# Influences of Autonomous Cars on the Insurance Market from the Perspectives of Insurance Companies and Auto Insurance Agencies

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## Abstract

Driverless cars will dominate the road ways in the near future. Insurers often strategize to understand the technologies of autonomous cars, what they mean and the impact they may have on their business so they can then tackle that from an insurance perspective. In order to identify the changes going with autonomous cars development, the way of literature reviewing is conduct. AHP (Analytic Hierarchy Process), then, employed to evaluate the weights of the changes which go with the autonomous cars development from perspectives of insurers and agency separately. By applying Spearman Correlation Analysis, this study can tell the differences of understanding toward the changes are going with the autonomous cars development between insurers and insurance agencies. Based on the research findings, this study suggests 1. Insurance companies should accumulate their experiences in loss, utilize research data published by experts in autonomous cars, and consider autonomous car insurance products from several developed countries. 2. Insurers will need to consider various factors for underwriting and still use the existing practical model to manage underwriting, the claims process, and pricing. 3. Insurers must seek cooperation with professional institutions and insurance

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business departments, which could be a sizeable advantage for conventional car insurance companies.

# 1   Introduction

According to Google's reports, driverless cars will dominate the road ways in the near future and 90% of the 1.2million global fatalities due to auto accidents could be avoided with driverless cars [1]. NHTSA (The National Highway Traffic Safety Administration) s for says the most effective is automatic braking, which is in fewer than 10% of cars now but will be standard on new cars by 2020. Meanwhile, The Highway Loss Data Institute for Highway Safety finds that 11 front-crash-prevention systems from six manufacturers showed 10% to 15% lower rates of claim for damaging other vehicles, compared with models without the gear [2]. In a report last year, KPMG actuaries estimated an 80% drop in the U. S. accident-frequency rate by 2040. In other words, insurers are already scrambling to deal with expected decline in premium revenue [2].

After realizing the above mentioned implications, insurers often strategize to understand the technologies of autonomous cars, what they mean and the impact they may have on their business so they can then tackle that from an insurance perspective, by serving new markets and create tools to address these new trends [3].

Unfortunately, what are the changes of the new market, practical operations and exposure risks when cars develop from no automation to full self-driving automation, so far, is not well explored by prior studies. Thus, identifying changes for insurers to improve their auto insurance strategies is not only a critical competitive differentiator but a necessity. Several experts have been proposed to explain the expansion of autonomous cars. However, identifying and qualifying the changes for the autonomous cars contest is a complex issue that often depends on the subjective assessments of managers. Strategic planners at insurers, however, usually lack objective decision-making procedures and clearly defined evaluation

processes to identify the changes for insurers, not mention to assess the weight of each change.

To fill this research gap, this study has two aims,

1. Identify what the changes are going with when autonomous cars become common in the conventional insurance industry.

2. Evaluate the weights of the changes which go with the autonomous cars development.

3. Explore the differences of understanding toward the changes are going with the autonomous cars development between insurers and insurance agencies.

## 2   Literature Review

An autonomous car (sometimes called a self-driving car, an autonomous vehicle or a driverless car) is not yet legal on most roads and is a robotic that is a designed to travel between destinations without a human operator. Moreover, according to the definition from IT glossary, founded by Gartner, Inc. (the world's leading research and advisory company), an autonomous vehicle is one that can drive itself from a starting point to a predetermined destination in "autopilot" mode using various in-vehicle technologies and sensors, including adaptive cruise control, active steering (steer by wire), and anti-lock braking systems (brake by wire), GPS navigation technology, lasers and radar. Apparently, autonomous vehicles can be defined by different viewpoint, therefore have various levels of automation [4].

### 2.1 What Are Autonomous Vehicles

From viewpoint of technical processes, there are four key stages of the technology on the autonomy- often referred to as feet off, hands off, eyes off, brain off- with landmarks of when assisted driving will be usurped by automated driving [5]. The car will use a raft of sensors, including radars, cameras and lasers, to build a picture of the road environment ahead. When off the motorway, these cars will be fitted with very advanced assistance systems to aid drivers when they are in control [5].

In contrast to defining cars by technical processes, the U. S. Department of Transportation's National Highway Traffic Safety Administration (NHTSA) tried to define autonomous vehicles by levels of vehicle automation. According to its

May 2013 Preliminary Statement of Policy Concerning Automated Vehicles, there are five levels of vehicle automation as the Table 1 presents. However, autonomous vehicles at Level 3 and 4 are still in the testing phase.

Table 1: Five Levels of Vehicle Automation

| Levels | Automation | Definition |
|--------|------------|------------|
| Level 0 | No Automation | The human driver does all the driving. |
| Level 1 | Driver Assistance | An advanced driver assistance system (ADAS) on the vehicle can sometimes assist the human driver with either steering or braking/accelerating, but not both simultaneously. |
| Level 2 | Partial Automation | An advanced driver assistance system (ADAS) on the vehicle can itself actually control both steering and braking/accelerating simultaneously under some circumstances. The human driver must continue to pay full attention ("monitor the driving environment") at all times and perform the rest of the driving task. |
| Level 3 | Conditional Automation | An Automated Driving System (ADS) on the vehicle can itself perform all aspects of the driving task under some circumstances. In those circumstances, the human driver must be ready to take back control at any time when the ADS requests the human driver to do so. In all other circumstances, the human driver performs the driving task. |
| Level 4 | High Automation | An Automated Driving System (ADS) on the vehicle can itself perform all driving tasks and monitor the driving environment – essentially, do all the driving – in certain circumstances. The human need not pay |

| | attention in those circumstances. |
|---|---|
| Level 5    Full Automation | An Automated Driving System (ADS) on the vehicle can do all the driving in all circumstances.    The human occupants are just passengers and need never be involved in driving. |

