

DEVELOPMENT OF SOFTWARE ENGINEERING BUSINESS BOARD GAME

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ABSTRACT

In recent days, software engineering has become a collaborative effort with others. Based on good communications, to control software development, skills for management of human resources, process, cash and others have become vitally necessary. To provide opportunities to learn such skills related to technology, we developed a board game called the Software Kaihatsu Game (SKG; Kaihatsu means 'development' in Japanese) in 2009. Students form teams to manage software firms, and assume roles as a Chief Executive Officer (CFO) or Project Manager. SKG has been used at the Graduate School of Information Sciences, Tohoku University, and at Sirindhorn International Institute of Technology, Thammasat University, Thailand. It was also used for the training of business people in the software industry around Sendai City, Japan. This paper introduces the features, effects, and expected improvements of SKG.

INTRODUCTION

Compared with the beginning of its history, software engineering has become increasingly comprehensive. Now is a time for distributed works related to common hardware. Most source codes, ideas, and functions are already compiled in a common environment. Programming skill remains important, but skills of project management have become extremely important. Required skills are no more related solely to technology. Engineers who were nominated as project managers must learn widely, including diverse skills related to sales, human resource management, process control, cash, and good

communications with others. However, trying to learn everything will take a long time and will entail great costs. Moreover, such skills are completely different from those used in traditional ICT enterprises.

The lead author, Ryoju Hamada, has been working for the Graduate School of Information Sciences, Tohoku University since 2003 and has confronted the low motivation of computer science students to learn problems that have social surfaces. In those days, the Japanese economy had been mired in a long recession. Producing new entrepreneurs was the strongest need of society. Nevertheless, few students showed an interest in starting a business. Was there some easy and interesting way to increase their motivation related to business? That question became the origin of our research, which led to the creation of a software engineering board game, which would come to be called SKG.

PREVIOUS WORKS RELATED TO SOFTWARE ENGINEERING EDUCATION

Although the term 'Software Engineering' has been used for more than 40 years, no clear consensus prevails on how to teach 'Software Engineering'. Garrat (1988) analyzed it and found that it includes disparate ideas, making it difficult to define. He compared software engineering education taking place at industrial and academic environments, and tried to teach it at a university. In 1995, he invented two computer-based software management games for computer science students. They included ideas related to the operation of a mock up company, project cost, quality improvement, and teamwork. Martin (2000) introduced a board game called 'THE-MIS' and a computer-based game called

‘Information Systems Project Manager’ and tried comparative analysis of effectiveness. Baker, Navarro, and van der Hoek (2005) described that knowledge and practice are important for software engineering education, and proposed a card game called ‘Programmers and Problems’.

Carlos Mario Zapata J. (2009) recognized that engineers need three attributes: knowledge, methods, and communication skills. He compared diverse theories to teach software engineering and finally chose to use a game. He introduced the ‘Software Development Game’ using origami, which represent parts of large software. Nakamura (2012) introduced his computer-based role-playing exercise and argued that it encouraged students.

