USING GAME THEORY TO MODEL THE INTERACTION BETWEEN THE AIRLINE AND CUSTOMERS AFTER AVIATION ACCIDENTS

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1. INTRODUCTION

While aeronautical technology develops, nowadays aviation accidents still cannot be prevented. Most of accidents are serious, so it usually arouses huge public concerns and responses. Unlike aviation industry related experts or staff, lay people can only tend to believe in the media. Until now most of people have incorrect prejudice and unprovoked safety perception to accidents. Therefore, customers are not willing to use the involved airline because of public fear of flying and safety concerns for a period. Wong et al. (2003) used 26 accidents which took place during the 19-year period to estimate customer loss and influential period for airlines, and found that an accident occurs during or just before an off-peak period, it is averagely associated with a 2.54 month effect and a 22.11% monthly traffic decline. In recent years, two air crash events happened in Taiwan with the same airline, TransAsia Airways, and had a strong social impact on public safety perception. For the involved airline, if there are no or less airline rivals and if the lowest safety standard has been met, the airline may not be motivated to spend extra investment for safety improvement, because customers still have to use air transport due to choice limitation and abating of worries with time.

2. OBJECTIVES

For safe and sound development of air transport industry, it's important for airlines to examine the safety management system thoroughly again to lower risk and to prevent accident occurrences. There are still many airlines trying to upgrade and conduct safety measures after accidents, but their motivation may decrease if they couldn't retrieve passengers. A problem has been stated here: as long as airlines can pass the impact duration, they may tend to do nothing or lower airfare to attract customers instead of spending huge amount of costs in safety measures. If the government authority is not strict, airlines may only satisfy the lowest requirement, because airlines are considering maximum of profits, making it a trade-off with safety. This situation can be explained by non-cooperative game theory to model diverse stakeholders. Therefore, objectives of this study are to make a game to analyze the interaction between one airline and customers, to quantify the factors that dominating their consideration, and to find the motivation for airline safety improvement.

3. LITERATURE REVIEW

Game theory, consisting of cooperative and non-cooperative games, is widely used for decision making with different player's strategy and the utility. The players of the game are the main portion to make decisions, and they are involved to participate in a game for getting maximum benefits. The main elements in a game include players, information, strategy and payoff functions. Game theory provides a framework for interpreting the interaction among decision-makers for determining the outcome jointly. In order to model the competition or cooperation among independent players, it is a powerful tool in understanding the relationships. In transport or administrative field, it was firstly used to express behavioral hypothesis such as route choices, and after that diverse application has been addressed. Roumboutsos et al. (2008) applied a game theoretical approach to the issue of integration within urban public transport networks provided by service operators. Wang et al. (2005) used it to model the strategic interactions between the operators in a deregulated bus market basing on the competition over price and service frequency. Dong et al. (2010) found there are conflicts of the interest between the government and the industry, and added policy variables to specify the payoffs for policy improvements. Talebpour et al. (2015) compared the difference for players with complete and incomplete information with an example of the Nash non-cooperative game. Game theory has been applied to transport modeling until now, and it is possible to describe how an airline and customers respond to this game of safety improvement.

4. GAME FORMULATION

4.1 Game Setting

Two players (player A: the airline which had one accident occurred recently; player B: customers) have two strategies respectively. Player A can take active action to improve safety or take passive action to give airfare discount. Player B can consider to use or not to use the airline, but because various samples compose of one role, player B can be further classified into those who consider safety as priority (type I) and those who rather think service quality as main airline selection criteria (type II). The airline provides air transport service and is aimed to earn maximum profits, while customers have demands and hope for either less worries or better satisfaction, making it to be a non-cooperative game.