Source: NHTSA, U. S. Department of Transportation

The auto industry is already seeing improvements from advances in safety features built into driver-assist systems and even further into full self-driving automation level, which have brought reductions in accident frequency and bodily injury severity and should continue to do so as autonomous vehicles become more widespread. Face to this new era in autonomous vehicles, safety, insurers, legal specialists' viewpoints is this will result in many new challenges to the way insurance companies do business and how they view and manage risk, retail insurance and liability [6]. As the size of the automobile insurance pie shrinks, the allocation of the slices across personal auto, commercial auto and products liability cold also change [7].

## 2.2 The Change of Auto Insurance Market

Autonomous vehicles will help reduce the human error that is the cause of vast majority of accidents [8]. KPMG, the international audit, tax and advisory firm with regional offices in Stamford and New York City, issued their findings in the arena of autonomous vehicles and found the coming technology could bring an 80 percent potential reduction in accident frequency by 2040. Not surprisingly, this will result in potentially drastic reduction in loss costs and premiums. KPMG report titled "Marketplace of change: Automobile Insurance in the Era of Autonomous Vehicles" stated "A decline in accident frequency due to safer vehicles and the adoption of autonomous vehicles could shrink the U. S. personal auto insurance sector by 60 percent within 25 years ." This simply means that autonomous vehicles can become even more advanced. It would reduce the rate of accidents to a never before seen low. Normally, drivers would buy less auto insurance if this happens. However, it is a remarkable fact that autonomous cars might bring reductions in accident frequency and bodily injury severity. But these

reductions are somewhat offset by the increased cost of repairing the new technology [9]. Overtime, the technology will be expected to become less expensive, and repair costs will be less of a concern [6].

Does the higher penetration rate of autonomous vehicles mean the lower demand of insurance? It is obvious that the size of automobile insurance pie shirks, the allocation of the slices across personal auto, commercial auto and products liability could also change [7].

By the time autonomous vehicle technology becomes affordable enough for general adoption, vehicle ownership will look markedly different than it does today. Owning a car may itself become a luxury, as autonomous vehicles allow the sharing economy to replace individual vehicle ownership [10]. As the era of ride sharing and fully autonomous cars quickly approaches, insurers are crafting new coverages and endorsements to meet the needs of the new mobility eco-system [3]. Auto insurance demand increasingly will likely come from mobility management companies in the car-sharing and ride-hailing business and hardware and software providers for self-driving vehicles, rather than individual car owners [11]. In other words, automation will mean fewer accidents, but the accidents that do occur will more likely be the fault of automakers, not human. Therefore, personal car insurance premiums will hold steady for seven or eight years. Then, some of premiums could migrate to product-liability insurance and coverage bought by ride-sharing business [2].

Autonomous vehicles shift the insurance toward automakers and away from drivers or car owners. This also implies that vehicle manufacturers will become liable for a higher percentage of accidents. If car manufacturers are required to accept more responsibility for damage and injuries, they may consider to offer the insurance to car buyers themselves [12]. In fact, some autonomous manufacturers have already embraced this change with the likes of Tesla already beginning to factor in the cost of insurance when pricing their cars [13]. In the other words, auto manufacturers will assume more of the driving risk and associated liability, and have new opportunities to provide insurance to car buyers, taking market share away from traditional insurers.

Insurers may see some consolidation in the market because of upcoming changes and declining premiums. But not every car will be autonomous. Such as driverless cars and ride sharing only likely occur in densely populated cities. But in rural

areas where cars are more like utility vehicles, will be less apt to move into the world of share economy [3]. Therefore, the coming of autonomous vehicles will be a sea change in the driving experience and impact the insurance industry in similar fashion. Unfortunately, many insurers don't have the structural agility to shed costs quickly in an environment of rapid changer. Once the massive market disruption begins and traditional insurance business models are flipped upside down, it will be expected significant turmoil across the industry [7].

## 2.3 The Change of the Way Insurance Companies Doing Business

Regardless of who or what was at fault in those instances, autonomous vehicles will still have to interact with drivers, bicyclists, and pedestrians. Who's responsible if a self-driving car is involved in-or causes-a crash? However, determining the causes of autonomous vehicle collisions will be more complicated and present some unique challenges. For instances, is the accident due to human error operating a vehicle with no or limited automation? Does the collision occur due to an inappropriate or unsuccessful driver override? Does the vehicle's software malfunction, contain a computer virus, is it breached by hackers or cyber terrorists, of simply due to not receiving regular system upgrades? In brief, the above mentioned problems lie with the fault clause. If an autonomous vehicle causes an accident, who is at fault? The driver for not taking charge of the situation? Or the car itself [14]? In other words, instead of a simple tort negligence action between two drivers, future collisions may trigger product liability actions against automakers, component manufacturers, federal and state agencies, and various municipalities [15].

General speaking, in the autonomous vehicles context, product liability claims have the potential for involving automakers, manufacturers of the auto's critical technology and components, car dealships, software and hardware providers of the navigating or communicating equipments or services [2].