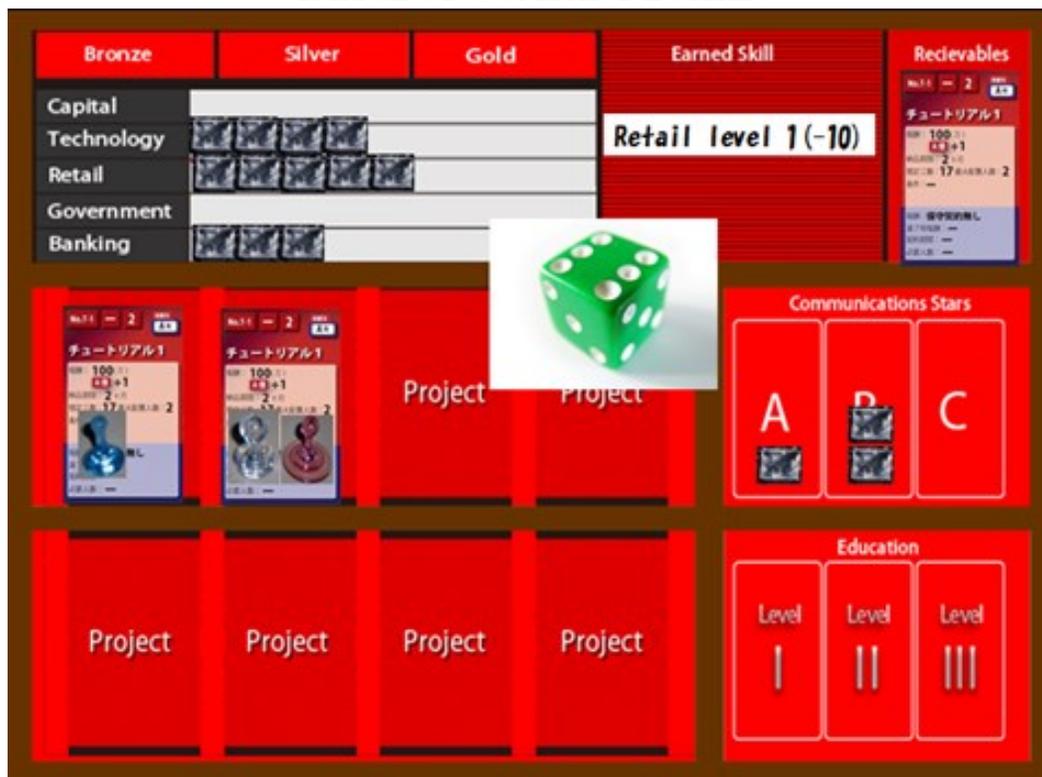
We strongly support those previous works. We do believe that to develop software, engineers need combined skills from diverse disciplines, as Zapata J. described. However, we found that most of them specifically examine software development theories and process, but lack a president’s viewpoint. Many know that it takes costs for each project, but it seems insufficient to teach students how to control human resources and budgets at a whole company scale. Secondly, we hoped to teach accounting. To achieve this goal, we had an idea to make students operate using long-term and complete financial statements. For these reasons, we chose to create a new business game.

EDUCATIONAL POLICY OF SKG

Before developing SKG, we defined the following educational policy.

1. The target audience is engineers in the software industry who are going to be promoted to management. However, it is available to be played by university students who have learned ICT.
2. Purpose: Learners will be able to do the following.
 - i. Understand how to manage a project
 - ii. Manage human resources for respective projects
 - iii. Manage financing for each project
 - iv. Understand why increasing experience and skills is important
 - v. Encourage communication skills
3. Methods: to realize these purposes, we admitted the following ideas and expressed them tangibly. Figure 1 presents a whole image, and detailed information is presented in section 5.
 - i. Company Board, Project Cards, and Gantt Chart (GC).
 - ii. Doll ()denoting an engineer
 - iii. Cash flow management sheet, Profit and Loss Statement (P/L), and Balance Sheet (BS)
 - iv. Stars that denote experience or knowledge.
 - v. Card Exchange session

FIGURE 1
IMAGE OF COMPANY BOARD.



BASIC IDEAS

Basic Story

Students form teams and start software development firms. Several strategies might be used to grow a firm. Throughout experiences at management of sales, cash, project, and accounting, they will find a way to promote their level, be able to attract profitable work, and lead a company to the ‘ultimate goal project’.

Time Scale

We admitted the ideas of months and years in this game. Students can take one action every month. Students usually play four year sessions during 16 hour lecture courses.

Initiation

Two to three students form teams and manage a company. Each team must choose a CEO and Project Manager. They receive a small share of capital (50,000 USD) and establish their company, which develops IT systems for customers.

Monthly Role

We show playing-processes in Figure 2.

