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Telematics System in Usage Based Motor Insurance

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Abstract

For the premium calculation and billing process in the motor insurance, current billing models are very general and not optimally tailored for the end users. Important parameters such as mileage, driving behavior and types of roads driven are not considered for the premium calculation. Development of advanced information and communication systems, significant drop in the technology cost of ownership, as well as the necessity for market differentiation in the insurance industry, facilitated the appearance of new billing models in the motor insurance industry. The purpose of this paper is to demonstrate underlying principles of the technology facilitating new billing models in the motor insurance industry. This paper gives an overview of the system architecture of one of the telematics systems offered and used on the market, as well as the data model used in the billing process. The potential of such a system is demonstrated through the real case project implemented in Eastern Europe.

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Keywords: Usage Based Insurance; Pay How You Drive; Pay As You Drive; Insurance Telematics; Motor Insurance Billing

1. Introduction

1.1. Importance of telematics-based insurance

Insurance industry, at least when it comes to motor insurance, reached its mature lifecycle stage. Fierce competition and lack of product differentiation are leading to significant revenue reduction for majority of incumbent and established Insurance companies in the market. Especially when it comes to less developed markets,

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where Motor Insurance is the most important part of the product portfolio, this imposes significant risk for business sustainability.

Insurance companies may suffer loss of revenue [1, 2], primarily because of two reasons. Firstly, the prices on these markets are likely to plunge [18]. Secondly, pricing is not consistent with individual risk [2]. For example, there are people who drive 35.000 Km per year and pay the same price like people who drive less than 10.000 per year. This has led to a change in the paradigm of traditional insurance policies by offering new usage-based insurance (UBI) policies.

UBI is based on a myriad of data such as mileage, speed, location, time, total duration of trip, G-force, etc. extrapolated from telematics devices. This data can be predictive and companies could gain competitive advantage by analysing drivers' behaviour [1]. UBI products are still new on some markets, and to introduce it to their respective markets, insurance companies will have to put a lot of effort to increase the adoption of UBI [20] [21]. In contrast to developed markets, the emerging markets such as Eastern and South Eastern Europe are constrained to limited UBI activity but emerging interest [1].

In the next few years, the number of insurance telematics subscribers will grow at a compound annual grow rate of 90% from 1.85 million in 2012 to 89 million in 2017 [6]. For example, only Croatian market is expected to ensure 39.000 telematics based policies, whereas Slovenia only up to 25.000 telematics based policies by 2018 [18]. This data suggests that insurance operators are likely to benefit from these emerging markets.

Therefore, ongoing questions and perspectives on implementing UBI need to be extended beyond the developed markets, by including emerging markets like Eastern and South Eastern Europe. Recent evidence suggests that early movers will make the greatest benefit [3].

1.2. Importance of rich telematics data

Telematics data is used to determine the policyholder's vehicle insurance premium [28]. Insurance companies require richer data to quantify risk more precisely and understand driver's behaviour [7]. It's crucial for insurance companies to differentiate these data and that their UBI systems collect the right telematics parameters. In addition, this could allow insurance companies to improve their billing methods by aligning individual price and risk more precisely.

Insurance telematics depends on the accuracy of the received GPS (Global Positioning System) data from the telematics device. Various environmental factors such as atmospheric effects, sky blockage, etc. may cause a certain noise in the accuracy and reliability of a GPS data. This could cause relevant revenue-loss risk to insurance company.

Additionally, contextualization of the received telematics data is significant aspect of ensuring precise and reliable data for delivering customized policies. The context refers to the environmental factors such as location where certain events occurred, conditions on the road, weather conditions, and their overall contribution to risk. The environmental factor has been identified as fundamental for the latest UBI generation and better understandings of driver's behaviour [7].

For example, it would be quite easy to explain why breaking events on a crowded highway are more risky than breaking events on some local road. But it could be difficult to explain other types of events with different environmental characteristics [7]. Therefore, it is necessary to implement UBI system that could differentiate such events and provide more precise information to insurance companies for billing purposes.

