the privacy fears, actually can be forgotten when the economic incentive for consumers is just high enough. A quantitative study about understanding towards the mitigating effect of perceived usefulness and monetary rewards on privacy concerns regarding the likelihood of use for mobile insurance services showed this (Derikx, 2014). By performing an assessment survey, it answered the question: “How much monetary benefits are required to buy off mobile insurance related privacy concerns?” The assessment proved that privacy can be seen as a tradable interest, because it shows that respondents are in favour of selling their privacy for a quite low monetary compensation per month (Derikx, 2014). So, theoretically, the optimal solution to decrease the privacy fears to a minimal level, would be an individual estimation of the value of privacy of each driver. Nevertheless, this solution is currently unachievable in practice because of the amount of effort. An average estimation of the value of privacy could be a precious alternative. Important to notice is that this solution does not take into account the revenue-part of the UBI, where the discounts cannot exceed the amount of cost savings. This assumes a certain scale should be determined to do so.

4. Advantages and disadvantages of using UBI

As explained in previous chapters, several privacy and security concerns play a significant role in the implementation process of UBI. However, many other important advantages and disadvantages exist for the different parties involved regarding the feasibility of the implementation. In this chapter the advantages and possible disadvantages of the UBI for every stakeholder will be discussed.

4.1 Consumers

4.1.1 Advantages

Consumers need to be convinced of the benefits a Usage Based Insurance has to offer. Telematics-based UBI programs offer several potential consumer advantages. The most obvious advantage for drivers is a decrease of, or discount on their insurance premium. Premium reductions can come from the insurer's participation discounts, improved driving performance, and elimination of cross-subsidy by mileages or voluntary reductions in mileages driven. According consumer surveys, getting discounts and controlling premiums are the main reasons for consumers to participate in a UBI (Soleymanian, Weinberg, & Zhu, 2016). According to the 2014 Annual LexisNexis Insurance Telematics study, 78 percent of respondents cited discounts as an incentive to adopt Telematics insurance programs. Seventy-four percent cited the ability to control their auto insurance costs as an incentive (LexisNexis, 2014). In addition, the elimination of cross-subsidy increases the affordability for lower mileage drivers, resulting in a 28% average reduction in premium (Soleymanian et al., 2016).

However, the economic incentive is not the only motivation for consumers to improve their driving behaviour. The improvement occurs also because consumers respond to feedback from a telematics device. That is, drivers will learn and improve their driving performance by getting daily feedback on different factors (mileage, number of hard brakes, UBI score, etc.) even without an economic incentive (Soleymanian et al., 2016)**.**. So when not taking the lower premiums into account and just focusing on the improvement of driving behaviour, this can be seen as a significant advantage for the consumers on its own. The only limitation of this advantage is that the consumers should realize how important safe driving is, without thinking about the lower bills.

4.1.2 Possible disadvantages

Except from the privacy fears mentioned earlier, literature barely shows strong opposing reasons for consumers to participate in a UBI program. A usage based insurance consumer survey of Towers Watson shows that 79% is interested in buying a UBI policy in the US, without any concerns. This percentage increases to nearly 90% when there is no risk of increased premiums. Therefore almost no UBI products exist in the U.S that increases premiums based on driving data. It also states that the biggest part of this group interested in UBI are willing to improve their driving behaviour (Towers Watson, 2013). So, the only group consumers that would be harmed by the UBI are the risky drivers who are not willing to adjust their driving style and therefore will be rejected by the insurance company and pay a higher premium. Also in the Netherlands, the ANWB first pulls back the discounts and give drivers the opportunity to improve their driving style within 30 days. No improvement will result in an ending of the consumer's UBI by the insurer (ANWB, 2017). However, the consumers that are self-assured of their aggressive driving style and are not willing to improve, probably would not participate in a UBI program and hold on to the lump-sum insurance. The ones that are not self-assured of it will discover it by losing discounts and afterwards improve, or they will be rejected and switch back to the lump-sum insurance as well. So as long as it takes to fully implement UBI, risky drivers will only suffer from a higher premium compared to UBI.

4.2 Insurance company

4.2.1 Advantages

UBI programs also offer many advantages to insurers, mostly based on cost-savings. These cost-savings in general can be explained from the revenue-model of the UBI programs. Because the UBI system allows insurers to monitor driving behaviour, they can link insurance premiums more closely to actual individual vehicle or fleet performances and so price premiums more accurately. Those more accurate premiums give insurers the opportunity to offer discounts to consumers with safe driving behaviour. As mentioned earlier, the discounts offered are a strong economic incentive to at least keep driving behaviour at the same safe level or even improve it. This causes on average a safer driving environment, which means fewer accidents occur. Fewer accidents mean fewer claims, which results in less indemnities and so cost-savings.

