Fundamental Study of Key Factors Promoting Smooth Penetration of AI using Analogue Business Games

Tomomi Kaneko[†], Ryoju Hamada[††], Masahiro Hiji[†††]

Abstract— **In recent years, many companies have researched and developed vehicles that offer automated driving. The newly developed vehicles have numerous sensors, cameras, and AI features. These semi-automated driving vehicles might become very popular during the next decade. In the future, as often seen in movies and cartoons, all vehicles might become connected to traffic control systems operated by public organizations. For promoting smooth penetration of the system, the system might adjust coexistence of the most suitable traffic control and the human satisfaction. However, the authors conducted lectures using analogue business games, which are BASE business games, for lectures at the School of Management Technology (MT) of the Sirindhorn International Institute of Technology (SIIT), Thammasat University since 2013. For this study, the authors attempt to consider similarity between a society with fully automated driving systems and lectures using analogue business games. Furthermore, the authors analyzed student responses to a questionnaire from coexistence of systems and human satisfaction perspectives. Then they clarify key factors promoting smooth penetration of AI.**

Index Terms— **Automated driving system, Coexistence, Human satisfaction, Analogue game, BASE business games**

I. Introduction

Development of artificial intelligence (AI) recently is remarkable in its scope and depth. With improvement of AI capability and computer processing capacity, AI has become a powerful technology to calculate optimum solutions. One future application might be traffic control of automated driving vehicles. Its effectiveness is highly anticipated for the control of traffic flow, but satisfaction of the vehicle driver is not considered. For wider use among automated driving vehicles, key factors of human satisfaction must be clarified in accordance with the system. Then they must be integrated into an effective traffic control system. However, the authors have investigated the effectiveness of a participation-type education technique using analogue business games, which are called Business and Accounting School for Entrepreneurs business games (BASE business games) since 2007. Experience from lectures shows that the participants invariably play the game to win against other teams. However, they do not always play amicably. Therefore, they compromise with the lecture's circumstances and try to get along as best they can. In this study, the authors attempt to consider similarity between a society of fully automated driving systems and the lectures using analogue business games. Furthermore, the authors analyzed student responses to a questionnaire about student satisfaction in accordance with the system perspective.

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The results clarified key factors of coexistence under lecture circumstances and not merely getting along. These factors might be important to realize a society of highly automated driving with human satisfaction.

II. Literature Review

The authors have some experiences related to research of satisfaction factors of the system. Tsukada and Yamada [1] discussed employee satisfaction of Toyota Dealers in Shikoku, Japan. Usuki, Takahashi, and Kitaoka [2] described the success of Computerized Vehicle Routing and Scheduling (CVRS) technology in terms of cost and benefit as well as user satisfaction. The authors also have some experience related to participant satisfaction with business games. Patton, Davis and Govahi [3] reported the use and evaluation of experiential exercises in the business classroom. Maddox and Nicholson [4] reported exploratory research on business students' satisfaction with their academic experiences. Hamada, Hiji and Kaneko [5] produced SKG, a card game, for management skills used in the IT industry, and demonstrated the effectiveness of participant learning and satisfaction. Kaneko, Hamada, and Hiji [6] also reported the participant satisfaction using analogue business games.

III. Present circumstances of automated driving in Japan

Automated driving systems have been researched and developed by automobile manufacturers since the 1980s. Some manufacturers developed Advanced Safety Vehicle (ASV), which is equipped with technology such as Pre-Crash Safety Systems (PCS), Adaptive Cruise Control

(ACC), and Lane Keep Assist (LKA). Furthermore, many companies, e.g., Apple Computer Inc. and Google Inc., have developed an automated driving vehicle. A newly developed car, which has many sensors, cameras and the AI, has an "on-board system". A vehicle connected to a traffic control system operated by a public organization, is called a "connected system." In 2014, the Cross-ministerial Strategic Innovation Promotion Program (SIP) presented the definition of Automated Driving Level in Japan shown in Table I.

TABLE I
Definitions of Automated Driving Levels [7]

Automation Level (SIP definition)	**Overview**	**Systems to realize the level**
Level 4	All functions of acceleration, steering, and braking are controlled without a driver. The driver is completely uninvolved.	Fully automated driving system
Level 3	Vehicle controls all functions of acceleration, steering, and braking. The driver intervenes in cases of emergency.	Semi-automated driving system
Level 2	Simultaneous multiple functions of acceleration, steering, or braking	
Level 1	Single function, either acceleration, steering, or braking	Safe driving assistance system

The authors assume that the "Level 3" automated driving system might be used because these vehicles have an advanced on-board system and a slight ITS (Intelligent Transport Systems) connection. However, a combined on-board system and connected system is necessary to realize "Level 4," for which all vehicles must be connected to the traffic control system operated by a public organization and in which drivers are completely uninvolved. The authors assume that a public organization controls each car to create the most suitable traffic flow, but optimal control might not satisfy all people. Therefore, to achieve a "Level 4" society, the system must adjust not only to suitable traffic control but also to human satisfaction.