Therefore, to extend the understandings of driving behavior, it is necessary to make rich data available to insurance companies. As a result, insurance companies may not only measure traditional telematics parameters (mileage, speed, acceleration, breaking events, etc.), but also measure how people actually drive and analyze driver's behavior more precisely by contextualizing received data [7]. The use of more refined data leads to an improved method for determining the cost of insurance that reduces rating errors that arise from the grouping of drivers into general actuarial classes [27].

1.3. The next-generation solution for telematics-based insurance

Various UBI solutions have been implemented worldwide such as [8], [9], [10], [11], [12], [13], [14], [15], [16], [17] and [22] provides comparative analysis of 24 main UBI solutions. The main disadvantage is that these solutions have tendency to analyze only traditional telematics parameters for assessment of the driver's behavior. Table 1 contains summarized list of these UBI solutions and their key features.

Table 1. Summarized list of UBI solutions implemented worldwide.

Insurance company	Country	Name of the UBI program	Insurance concept	Technology platform	Data transmission
AIOI [8]	Japan	Pay as you drive	Distance-based vehicle insurance	G-book (telematics subscription service provided by Toyota Motor Corporation)	Mobile data service
Aviva [9]	Canada	Autograph	Insurance is based on traditional telematics parameters with several levels of risk within 24 hour period.	Device connected to vehicle diagnostic port	Universal serial bus
AXA [10]	Italy	Autometrica	Distance-based vehicle insurance	GPS-based	Mobile data service
Generali [11]	Italy	Protezione Satelitare	Insurance is based on traditional telematics parameters	GPS-based	Mobile data service
AXA Winterthur [12]	Switzerland	Crash Recorder	Recording events	Event-data recorder	Data retrieved from event-data recorder
MAPFRE [14]	Spain	YCAR	Insurance is based on traditional telematics parameters with several levels of risk within 24 hour period.	GPS-based	Mobile data service
RSA Insurance Group [15]	United Kingdom	More Than Green Wheels Insurance	Insurance is based on traditional telematics parameters with several levels of risk within 24 hour period.	Device connected to vehicle diagnostic port	Mobile data service
Uniqa [16]	Austria	Safeline	Insurance is based on traditional telematics parameters with several levels of risk within 24 hour period.	GPS-based	Mobile data service
WGV [17]	Germany	Young & Safe	Insurance is based on traditional telematics parameters with several levels of risk within 24 hour period.	GPS-based	Mobile data service

Furthermore, UBI solutions such as in Canada [9] and Spain [14] are taking into consideration several level of risk during 24 hour time period. This approach may suffer from a plethora of pitfalls, thus causing bias in aligning individual risk and price. This is because, for example, breaking events during rainy night could contribute more to overall risk than breaking events during a sunny day. Therefore, it is necessary to analyse more contexts in which certain events occur.

Many current UBI solutions may cause inconsistency in aligning price and individual risk. Moreover, most of these previous systems have failed to include the environmental factor to contextualize telematics data more precisely. Environmental factor is fundamental for the next-generation UBI.

The aim of this paper is to provide an overview of the technical solution with data model for collecting, communicating, managing, and analysing very high volumes of UBI telematics data. To validate our model, we conducted preliminary small-scale study on a 22 participants. In addition, a parallel research has recently been started on a larger sample in Eastern Europe by the authors in collaboration with a major company in the field of UBI - Amodo Ltd.† and insurance consultants.

We think that our findings on UBI might be useful for drivers and insurance companies. This could potentially lead to motivate good driving behavior, resulting in lower insurance rates for good drivers. Insurance companies could reduce the average claim frequency after 1 year up to 30% [19]. An additional important implication is encouragement for replacing traditional insurance policies on emerging markets especially when there's evidence that early movers will generate the greatest benefit [3].

