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The Key Factors to Promote the Pay-As-You-Drive Insurance in Taiwan

Marzieh Khakifirooz[a,*], Mahdi Fathi[b], Jei-Zheng Wu[c], Kuan Yu[c]

[a] *Tecnologico de Monterrey, Mexico*
[b] *G. Brint Ryan College of Business, University of North Texas, Denton, TX, USA*
[c] *Business Administration, Soochow University,Taipei, Taiwan*

Abstract

Advanced insurance companies move toward using advanced technologies such as telematics to develop fair and transparent pay-as-you-drive (PAYD) automobile insurances. The expert service providers' opinions are essential and valuable for them to avoid and control any risk of entering a new market. Therefore, this study explores the critical factors for introducing and promoting the PAYD insurance system in Taiwan. We adopt the telematics business ecosystem of Taiwan's vehicle insurance market to construct partnerships for supporting managerial suggestions for promoting PAYD insurance in Taiwan. The supportive data extracted from reviewing automobile insurance-, and telematics-related literature and conducting interviews with experts in telematics and insurance-related industries in Taiwan to understand their perspectives. Fifteen key factors for introducing PAYD in Taiwan are organized, and several managerial suggestions are developed. Results show that the car dealership industry is most likely the leader of the PAYD insurance market in Taiwan and that telematics companies are niche players for promotion. According to our findings, the business ecosystem of PAYD in Taiwan requires new system integrators. Telematics services can integrate into the Omni-Channel model and bring additional value to customers and service providers.

Keywords: Business ecosystem, Pay-as-you-drive (PAYD), Automobile insurance, Telematics, Interviewing methodology.

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1. Introduction

The vehicle insurance sector is slowly adopting new megatrends such as digitalization, IoT, and AI due to the rapid development of road transportation derived from emerging technologies in autonomous vehicles (AV). One of these technologies is road vehicle telematics (hereafter called telematics), which integrates information and communication with AVs [1]. Telematics can effectively gather useful vehicle information, including vehicle speed, vehicle status, driver behavior, and position parameters in real-time. It has a wide range of applications, including individual navigation, vehicle positioning, fuel consumption monitoring, carbon emission monitoring, and repair recordings. The use of telematics data as a basis for calculating automobile insurance rates, is a development trend that has been gaining attention.

Even by the development of AV, vehicle insurance premiums are calculated mainly in a traditional way using the vehicle and human factors. Vehicle factors include the type of automobile being insured, type of use, area in which a vehicle is used, safety equipment, capability of the automobile, cylinder volume, and rated load capacity. Human factors include a driver's gender, age, marital status, years of driving experience, driver training, violation record, and accident record [2]. For example, vehicles used for business have higher accident rates than privately used vehicles because such vehicles are used more frequently. The older the car, the more likely that metal fatigue will occur, and the higher the accident rate. Large vehicles are more restricted than small vehicles, influencing their accident probability. Thus, the insurance premiums for large vehicles must be calculated differently [1]. However, the vehicle and human factors for calculating premiums cannot adequately reflect a motorist's actual driving behavior, leading to concerns about unfair premium calculations. For example, low-income families tend to buy old and cheap previously owned cars and use

*I am corresponding author

Email addresses: mkhakifirooz@tec.mx (Marzieh Khakifirooz), mahdi.fathi@unt.edu (Mahdi Fathi), jzwu@scu.edu.tw (Jei-Zheng Wu), fisheaven@hotmail.com (Kuan Yu)

their vehicles infrequently to minimize usage costs. However, they are often charged high premiums because of the age of their cars. This high premium causes such users to forgo automobile insurance and drive their vehicles illegally [3]. According to the reports, 94% of car crashes can be attributed to human error. Due to this, the liability of car crashes and accidents are mainly on the car owners, while by adaptation of AV, this percentage will drop dramatically. On the other hand, worldwide programs for emission reduction force governess to regulate the use of green fuel-friendly, newer, and AVs. Therefore, we required adaptation of new regulations to be compatible with the inclusion of AVs.

Telematics-driven insurance products are generally broken into two categories: 1) pay-how-you-drive (PHYD) and 2) pay-as-you-drive (PAYD) [4, 5]. PHYD insurance is primarily focused on using driving behavior to assess risk and price premiums. These products aim to improve pricing models for lower-risk drivers than traditional rating models would suggest. Some sorts of PHYD are "Good driving discount," "Teen driver insurance," "Accident forgiveness insurance," and "Safer driver acquisition." PAYD insurance is a type of pay-per-use mechanism [6]. The PAYD examples are "Pay per mile insurance," "On-demand insurance," and "Mileage verified insurance." PAYD insurance systems have been developed based on telematics included mileage, driving speed, gas and brake usage, location, and driving time as parameters in their premium calculations [1]. Using the PAYD system, customers will link insurance costs to driving behaviors, not just the cost of purchasing a car or fixed transportation costs [7]. For instance, [3] maintained that the probability of high-risk drivers getting involved in an accident is ten times that of low-risk drivers; therefore, the premium for high-risk drivers should theoretically be ten times that of low-risk drivers. However, under a traditional fixed premium system, motorists typically cannot afford such high premiums, which results in the premium payments of low-risk drivers being used to subsidize those of high-risk drivers. Offering the same premium for all low-risk and high-risk drivers can result in low-risk drivers becoming unwilling to maintain insurance coverage and leaving

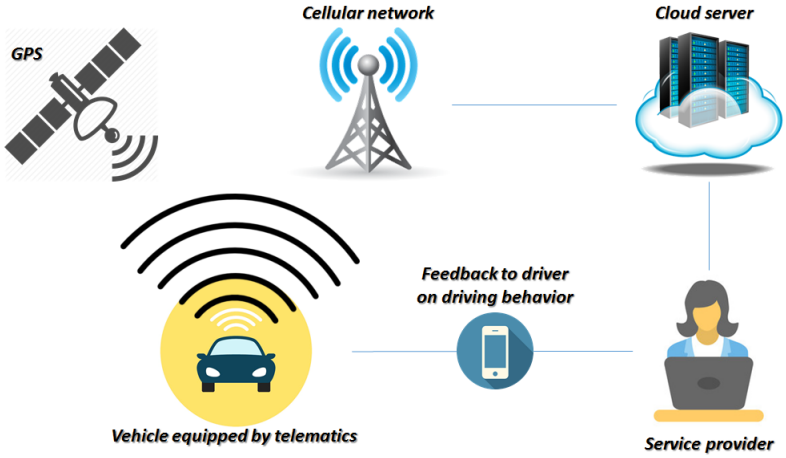

Figure 1: Schematic of PAYD ecosystem.

the market, and it can lead to the insurance market's ultimate failure in a long time [8].

A review and comparison among different PAYD insurance systems are provided in Table 1. In addition, a comprehensive review of different PAYD system can be found in [3].

[3] and [16], counted the benefits of a PAYD system as (1) fair automobile insurance system, (2) safe driving behaviors encouragement, (3) noise and pollution reduction due to less use of vehicles, (4) improve the fairness of premium pricing based on good and bad driving behaviors, and (5) increase the profits of insurance companies, when costumers with lousy driving habits improve their driving performance or change their insurance provider. The schematic of the PAYD ecosystem is illustrated in Figure 1.

With telematics monitoring, insurance operators can obtain motorists' actual driving status and request different insurance premiums for different driving behaviors [9]. Insurance premiums can be reduced for customers who exhibit safe driving behaviors (e.g., following the speed limit while driving and reducing nighttime driving). Higher premiums can be obtained from customers who exhibit poor driving behaviors (e.g., excessive driving time and improper braking), and insurance companies can even deny severe violators coverage [11]. This new automobile insurance system can reduce problems produced by unfair premium calculations, encourage safe driving, and avoid road accidents.