IV. BASE Supply Chain Collaboration Games

Students study diligently and acquire much knowledge related to Supply Chain Collaboration and Inventory Control through university lectures. This knowledge has high specialty and difficulty. The authors assume that it is possible for students to understand Supply Chain Collaboration and Inventory Control as knowledge, but it is difficult to characterize them as experimental. The author created two types of BASE business games to provide opportunities to learn: "Supply Chain Collaboration Game (SCC game)" and "Supply Chain Collaboration 2 Game (SCC2 game)." These games, which use a simple model of smartphone manufacture, require that players form teams and operate a mock-up company. Figure 1 presents an SCC game outline. Players operate smartphone manufacturers and create smartphones comprising a motherboard and a display. Then they sell them in the market.

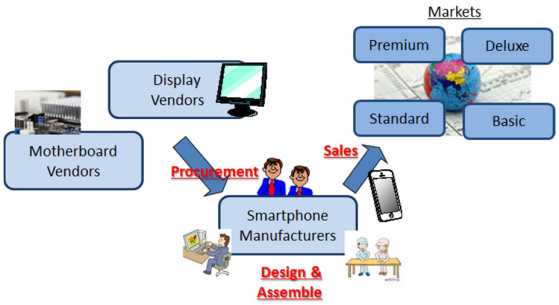

Fig. 1. Outline of the SCC Game.

Figure 2 presents the SCC game flow. The period of the game is one year, which is divided into 12 months. One month is the minimum time scale. Players who want to sell a smartphone must choose many actions, such as "Sell a Smartphone," "Assemble," "Procurement," and "Payment."

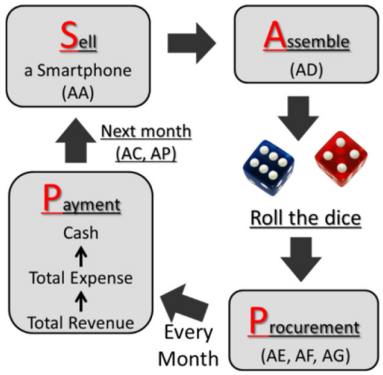

Fig. 2. Game Flow of SCC Game.

Through the sales process, players can sell smartphones every month. Four different markets exist: Premium, Deluxe, Standard, and Basic. Figure 3 shows that each market is defined as having "Acceptable Quality," "Price Cap," and "Market Volume." These conditions change annually. Players must choose a market after comparing their smartphone's quality and the market's acceptable quality.

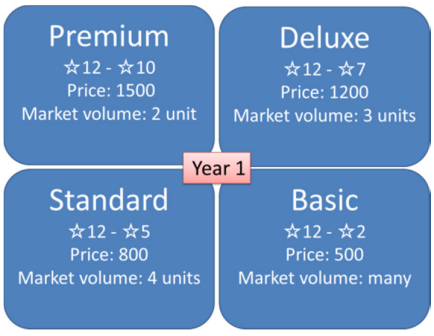

Fig. 3. Market Sheet.

When the total sales volume does not exceed the market volume, players receive the maximum sales revenue, which is the same as the market price cap. However, when total sales volumes exceed market volume, open bidding occurs. Open bidding is face-to-face bidding: the most outstanding action in these games. Players come to the market board at which they want to sell smartphones. Then they put them on the market. After they are ready, they show the price to other companies with a calculator at the signal of the facilitator. If a player wins the bidding, then they receive sales revenue of their sales price. For a loser of the bidding, one special rule exists, the "Lose quality rule." Smartphones of the loser of the bidding lose two quality stars. This special rule teaches players that the value falls once the product becomes widely known to the market. Figure 4 portrays photographs of the open bidding process.

Fig. 4. Photographs of Open Bidding.

Figure 5 presents an SCC2 game outline. It is more complex than the SCC game. In the SCC2 game, players separate and form three companies: motherboard vendors, display vendors, and smartphone manufacturers. Each company assembles motherboards, displays, and smartphones, as in the SCC game. A salient difference between the SCC2 game and the SCC game is that Motherboard Vendors and Display Vendors are subcontractors of the Smartphone Manufacturers. Thereby, Smartphone Manufacturers must negotiate with Motherboard Vendors and Display Vendors on prices and many motherboards and displays. All companies must negotiate with awareness of their own company's cash flow. Moreover, players play a role as a company of one of three types throughout SCC2 game. Therefore, they come to understand the viewpoints of prime contractors and subcontractors. These are outstanding features of the SCC2 game.

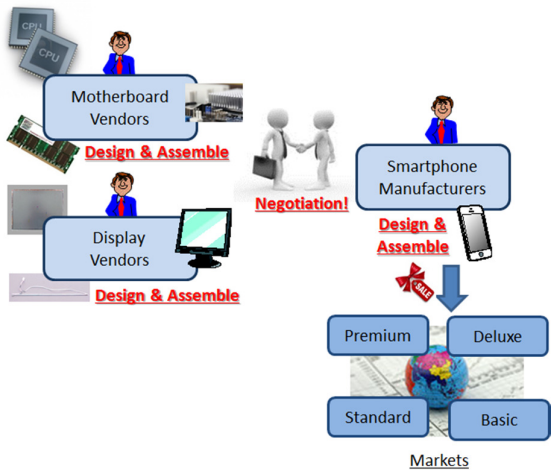

Fig. 5. Outline of the SCC2 Game.