1. The CEO draws project cards.
2. The project manager and CEO assign dolls to each project card. In the limitation of work and its stability of cash, the manager decides the job to do and sets its cards onto a project area.
3. The project manager records the expected progress to GC.
- 4-5. The project manager rolls the dice and records actual

processes of projects to GC.

6. The CEO pays labor costs, general administrative costs, office rent, interest, and other payments and checks the cash amount.

Closing Role, Accounting and Debriefing

At the end of year, the CEO must finish workflow.

1. Reconfirms all revenues.
2. Recalculates all expenses and checks the cash flow integrity
3. Compiles P/L and BS

We do not use computers in the calculation process. The purpose is to make students learn the strict requirements of correct numbers in business. Instructors gather data and make short lectures as a part of the debriefing.

Spiral up through routine work experience

Following the previous strategy, companies strive to become experts in specified markets among their rivals. However, they can not control the cards which are set in reverse. To maintain cash, they often must do other projects. Students repeat routine work (as described in a previous subsection) every month to bolster the company.

Path from Death Valley to a Bright Future

At the beginning, cash is short. Managers cannot choose their projects and must accept short range projects. They often must be extremely patient. When their stage is promoted, their cash flow will be stabilized. Subsequently, they can try longer range, more profitable projects. They

FIGURE 2
BASIC ROUTINE ON SKG



will be able to choose projects according to their interests and can concentrate stars in a specified company or category. They can also select options such as education, loans, and sales promotion. Finally, they can try to finish ‘goal projects’. The first team to complete goal work is the winner.

KEY CONCEPTS REALIZED ON THE BOARD GAME

Software engineering includes complex activities executed by many people. The time and budget of our audiences are limited. Compared with computer games, board games have numerous physical limitations. Therefore, we were compelled to pick important concepts

that we wanted to teach, and we defined physical symbols related to these ideas to raise each learner’s understanding.

Project Cards

What is the ‘Software Engineering Business’? There are thousands of software programs in the world. Most are customized based on customer needs. Some are cheap and some are extremely expensive. To realize this idea, we printed 150–200 different cards in one market, at three levels.

In SKG, most projects come from Vendor A, B, or C and belong to Retail, Government, and Banking categories. All samples in Figure 3 require some stars to start the project. However, they promise that once the company finishes the project, they can get not only money, but also stars, indicating a line of ‘Credit’.

FIGURE 3
SAMPLES OF PROJECT CARDS (BRONZE, SILVER, AND GOLD)