Due to not easy to identify who is at fault which causes an autonomous vehicle's accident, the auto owner's policy may con not provide the well coverage to resolve claims in a timely manner and it also leads to higher legal costs [8]. In order to pay to the party who suffers for the damage or injury efficiently, some states in U. S. past legislation addressing self-driving cars and insurance. The law says that if an autonomous vehicle's operating system is at fault for a collision, then the auto

manufacturer takes responsibility firstly. It means liability insurers will often pay the claim in the first place, then pursue subrogation rights against the auto manufacturer or another liable party [16].

How to assess the loss severity and frequency of autonomous vehicle accident is another issue that insurers need to face. Insurance is a data-based effort to really predict the future based on the past, and when insurance business operating has dramatically different technologies and new applications for automated driving, it makes predicting the future much harder because insurers don't have those reliable data about the past and present [8].

In a future of autonomous vehicles, what are reliable data about the past and present that actuaries may use to replace calculations about individuals with issues such as: how often cars are hacked and which parts of the country have better satellite imagery. Actuaries will also have to identify the safety differences across autonomous vehicles from Google to Tesla. Just as they know that today's auto makers have safety features of varying quality [2].

Because of assuming more of the driving risk and associated liability, auto manufactures and critical components makers will buy more product liability. KPMG estimates that by 2050 there will be significant increase in product liability insurance to 57% of total auto losses, in order to cover the autonomous technology in vehicles, and a considerable decrease in personal auto insurance to 22% of total auto losses [17]. As a result, product liability coverage and other new types of liability insurance are expected to pay a greater share of claims resulting from roadway accidents.

With the development of the autonomous vehicle, insurance will need to consider how to incorporate autonomous vehicles into their business models from policy declarations and endorsements, and property damage assessment and replacement, to claims handling, liability determinations and apportionments of fault [15]. Therefore, the operating procedures, such as underwriting, product management and claims, in insurance companies will all require significant adjustment as autonomous vehicles enter the market [18] .

## 2.4 The New Risks Arise When Autonomous Vehicles Becoming Popular

Autonomous vehicles will slowly become a mainstream form of transportation. While consumers will reap the benefits like less emission and fewer auto related

fatalities, new risks will arise [19].

What are the risks going with autonomous vehicles? The first risk is the loss or damage caused by the failure to use the manual override function to avoid an accident in the event of a software or mechanical failure, and the failure of manufacturer software or any other authorized software for the car [12].

The second risk is the damage or loss occurs because of hacking or attempted hacking of vehicle's software, particularly the operating system. A hacker could commandeer the vehicle's software and refuse to release the vehicles an act of cyber-extortion called ransom ware. Because of risks like these, coverage for hacking may become necessary [12].

The third risk is the losses or damages caused by satellite failures or outages affecting the navigation system of the vehicle and failures to install updates to the car's operating system, firewall or navigation system [12].

The fifth risk is that new legal and insurance solutions that are not ready when the car is in an autonomous mode. Thus, passengers and other road users are not protected well when an autonomous vehicle has an accident [20] [9].

The sixth risk is as Mary Barra, CEO of General Motors, said that car will wear down faster with more frequent use, and there may be more accidents with multiple drivers. Insurers will need to adapt to covering multiple drivers who may not be in the same household or family, and who may not always be driving the same vehicle [21].


## 3   Methodology

The research procedures, the relationship between research goals and methodology are showed as Figure 1 and Figure 2. This research, first of all, reviewing literatures as the base to design the questionnaire. Second, this research conducts a pilot test to assess the validity and reliability of the questionnaire. Third, referring to the results of pilot test, this research modifies the questionnaire if it is necessary. Fourth, this research decides the sample size, the way of sampling and how to distribute the questionnaire. Fifth, this research collects the data and then analyzes the data to have some conclusions and suggestions accordingly. In order to identify the changes going with autonomous cars development, the way of literature reviewing is conduct. AHP (Analytic Hierarchy Process), then, employed to

evaluate the weights of the changes which go with the autonomous cars development from perspectives of insurers and agency separately. By applying Spearman Correlation Analysis, this study can tell the differences of understanding toward the changes are going with the autonomous cars development between insurers and insurance agencies. Finally, this study can make some conclusions and suggestions to help insurers or agencies to plan their new auto insurance business strategy.



Figure1: The Research Procedures

Figure 2: Methodology and Research Goals

## 4 Research Results

After conducting pilot test, the result receiving Cronbach's $\alpha = 0.92$, represents the high reliability of the questionnaire employed in this research. On the other hand, the questionnaire designed is based on the literature review, therefore, the validity of the questionnaire is acceptable.

Autonomous car manufacturing and car insurance are highly knowledge-based professions; thus, general market survey methods may be inappropriate for exploring attitudes and opinions toward them. Thus, this study distributed questionnaires by using the purposive sampling method. To increase the representativeness of the questionnaire respondents, the selected respondents were those who were employed by the top three insurers in the auto insurance market, insurance companies funded by automotive manufacturers, insurance companies that provide automobile insurance services through science and technology innovation, and the largest professional car dealer–owned insurance agencies in

Taiwan. Because analytic hierarchy process (AHP) questionnaires are usually distributed to professionals, the number of questionnaires distributed is comparatively few [22] [23]. Sources of survey respondents and numbers of questionnaires distributed are detailed in Table 2.