Table 1: PAYD system in other countries

PAYD system	County	System Integrator	Premium Rules
Metromile [9]	USA	Venture-capital firms	Driving app. providing per-mile insurance, car location, and car health. Do not use behavioral statistics like the type of driving or time of day to price the insurance premium. Premium is calculated based on a fixed base rate per month plus a per-mile-rate.
Snapshot [10]	USA	Insurance company	Voluntary discount program. Use the behavioral habit, how fast and frequently the vehicle operator brakes, to calculate the premium.
Milewise. [11]	USA	Insurance company	Insurance package, analyzing speed, braking, and time of day to calculate the premium.
OnStar [12]	USA, Canada, China, Mexico, Europe, Brazil, and Argentina	Car Manufacturer	Insurance package based on drive less, pay less rule provided by General Motors.
RightTrack	USA	Insurance company & Car manufacturer	Penalty free insurance package, 5-30% discount for good drivers.
Onboard Advisor [13]	USA	Insurance company & Telematics companies	Safety-Driven Insurance product from Liberty Mutual Insurance; in addition to driving performance and vehicle features, driver's address, parking's locations and who derive the vehicle effect on the premium (such as newly married, teens, newly graduated, and newly retired)
AIOI [14]	Japan	Insurance company & Car Manufacturer	Insurance package for Lexus and Toyota cars based on speed, acceleration, and braking behaviors.
Real Insurance	USA	Insurance company	insurance package only pays for the kilometers with maximum limits; if driving more than maximum should pay the extra fee.
Insurance Box [15]	UK	Insurance company	Insurance package provides an online personal dashboard for scoring the deriving speed, braking, acceleration, and night driving behavior. An additional discount is available for the best and most improved drivers. The capability of proactive post-accident claims services and satellite location theft recovery using telematics data.
The Floow	UK	Telematics companies	insurance packaged based on driving smoothness, distraction, time of day, road risk, fatigue, and speed, through a user-friendly mobile application platform, and provides international service.
Sony Assurance Inc	Japan	Financial Holdings Inc.	Insurance package called "Gentle Driving Cash-Back Plan." Devices will be installed free of charge, and analyses based on acceleration, deceleration, and other factors will be sent to the driver via the Internet.

Currently, vehicle insurance premiums in Taiwan, called compulsory automobile liability insurance (CALI), are calculated using vehicle factors, diver age and gender, and records of violating traffic rules and accident [17]. The PAYD insurance system has not yet been introduced in Taiwan. Therefore, this study investigated whether the new type of automobile insurance system can be introduced into the Taiwanese automobile insurance market, the key factors involved in a successful introduction, and the market ecology status. Therefore, similar to the research methodology of [18], we used the telematics business ecosystem of vehicle insurance system in Taiwan to extract partnership relationship for exploring the key factors and market ecology for introducing PAYD in Taiwan.

In this study, the data is collected through the interview with expert service providers. We also provided managerial suggestions as references for related fields and industries for future operation and development.

The remainder of this study is organized as follows. Section 2 presents the research methodology and framework. Section 3 reviews the background automobile insurance and the recent development of the insurance ecosystem in Taiwan. Sections 4 outlines the integration and qualitative analysis of interviews. Section 5 provides managerial decisions for implementing PAYD insurance in Taiwan and other countries with a similar insurance ecosystem to Taiwan. Finally, Section 6 concludes the study with discussions on future research directions.

2. Methodology

First, a literature review is conducted to collect information related to the industrial, governmental, and academic perspectives and reports related to the new insurance ecosystems. This review facilitated our understanding of the telematics environmental background, automobile insurance ecology of car fleets for the Taiwan case study PAYD system. The interview process was as follows:

1. Start with open-ended questions and allow the interviewees to explain their perspective on each question based on their experience.

2. Analyze the interview and extract the key point of the interviewee's perspective.

3. Merge interview results within each group and summarize the whole key point as the general perspective for each group of expert people.

4. Conduct the next interview providing feedback from other interviewees and asking to comment about their agreement or disagreement.

5. Continue interviews until saturation happens (i.e., if there is no significant new information)

The results are used to develop initial interview samples, directions, and topics. Because Taiwan does not yet have PAYD-related practices, exploring key PAYD introduction factors in Taiwan required examining current and future development in related industries. This question must be answered in terms of how and when? To find answers to specific questions, we focused on open interviews based on our theoretical framework. This interview method aims to confirm that interviewee responses are within the research scope and prevent excessively general answers. Interviewers used the interview process and content to understand and analyze the views and attitudes of interviewees. When using this type of interview method, problems must be carefully stated to avoid guiding the direction of interviewees' answers, resulting in an inability to achieve corroboration.

Through this process, a qualitative single-case study is reported, in which cross-examination business concepts were surveyed through 30 thematic interviews. Members of the concerned parties were interviewed:

- Experts in domestic automobile manufacturing who are familiar with the domestic automobile manufacturing situation and environment.

- Experts in domestic telematics companies who are developing the telematics market.
- Experts in domestic automobile dealers who understand domestic automobile sales, automobile insurance, and onboard systems.
- Experts in domestic telecommunications corporations familiar with the interactions between their company and other industries.
- Experts in the domestic property insurance company from the corporate group who have ample experience with automobile insurance.
- Sales division of imported high-end automobile brands who have a first-hand grasp of consumer market trends and can reflect the actual situation of Taiwan's automobile industry.

Each of the 30 interviews, ranging from 45 minutes to three hours, was semi-structured, recorded, and written from the tape. We described PAYD concepts to the interviewees during the interview process and asked related questions based on the interview outline. The interviewees are asked to describe the development of their respective industries' environment and the development of the PAYD system and describe their views. The interviewees are allowed to respond based on their professional knowledge and experience. We then conduct further questioning and discussions based on interviewee responses. Themes included how the respondent perceived:

1. Interviewer's business goals, and the nature and role of their service concerning the PAYD system.
2. The site-, segment- or customer-specific conditions for PAYD system from their business and service perspective.

3. The offered solution, the system's usability, and the PAYD service provider's performance concerning the market's needs and limitations.

4. Their role of the system integrator or service provider, benefits, expectations, and problems related to the PAYD solution/system for customers in Taiwan.

After the interviews, the interview contents are organized into transcripts, and references are compiled and summarized. In qualitative theory building analysis, conceptually and empirically valid categories, their properties, and their relationships are extracted from the interview data. The analysis followed the comparative procedures suggested by [19]. First, we analyzed each interview separately to identify the key points. Some of the interviews are reconducted because of clarity problems. Next, we compared the interviews within each respondent group and gathered all aspects, whether confirming or contradictory, to a group-specific write-up. Finally, we compared the extractions in a general-level analysis for each group.

After compilation, based on cross-case analysis methodology introduced by [20], the resulting data are used to analyze the current environments of the respective industries and to describe encountered problems, and illustrate the ownership structure of the PAYD system in Taiwan. Subsequently, we provide managerial suggestions and key factors for introducing PAYD-related fields to relevant industries and compose a conclusion and recommendations as references for industry management.

3. Background Review of Taiwan Automobile Insurance

Taiwan has a land area of 32,260 km^2 and a population slightly higher than 24 million. Two-thirds of the country consists mostly of rugged mountains, leading to a very high population density in the plains. This density, along with the unavailability of parking in cities and the excellent public transportation network, results in fewer private cars that are

low for an affluent country. It is rare for young individuals to own a car due to high costs and taxes. Due to the massive use of motorcycles, traffic density is high – a further deterrent to multi-car ownership. Automobile insurance in Taiwan is organized in a somewhat different way than in most western countries. Compulsory liability only covers bodily injury losses, and the vast majority of policyholders purchase coverage above the limit. Voluntary policies provide additional third-party bodily injury and property damage coverage [21].

