

DEVELOPMENT OF BASE SUPPLY CHAIN COLLABORATION GAME BY USING TANGIBLE BLOCKS

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ABSTRACT

To Teach Supply Chain Collaboration efficiently, we developed the BASE-SCC business game in 2012. Throughout the experience, we aimed to have more options especially on the supply-side. To attach a new rule makes a game complex. Therefore, we designed this new business game by utilizing physical blocks on the same topic, but from the opposite standpoint of SCC and named it "SCC-X." SCC-X is an on-demand manufacturing game based on students' close collaborations to procure correct raw materials. If we increase the variety of products been extended more than SCC, and we can reflect more on reality in the SCC series. In this paper, the basic idea of BASE SCC-X and the educational effectiveness of applying SCC-X games to the lecture of two Universities are introduced.

INTRODUCTION

Supply Chain Management or its advanced idea, and Supply Chain Collaboration are quite essential ideas for engineers. To provide an opportunity to learn these ideas, we chose a Business Game. Authors are the team that is developing various tangible business games under the brand name "BASE"(Hamada, Kaneko, and Hiji (2013)). We have been producing it since 2007 and persisted both in Japan and Thailand, and now we have 18 games in 7 categories. We introduced two of them in previous papers, one is a Software Development (Kaihatsu in Japanese) Game (BASE-SKG, Hamada, Hiji, and Kaneko (2014)), and the other one is a Supply Chain Collaboration Game (BASE-SCC, Kaneko, Hamada, and Hiji (2016a)). SCC has been grown as one of our core contents since its invention in 2012, because of its simple rules. This is a simulation of a smartphone manufacturer. Students form groups, build up a firm of smartphone manufacturers, purchase raw materials, assemble a smartphone, and sell in bidding (Kaneko, Hamada, and Hiji (2016b)). It is quite useful to learn the importance of inventory control and collaboration between firms throughout their experiences. However, there has been some criticism that its setting is far away from real SCM. To resolve this problem, we attached an advanced stage called SCC-2 to increase roles of students (Motherboard Supplier, Display Supplier, and Assembler). However, it was not free from the original framework and was still difficult to correspond with students who wish to study further.

To resolve this problem, we developed a new game named "SCC-X." SCC-X uses various colored tangible blocks to handle multiple materials and some products. To create SCC-X, we didn't attach new rules on SCC, so we left out many ideas to maintain a simple game. To cut off those ideas required a lot of energy, but as a result, we got a new game that mainly focuses on the supply side, instead of the sales side. It became possible to simulate by the group but also became able to simulate alone to review his/her work later. In this paper, we introduce SCC-X, introduce students' evaluation, and discuss things to be improved.

BASE SUPPLY CHAIN COLLABORATION GAME (SCC)

Before discussing SCC-X, we need to reconfirm the original SCC. SCC is a simple model of a Smartphone manufacturer. It has only two types of parts, e.g., Motherboard and Display. This business game requires students to form teams and operate a mock-up company. Figure 1 presents the SCC game outline. Players run as Smartphone Manufacturers and create smartphones comprised of a motherboard and a display and sell them on the market.

Figure 2 presents the game flow of the SCC game. The period of the game is one year, and the period is divided into 12 months. One month is the minimum timescale. Players decide many actions to "Sell a Smartphone", "Assemble", and "Procurement" and "Payment." If the players wish to sell a smartphone, they have to wait three months for procurement to sales.

FIG. 1
OUTLINE OF THE SCC GAME.