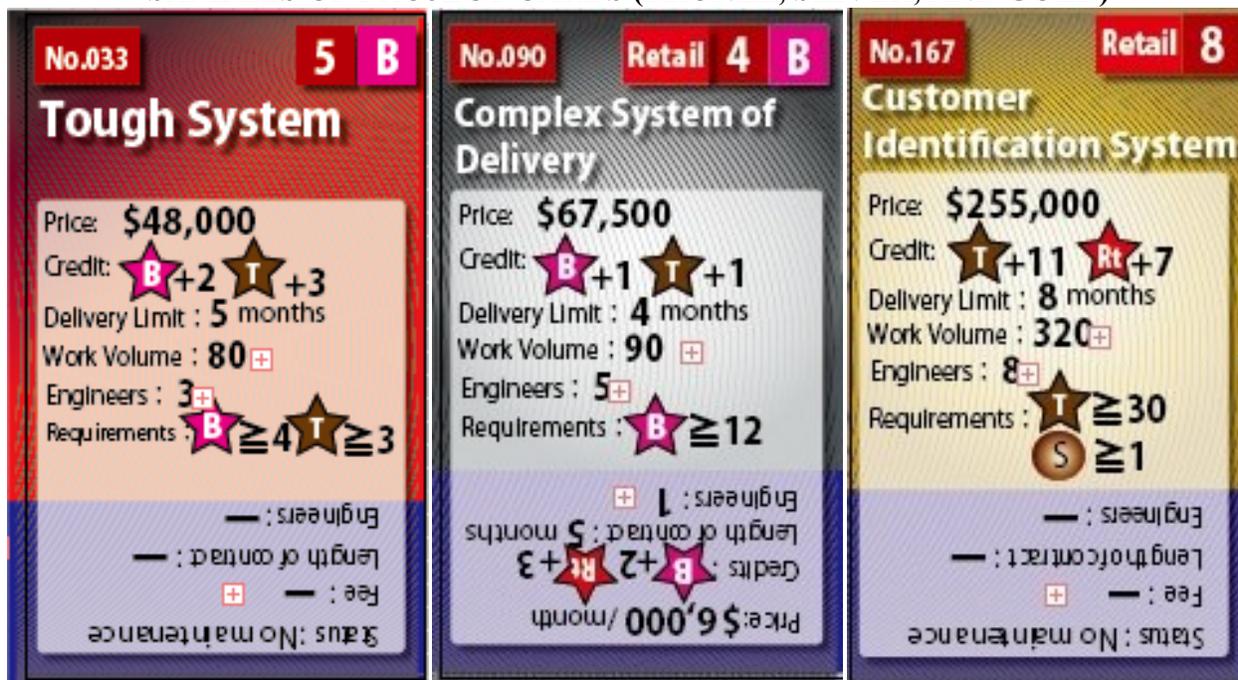


TABLE 1
STARS AND THEIR RESPECTIVE MERITS

| Name of Star | Merit |
|--------------------------------------|---|
| Company A Confidence Star | Prior access next project from Company A |
| Company B Confidence Star | Prior access next project from Company B |
| Company C Confidence Star | Prior access next project from Company C |
| Experience Star in Retail System | Save Work Volume on project on Retail |
| Experience Star in Government System | Save Work Volume on project on Government |
| Experience Star in Banking System | Save Work Volume on project on Banking |
| Technology Star | Required to promote project rank |

Stars

To compile software, it is insufficient that a company has money and laborers. Experience and confidence are critically important for small ICT companies. To realize this idea, we admitted stars to indicate a company’s skill. Figure 4 presents an example.

At the beginning, teams struggle with jobs and cash flow. When they finish each job, they can receive money and stars. Stars means ‘corporate value’ as measured in seven dimensions. See Table 1.

Dice

Prices of projects, numbers of expected stars, and work volume were defined previously. However, employees are

not machines. The estimation of actual progress of work often turns out wrong or is delayed. To make students understand such uncertainty, we define the actual progress of work using dice as shown in Table 2. The average rate of delay is 8.3%.

Card Exchange Session

The business negotiation phase comes twice a year, in June–July and in December–January. The companies can exchange their project cards with other companies to adjust their strategy and to define their next active works. This process is very important to promote communications between students.

**FIGURE 4
STARS.**



**TABLE 2
DICE AND WORK VOLUME**

| Dice spot | Actual progress | Example of record on GC |
|-----------|-------------------------------------|-------------------------------|
| 1, 2, 3 | 100% (All projects are on schedule) | (10)→ ————→ 10 |
| 4 | 90% (All projects delayed 10%) | (10)→ ————→ 9 |
| 5 | 80% (All projects delayed 20%) | (10)→ ————→ 8 |
| 6 | 70% (All projects delayed 30%) | (10)→ ————→ 7 |

TEACHING EFFECTIVENESS

Overview

SKG is used at the Graduate School of Information Sciences, Tohoku University, Japan and at Sirindhorn International Institute of Technology, Thammasat University, Thailand. To verify the effectiveness of SKG, we conducted surveys in Sendai, Japan in 2009 and 2010.

SKG session in 2009

In October 2009, 13 university students and 7 businesspersons joined this game program for a survey. One university student and one businessperson formed one team. Seven teams were thus formed. The remaining six students formed three teams of two players. Therefore, the total number of teams was ten. The ten teams were divided into two groups. Each group had five teams. Five teams in the same group mutually competed. Each team managed the company for three terms (years).