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4.2 Game Conditions

Several characteristics of this game with extensive form in Fig. 1 have been addressed as follows:

- Two-person non-zero-sum game: Nash equilibrium exists, so a suitable solution for two players can be identified.
- A game with imperfect information: Because the airline cannot predict customers' willingness, and customers are not familiar with safety measures, a skill to let two players make decisions at the same time can model this condition.
- A game with incomplete information: Individuals have their personal consideration, and the airline cannot specify what customers consider respectively such as preference for safety perception or service quality, so a random nature is used to divide the game into type I and type II two parts.
- Repeated game: It can be finitely or infinitely repeated game, but in this study a discount factor δ can represent people's abating of worries with time passing, making it become a continual game.
- Game with perfect recall: Both players A and B remember their previous decisions, and then make the next one.
- Information asymmetry: Customers know which type they belong, while the airline doesn't. This may cause adverse selection problem, which was given an example in second-hand car market: making high-quality product from the market due to market mechanism and conflicts between dealers and car owners (Akerlof, 1970).

5. RESULTS: PAYOFF ANALYSIS

In this research, monetary unit was used to quantify airline's payoff covering airfare revenues, safety measures costs, promotion costs, discount costs, fixed costs, penalty, and qualitative factors such as airline reputation, customer loyalty. As for customer's payoff, they wish to finish the journey after airfare payment, so several indicators toward airlines with five point Likert scale including trust, safety perception, perceived quality, airline image, satisfaction, and airfare acceptance were collected though a survey toward 393 Taiwanese citizens from January 27 to February 16 in 2015 to make a utility function to quantify customers' payoff. Moreover, a variable δ_T was used to express people's worries decline with time, which is attached to safety perception indicator and will increase player B's payoff, because their worries toward accidents decrease when time passing. As a result, Nash equilibrium which changes at the timing that customers are willing to use and the airline takes strategy of safety measures, will be a solution for win-win and social overall benefits.

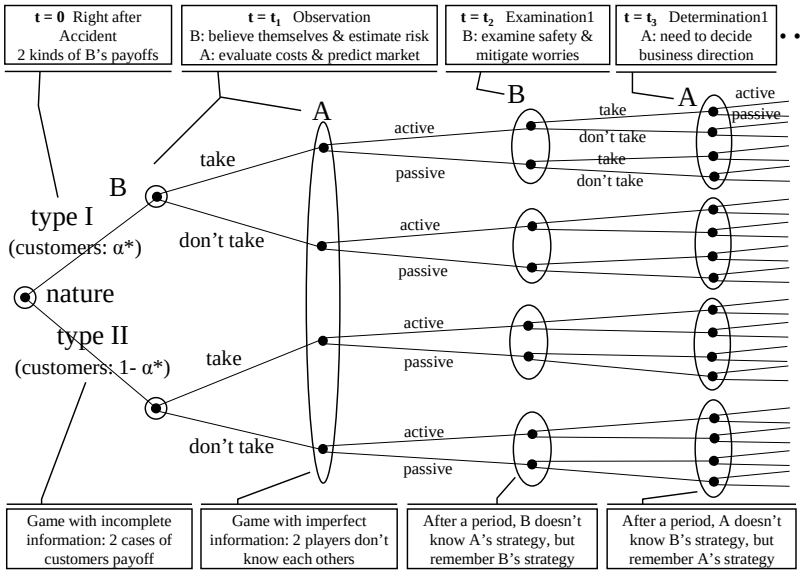

Fig. 1 Game of Safety Improvement Extensive Form

6. CONCLUSIONS AND RECOMMENDATIONS

Currently, payoff quantification is on the process and data will be retrieved through an interview with TransAsia Airways. From the expected results of this study, timing and the best strategy for players can be identified, which can show customers' attitudes are controlling airline motivation, encourage airlines to implement safety measures, and help improve overall safety standards to prevent accidents. However, there are some issues needed to be further discussed. When airline companies make decisions, diverse factors such as passenger loss, passenger recovery trend, limited budget, current resources, government requirement, previous experience, accident report, etc. should be considered to facilitate safety improvement decision making process. Besides, how to evaluate safety improvement performances is important for upgrading future program, and making an index to assess the effects is recommended.

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