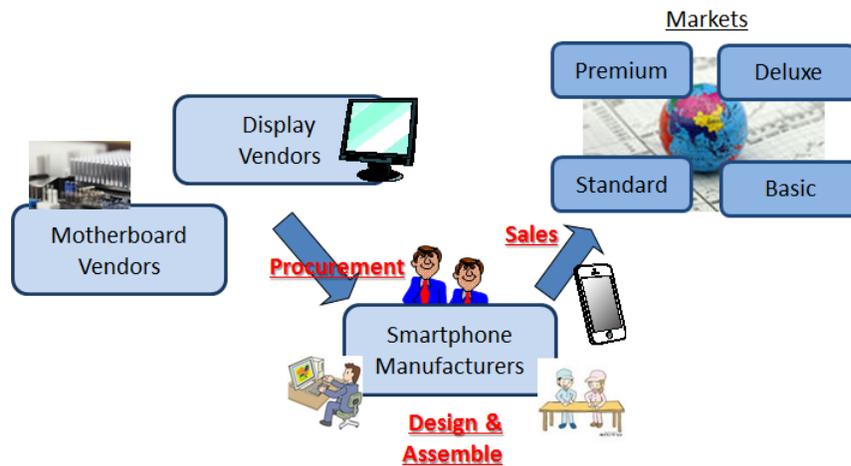
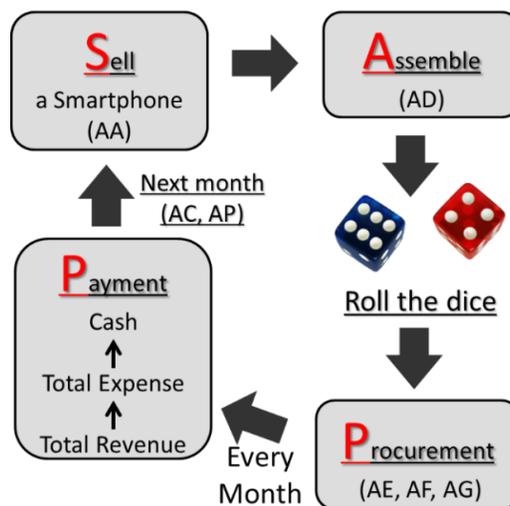


FIG. 2
GAME FLOW (SAPP CYCLE) OF SCC GAME



In the procurement process, each company purchases Motherboards and Displays every month by the conditions of procurement in table 1. In case the dice spot 6 appears, every company can buy only 6-star quality materials up to 3 lots. To let the students learn the uncertainty of the market, six-square dice are controlled by the teacher, and students cannot touch them. They must devote careful consideration to which combination of dice represents the best choice for the market situation and other companies'

TABLE 1
CONDITION OF PROCUREMENT MOTHERBOARD AND DISPLAY

Spot	Quality	Max. lots	Price/lot
6	☆6	3	60
5	☆5	3	50
4	☆4	3	40
3	☆3	3	30
2	☆2	3	20



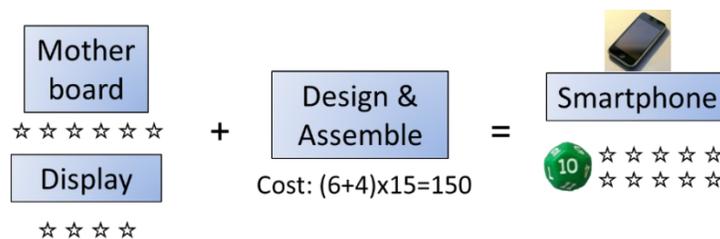
strategies. After the procurement, students make records in their Inventory Control Sheet in Figure 3.