SKG session in 2010

In July 2010, 21 university students joined the same game program for a survey. They formed eight teams of 2–3 players. The eight teams were divided into two groups, each with four teams. Four teams in the same group mutually competed. Each team was managed for four terms.

Half of the teams showed very tight cash-flow status in the second term, but all teams grew their sales and profits. The average of total sales of four terms was about 3M

USD. The average of total profits of four terms was about 0.9M in USD. All the teams managed their companies well.

The company finished 48 projects on average. The number of finished projects differed depending on the company. The fewest finished projects were 32. The largest number was 72. Differences in the number of finished projects directly influenced to the amounts of sales and profits.

Comparative analysis of Questionnaire on Knowledge

We evaluated the change of attendees' perceptions about corporate management before and after the game. Table 3 shows answers for questionnaires. We asked students to report their responses according to a five-point Likert scale, with '1' representing a very low level of understanding of the point, and '5' denoting a very good understanding.

Before playing SKG, businesspersons were more knowledgeable about different matters than students. Differences between students and businesspersons were great, especially for question No. 9. One reason why businesspersons seemed to have better understanding than students do might be simple. It might be because businesspersons have numerous chances to think about these themes in daily business and interactions with colleagues in a company. Knowledge unfamiliar to some students is that related to Questions No. 4, No. 5, No. 6, and No. 7. The knowledge unfamiliar to some businesspersons is that of Questions No. 2, No. 5, No. 6, and No. 7. Most of the difficult questions were common

TABLE 3
RESULTS OF QUESTIONNAIRE ON CORPORATE MANAGEMENT KNOWLEDGE

| No. | Question | 2009 | | | | 2010 | |
|-----|--|----------|-------|------------------|-------|----------|-------|
| | | Students | | Business persons | | Students | |
| | | Before | After | Before | After | Before | After |
| 1 | A company can go bankrupt, even if profit on a financial statement is positive. | 2.77 | 4.08 | 4.00 | 4.86 | 4.22 | 4.67 |
| 2 | A company cannot select a project to work on if a company runs short of cash. | 3.38 | 4.85 | 3.71 | 5.00 | 4.11 | 4.76 |
| 3 | A company must increase the number of projects to reduce the fixed cost per project because fixed cost is constant. | 4.54 | 4.92 | 4.29 | 4.86 | 3.32 | 4.71 |
| 4 | Labor cost can be drastically reduced if a company outsources a service. | 3.08 | 4.69 | 4.00 | 5.00 | 3.94 | 4.86 |
| 5 | Managers often must ask engineers to shift jobs irrespective of their preferences. | 3.69 | 4.54 | 3.86 | 4.43 | 3.33 | 3.81 |
| 6 | Companies tend to lose their mission and long-term vision once they are under tight cash flow and shoestring operations. | 3.46 | 4.31 | 3.86 | 4.86 | 3.94 | 4.71 |
| 7 | Keeping good engineers requires much money. | 3.62 | 4.69 | 3.86 | 5.00 | 3.89 | 4.71 |
| 8 | Technical capabilities, experience, and reliance from customers are important, but they are not obtained easily. | 4.77 | 4.54 | 5.00 | 4.57 | 4.50 | 4.57 |
| 9 | Management of human resources and project status is important to keep delivery dates. | 4.23 | 4.92 | 5.00 | 5.00 | 3.72 | 4.57 |
| 10 | Training and fostering good engineers takes a long time and much money. | 4.62 | 4.77 | 4.86 | 5.00 | 4.28 | 4.71 |

between students and businesspersons. Students and businesspersons reached a better understanding of these questions because they experienced such situations in the game. We believe that SKG promoted a better understanding of corporate management.

Questionnaires on Satisfaction

To evaluate the usefulness of this game, we conducted a questionnaire survey of the 20 attendees in 2009 and the 21 attendees in 2010. Questionnaire results are shown in Table 4.