Important though at this revenue model is the distinction between the amount of discounts offered by the insurer and the amount of savings, caused by a decrease of claims. If the value of the discounts would be higher than the value of the prevented claims, the cost-saving

revenue model described above would not hold. That is why insurers should not only focus on the level of safe driving at one moment in time, but constantly adjust premiums in relation to changed driving behaviour. This allows the insurers to correct risk misclassifications (EY, 2016).

Besides, when focusing on the position of the UBI companies in the entire car insurance market, the insurers also gain several competitive advantages. First, insurers can identify their lowest-risk drivers, raising retention levels for preferred risks. Secondly, they could gain from product differentiation. Because not all consumers will immediately be convinced of the advantages of the UBI program, it is reasonable to expect the insurance companies will both offer the traditional lump-sum insurance and the UBI as separated products. A practical example of this brand differentiation can be found at the “ANWB”, a Dutch insurance company that already has implemented the UBI in their product segment. Drivers already associated with the insurer can choose whether they keep their lump-sum insurance or switch to the UBI, which means no clients leave because of forced insurance policy changes. Thirdly, early corporate adopters will have a competitive advantage regarding the driving behaviour data they collect. It is hard for competitors who do not have this data to price their products as good as the UBI Company. At last, consumers who already bought a UBI will experience a low incentive to switch to another one, because they would need to be monitored again to earn a discount, not knowing whether this discount will be higher than the one they had (LexisNexis, 2014).

4.2.2 Disadvantages

According to an interview with a project manager of Allianz, an insurance company that did specific research on UBI, the distinction between discounts and amount of savings as discussed above could also be seen as an important limitation with regards to the implementation of the UBI in certain countries. These countries, for example The Netherlands, have one thing in common: their car insurance market is extremely competitive. Because of that, the premiums offered in case of the traditional lump-sum insurances are very low. This means insurers already have a very low profit margin, even without any discounts charged. As already discussed, UBI will also cause cost-savings, but because it is a new business plan in these countries, it is difficult to make predictions that assure financial certainty. Although profit should not be the main purpose from the beginning when implementing UBI, also according Allianz, it is a factor that definitely should be taken serious. For sure, when looking at the investments the insurance company has to make to perform their business plan. They need to invest in a telematics platform, data-analysing technology, software and storage room. Because the biggest part of

this investment can be seen as sunk costs, and the profit margin of the UBI is hard to predict, it is an irreversible decision that could have enormous negative consequences when failing. These investments in combination with the low profit margins could explain the lack of implemented UBI's for countries with a competitive car insurance market.

To validate the contrast with countries in a less-competitive insurance market, a research in which a database from an US insurance company is used, can serve as a clear example. This research proved the fact that insurers can improve their profits, even when the costs of the program and the discounts are taken into account (Soleymanian et al., 2016).

4.3 Society & environment

Besides the two main stakeholder of the UBI program, society and the environment are also important parties that could definitely benefit from the changes the UBI causes. In the first place, the reduction of accident frequency would cause a decrease of fatalities. For example, a study in the Netherlands showed that if PAYD were to be implemented, total crash reduction could be reduced more than 5% leading to 60 less fatalities as well as 1000 less injured each year in the Netherlands (Tselentis et al., 2016). This reduction is only based on the "mileage-part" of the UBI, without taking the behavioural consequences into account. Imagine that the impact of the total UBI program on the reduction of fatalities would be even bigger. Although saving lives can be seen as the most important reason to reduce accidents, certain costs regarding security services, road maintenance and traffic jams will also decrease as a consequence of the accident reduction. In the Netherlands for example, the total costs of 1 fatal car accident are on average 2.6 million euros, including traffic jams, material and immaterial damage, medical costs, loss of production and settlement costs (SWOV, 2014). So when using the reduction of 60 fatalities as mentioned above, only a mileage based insurance could already save 156 million euros on accident costs, resulting in a decrease of 1.25% in yearly accident costs. Furthermore, the reduction of mileages driven is not only an advantage for consumers. Limited vehicle usage and fuel-efficient driving behaviour will also reduce fuel consumption, resulting in a decrease of CO_2 emissions and energy consumption (Husnjak et al., 2015).

From an economic perspective, some parties could suffer from the safer driving behaviour. For example, a reduction in car accidents also mean fewer visits at the car-repair shop or in case of bigger accidents the procurement of a new car. Depending on the level of accident reduction, maybe even the labour market for security services could be effected negatively. No clear research is done yet, but if UBI will replace the lump-sum insurance entirely, this could have a negative influence on the future automotive market and labour market for security services.

4.4 Overview

The two tables below give an overview of the different advantages and disadvantages of using UBI as discussed in chapter 4. These will be used to determine the positive and negative factors that have influence on the implementation of UBI in the car insurance market of today, as described in the problem statement.