In general, as required by law, all property and liability insurance companies in Taiwan are members of the Non-Life Insurance Association and offer the same automobile insurance contract options under highly regulated pricing rules. On the other hand, corporate governance plays a vital role in influencing efficiency for property-liability insurers in Taiwan [22]. An automobile insurance policy is usually a 1-year contract. An insured is free to move from one insurer to another, carrying his bonus-malus record. Since the base premium for males in Taiwan's automobile insurance market is higher than that for females, the insurance policy in a typical family is usually under a female household member's name. This kind of "premium evasion" behavior does not violate the law but does distort the gender information about policyholders [23].

Additionally, in Taiwan, most car owners tend to purchase additional "voluntary" automobile insurance policies (AIPs) to cover the potential risks associated with traffic accidents [24]. According to the finding of [24], if the insurer chooses to increase the market share of a specific AIP alternative, a steeper discount on the premiums for that AIP should be offered. For instance, the insurer could offer young adults more premium discounts or gifts to increase purchase intentions for physical damage coverage.

The study of [25] shows that the design of the rating formula of car insurance in Taiwan appears consistent with observations from the United States, which generally show that for young drivers, the accident rates decline rapidly with age, then level off, rising again as age increases and that men tend to have higher accident rates than women. The applicability

of the design to the Taiwan market may be misguided. In the United States, insurance premiums are based on the highest-rated driver's characteristics in the household. In Taiwan, the premiums are based on the characteristics of the owner of the car. Thus a household can save substantial amounts of money by having the automobile registered in the person's name in the family with the lowest premium after considering age, gender, and prior claim history. Hence the rating formula may well have the effect of discriminating against young drivers, who, for some reason, must declare themselves as car owners and against older people within the same family who drive their car.

The empirical study conducted by [26] provides partial evidence to demonstrate that loss frequency and loss ratio were reduced by issuing different types of insurance coverage policies to create self-selection mechanisms and also by the introduction of the deductible. Their study also indicates that the types of deductible amounts, experience rating systems, and better control of underwriting and claims processing were shown to have reduced possible losses caused by the moral hazard and adverse selection problems.

[27] found that owners of newer vehicles, of larger engine capacities, of imported vehicles, and more insurance claims tend to purchase wider coverage of insurance packages. The empirical results by [27] and [28] also provide evidence of adverse selection in the automobile insurance market. The wider the insurance coverage, the less motivation the insured would reduce the number of claims. The empirical findings by [29] strongly support the notion that increasing deductible provision helps control moral hazard and insurance fraud.

As mentioned in the literature, the current car insurance market in Taiwan has several weaknesses, and opportunities together, which for introducing a new product, the service provider needs to consider. Therefore, further questions based on the interviewee's perspective regarding cost (service, equipment), governmental law, sales and marketing channels, and customer willingness are discussed with interviewees within the interview process.

4. Integration and Qualitative Analysis of Interview

The following section presents the findings organized as a categorization of the opinions. The opinions of expert interviews are divided into system integrator and key factor perspectives.

4.1. Perspectives of Expert Interviewees as System Integrator

General perspective of domestic automobile manufacturers: Taiwan has large car dealers which numerous of them have automobile manufacturing, property insurance, and used certified car subsidiary companies. Usually, consumers purchase a new or used car from a car dealership with their insurance products. Generally, salespeople at dealerships recommend their insurance products from the same corporate group because of the salesperson's commission and convenient follow-up services regarding new and old car sales operations and property insurance. Thus, car dealers can be the system integrators who possess the most market drive with a strong influence on the market.

General perspective of telematics companies: PAYD system integrators in Taiwan compete with car manufacturers, automobile dealers, insurance, and telematics companies. Who will direct, or can direct the market, possess this platform, or become the actual system integrator in the future? The competitive advantage of telematics companies is controlling related technology, including software and hardware technology and subsequent data analysis abilities. This technology is currently out of reach of the other industries. In other countries, usually, insurance companies cooperating with telematics companies use their name to introduce related products and compete with other insurance companies in the market. Besides, by the popularity of AVs, most of the new vehicles are equipped with a telematics device, and the rule of telematics companies in the future will be working with telematics data.

General perspective of car dealers: There is heavy competition in Taiwan's auto-

mobile manufacturing industry. Therefore, additional interest does not exist for promoting PAYD. Furthermore, the information asymmetry problems brought by high-risk drivers paying low premiums and low-risk drivers paying high premiums influence insurance companies and do not have any real influence on automobile dealers. Car dealers wish to obtain higher premiums to receive higher commissions. Therefore, automobile dealers do not have the desire to become system integrators. However, because telematics companies understand the situation, they have opportunities to become system integrators. The premise is that they must establish a close cooperative relationship with automobile manufacturers and insurance companies to obtain support from other industries.

General perspective of telecommunication companies: Any services that involve communications will actively involve telecommunications companies. Whether telecommunications companies can become system integrators depends on the scale of the market. If the market scale is large enough, it can attract telecommunications companies who will have an opportunity to use PAYD. However, the gap between industries is broad, and telecommunications companies are unlikely to be directly involved in the insurance industry. Most likely, telecommunications companies can play a supporting role and rent communications services or equipment to insurance industries that provide related services or strategically cooperate with insurance operators to provide insurance products.

General perspective of insurance companies: Car dealers control most of Taiwan's automobile insurance industry. Insurance companies rely on car dealers to sell car insurance and are not willing to offend car dealers. However, if vehicles are already equipped with hardware equipment, related insurance can be decreased based on the equipment. For example, vehicles in which anti-theft devices are installed can have theft insurance premiums deducted. Insurance companies influence government insurance monitoring agencies, and product reviews follow the opinions of insurance companies. Car dealers exert considerable influence and account for a majority of the market share. Therefore, only car dealers can

become system integrators. However, existing insurance ambiguities can provide car dealers with additional profits, and car dealers would not be willing to change and introduce new products.

General perspective of salesmen of imported automobile: The profits of property insurance companies mostly come from car insurance. In Taiwan, car dealers are the primary contact window for customers. Thus, insurance companies are highly reliant on car dealers to sell car insurance. Property insurance companies actively offer and sign contracts with car dealers and provide additional flexibility to contract car dealerships when processing claims. Thus, insurance companies can reduce the external solicitation costs of their sales personnel. Car dealers trusted by customers can even promote other insurance products and car insurance and increase product sales and efficiency. Therefore, car dealers have tremendous power in the automobile insurance market and are the most likely system integrators.

4.2. Key Factors

General perspective of domestic automobile manufacturers: The current insurance-related laws in Taiwan are inflexible, and insurance vendors can only design-related products according to law. If related laws can be revised, then insurance companies can provide various products. Furthermore, because insurance companies' operating objective is profitability, insurance companies will only have the incentive to provide new products if PAYD can provide them with additional profit. Otherwise, insurance companies will maintain their current positions. With recent advancements in technology, automobile vendors provide more personalized and customized services, such as embedded sensors. Only when insurance companies intend to extend customization concepts to insurance will there be an opportunity to introduce premiums based on user behaviors.

General perspective of telematics companies: Because of current insurance-related laws, Taiwanese insurance companies are subject to multiple limitations. Taiwanese insur-

ance companies cannot offer excessive discounts, hidden discounts, or rebate mechanisms. Thus, the products of various companies are not differentiated, and the premiums are approximately the same. Therefore, current laws must be revised and adjusted before PAYD can be introduced in Taiwan. Another key factor is the attitude of the insurance companies. Insurance companies must be willing to use new business models and technologies to provide new products and services before promoting PAYD is possible. If insurance companies do not have willing, the market will not be developed even if laws do not regulate it.