2. The new paradigm of motor insurance billing

Billing of the motor insurance policies based on the usage, appears in the literature under acronyms such as: UBI (Usage Based Insurance), PAYD (Pay As You Drive), PHYD (Pay How You Drive), MHYD (Manage How You Drive) or PHHYD (Pay How and How much do You rive). The basic characteristic of all these acronyms is billing of motor insurance products based on new sets of information such as: miles driven, time of the day and driving behaviour as well as others.

2.1. Definition of terms and models

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. Relationship between different systems is depicted in Figure 1. 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.

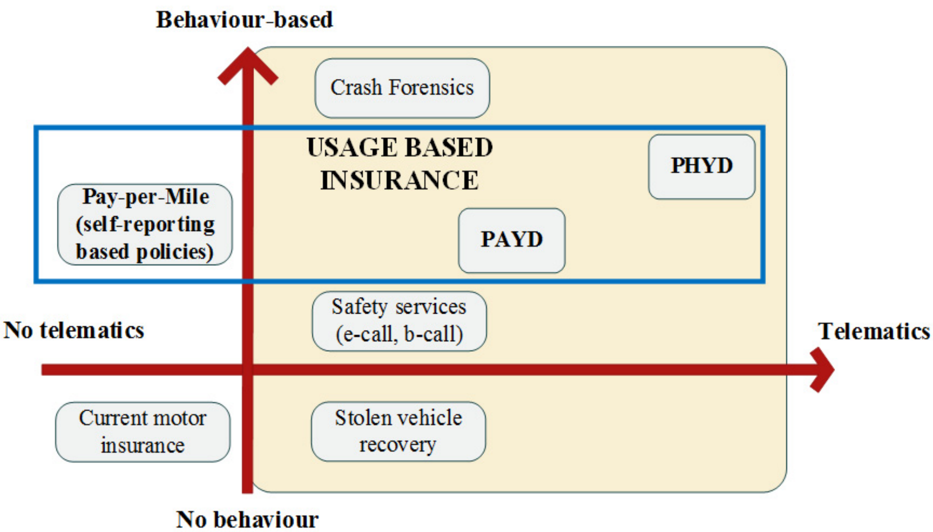

Fig. 1. The variety of terms related to telematics solutions of car insurance, [4].

Reference [4] shows that today UBI offerings are based on a various range of pricing models:

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- Self-reporting based insurance: the premium is calculated based on the driver's report of its mileage
- Pay-As-You-Drive (PAYD) - also called Pay-As-You-Go (PAYG): a device in the vehicle sends mileage data to the insurance company. The premium is entirely or partly mileage-based (Sometimes combined with time and location data)
- Pay-How-You-Drive (PHYD): a device in the vehicle sends driving style data to the insurance company. The premium evolves with the driver's risk rating

Devices installed in the vehicle via OBD (on-board diagnostics) Interface, or professionally installed telematics devices, collect data on driver behavior 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. Collection of vehicle data, driving behavior data and all related parameters is basis of every telematics system. Telematics system enable data collection from all sensors and location data.

Some of the most common devices collecting this data from the car can be categorized in a) aftermarket professionally installed devices (black box devices), b) aftermarket self-fitted devices usually plugged into OBD Interface (OBD dongles), c) OEM devices installed during the manufacturing process d) Smartphones.

OEM devices installed during the manufacturing process represent available solutions in a way that car manufacturers in their vehicles install pre-defined telematic devices. Smartphones and applications, also allow data collection from the vehicle. Some of these applications do not connect with the vehicle, however in such a case collected data are not that precise afterall. The other kind of applications can be connected with the vehicle, collect the data from the vehicle, but also location data.

2.2. Benefits of using UBI

UBI programs offer many advantages to insurers, consumers and society. Linking insurance premiums more closely to actual individual vehicle or fleet performance allows insurers to more accurately price premiums. This increases affordability for lower-risk drivers, many of whom are also lower-income drivers. It also gives consumers the ability to control their premium costs by incenting them to reduce miles driven and adopt safer driving habits. Fewer miles and safer driving also aid in reducing accidents, congestion, and vehicle emissions [26].