Advantages

Stakeholder	Description
Social benefits	- Fewer accidents → decrease of injured drivers and fatalities through: o Reduction of mileages driven o Improved driving performance - Decrease of accident costs including costs of traffic jams, material and immaterial damage, medical costs, loss of production and settlement costs.
Environmental benefits	- Decrease of CO2 emissions and energy consumption through: o Limited vehicle usage o Fuel-efficient driving behaviour
Benefits for insurance companies	- Cost-savings through: o Pricing premiums more accurately o Fewer accidents → fewer claims → less indemnities - Competitive advantages o Identify lowest-risk drivers o Product differentiation: lump-sum insurance & UBI o Collected driving behaviour data o Low incentive for consumer to switch
Benefits for consumers	- Decrease of insurance premiums by: o Participation discounts o Improved driving performance o Elimination of cross-subsidy by mileages o Voluntary reductions in mileages → lower fuel costs - Improved driving behaviour by getting daily feedback

Table 1: *Description of different advantages for using UBI, categorized per stakeholder.*

Disadvantages

Stakeholder	Description
Social disadvantages	- Accident reduction could cause a decrease in demand for: o Purchasing a new car o Automobile repairs o Security services
Disadvantages for insurance companies	- Financial risks caused by o Low profit margin because of competitive market o Hard to predict demand for UBI o Big investments in technology
Disadvantages for consumers	- Rejection by UBI insurance company because of risky driving behavior → pay higher premium for lump-sum compared to UBI - Being forced to improve driving behavior

Table 2: Description of different disadvantages for using UBI, categorized per stakeholder.

5. Conclusion and recommendations

5.1 Conclusion

This research focused on the positive and negative factors that could have significant influence on the implementation of a Usage Based Insurance into the car insurance market of today. The findings of this research implied many potentials for both drivers and insurance companies to implement the system and showed that UBI is preferred instead of the lump-sum insurance. Regarding this preference, the solidarity and reciprocity between consumers as they hold in the healthcare insurance is not experienced as a limitation, so far. The biggest incentives for UBI are financially, resulting in lower premiums for consumers. The discounts are based on participation, driving behavior and mileages driven. Insurance companies can realize cost-savings because of less indemnities and by pricing premiums more accurately. In addition, a reduction in accidents caused by the UBI has positive consequences for both stakeholders, as for society and the environment. Accident costs will decrease as well as the CO2 emissions. In spite of these potentials, the digital transformation from the lump-sum insurance towards a usage based insurance is going slow. Insurance companies should guarantee the security of collected driving behavior data by using local calculations for driving scores, public key cryptography and improving the matching process between driver, data and car. However, the biggest challenge for insurance providers is to prevent privacy fears by consumers. Because they cannot determine to what extent their data is being collected, trust in the UBI should be reached. This can be accomplished by providing clear requirements, but most important by offering enough monetary benefits in return. In countries with a competitive insurance market, these benefits, in combination with big investments in technology and difficulty in predicting demand, could result in financial uncertainty in the UBI system by insurance providers. So the fact that most savings are passed back to the consumers can actually be seen as an advantage to convince consumers, but at the same time as a limitation to implement UBI. It is up to the insurance market to get rid of the limitations they experience and try to successfully implement the UBI system.

5.2 Recommendations

The outcome of this literature review leads to new actions, which particularly need to be taken by the insurance company, to eliminate the negative factors of UBI and remain positive ones for every party involved. To get rid of uncertain revenues and doubtful demand for use at the same time, they could try to convince the government to subsidize in the UBI project. They can use the benefits of UBI, especially the ones regarding the environment and society, as valuable arguments. The subsidies can be used for pilot projects to do better predictions in demand and the quality of data collected, or to contribute in certain investments. An additional benefit of subsidy could be the exposure of UBI to consumers.

Regarding all benefits discussed in the previous chapters and the fact some countries have already implemented UBI successfully, the question is not if it will be fully implemented but when it will happen. Therefore insurance providers should use long-term thinking and accept possible short-term losses. The earlier they adopt UBI, the more they can benefit from competitive advantages.

Towards a critical point of view, it should be mentioned that certain parameters such as use of alcohol, vehicle maintenance condition and vehicle safety rating are not included in the insurance schemes so far, whereas these parameters can have influence on the corresponding risk of a driver too (Tselentis et al., 2016). The same holds for impulsive steering actions or hard braking, in case of emergency situations like for example a child crossing the streets. To improve the accuracy of the risk and create an optimal rate based on all possible parameters, research should be done to implement these parameters in the UBI as well.