General perspective of car dealers: Introducing an entire system will require tremendous costs, including back-end system operation. Although the popularity of AVs, most vehicles will be equipped with a telematics device in the future, collecting telematics information can be converted into pricing standards. The technical aspect and the scope covered are also key factors. For example, how is the premium calculation for multiple motorists using the same vehicle?

General perspective of telecommunication companies: The key factor for introducing PAYD in Taiwan is overall system stability, includes whether the company that stores and processes the data is credible, whether the data is backed up, whether third parties can deliberately adjust data, and whether the owner or the customer covers related equipment costs. In addition, the attractiveness of the new automobile insurance for consumers is also a key factor. If the new automobile insurance does not give consumers sufficient motivation, they may not choose to use the new insurance. Whether automobile manufacturers can pre-install equipment to save on costs and not influence the car's internal aesthetics is also a factor. Telematics that are built-in by car manufacturers can also increase the popularity of the equipment.

General perspective of insurance companies: The key factor is whether automobiles are already installed with related equipment upon manufacturing, then insurance companies can provide insurance that matches the system. On the other hand, car dealers

deeply influence the Taiwanese automobile insurance industry. Their complex structure is enormous and unbreakable. The introduction of PAYD will damage the balance in this ecology and eliminate car dealers' operating space. Thus, introducing PAYD will engender interference from multiple directions, and it is challenging to implement it in Taiwan unless international companies use extraordinary measures, investment, or influence to break the existing inferior automobile insurance ecology in Taiwan.

General perspective of salesmen of imported automobile: Regarding the concept that motorists who use their vehicles less frequently should pay lower premiums than those who use their vehicles more frequently, the frequency of vehicle use does not have a direct link to risk. People who do not frequently use their vehicles may have higher risks because they are unfamiliar with the equipment. By contrast, people who frequently use vehicles can have lower risks because their skills are mature. The key factor in this new type of automobile insurance is whether the calculation standard can accurately reflect drivers' risk values or not. The standards must be fair. If consumers are offered diversified choices, and different products can be provided for different groups with varying driving habits, they are more likely to be attracted and purchase insurance products.

5. Developing Managerial Decisions

Managerial decisions are developed to analyze expert interviewees' opinion, their perspectives, and corresponding key factors. The following questions are the base for proposed managerial suggestions:

1. Who is the system integrator for the PAYD insurance system in Taiwan?
2. Who is the technology provider for telematics equipment (hardware)?
3. Who is the technology provider for data analysis, storage and communication system (software)?

4. Who is doing the promotion, promoting the telematics to insurance sellers, and promoting the PAYD system to insurance users?

5. Who is paying the cost of promotion? Who does benefits from promoting?

6. Who is paying the cost of the equipment?

7. What is the requirement to lunch the PAYD system in Taiwan?

5.1. Analysis of Key Factors

We combined key factors for introducing the PAYD system in Taiwan with similar items obtained from literature reviews and expert interviews for subsequent examination. Overall, 15 key factors were organized, as shown in Table 2.

Table 2: Combined key factors

Dimension	Key factors
Automobile insurance	- Level of market information transparency
	- Premium evaluation standards
	- Attraction of PAYD
Telematics technology	- Development of telematics technology
	- System stability
System cost	- Costs of introducing the system
	- Costs of related equipment
Automobile manufacturer	- New car market
	- Differentiation of aftermarket products
	- After market sales channels
	- Whether car dealers are willing to provide related equipment
External	- Legal norms
	- Diverse selection for consumers purchasing car insurance
	- Whether influential companies wish to implement PAYD

5.1.1. Automobile insurance factors

Automobile insurance-related vital factors include the level of market information transparency, premium evaluation standards, the attraction of PAYD, and insurance companies' attitude. Regarding the level of market information transparency, the literature indicated that the existence of information asymmetry in the automobile insurance market could influence insurance companies' profits and result in the failure of the insurance market [8].

The current automobile insurance system in Taiwan is comprehensive and does not cause information asymmetry. Surcharges for accidents in the current insurance system yield high premiums from high-risk drivers. If motorists have accident records, increases in future premiums can be substantial. Implementing PAYD can expose poor driving habits that are not penalized and render premium calculations fair.

Consequently, PAYD does not sufficiently attract insurance companies or car manufacturers. Therefore, insurance companies and car manufacturers lack the motivation to promote PAYD. The competitive attitude of Taiwanese insurance operators is also a concern. A PAYD market can only be created in Taiwan if an insurance operator (out of numerous Taiwanese insurance operators) is brave enough to provide products and services with a new business model. If insurance operators are unwilling to change existing stable situations, no operator will promote PAYD even though PAYD possesses attractive characteristics.

Telematics companies are much more familiar with PAYD than professionals from other industries and understand actual PAYD operations in other countries. The introduction of PAYD in Taiwan must rely on telematics companies, which benefit from promoting PAYD, promoting the system, and convincing related industries. Practical foreign examples must be introduced in Taiwan to enhance the attraction of PAYD among related industries and develop the interest of these industries to ensure the success of the introduction of PAYD.

Proposal 1: *The introduction of telematics services in Taiwan must rely on promotions by telematics companies to increase the recognition of related industries in Taiwan.*

5.1.2. Telematics technology factors

Key factors related to telematics technology include system stability and software support for data transition. The PAYD must move transmitted information to back-end storage to prevent the intentional manipulation of data by a third party. As the development of telematics technology matures, the dimensions of practical applications of telematics can develop. Regardless of when the mass production and usage of AVs are started in

Taiwan, in the current situation, domestic telematics system integrators and operators are small- to medium-sized corporations, and are smaller in scale, and have insufficient resources compared with corporations in other industries. Domestic telematics companies also exert a small influence on the PAYD-related industry. Telematics companies possess key software and hardware technology and data processing abilities. PAYD directly benefits telematics companies, and telematics companies have incentives to introduce PAYD into Taiwan. Thus, telematics companies can become promoters of PAYD-related systems and convince related industries in Taiwan to introduce PAYD.

When small-scale companies discover attractive service markets, they may not develop the markets because of a lack of resources. However, for large companies, the scale of such new markets may be too small and not worth investing in resources. In this situation, large and small companies can cooperate and build a platform. Large companies can provide small companies with resources, assist with costs, and attract small companies by providing service platforms from the original large company [30]. Therefore due to the small scope of the telematics' market in Taiwan, telematics companies should cooperate with large-scale corporations such as automobile manufacturers or insurance companies and build a PAYD service platform to co-create value that can benefit both parties [31, 32].

Proposal 2: *Telematics companies in Taiwan should co-create a PAYD service platform with other domestic PAYD-related industries as a foundation for introducing PAYD.*

In addition to telematics development, the maturity of a backstage support system is also a concern. Telematics include GSM/GPRS modules, and telematics requires immediate information transmission. The collected information must be returned backstage for storage, processing, or calculation. This process must rely on the support of telecommunications operators. Therefore, the stability of telematics software and hardware, the stability of subsequent data storage and processing systems, and the interactions between telematics companies and telecommunications operators all influence the stability of PAYD. However, due

to differences in sales types, telecommunications companies could not be directly involved with PAYD. Telecommunications companies can provide PAYD operators with equipment or hardware rentals using suitable methods for handling information transmission, storage, and wireless data processing.

Proposal 3: *Telecommunications companies can play a supporting role for PAYD-related operators in Taiwan by renting communications transmission, data storage, and data processing equipment to operators for entering the PAYD market* [33].