Independent of the UBI program, UBI value is immanent not only for the user, but also for the entire ecosystem as shown in Table 2. The strengths of these technologies dominate over its weakness by far.

Table 2. Categories and description of the advantages of using UBI program, [4, 5].

Benefits	Description
Social benefits	Reduce accident frequency and severity; reduce accident response time; track and recover stolen vehicles; establish fault to improve equity in settling claims; reduce driving, pollution, traffic congestion and energy consumption
Economic benefits	Reduce chance of accidents; enhance efficiency of claims processing ; enable early detection and prevention of frauds; enable pricing based on risk profiles
Environmental benefits	Increase use of congestion-free routes and limit vehicle usage; reduce fuel consumption; limit the use of vehicle; improve vehicle maintenance; reduce CO2 emissions
Benefits for insurance providers	Correct risk misclassifications; enhance pricing accuracy; retain profitable accounts; fight fraudulent claims; enable lower premiums; reduce claim costs; differentiate brand
Benefits for users	Reduce premiums; demonstrate safe driving habits following an accident; value-added services (vehicle diagnostics, stolen vehicle recovery, emergency services, teen driver monitoring etc.)

3. Real life telematics system implementation

Vehicle telematics is the technology of sending, receiving and storing information about vehicles using information and communication technology [24]. Vehicle telematics is based on M2M (machine-to-machine) communication and represents the exchange of data between remote devices using wired and/or wireless communication network for telemetry and remote control [23]. Availability of computer processing power and network connectivity in cars and mobile terminal devices has led to an explosion of available applications and services for users [25].

Figure 2 gives an overview of the system architecture of real life telematics system implemented and used on the market. The technical overview includes end-to-end architecture along with a description of the components that constitute real life telematics system implementation. It also gives information on the data model used in the billing process whose details are explained in the text below.