Table 2: Sources of Survey Respondents and Numbers of Questionnaires Distributed

| Sources of Survey Respondents | Questionnaires Distributed |
|---|---|
| Top three Taiwanese insurers in the auto insurance market | 90 |
| Taiwanese insurers funded by automotive manufacturers | 20 |
| Taiwanese insurers that provide automobile insurance services through science and technology innovation | 20 |
| Largest-sized, professional car dealer–owned insurance agencies in Taiwan | 20 |

On the basis of the literature review, this study compiled 20 potential impacts of the prevalence of autonomous cars on the insurance industry. To satisfy the requirements of the AHP [24], the 20 impacts were categorized into three criteria (viz., "the change of auto insurance market," "the change of the way insurance companies doing business," and "new risk"), which allowed each main criterion to comprise six to seven subcriteria. Thus, the AHP questionnaires were designed on the basis of the hierarchical structure presented in Figures 3 and 5.

Criteria — Sub-Criteria

**The Cognitions of Insurers and Agencies on Autonomous Cars (Insurers)**

**The Change of Auto Insurance Market (L: 0.207)**

- Potentially drastic reduction in loss costs and premiums (L: 0.106 G: 0.022)
- Increased cost of repairing the new technology in automobile parts (L: 0.121 G: 0.025)
- The rate of individual vehicle ownership decrease (L: 0.102 G: 0.021)
- Increase the need of product-liability insurance (L: 0.290 G: 0.060)
- To factor in the cost of insurance when pricing an automobile (L: 0.156 G: 0.032)
- Autonomous cars make insurance business models flipped upside down (L: 0.081 G: 0.017)
- Driverless cars and ride sharing only likely occur in densely populated cities (L: 0.143 G: 0.030)

**The Change of the Way Insurance Companies Doing Business (L: 0.448)**

- Difficulty for insurers to determine the causes of autonomous vehicle collisions (L: 0.115 G: 0.051)
- Liability insurers will often pay the claim in the first place (L: 0.090 G: 0.040)
- Difficulty for insurers to assess the future loss of autonomous vehicle accident (L: 0.130 G: 0.058)
- Actuaries may use new reliable data in autonomous car's pricing calculations (L: 0.161 G: 0.072)
- Autonomous cars make liability claims have the potential for involving various associated parties (L: 0.202 G: 0.090)
- Autonomous cars make insurers pay a greater share of claims resulting from roadway accidents (L: 0.121 G: 0.054)
- Autonomous cars make operating procedures in insurance companies require adjustment (L: 0.181 G: 0.081)