5.1.3. System cost factors

Key factors related to system costs include the costs of introducing the system and costs of related equipment. Currently, Taiwan does not have PAYD products and lacks the related basic infrastructure. Introducing the PAYD system requires large amounts of funding, including equipment for operators to process-related information and devices installed in end consumers' cars. Who will be responsible for these costs will influence the introduction and use of PAYD by domestic vendors and consumers. If consumers are responsible for devices in their cars, this can reduce consumers' willingness to adopt PAYD.

Telematics for individual use can be divided into the before-market, where equipment is installed by Original Equipment Manufacturer (OEM) car factories before cars leaving the factories, or the aftermarket. Consumers install the equipment themselves after vehicle purchase [7]. Aftermarket operators must develop differentiated services from those of before-market operators or supplement before-market operators to consolidate the aftermarket [7]. The development of telematics technology is necessary for building PAYD systems. Because the before-market is linked to the new car market, the new car market's activity level is a key factor that influences the before-market. Aftermarket operators lack the resources and markets of before-market operators and must provide differentiated products to build an advantage. Therefore, product differentiation and the development of sales channels are key factors in the aftermarket [34]. Hereupon, automobile manufacturers are the

most suitable candidates for bearing the related costs of the telematics device. First, the automobile industry has sufficient resources and scale. Second, car manufacturers can install related equipment into new cars, eliminating consumers' need to purchase and install additional equipment, which increases the popularity of telematics. In addition, by developing technology, cars are already equipped with many embedded computing platforms [35].

Proposal 4: *If telematics companies in the aftermarket, vendors must provide equipment at a price that consumers can afford and provide differentiated services from car manufacturers.*

5.1.4. Automobile manufacturer factors

Four key factors are related to automobile manufacturers. New car markets and whether car dealers are willing to provide related equipment are related to the before-market. Installation of related equipment in new cars by car manufacturers can reduce consumers' need to select and purchase equipment. Car manufacturers can use the before-market to provide additional services and produce competitive advantages for their cars. Therefore, if domestic car manufacturers are willing to provide related equipment, they can use the before-market to provide PAYD and create a competitive advantage for themselves.

Proposal 5: *The introduction of PAYD in Taiwan to end customers must rely on automobile manufacturers to pay for introducing the system and providing consumers with related equipment.*

5.1.5. Sustainable Socioeconomic Factors

Lowering emissions through technology would support sustainability issues in society and for vehicle owners to save on insurance costs. Telematics technology gathers information such as fuel/energy usage, idle time of vehicles, and maintenance requirements for monitoring and tracking operational fleet activity. Therefore, based on telematics technology, the insurance companies can develop a new insurance product that can be developed and offered solutions

for drivers to manage fuel consumption and consequently emission reduction.

Traffic policy is set by governments, whereas insurance firms provide vehicle insurance. Although the two issues appear to be unrelated, vehicle insurance data can help establish traffic policy aimed at reducing road traffic accidents. This is consistent with the argument of [36] that the insurance industry may act as an agent in support of the traffic safety policy established by a government.

Proposal 6: *There is an urgent need for governments to develop alternative means of financing the installation of telematics devices to control the carbon emission from vehicles..*

5.1.6. External factors

Key external factors include legal norms, a diverse selection for consumers purchasing car insurance, and whether influential companies wish to implement PAYD. Regarding legal norms, Taiwanese laws influence the evolution of the Taiwanese automobile insurance system. Currently, laws are not designed for PAYD. Thus, the introduction of PAYD is limited. For example, current regulations do not allow operators to use premiums as a reward mechanism. The new insurance system also involves privacy issues. If PAYD is to be introduced in Taiwan, related laws must be revised for PAYD and enable PAYD to conform to Taiwanese laws and implement PAYD with support measures.

The diverse selection available for consumers purchasing car insurance does not mean that PAYD has to replace the existing insurance system entirely. Deficiencies may exist in the current insurance system, but the current insurance system still has its value. If operators can provide various insurance products for consumers, consumers can select the most advantageous rating system based on vehicle use, which creates an additional attraction for consumers.

The current insurance system in Taiwan involves numerous ambiguous areas, which car dealers can manipulate to obtain additional profits. Mutual interests link car dealers, insurance operators, and government review agencies and form a large, complicated structure

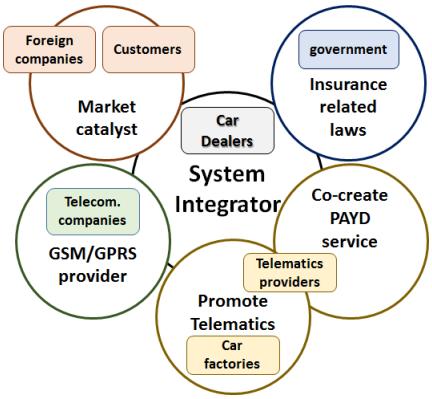

Figure 2: The role of each party in Taiwanese PAYD ecosystem

with an enormous scope of influence. Any new system or technology that can damage this ecology will encounter obstacles and will be extremely difficult to promote in Taiwan.

Proposal 7: *For introducing PAYD in Taiwan, current automobile insurance-related laws must be revised and enable PAYD to conform to Taiwanese laws. Operators must provide consumers with a diverse product selection. International sectors that possess a strong influence to change the current automobile insurance ecology can play market catalyst.*

The summary of proposals 1-7, which identified each party's role in the Taiwanese PAYD ecosystem, is demonstrated in Figure. 2.

5.2. Relationships in the Taiwan PAYD Ecosystem

The goal of delivering a "win-win" outcome in sales and marketing is achieved in the interaction of seller's needs, buyer's need within a useful commercial construct. Regarding expert interviewees' perspectives, the required metrics for delivering the PAYD insurance system in Taiwan are illustrated in Figure 3.

The business ecosystem of automobile insurance is generally designed based on three major participants, customer, insurance provider, and car manufacturer. However, the market's high potential for selling additional services rather than only insurance brings extensive opportunities for third parties in this market. The major third-party contributors in Taiwan are car dealers (according to the interviewees' opinions). Specific reasons are as follows:

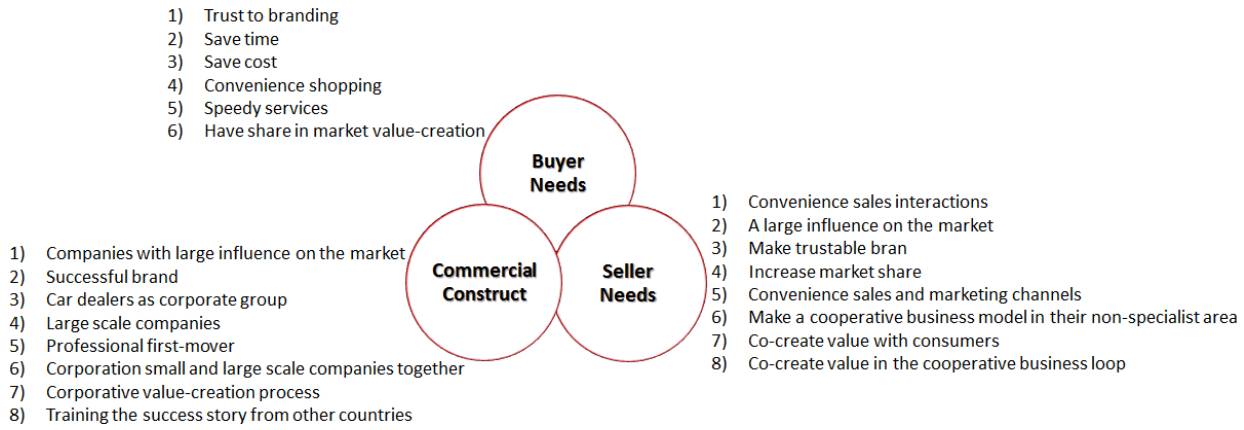

Figure 3: Relationship between seller's need, buyer's need and commercial construct

1. Some Taiwanese car dealers are managed as a corporate group, and their group are divided into subsidiary companies that include automobile manufacturing, property insurance, used car certification, and automobile lease companies. The scope of sales coverage is broad and exerts a large influence on the market. When these companies belong to the same corporate group, their sales interactions become convenient. When consumers purchase new cars, the exchanged used car can be certified, maintained, and sold by companies in the same corporate group. This comprehensive system allows that specific brand to receive evaluations superior to other brands and obtain huge domestic market shares.