V. Discussion

a. Comparison between the society of Level 4 and the lecture of analogue business games

The authors attempt to compare the society of Level 4 and the lecture using analogue business games at SIIT Thammasat University as the following four perspectives.

- Closed circumstances
  - Level 4: society in which fully automated driving realized
  - Lecture: the classroom
- Objective
  - Level 4: a person who wants to arrive at one's own destination easily (except for drivers who enjoy driving itself)
  - Level 4: a person who wants to learn business using business games (except for students who want to learn business using traditional lectures)
- Desire
  - Level 4: arrive at one's own destination faster
  - Lecture: win business games
- Information for operation
  - Level 4: data from the system and each vehicle
  - Lecture: management information shown in every team

In the lecture, every team produces a suitable strategy based on all data. This process brings the best solution of managing business games. However, in a Level 4 society, the system must meet the best solution of traffic flow. As explained in the discussion above, the author assumes that a society with a fully automated driving system can be interpreted in this way.

b. Clarify key factors of system and human satisfaction coexistence

The authors conducted a lecture: "Entrepreneurship for IT Business Development" from 2013. All were senior students of the undergraduate Management Technology Course and Engineering Management Course. They understood supply chain management to a certain degree, but they had no ideas related to supply chain collaboration. The SCC game and SCC2 game were used in most lectures. At the beginning of the lecture, they were concerned about the adjunct Japanese Associate Professor and the lecture contents. However, as they came to understand the game rules, they were able to enjoy lectures more.

To verify the game's effectiveness, the authors conducted questionnaire research for self-evaluation. Table II presents results of the questionnaire.

TABLE II
Can you recommend ITS442 to younger students?

2014	2015	
1	0	1. Strongly do not recommend
1	1	2. Do not recommend
3	4	3. Neutral
10	22	4. Recommend
24	30	5. Strongly recommend
4.41	4.42	Average

TABLE III
Insights students gained during this lecture in 2015, ranked 1–5

Choice	Rank					Total Number
	1	2	3	4	5	
Inventory Management	6	4	9	8	5	32
Bid & Price Setting	8	7	5	8	4	32
Teamwork	12	2	8	2	4	28
Finance & Accounting	3	5	6	9	3	26
Business Strategy	10	6	4	0	4	24
Marketing Strategy	2	10	2	3	2	19
Long Term Relationship	2	5	2	5	4	18
Product Cost	3	3	2	4	4	16
Product Quality	1	4	3	4	1	13
Risk Management	0	1	1	3	6	11
Customer Relationship Management	1	1	3	2	3	10
Entrepreneurship and Innovation	0	0	1	0	4	5
Economics	0	0	1	0	2	3
External Factor	0	0	1	0	1	2
Kaizen	0	0	0	0	1	1
Blue Ocean Strategy	0	0	0	0	0	0
Capital and Loan	0	0	0	0	0	0

The average was calculated as shown below.

$$Average = \frac{\sum(the\ scale\ \times\ number\ of\ response)}{number\ of\ response}$$

The authors assume that this question is representative as a summary of student satisfaction. In both years, many students might recommend ITS442 to younger students. Whether the students win or lose the business games, they generally enjoy this lecture and are satisfied with it.

Table III presents ranks of 1–5 for insights gained throughout this lecture in 2015. Rank one symbolizes "most understanding." The authors specifically examine the total number of responses received, which are calculated to sum up respondents' number from rank one to rank five. Results show that more than half of students among 48 respondents chose "Inventory Management," "Bid & Price Setting," "Teamwork," "Finance & Accounting," and "Business Strategy" among the top five. Aside from "Teamwork," the other four choices are learned through BASE business games. The most outstanding result is "Teamwork," which has nothing to do with BASE business games directly. Moreover, "Teamwork" was most often chosen as first place, which indicates that respondents might feel that "Teamwork" is necessary for managing BASE business games. Furthermore, the authors observed that the team using communication well manages BASE business games well. Certainly, no communication-lacking team can manage the BASE business game well. The authors assume that "Teamwork" is almost equal to communication among students and that communication might be indispensable for lecture satisfaction.

VI. Conclusions

The authors assume that, to reach a society for Level 4 automated driving, it might be necessary to realize not only effective traffic flow but also driver satisfaction. This paper presented a fundamental study of key factors of the circumstances above.

(1) A society supporting a fully automated driving system can be interpreted from results of lectures using analogue business games.

(2) The authors assume that communication among students might be a key component of their satisfaction that mitigates conflict between the lecture's circumstances and their own demands.

By extension of these results, one-sided instructions from the system to drivers might not be satisfying to humans. The system must have intractability and confirm human thought to ascertain whether the system follows human thought or not. The authors know that these results are insufficient to support this hypothesis. As a subject of future study, the authors will undertake detailed questionnaire research of key factors affecting their satisfaction in spite of unsatisfactory games' results.

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