**The New Risks Arise (L: 0.345)**

- Failure of internet system, automaker's software or authorized software for the car (L: 0.219 G: 0.076)
- Loss occurs because of hacking of vehicle's software (L: 0.146 G: 0.050)
- Damages caused by satellite failures (L: 0.176 G: 0.061)
- Failures to install updates to the car's operating system (L: 0.163 G: 0.056)
- Legal and solutions are not ready in an autonomous mode (L: 0.203 G: 0.070)
- Car will wear down faster with more frequent use in sharing mode (L: 0.094 G: 0.032)
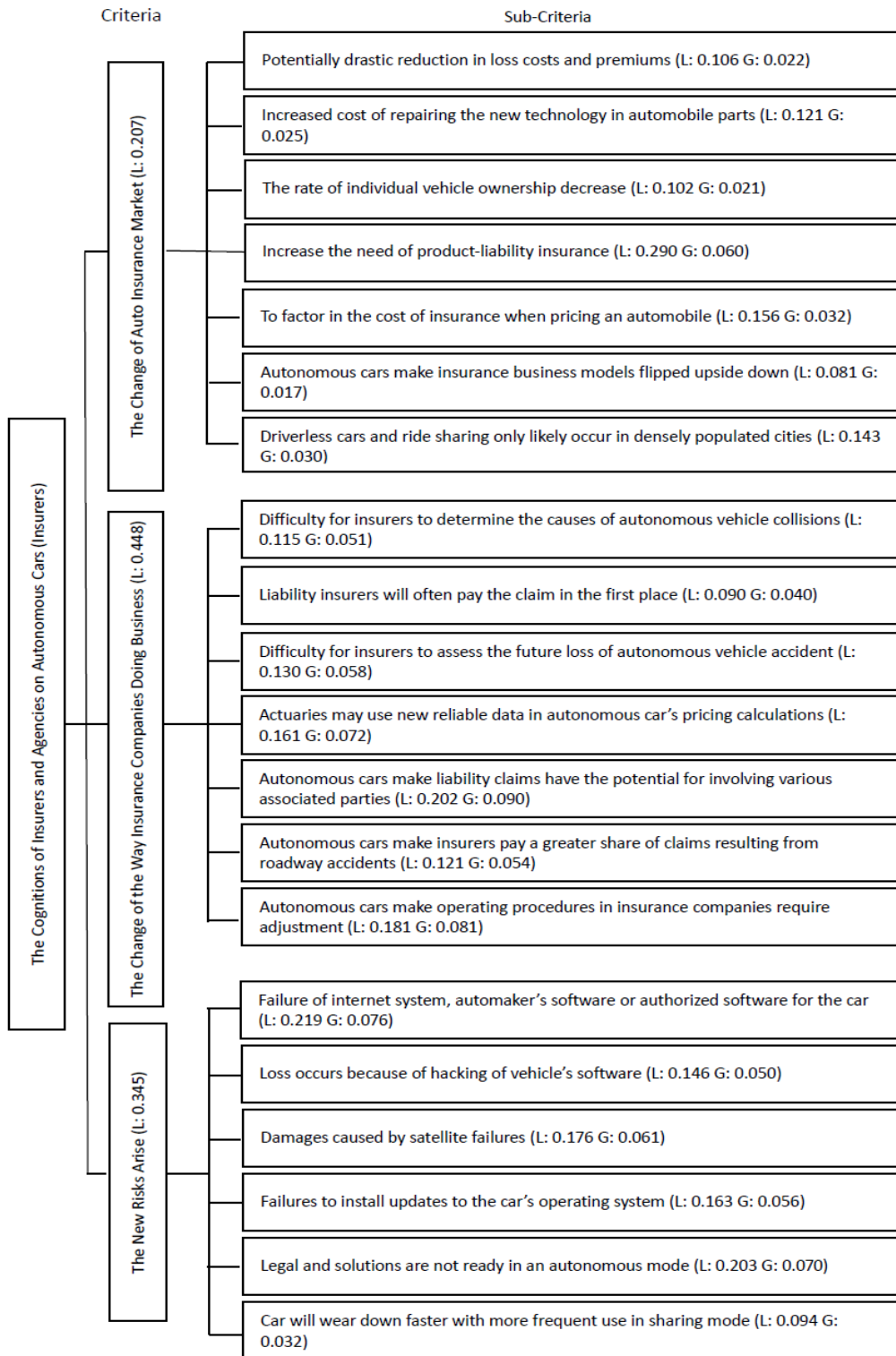
Figure 3: AHP Framework for the Understandings of Insurers toward the Changes Are Going with the Autonomous Cars Development
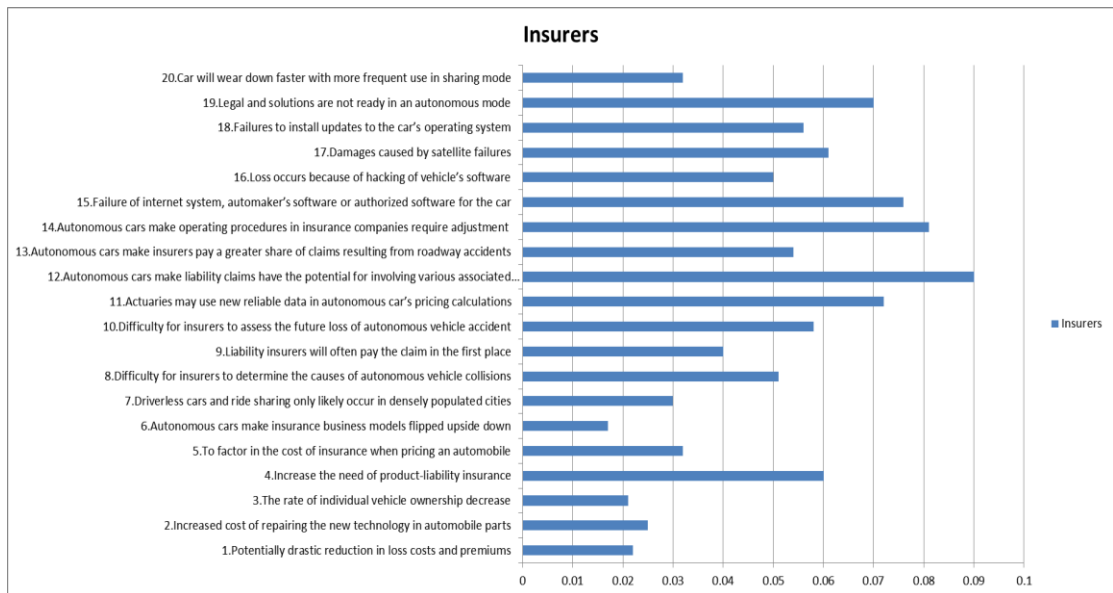
Figure 4: Overall Weights for the Understandings of Insurers toward the Changes Are
Going with the Autonomous Cars Development

## 4.1 Perspective of Insurers

The returned questionnaires were compiled and analyzed using Expert Choice
2000. As indicated in Figure 1, "the change of the way insurance companies doing
business" (L = 0.448) has the greatest impact from autonomous cars on the
insurance businesses as perceived by the respondents, followed by "new risk" (L =
0.345) and "the change of auto insurance market" (L = 0.207). Regarding the
criterion of "the change of the way insurance companies doing business,"
"autonomous cars liability claims may involve various third parties" (L = 0.202) is
the most influential subcriterion for the respondents, which signifies that
attributing liability for loss to the various parties (e.g., manufacturers, key
technology and part providers, and distributors of autonomous cars) after
autonomous car collisions is complicated. Regarding the criterion of "the change
of auto insurance market," "autonomous cars make insurance business models
flipped upside down" (L = 0.081) is the least influential subcriterion, which
indicates that insurance companies must have the flexibility to transfer the business
model of auto insurance orientation to that of liability insurance. By doing so,
when the market share of autonomous cars grows in the automobile market,
conventional insurance companies can overcome the pressures incurred by changes

in the existing business model. Thus, if insurance companies develop liability insurance products for autonomous cars, then these internal business changes would not affect insurance companies.