2. Currently, in Taiwan, automobile insurance is mostly sold through car dealers, with a minority being sold by other property insurance companies or insurance agencies. Consumers typically purchase automobile insurance products from car dealers to save time and costs of shopping for insurance. If accidents occur, customers who purchased insurance from car dealers can benefit from insurance companies' great flexibility during the subsequent claims processing.

The reasons mentioned above show that Taiwanese car dealers have a specific position in the Taiwanese automobile insurance market and have considerable influence on the insurance

industry. Therefore, we provide the following recommendations in this study:

Proposal 8: *Of all the PAYD-related operators in Taiwan, car dealers under the umbrella of corporate groups possess the most influence. Car dealer companies can become system integrators for PAYD*

The aforementioned suggestion could support by the study of [37] and [38]. A consumer in the market for a new car might select a make and model based on his/her own experience, research from auto magazines/websites and consumer reports, or recommendations from others. He/She would then agree on the price, order the vehicle, and take delivery through a car dealer, arrange to finance through a bank, and purchase insurance from an insurance company. By dramatically lowering the transaction, distribution, and binding costs, car dealers can offer all of these products and services. In addition, the Internet of things (IoT) can facilitate services. For instance, car dealers can increase their business by providing proactive service management and acquiring information about aging components of an automobile to order new components. When the car needs repair, this will help reduce owners' anxiety levels and improve automobiles' general conditions. For accessing such information, automobiles can be equipped with smart sensors (i.e., telematics) that keep track of how much wear and tear a car component has gone through [39].

In addition, the third party (i.e., car dealer) can provide sufficient information for the insurance company to capture how is the car's condition and safety to evaluate a fair premium insurance [40].

Customers need to receive the insurance service within a short time or in the best situation when they buy a new car, which is an excellent opportunity for the third party to sell the insurance products to new buyers. In addition, promoting telematics service could be provided with various products to satisfy the fondness of first use customer, especially if the telematics device is installed in the vehicle after manufacturing [41].

Despite the facts mentioned above about the car dealer's role as a system integrator,

the PAYD ecosystem in Taiwan can be emphasized for the before-market and aftermarket situation. However, regardless of the aftermarket or before-market situation, the system follows up the multi-principal collaboration model [42, 43].

6. Conclusion

6.1. Summary of Research and Finding

We use a telematics business ecosystem to explore the key factors and market ecology of introducing the PAYD system in Taiwan. This study provides various related fields and industries with managerial suggestions as a reference for future development. A literature review is conducted to understand the development of automobile insurance, telematics application, and current business ecosystem, to confirm the telematics industry's current situation. In-depth interviews are conducted to obtain the opinions and perspectives of experts in related industries. Case studies are used to analyze the contents of the interviews, compile references and discussions. Managerial suggestions are provided to the case industries as references for management. Overall, 15 key factors are organized by combining the results of analyzing the references and experts' perspectives obtained in interviews.

Our finding explores the various roles and positions in a telematics business ecosystem. According to our findings, system integrators build new service platforms, integrate the numerous activities of upstream supply chain vendors, provide consumers with practical activities, and charge consumers based on system performance. Consumers are no longer required to interact with multiple vendors, enabling them to focus on their core activities.

To introduce PAYD in Taiwan, telematics companies must promote the implementation of PAYD, increase the attraction of PAYD for business operators, and build service platforms with other industries. In other countries, usually, insurance companies cooperating with telematics providers use their names to introduce related products and compete with other insurance companies in the market. In Taiwan, due to geographical situation (the country

is small compared to some country with a competitive insurance market, such as the USA) and population, car dealers are scattered everywhere around the country and have a chain business model. In terms of marketing cost and size of insurance companies, it is more profitable for insurance companies to do marketing through car dealers rather than direct marketing. Besides, due to governmental regulations, the insurance premium is almost fixed. Insurance companies cannot make any adjustments on premium; therefore, there is not enough initiative for insurance companies to compete in this market and by direct marketing engage more customers to use their products.

Similarly, for customers, since almost all insurance companies gave the same service and offered the same premium, it is not important which insurance company will be their service provider. Considering all the facts, mentioned above the most beneficial way for insurance companies is to do indirect marketing through car dealers. The consequences of the above scenario's effects on insurance companies keep their size very small compared to car dealers. Therefore, when PAYD is going to introduce to the market, insurance companies do not have enough power and influence to impact the market and benefit from introducing PAYD to customers, while car dealers are more trust-able and well-known by customers. Therefore, they can benefit from this opportunity and receive more commission from insurance companies (by marketing the PAYD service) and receive more interest from customers; therefore, car dealers possess the most influence and are the most likely candidates for becoming the system integrators of automobile insurance-related activities and services for end consumers. Telecommunications companies can enter this service platform in a supporting role and provide backstage data processing, storage services, or equipment. For the external environment, the promotion of PAYD must consider the role that governmental agencies play. If PAYD is to be introduced in Taiwan, related governmental agencies must propose revisions in legal norms. In summary, the telematics business ecosystem was used to compile managerial suggestions related to the introduction of PAYD in Taiwan, which can be used

as references by telematics-related industries in Taiwan for future management directions.

In Taiwan, due to the monopoly system created by corporation groups, the core business model for PAYD is dependent on car dealers, and the development of the business depends on their knowledge, ability, and willingness. However, the corporate group's power is not that high to influence the government to relieve the insurance rules. Also, apart from the geographical, cultural, and governmental limitations, some individual investigation is required to design the future of telematics services, especially the PAYD insurance system such as developing technical audits, end-to-end solutions for customers, and live connected services.

The possible governmental actions that can facilitate the implementation of PAYD are:

1. The governmental regulations should be revised, such as rules like priced by the vehicle-year.
2. Rules and practices which discourage pricing innovations should be removed.
3. Encourage PAYD pricing, which offers a tax rebate, should be implemented.
4. Mileage should be given significant weight as a rating factor in premium calculation.
5. Supporting PAYD pricing by educating the insurance industry should be planned.
6. Optional PAYD policy will be needed so all motorists can choose between vehicle-year and vehicle-mile pricing.

In addition, in the future, by advancement in the automotive industry and transition to a make-to-order environment for better customization of consumer's orders, the government may suggest the dealers to be part of manufacturing companies to have better service to customers. This will change the current after-sale services such as PAYD insurance in the automotive supply chain in Taiwan.

Consider the great opportunity of locating Asian Silicon Valley in Taiwan, under government regulations, there could be a potential market for startups and entrepreneurs to utilize IoT technologies in PAYD insurance companies.

6.2. Discussion, Key Limitation, and Future Work

Because Taiwan does not yet have PAYD, the interviewees' knowledge regarding PAYD is completely reliant on our introduction. On the other hand, customers' opinions are also essential when promoting PAYD to automobile insurance.