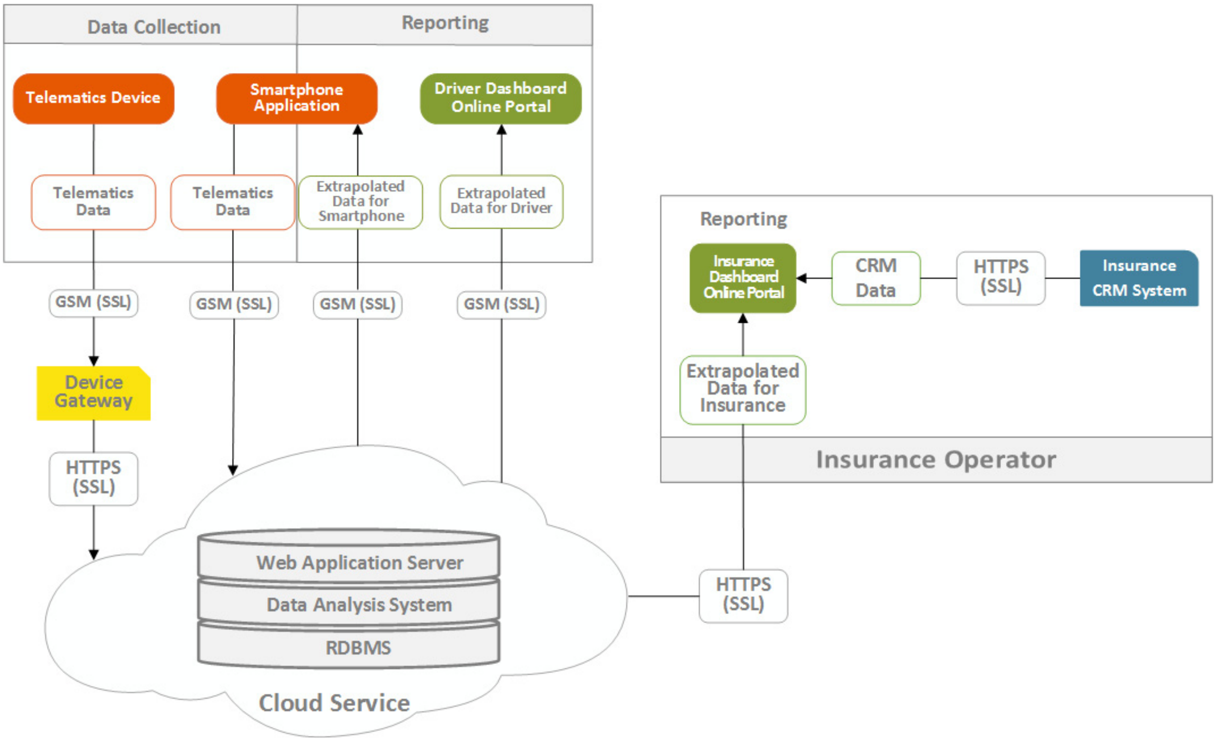

Fig. 2. Overview of a technical solution of real life telematics system.

3.1. Data collection process

The data is recorded by a dedicated telematics device. Majority of the data being used either by the driver, insurance or some other stakeholder is extrapolated from the basic set of raw data acquired by the telematics device. For that reason, precision and reliability of the acquired data plays essential role in usability of the systems relying on the raw data.

Example of the raw data being collected from the telematics devices, are given in a Table 3. It is the set of data being collected and processed for the needs of an insurance company in one of the projects implemented in the Central and Eastern Europe.

Table 3. Set of data collected by Telematics Device.

Data	Raw data	Description
Location of the vehicle (A GPS point)	Latitude	Global Latitude of the vehicle
	Longitude	Global Longitude of the vehicle
	TimeStamp	Time in milliseconds when the GPS point was recorded
	Speed	Speed of the vehicle based on last two GPS points
Excessive forces acting on the vehicle	X-axis force	Force larger than 0.2G acting perpendicular to the length of the vehicle
	Y-axis force	Force larger than 0.2G acting parallel to the length of the vehicle

3.2. Data extrapolation and processing

Set of data extrapolated from the raw data collected by a telematics device can be highly different depending on the business requirements of the insurance company using it. Some of the extrapolated data used in a project named above, is also set of the most common extrapolated data in the industry for the needs of a driver. The non-exhaustive list of data that is commonly extrapolated is outlined in the Table 4.

Table 4. Non-Exhaustive list of commonly extrapolated data.

Extrapolated data	Description
List of all trips	List of all trips the vehicle has taken with the detailed trip map
Trip Duration	Time duration of each individual trip
Trip Distance	Distance of each individual trip
Trip Start	Start time for each individual trip
Trip End	End time for each individual trip
Average Speed	Average speed of each individual trip
Max Speed	Maximum speed of each individual trip
Driving style*	A combined score based on 2 levels of harsh braking, accelerating and cornering events
Trip Map	Detailed trip map for each individual trip
Total Duration	Total duration of all trips recorded
Total Distance	Total distance for all trips recorded
Time of day	A table storing daily hours during which the vehicle is being driven
Long Trips	Percentage of trips without a break and with duration exceeding the predefined threshold by Insurance Company
Idle Time	Total time spent in traffic without movement (indicating traffic jams and congestions)

Data fields marked with * (G-Force data and data extrapolated from it) are available only if the recording device is equipped with 3-axis accelerometer.

3.3. Data precision and reliability

Billing process is one of the key processes being executed in insurance telematics products. Billing process in case of insurance telematics relies highly on the accuracy of the GPS data received from the telematics device. Nonetheless, quality of the GPS data is a subject to environmental circumstance such as atmospheric effects, sky blockage. In fact, this may impose relevant revenue-loss risk to insurance company or even for the telematics insurance coverage holder.