The rules of SKG are intelligible but not very simple. Because dice throws determine the progress of projects, it involves a certain level of uncertainty, just as reality does. Managers should pay for overtime and their cash flow status should be worsened if progress of projects is delayed. This is a great risk in corporate management. Players must understand and take this risk into account when they make decisions on each order received. This is the most difficult and interesting part of SKG. The attendees communicated actively about the expected cash flow and project priorities. The attendees felt that they made decisions about management policy and strategy. The

attendees enjoyed SKG and were satisfied with SKG. Therefore, we believe that SKG gave attendees both opportunities and incentives to learn corporate management because the results showed that 85% of attendees were extremely interested in our method and were motivated to learn management skills in the future.

CONCLUSION

Herein, we introduced our board game, SKG, to simulate software engineering business. It is still used at Tohoku University and Thammasat University. There is no fatal confusion related to concepts, rules, or settings of numbers. As a conclusion, we confirmed our work and discovered some approaches to inspire ideas. While recognizing that many formats of the Software Development Model exist, based on these established models, we would like to improve the quality of the Business Game, not only in terms of its style, but also in the theories it addresses.

TABLE 4
RESULTS OF QUESTIONNAIRES RELATED TO THE USEFULNESS OF SKG

| No. | Question | Answer | 2009 | 2010 |
|-----|---|-------------------------|------|------|
| | | | % | % |
| 1 | Was SKG difficult? | Very difficult | 40 | 10 |
| | | Difficult | 45 | 70 |
| | | Easy | 10 | 20 |
| | | Very easy | 5 | 0 |
| 2 | Did you enjoy SKG? | Enjoyed very much | 85 | 60 |
| | | enjoyed | 10 | 40 |
| | | Slightly enjoyed | 5 | 0 |
| | | Did not enjoy | 0 | 0 |
| 3 | Are the rules intelligible? | Very intelligible | 35 | 10 |
| | | Intelligible | 55 | 60 |
| | | Slightly unintelligible | 10 | 25 |
| | | Not intelligible | 0 | 5 |
| 4 | Were you able to learn management knowledge? | Learned | 55 | 35 |
| | | Slightly learned | 45 | 65 |
| | | Not learned | 0 | 0 |
| 5 | After playing SKG, did you feel like learning management more? | Want to learn more. | 100 | 85 |
| | | Do not want to learn. | 0 | 15 |
| 6 | If there were a more advanced training program, do you want to participate? | Will participate. | 100 | 85 |
| | | Will not participate. | 0 | 15 |
| 7 | Was the training program using SKG satisfactory? | Very satisfactory | 75 | 50 |
| | | Slightly satisfactory | 15 | 40 |
| | | Neutral | 5 | 5 |
| | | Slightly unsatisfactory | 5 | 5 |
| | | Very unsatisfactory | 0 | 0 |

Potential of board game

From the experience of creating SKG, we confirmed the potential educational power of board games. In the early days of development, some doubts arose about whether analog board games are sufficient to describe real businesses, even among our staff. To adapt to physical limits and time limitations, we were unable to include everything that we observed. We waived many important ideas. Nevertheless, we were thereby able to create a very familiar game to beginners.

After SKG, we improved and developed some different board games using the same concept. We believe that board games have strong availability to express actual customs if we can omit some details and simplify a true environment through observation.

Preparing further Customization

SKG has a regular rulebook, Power Point (Microsoft Corp.) adjuncts, and some teaching materials for students. We can customize whole processes depending on students' educational level or time limitations. However, this fact means that SKG can not be operated easily by other instructors. To make this game more available worldwide, we must establish fixed methods of operation. We must also consider how to educate instructors. SIIT is an international school at which we can operate only in English. However, many Thai software engineers can not learn in English. Increasing local language versions and seeking future partners might be critically important for its development and wider use.

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