Figure 4 clearly displays the perceived attitudes of the respondents on the effect of autonomous cars on the insurance business. The most three influential subcriteria are "autonomous cars liability claims may involve various third parties," "autonomous cars business operating procedures in insurance companies must be adjusted," and "failure of the internet, automaker's software, or car's authorized software," whereas the three least influential subcriteria are "autonomous cars make   insurance business models flipped upside down," "a decrease in the rate of individual vehicle ownership," and "a potentially drastic reduction in loss costs and premiums."

Criteria                                                    Sub-Criteria

The Cognitions of Insurers and Agencies on Autonomous Cars (Agency)

The Change of Auto Insurance Market (L: 0.207)

Potentially drastic reduction in loss costs and premiums (L: 0.068 G: 0.015)

Increased cost of repairing the new technology in automobile parts (L: 0.121 G: 0.023)

The rate of individual vehicle ownership decrease (L: 0.125 G: 0.028)

Increase the need of product-liability insurance (L: 0.230 G: 0.051)

To factor in the cost of insurance when pricing an automobile (L: 0.176 G: 0.039)

Autonomous cars make insurance business models flipped upside down (L: 0.114 G: 0.025)

Driverless cars and ride sharing only likely occur in densely populated cities (L: 0.183 G: 0.041)

The Change of the Way Insurance Companies Doing Business (L: 0.448)

Difficulty for insurers to determine the causes of autonomous vehicle collisions (L: 0.073 G: 0.034)

Liability insurers will often pay the claim in the first place (L: 0.104 G: 0.048)

Difficulty for insurers to assess the future loss of autonomous vehicle accident (L: 0.167 G: 0.077)

Actuaries may use new reliable data in autonomous car's pricing calculations (L: 0.207 G: 0.095)

Autonomous cars make liability claims have the potential for involving various associated parties (L: 0.139 G: 0.064)

Autonomous cars make insurers pay a greater share of claims resulting from roadway accidents (L: 0.120 G: 0.055)

Autonomous cars make operating procedures in insurance companies require adjustment (L: 0.189 G: 0.087)

The New Risks Arise (L: 0.345)

Failure of internet system, automaker's software or authorized software for the car (L: 0.185 G: 0.059)

Loss occurs because of hacking of vehicle's software (L: 0.196 G: 0.063)

Damages caused by satellite failures (L: 0.180 G: 0.057)

Failures to install updates to the car's operating system (L: 0.144 G: 0.046)

Legal and solutions are not ready in an autonomous mode (L: 0.221 G: 0.070)

Car will wear down faster with more frequent use in sharing mode (L: 0.074 G: 0.024)
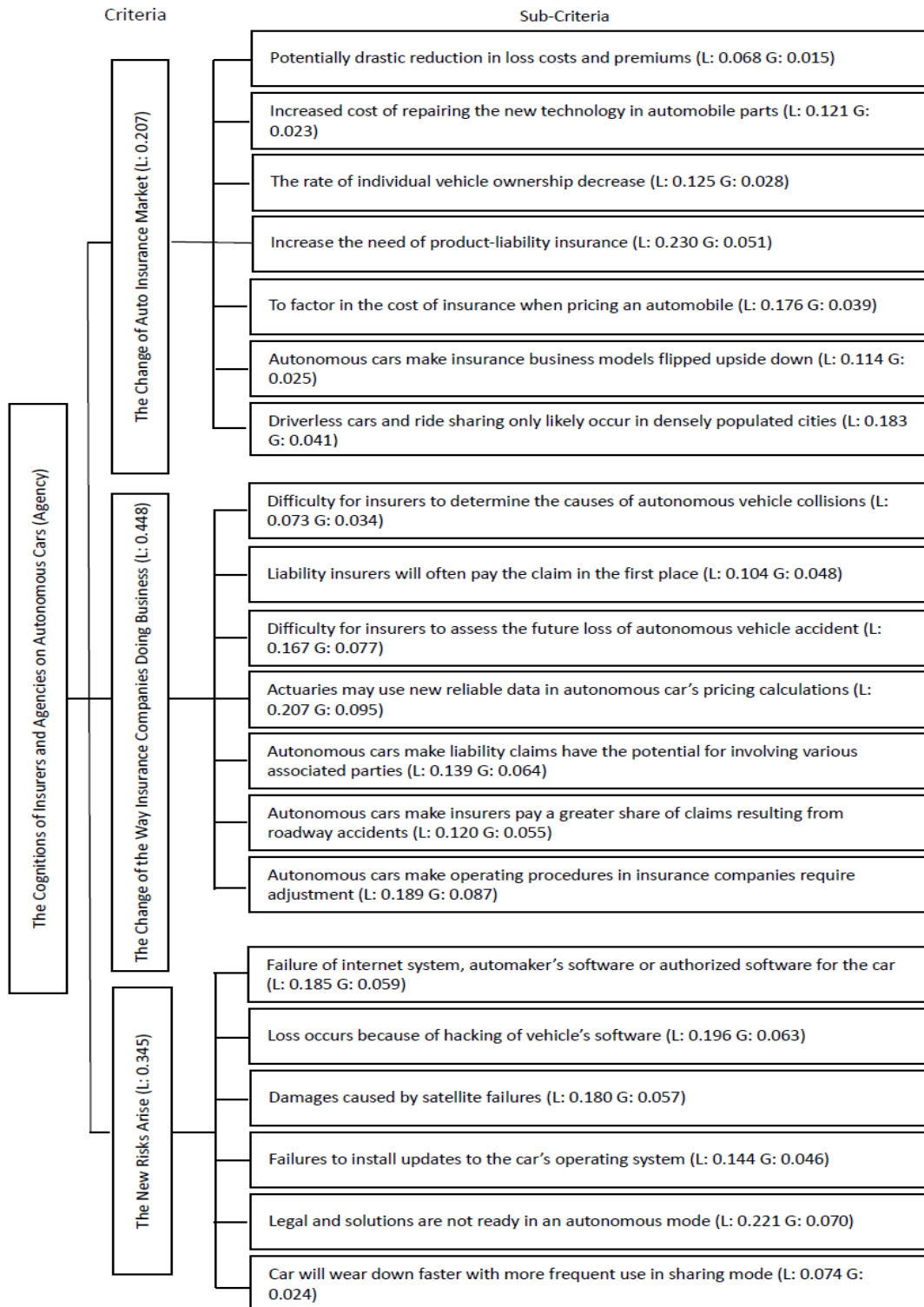
Figure 5: AHP Framework for the Understandings of Insurance Agencies toward the Changes Are Going with the Autonomous Cars Development