FIG. 3
INVENTORY CONTROL SHEET

Year 1	Company Color: <u>Red</u>		Student ID & Name:										Table B
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Motherboard	5 x 1	5 x 0	x	x	x	x	x	x	3	1	3 x 0	x	x
	x	3 x 1	3 x 0	x	x	x	x	x	x	5 x 1	5 x 0	x	x
	x	x	5 x 1	5 x 0	x	x	x	x	x	x	x	x	x
	x	x	x	5 x 1	5 x 0	x	x	x	x	x	x	x	x
	x	x	x	x	4 x 1	4 x 0	x	x	Quality	Lots	x	x	x
	x	x	x	x	5 x 1	5 x 1	5 x 0	x	x	x	x	x	x
Display	3 x 1	3 x 0	x	x	x	x	x	x	3	1	3 x 0	x	x
	4 x 1	4 x 1	4 x 0	x	x	x	x	x	x	5 x 1	5 x 0	x	x
	x	x	6 x 1	6 x 0	x	x	x	x	x	x	x	x	x
	x	x	3 x 1	3 x 1	3 x 1	3 x 0	x	x	x	x	x	x	x
	x	x	x	5 x 1	5 x 0	5 x 0	x	x	x	x	x	x	x
	x	x	x	x	5 x 2	5 x 2	5 x 1	5 x 0	x	x	x	x	x
Smartphone	7 x 0	9 x 0	x	x	x	x	10 x 1	10 x 1	8 x 1	8 x 1	6 x 1	6 x 0	x
	x	8 x 1	8 x 0	x	x	x	x	10 x 1	10 x 1	10 x 0	x	x	x
	x	x	7 x 1	7 x 0	x	x	x	x	7 x 1	7 x 0	x	x	x
	x	x	x	11 x 1	11 x 0	x	x	x	x	6 x 1	6 x 0	x	x
	x	x	x	x	10 x 1	10 x 1	10 x 1	10 x 0	x	x	10 x 1	10 x 0	x
	x	x	x	x	x	7 x 1	7 x 1	7 x 0	x	x	x	x	x

Figure 4 shows the example of an assembly process. In case one six stars quality Motherboard and one four stars Display are assembled with assembly costs, which is calculated as total stars times 15, players get one smartphone which is represented as one dodecahedron dice.

FIG. 4
ASSEMBLE PROCESS

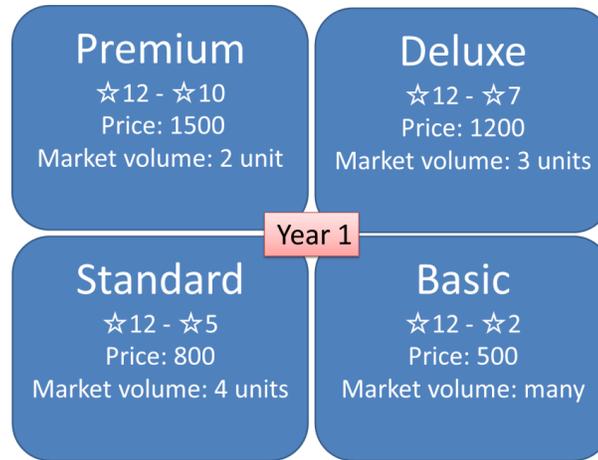


In the selling process, players can sell smartphones every month. There are four different markets in the world, e.g., Premium, Deluxe, Standard, and Basic. Each market is defined “Acceptable Quality,” “Price Cap” and “Market Volume” in figure 5. They must choose the market in a comparison between their smartphone’s quality and the market’s acceptable quantity and quality.

In case total sales volume does not exceed market volume, players get maximum sales revenue from the market’s price cap. On the other hand, in case total sales volume exceeds market volume, the open bidding is opened. Open bidding is face-to-face bidding. The students come out to a market board, by which they want to sell smartphones, and show a price to other companies with a calculator.

In the payment process, players calculate total revenue and total expenses and then check their cash amount every month. At the end of the game’s first year, they will have made a basic Income Statement and Balance Sheet. In SCC, all sheets are purely hand-scored. Players must manage cash, finances, human resources, and inventory with pencils and a calculator.