References

- American Associates, Ben-Gurion University of the Negev. (2017, April 7). Driver privacy can be compromised in usage-based insurance systems. *ScienceDaily*. Retrieved May 17, 2017 from www.sciencedaily.com/releases/2017/04/170407132744.htm
- ANWB. (2017). ANWB veilig rijden. Retrieved from https://www.anwb.nl/verzekeringen/autoverzekering/veilig-rijden
- Bian, Y. (2005). Personalized Vehicle Insurance : Driving Behavior Matters, (Vlakveld 2005), 1–10.
- Boquete, L., Rodríguez-Ascariz, J. M., Barea, R., Cantos, J., Miguel-Jiménez, J. M., & Ortega, S. (2010). Data acquisition, analysis and transmission platform for a Pay-As-You-Drive system. *Sensors*, *10*(6), 5395–5408. http://doi.org/10.3390/s100605395
- Butler, P., Butler, T., & Williams, L. L. (1988). Journal of Insurance Regulation. *Journal of Insurance Regulation March*, *6*(4).
- Clarke, D. D., Ward, P., Bartle, C., & Truman, W. (2006). Young driver accidents in the UK: The influence of age, experience, and time of day. *Accident Analysis and Prevention*, *38*(5), 871–878. http://doi.org/10.1016/j.aap.2006.02.013
- Dean, A., Moreland, C., Ohio, H., & Heinen, J. P. (1998). (19) United States Patent.
- Derikx, S. A. J. . (2014). *Mobile Insurance*.
- Edmunds. (2016). Number of Leased Vehicles Reaches All-Time High in First Half of 2016, Says Edmunds.com. Retrieved from https://www.edmunds.com/about/press/number-of-leased-vehicles-reaches-all-time-high-in-first-half-of-2016-says-edmundscom.html
- EY. (2016). *Introducing " Pay How You Drive " (PHYD) Insurance*.
- Factor, R., Mahalel, D., & Yair, G. (2008). Inter-group differences in road-traffic crash involvement. *Accident Analysis and Prevention*, *40*(6), 2000–2007. http://doi.org/10.1016/j.aap.2008.08.022
- Husnjak, S., Peraković, D., Forenbacher, I., & Mumdziev, M. (2015). Telematics system in usage based motor insurance. *Procedia Engineering*, *100*(January), 816–825. http://doi.org/10.1016/j.proeng.2015.01.436
- Koushik, S., & Mehl, D. R. (2015). The Automotive Industry as a Digital Business. Retrieved from www.nttdata.com/de
- LexisNexis. (2014). 2014 Usage-Based Insurance (UBI) Research Results for Consumer

and Small Fleet Markets, (August).
- Litman, T. (2005). Pay-As-You-Drive Pricing and Insurance Regulatory Objectives. *Journal of Insurance Regulation*, *23*(3), 35. Retrieved from http://www.vtpi.org/jir_payd.pdf
- Litman, T. A. (2011). Pay-As-You-Drive Pricing For Insurance Affordability. *Victoria Transport Policy Institute*, *10*(June), 19. Retrieved from http://www.vtpi.org/payd_aff.pdf; Abgerufen am 17.03.2012
- Masseran, V., Parreiras, A., Maria, A., Antunes, D. S., & Lowe, L. (2013). Proposal of an Observatory of Trends for Nanotechnology in the C ontext of Technology Management in an Oil and Gas R & D Center – Case : Nanotechnology, *8*(4), 68–78. http://doi.org/10.4067/S0718-27242013000500006
- Osborn, B. E., & Hershey, J. E. (2001). (12) United States Patent. http://doi.org/10.1145/634067.634234.
- Paper, C., Lim, S., & Lim, S. (2016). A privacy preserving GNSS based Pay as You Drive insurance scheme A Privacy Preserving GPS-based Pay-as-You-Drive Insurance Scheme, (January 2006).
- Rouse, M. (2017). Telematics. Retrieved from http://searchnetworking.techtarget.com/definition/telematics
- Soleymanian, M., Weinberg, C., & Zhu, T. (2016). The Value of Usage-Based Insurance beyond Better Targeting : Better Driving, 1–45.
- SWOV. (2014). Kosten van verkeersongevallen. Retrieved from https://www.swov.nl/feiten-cijfers/factsheet/kosten-van-verkeersongevallen
- Towers Watson. (2013). Usage Based Insurance Consumer Survey: Understanding What Consumers Want. Retrieved from https://www.towerswatson.com/DownloadMedia.aspx?media=%7B7B1AF5A1-3E67-4458-9FC6-9FAD4615A49A%7D
- Tselentis, D. I., Yannis, G., & Vlahogianni, E. I. (2016). Innovative Insurance Schemes: Pay as/how You Drive. In *Transportation Research Procedia*. http://doi.org/10.1016/j.trpro.2016.05.088
- Xue, M., Kalnis, P., & Pung, H. K. (2009). Location diversity: Enhanced privacy protection in location based services. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, *5561 LNCS*, 70–87. http://doi.org/10.1007/978-3-642-01721-6_5