For that reason contextualization of the data received from the telematics device, is the second most important aspect of ensuring the precise and reliable data for system usage. Data is being contextualized through advanced algorithms of GPS data and map matching. Throughout this process, many of the deviations caused by environmental factors influencing the GPS data precision can be eliminated, thereby increasing the overall reliability of the data significantly. Based on the above, choice of the right data processing solution in the insurance telematics is of an utmost importance for the insurance company.

3.4. Data integration

Besides contextualization of the data in the purpose of achieving better data quality, data is contextualized also with the purpose to get a better understanding of the customer needs, leading to better customer relations, higher customer satisfaction, lower customer churn and finally higher customer lifetime value. In order to realize the full potential of the data collected via telematics technology, this data is integrated with the existing organizational data available in CRM (Customer Relationship Management) systems. Minimum set of data required from the insurance CRM, also used in the project we analyzed is depicted in the Table 5.

Table 5. Minimum set of data required from the Insurance CRM.

Data	Description
Insurer's personal information	A table storing Insurer's name, surname, e-mail, age
Vehicle Information	A table storing vehicle make, model, year, registration number
Vehicle insurance policy	A table storing vehicle's policy type and expiration date

4. Results and discussion

The main objective of this paper was to provide an overview of a technical solution and underlying data model for billing process. Presented technical solution include environmental factor in order to better contextualize gathered data. Collected, extrapolated and processed data allowed quantifying risk more precisely and understand driver's behavior. This allows more consistent pricing with individual risk, thus improving billing process.

Furthermore, a preliminary small scale study was conducted by Amodo Ltd. which included 22 participants in Eastern Europe. As a result, this allowed us to investigate possible effects of validating the presented technical solution which includes environmental factor. In addition, the aim was to extend the possibility of implementing UBI on emerging markets. The key effects of this solution on driving behavior based on a small scale study are summarized in Table 6.

Table 6. Summary of the key results of a small scale study.

Parameter	Value	Description
Number of drivers	22	Total number of drivers in the sample
Average reduction of parameters related to accident risk	38%	Impact on parameters with direct and indirect relation to risk of accident
Number of participant indicating positive impact on their driving safety	70%	Percentage of drivers with improved driving score due to implemented UBI solution

Additionally, we found that 70% of 22 participants indicate positive impact on their driving score. These results are consistent with previous studies [3], [4], and [5]. These results indicate, as stated in Table 6, possible benefits of UBI on drivers. In addition, we found that parameters related to risk have fallen 38% on average. Our experiments are in line with previous results on possible that UBI could reduce the average claim frequency after 1 year up to 30% [19].

Potential limitations of this study lie in the sample size. Our results motivated us to start the new study on a larger sample of 200 participants in Eastern Europe to get statistically relevant results. To avoid data privacy and ethics issues we are currently unable to provide detailed data from this study. Furthermore, it will take at least two year to obtain any relevant parameters and investigate possible effects on drivers and insurance companies.

Conclusion

We have presented the architecture of a UBI solution for collecting, communicating, managing, and analysing telematics data. The data model was also introduced as one of the most important factor to billing process of an insurance company.

The findings of this study imply potential both on insurance companies and drivers. We have confirmed that UBI policies may prove useful especially on the emerging markets. In addition, emerging markets have great potential and insurance companies will have to be proactive in introducing new business models.

The most critical part for insurance companies is to recognize the importance of environmental factor in aligning the individual risk and price. Presented telematics solution, although implemented in Eastern Europe, should prove readily adaptable to other countries.

Future studies should attempt to validate the model with larger, more heterogeneous samples, which in turn will allow estimating benefits for insurers and drivers for a larger-scale study. One key concern in such work will be ensuring the privacy of volunteer data. Future work should also examine the possibility of implementing UBI on other types of vehicles such as trucks, trains, ships etc.

The benefits are various; from economic to social and benefits for drivers. Therefore, insurance companies need to find a way to bring closer UBI insurance policies to driver, either through offering discounts or any other benefits that could attract new users.

Therefore, proactive insurers will continually introduce new products such as UBI policies which will in turn reinforce or even increase their market share.

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