Despite the introduction of telematics twenty years ago for the PAYD system [44], the adoption rate still is minimal in many countries and regions. Several factors are anticipated to hinder telematics' growth, including privacy issues as the main concern [45], and lack of awareness of telematics solutions. Besides, decision making for insurance companies based on telematics data includes extra challenges as follows:

- Day and night driving index for estimating the premium is not fair when many folks are driving at night for going to work to provide a service to society (i.e., health care professionals or night guards)
- The majority of current methods to set premium based on telematics data [46] are limited by the availability of data, historical methods, and contemporary culture.
- New data create the opportunities for new business approaches, which then require an algorithm. Altering behavior makes the historical data inefficient; therefore, any algorithm for rating groups must be dynamic.
- Altering behavior increases the uncertainty in revenue for insurance companies.
- A part of the social contract of insurance is shared risk [47]. To keep the premium down, we need people buying insurance that, on average, has low costs.

This study uses qualitative methods to explore key factors for introducing PAYD in Taiwan. Subsequent researchers can use quantitative research methods to establish the weight and the priority order of the key factors for introducing PAYD in Taiwan. Furthermore, subsequent researchers can select comparatively more representative industrial, governmental, and academic experts as interviewees. The key factors and market ecology for introducing PAYD in Taiwan can be comprehensively explored by combining their opinions.

Nevertheless, the PAYD system's implementation in different societies may need a long time of cultural investigation. Therefore, the service providers could implement other telematics services to build the culture for telematics and encourage society to use the PAYD system. Some of these services are included 1) roadside assistance, 2) car leasing, 3) car sharing, 4) carpooling, 5) car rental, 6) stolen vehicle tracking and recovery, 7) emergency assistance, 8) road charging, 9) fuel cards, 10) remote diagnostics, 11) fleet management, 12) in-car Wi-Fi hotspots, and 13) connected navigation.

Regarding these applications, the PAYD business model can work as a cross-channel business to improve the user experience by providing additional services through the telematics rather than only the PAYD service, which is similar to the Omni-channel (OC) business model [48]. The OC business model for the PAYD system can integrate the customers' needs in one package and build relationship and trust [49]. Therefore, creating a coherent, evolving, and cross-channel experience for customers persuade them to pay an extra fee for better services because of supporting resources. Using the OC business model does not need to support all aspects of telematics services. Instead, it can imply integrating services that have more popularity and bring more pleasant for customers.

Furthermore, one of the critical risks for AV is cybersecurity attacks. The cybersecurity of computer systems is bad, but AV is dangerous and frightening. One of the insurance companies' products would be cyber Insurance for AV, which is vital for improving consumer trust. Moreover, offering insurance products on Technology Errors & Omissions and Cyber

Liability of AVs would improve safety issues.

Existing regulation requires drivers to remain in physical control of the car. However, new legislation often requires systems to be overridden or switched off by the driver. Moreover, some countries such as China, United States have their national regulation on ride-sharing and AVs. Different governmental regulation would be related to registration of AVs, categorizing AVs to A, B, C, D, and E based on automatically commanded steering function (ACSF), private or public roads, active safety, driverless vehicle, car sharing, mixed usage, and multi ownership, ethical considerations, limited, shared and collective liability, AVs actions in emergencies (killing pedestrians vs. passengers in AVs), and cybersecurity. Many countries are testing AVs and their regulations, including Singapore, the US, Japan, Netherlands, and Sweden (robotic taxis, driverless shuttles, platooning trial, shuttle buses, robotic shuttles, driverless on-demand delivery) in private roads (e.g., airports, and campuses), and public roads with licenses. Moreover, autonomous trucks and vans will be utilized in many on-demand deliveries and last-mile delivery by different companies such as Amazon. Many autonomous buses and driverless shuttles can be useful for short distances in governmental organizations, transportation departments, and universities. We believe that insurance companies and governmental regulations will utilize AI, deep learning, and machine learning algorithms to learn about different AV aspects to make more insurance regulations. For more information on AV regulations and its social dilemma, one may refer to [50, 51, 52, 53, 54, 55, 56].

References

[1] A. Goel, Telematics, in: Fleet Telematics, Springer, 2008, pp. 7–30.

[2] J. W. Bolderdijk, J. Knockaert, E. Steg, E. T. Verhoef, Effects of pay-as-you-drive vehicle insurance on young drivers' speed choice: Results of a dutch field experiment, Accident Analysis & Prevention 43 (3) (2011) 1181–1186.

[3] T. Litman, Pay-as-you-drive pricing for insurance affordability, Victoria Transport Policy Institute, Victoria (2004) 1–17.

[4] B. Wagner, Pay-as-you-drive: a telematics-based car insurance model, PTV Traffic Mobility Logistic.

[5] J. Paefgen, T. Staake, E. Fleisch, Multivariate exposure modeling of accident risk: Insights from pay-as-you-drive insurance data, Transportation Research Part A: Policy and Practice 61 (2014) 27–40.

[6] S. Balasubramanian, S. Bhattacharya, V. V. Krishnan, Pricing information goods: A strategic analysis of the selling and pay-per-use mechanisms, Marketing Science 34 (2) (2015) 218–234.

[7] R. Guensler, A. Amekudzi, J. Williams, S. Mergelsberg, J. Ogle, Current state regulatory support for pay-as-you-drive automobile insurance options, Journal of Insurance Regulation 21 (3) (2003) 31.

[8] M. Rothschild, J. Stiglitz, Equilibrium in competitive insurance markets: An essay on the economics of imperfect information, in: Uncertainty in Economics, Elsevier, 1978, pp. 257–280.

[9] E. G. T. Cox, D. E. Goodman, D. R. Preston, S. T. Pretre, M. Waliji, System and method for profiling vehicle usage, uS Patent App. 14/177,192 (Aug. 13 2015).

[10] A. o. S. Offer, The influence of telematics on customer experience: Case study of progressive's snapshot program, Progressive 59 (31) (2013) 89.

[11] R. Srey, M. J. Manzella, Encouraging safe driving using a remote vehicle starter, uS Patent 9,911,159 (Mar. 6 2018).

[12] P. Farris, P. E. Pfeifer, R. R. Johnson, W. McCormack, General motors onstar, Darden Case No. UVA-M-0659.

[13] P. Vavouranakis, S. Panagiotakis, G. Mastorakis, C. X. Mavromoustakis, Smartphone-based telematics for usage based insurance, in: Advances in Mobile Cloud Computing and Big Data in the 5G Era, Springer, 2017, pp. 309–339.

[14] S. Nakagawa, K. Mori, A. Shinada, K. Nunokawa, H. Okajima, M. Sasaki, Vehicle insurance premium calculation system, on-board apparatus, and server apparatus, uS Patent App. 10/083,566 (Sep. 12 2002).

[15] M. Paine, et al., Road safety policy and practice: Telematics and vehicle safety, Journal of the Australasian College of Road Safety 29 (2) (2018) 46.

[16] T. Ippisch, Telematics data in motor insurance: Creating value by understanding the impact of accidents on vehicle use, Ph.d. dissertation, University of St. Gallen (2010).

[17] C. A. L. I. Taiwan, Premium table of Compulsory Automobile Liability Insurance for Car, http://law.tii.org.tw/Eng/FLAWDAT0202.asp?No=1A0030012&lsid=FL006900&hasChar=False&

btnType=0&rlType=, [Online; accessed 8-October-2018] (2017).

[18] K. Selviaridis, A. Norrman, Performance-based contracting for advanced logistics services: challenges in its adoption, design and management, International Journal of Physical Distribution & Logistics Management 45 (6) (2015) 592–617.