Figure 6: Overall Weights for the Understandings of Insurance Agencies toward the Changes Are Going with the Autonomous Cars Development

## 4.2 Perspective of Insurance Agencies

As presented in Fig. 5, the respondents from insurance companies considered that "the change of the way insurance companies doing business" (L = 0.460) would cause the greatest impact on autonomous car insurance, followed by "new risk" (L = 0.319) and "the change of the auto insurance market" (L = 0.221). Regarding the most influential criterion of "the change of the way Insurance companies doing business," the subcriterion of "actuaries may use new reliable data to calculate autonomous cars' pricing" was scored the highest (L = 0.207), which represents that the respondents believed that actuaries must consider multiple new factors to design autonomous car insurance products, such as the hacker frequency of autonomous car systems and the accuracy of satellite maps in various areas. Regarding the criterion of "the change of auto insurance market," the subcriterion of "potentially drastic reduction in loss costs and premiums" was scored the least (L = 0.068). This result indicates that most respondents agree that the popularization of autonomous cars would decrease incomes from conventional car insurance premiums but would also result in new income from autonomous car

insurance premiums (because of liability insurance), which could allow insurance companies to collect similar insurance premiums.

In this study, all of the respondents from insurance agencies were employed by the largest car insurance agencies in Taiwan, which enhanced the representativeness of the perceived attitudes toward autonomous car insurance. Moreover, most of the respondents from insurance companies were employed by the leading largest insurance companies in Taiwan. Because of the substantially high market shares of conventional car insurance, the questionnaire results should be sufficient to represent mainstream attitudes toward autonomous car insurance. Therefore, this study explored the common opinions of these two company types of the respondents, which can serve as a reference for Taiwanese insurance companies to develop related insurance strategies along with the popularization of autonomous cars.

Table 3 presents the overall weights and rankings of each subcriterion perceived by insurers and insurance agencies, and Figure 6 compares the overall weights of the subcriteria perceived by insurers and insurance agencies, allowing us to understand the similarities and differences between insurers and insurance agencies concerning autonomous car insurance. According to Spearman's correlation analysis, insurers and insurance agencies have a similar level of perceived attitudes toward autonomous car insurance (the correlation coefficient = 0.854; $p$-value = $0.000 < 0.05$) (Table 4). The six comparatively severe impacts of autonomous cars on the insurance business as perceived by both insurers and insurance agencies are "actuaries may use new reliable data to calculate autonomous car's pricing," "autonomous car liability claims may involve various third parties," "autonomous car business operating procedures in insurance companies must be adjusted," "difficult for insurers to assess future losses incurred by autonomous vehicle collisions," "failure of the internet, automaker's software, or car's authorized software," and "current laws and regulations are inadequate for attributing liability in autonomous car collisions." The four least influential subcriteria are the "potentially drastic reduction in loss costs and premiums," "increased cost of repairing the new technology in automobile parts," "autonomous cars make insurance business models flipped upside down," and "the rate of individual vehicle ownership decreases."

Table 3: Overall Weights and Rankings given by Insurers and Insurance Agencies

| Q1-Q20 | Insurer Weight (Rank) | | Agency Weight (Rank) | |
|---|---|---|---|---|
| Potentially drastic reduction in loss costs and premiums | 0.022 | (18) | 0.015 | (20) |
| Increased cost of repairing the new technology in automobile parts | 0.025 | (17) | 0.023 | (19) |
| The rate of individual vehicle ownership decrease | 0.021 | (19) | 0.028 | (16) |
| Increase the need of product-liability insurance | 0.060 | (7) | 0.051 | (10) |
| To factor in the cost of insurance when pricing an automobile | 0.032 | (14) | 0.039 | (14) |
| Autonomous cars make insurance business models flipped upside down | 0.017 | (20) | 0.025 | (17) |
| Driverless cars and ride sharing only likely occur in densely populated cities | 0.030 | (16) | 0.041 | (13) |
| Difficulty for insurers to determine the causes of autonomous vehicle collisions | 0.051 | (11) | 0.034 | (15) |
| Liability insurers will often pay the claim in the first place | 0.040 | (13) | 0.048 | (11) |
| Difficulty for insurers to assess the future loss of autonomous vehicle accident | 0.058 | (8) | 0.077 | (3) |
| Actuaries may use new reliable data in autonomous car's pricing calculations | 0.072 | (4) | 0.095 | (1) |
| Autonomous cars make liability claims have the potential for involving various associated parties | 0.090 | (1) | 0.064 | (5) |
| Autonomous cars make insurers pay a greater share of claims resulting from roadway accidents | 0.054 | (10) | 0.055 | (9) |
| Autonomous cars make operating procedures in insurance companies require adjustment | 0.081 | (2) | 0.087 | (2) |
| Failure of internet system, automaker's software or authorized software for the car | 0.076 | (3) | 0.059 | (7) |
| Loss occurs because of hacking of vehicle's software | 0.050 | (12) | 0.063 | (6) |
| Damages caused by satellite failures | 0.061 | (6) | 0.057 | (8) |
| Failures to install updates to the car's operating system | 0.056 | (4) | 0.046 | (12) |
| Legal and solutions are not ready in an autonomous mode | 0.070 | (5) | 0.070 | (4) |
| Car will wear down faster with more frequent use in sharing mode | 0.032 | (14) | 0.024 | (18) |