[19] K. M. Eisenhardt, Building theories from case study research, Academy of Management Review 14 (4) (1989) 532–550.

[20] U. Koners, K. Goffin, Learning from postproject reviews: A cross-case analysis, Journal of Product Innovation Management 24 (3) (2007) 242–258.

[21] J. Lemaire, S. C. Park, K. Wang, The use of annual mileage as a rating variable, Astin Bulletin 46 (1) (2015) 39.

[22] J. L. Wang, V. Jeng, J. L. Peng, The impact of corporate governance structure on the efficiency performance of insurance companies in taiwan, The Geneva Papers on Risk and Insurance-Issues and Practice 32 (2) (2007) 264–282.

[23] C.-S. Li, C.-C. Liu, J.-H. Yeh, The incentive effects of increasing per-claim deductible contracts in automobile insurance, Journal of Risk and Insurance 74 (2) (2007) 441–459.

[24] M.-J. Wang, C.-H. Wen, L. W. Lan, Modelling different types of bundled automobile insurance choice behaviour: The case of taiwan, The Geneva Papers on Risk and Insurance-Issues and Practice 35 (2) (2010) 290–308.

[25] C.-S. Li, C. H. Lin, C.-C. Liu, E. Venezian, Pricing effectiveness and regulation: An examination of premium rating in taiwan automobile insurance, The Geneva Papers on Risk and Insurance-Issues and Practice 35 (1) (2010) S68–S81.

[26] J. L. Wang, Asymmetric information problems in taiwan's automobile insurance market: The effect of policy design on loss characteristics, Risk Management and Insurance Review 7 (1) (2004) 53–71.

[27] C.-H. Wen, M.-J. Wang, L. W. LAN, Discrete choice modeling for bundled automobile insurance policies, Journal of the Eastern Asia Society for Transportation Studies 6 (2005) 1914–1928.

[28] C.-H. Wen, M.-J. Wang, L. Lawrence Wuuwang, Modeling repeated choice behaviors of physical damage coverage for new car owners, in: Proceedings of the Eastern Asia Society for Transportation Studies The 7th International Conference of Eastern Asia Society for Transportation Studies, 2007, Eastern Asia Society for Transportation Studies, 2007, pp. 114–114.

[29] J. L. Wang, C.-F. Chung, L. Y. Tzeng, An empirical analysis of the effects of increasing deductibles on moral hazard, Journal of Risk and Insurance 75 (3) (2008) 551–566.

[30] P.-A. Chiappori, B. Salanie, Testing for asymmetric information in insurance markets, Journal of Political Economy 108 (1) (2000) 56–78.

[31] C. K. Prahalad, V. Ramaswamy, Co-creating unique value with customers, Strategy & Leadership 32 (3) (2004) 4–9.

[32] J. A. Siguaw, J. B. Gassenheimer, G. L. Hunter, Consumer co-creation and the impact on intermediaries, International Journal of Physical Distribution & Logistics Management 44 (1/2) (2014) 6–22.

[33] P. Desyllas, M. Sako, Profiting from business model innovation: Evidence from pay-as-you-drive auto insurance, Research Policy 42 (1) (2013) 101–116.

[34] J. Andersson, P. Jonsson, Big data in spare parts supply chains: The potential of using product-in-use data in aftermarket demand planning, International Journal of Physical Distribution & Logistics Management 48 (5) (2018) 524–544.

[35] C. Bisdikian, I. Boamah, P. Castro, A. Misra, J. Rubas, N. Villoutreix, D. Yeh, V. Rasin, H. Huang, C. Simonds, Intelligent pervasive middleware for context-based and localized telematics services, in: Proceedings of the 2nd international workshop on Mobile commerce, ACM, 2002, pp. 15–24.

[36] L. Hultkrantz, J.-E. Nilsson, S. Arvidsson, Voluntary internalization of speeding externalities with vehicle insurance, Transportation research part A: policy and practice 46 (6) (2012) 926–937.

[37] Y. Bakos, The emerging role of electronic marketplaces on the internet, Communications of the ACM 41 (8) (1998) 35–42.

[38] M. Younas, I. Awan, D. Duce, An efficient composition of web services with active network support, Expert Systems with Applications 31 (4) (2006) 859–869.

[39] U. Varshney, R. Vetter, A framework for the emerging mobile commerce applications, in: System Sciences, 2001. Proceedings of the 34th Annual Hawaii International Conference on, IEEE, 2001, pp. 10–pp.

[40] M. Neustadt, P. Kane, D. Diem, J. Edelstein, R. Humphreys, Automated dealership data extraction and insurance processing system and method, uS Patent App. 10/449,958 (Dec. 2 2004).

[41] H.-H. Chen, S.-C. Chen, The empirical study of automotive telematics acceptance in taiwan: comparing three technology acceptance models, International Journal of Mobile Communications 7 (1) (2009) 50.

[42] E. Delbufalo, M. Bastl, Multi-principal collaboration and supplier's compliance with codes-of-conduct, The International Journal of Logistics Management 29 (4) (2018) 1237–1254.

[43] S. Keow Cheng, B. Hon Kam, A conceptual framework for analysing risk in supply networks, Journal of Enterprise Information Management 21 (4) (2008) 345–360.

[44] R. J. McMillan, A. D. Craig, J. P. Heinen, Motor vehicle monitoring system for determining a cost of insurance, uS Patent 5,797,134 (Aug. 18 1998).

[45] P. H. Steiner, P. Maas, When customers are willing to disclose information in the insurance industry: A multi-group analysis comparing ten countries, International Journal of Bank Marketing 36 (6) (2018) 1015–1033.

[46] Y.-L. Ma, X. Zhu, X. Hu, Y.-C. Chiu, The use of context-sensitive insurance telematics data in auto insurance rate making, Transportation Research Part A: Policy and Practice 113 (2018) 243–258.

[47] C.-Y. Lee, Does corporate social responsibility influence customer loyalty in the taiwan insurance sector? the role of corporate image and customer satisfaction, Journal of Promotion Management 25 (1) (2019) 43–64.

[48] S. S. Saghiri, M. Bernon, M. Bourlakis, R. Wilding, Omni-channel logistics special issue, International Journal of Physical Distribution & Logistics Management 48 (4) (2018) 362–364.

[49] D. R. Bell, S. Gallino, A. Moreno, How to win in an omnichannel world, MIT Sloan Management Review 56 (1) (2014) 45.

[50] J. S. Brodsky, Autonomous vehicle regulation: How an uncertain legal landscape may hit the brakes on self-driving cars, Berkeley Technology Law Journal 31 (2) (2016) 851–878.

[51] J.-F. Bonnefon, A. Shariff, I. Rahwan, The social dilemma of autonomous vehicles, Science 352 (6293) (2016) 1573–1576.

[52] M. A. Geistfeld, A roadmap for autonomous vehicles: State tort liability, automobile insurance, and federal safety regulation, Calif. L. Rev. 105 (2017) 1611.

[53] J. Claybrook, S. Kildare, Autonomous vehicles: No driver... no regulation?, Science 361 (6397) (2018) 36–37.

[54] K. O. Fregene, M. R. Elgersma, S. Dajani-Brown, S. G. Pratt, Automatic planning and regulation of the speed of autonomous vehicles, uS Patent 7,979,174 (Jul. 12 2011).

[55] M. Garavello, P. Goatin, T. Liard, B. Piccoli, A multiscale model for traffic regulation via autonomous vehicles, Journal of Differential Equations 269 (7) (2020) 6088–6124.

[56] D. J. Fagnant, K. Kockelman, Preparing a nation for autonomous vehicles: opportunities, barriers and policy recommendations, Transportation Research Part A: Policy and Practice 77 (2015) 167–181.