Figure 6: Comparison of the Overall Weights for the Understandings of Insurers and
Insurance Agencies toward autonomous car insurance

Table 4: Spearman's Correlation Analysis on the Understandings of Insurers and
Insurance Agencies toward autonomous car insurance

|  |  |  | Insurers | Insurance Agencies |
|---|---|---|---|---|
| Spearman's rho | Insurers | Significance of the Correlation Coefficient | 1.000 | .854(**) |
|  |  | (Two-tailed test) | . | .000 |
|  | Insurance Agencies | Significance of the Correlation Coefficient | .854(**) | 1.000 |
|  |  | (Two-tailed test) | .000 | . |

**$p < 0.01$ (two-tailed)

# 5   Conclusions and Suggestions

## 5.1 Conclusions

According to the research results, we conclude the following:

5.1.1 Insurance companies have high market shares and substantial experience in claims, and professional auto insurance agencies have attained close relationships with consumers and automobile manufacturers. Both insurers and insurance agencies hold similar views toward the influences of autonomous cars on the car insurance market, business models, and risks; thus, relevancy is observable for these widely recognized effects. Respondents from both insurance companies and insurance agencies agreed that the development of autonomous cars would create new factors that must be considered, requiring the insurance industry to develop new insurance products. However, because the industry has insufficient experience in autonomous car insurance, liability could be difficult to attribute among multiple parties involved in car collisions, which results in challenges in predicting chance of loss.

5.1.2 The respondents from both insurance companies and insurance agencies exhibited a low recognition level of "potentially drastic reduction in loss costs and premiums," "increased cost of repairing the new technology in automobile parts," "autonomous cars make insurance business models flipped upside down," and "the rate of individual vehicle ownership decreases." Although autonomous cars may reduce the frequency of car collisions (caused by human mistakes) and insurance premium income, the demand on liability insurance products for autonomous cars would grow, offsetting the premium income from conventional car insurance premiums. The per capita car ownership rate in Taiwan would not drop significantly. The literature review indicates that most of the residents in low-density suburbs have low demand for car sharing and still need private cars. Moreover, cars will become more affordable alongside scientific and technological progress, which has gradually reduced costs for manufacturing and repairing cars. Therefore, because liability attribution is difficult following car collisions, insurers will need to consider various factors for underwriting and still use the existing practical model to manage

underwriting, the claims process, and pricing.

5.1.3 Insurers that have high market shares and substantial experience in claims and insurance agencies that have attained close relationships with consumers and automobile manufactures hold similar attitudes toward the influences of autonomous cars on the car insurance market, business models, and risks. However, they regard the respective changes and impacts differently, which indicates that the changes and impacts are potentially wide ranging. In other words, even though these changes and effects concerning autonomous cars were proposed by noninsurance experts, most insurers and insurance agencies regard these views positively.

## 5.2 Suggestions

On the basis of the research results and conclusions, this study proposes the following suggestions:

5.2.1 In the car insurance market, the chance of loss caused by autonomous car collision is difficult to predict, which causes challenges for insurance companies in designing insurance products and policies, including insurance coverage, exception clauses, and premium rates. Autonomous cars have gradually improved. Therefore, with the development of autonomous cars, insurance companies should accumulate their experiences in loss, utilize research data published by experts in autonomous cars, and consider autonomous car insurance products from several developed countries. This allows domestic insurers to enhance their ability to respond to the inevitable development of autonomous car insurance.

5.2.2 Because multiple parties may be liable in cases of autonomous car collisions, insurance companies spend comparatively substantial time processing claims, which could hinder the timely payment of compensation to the relevant parties. Therefore, methods for shortening claim schedules are essential to maintain the service quality of insurance companies. This study suggests that insurance companies consider a policy similar to no-fault liability insurance, which allows insurance companies to compensate the damaged party following an autonomous car collision and subsequently exercise subrogation rights to file claims against the liable party for reimbursement after liability is determined.

5.2.3 Numerous technology companies and automobile manufacturers are highly interested in the car insurance market. Conventional insurance companies could seek either business or investment opportunities with technology companies and automobile manufacturers to secure their business base and competitiveness in the market and to increase insurance premium incomes. Furthermore, although the retail prices set by automobile manufacturers include insurance premiums, in order to serve the underwriting and claim to insured efficiently, they must seek cooperation with professional institutions and insurance business departments, which could be a sizeable advantage for conventional car insurance companies.

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