FIG. 5
MARKETS OF SCC

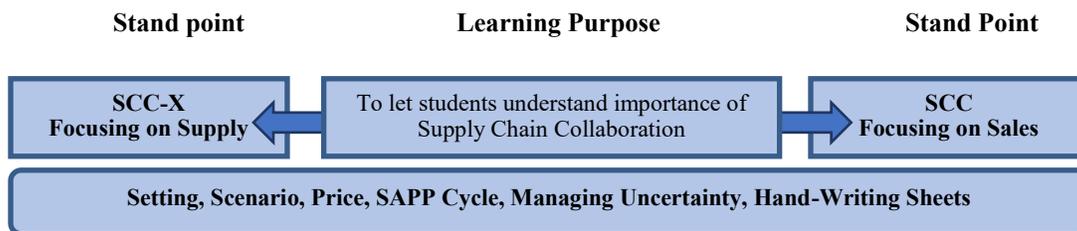


PROBLEMS OF SCC AND CONCEPT OF SCC-X

Problems of SCC

It is the simplest model of SCC. To represent complexed manufacturing by using only two parts; Displays and Motherboards resemble real industry. In this game, the supply side is well considered, to combine risk (Dice spot 1) and stable supply (up to three items). These are all the story of the supply side. SCC is basically following the tradition of BASE business games to arrange and encourage the sales side, optimized by bidding. Consequently, most players develop the same strategy, to chase higher-grade markets. There is no difference in their products; it has only the quality difference, not variety. No one can create a smartphone that has more than a twelve-star value. So, higher markets tend to be crowded, and price competition becomes of significant interest to the players. Once they remember how to record in table B, supply and inventory control become of minor attention to them than sales. Moreover, smartphone assemblers don't sell their products to the market directly. The nature of manufacturers should be based on a specification document, by the due date; submitted to complete products to specified customers. SCC cannot describe this story. We consider that if we have one more game, which focuses on the Supply side more than the Sales side, by using either of these games, we can comply with student's demands to learn SCC adequately. SCC is a good game and is still respected, maintained, and used in actuality. SCC-X has no desire to replace SCC. It locates the opposite side of learning and provides options on the supply side in case it's needed. They cannot be merged because it will be too weighty. Figure 6 shows our idea briefly.

FIG. 6
STANDPOINTS OF SCC AND SCC-X



Common Ideas in two games

Concept of SCC-X

We carefully considered SCC's merits and demerits, tried to retain the basic structure, but to include new ideas that make it impossible to learn by SCC. SCC is based on the Sales side, so SCC-X should focus on the supply side. SCC has a limit of products up to 12 stars, but this number is extended in SCC-X. Meanwhile, we cut-off a lot of functions of SCC, to avoid it being a massive game. We dismissed the price competition. We disclosed a one-year demand from customers previously. We provided sample sheets to be followed. Table 2 shows the differences in characteristics. Consequently, the relationship between SCC and SCC-X is that they have become a complementarity set of games.

TABLE 2
COMPARISON OF SIGNIFICANT CHARACTERISTICS OF SCC AND SCC-X

	SCC	SCC-X
Physical Surface	Dodecahedron dice	Block
Main Focus	Market-Oriented	Supply-Oriented
Accent	Thrill of bidding	Fear of failure of supply from material bag
Number of Raw materials	Motherboard and Display	Six items
Collaboration	Sharing the market in order	Exchanging raw materials
Stars	Up to Twelve	No Limitation
Price of Products	Depend on Market	(Number of stars) x 85
Uncertainty on Supply Side	Dice Spot \square 1 \square suspend new supply	Cannot gain adequate items
Uncertainty on Sales Side	Price Competition	Contract-based Stable Business
Playing by Single	Impossible	Possible

Common Ideas in two games

SCC-X RULE DESCRIPTION

Purpose

Each player receives capital stocks (6,000) and establishes their company at the beginning of the game. The business is Smartphone Manufacturing. The players are expected to develop their firm by employing workers and handling inventories and cash by their five senses and communications from supply to delivery.

In most BASE Business games, we define the winner by retained earnings at the end of the game. On the other hand, SCC-X's sales price is fixed by a previous contract. So, in any company, the contents of sheets must be the same. Thus, we don't define a winner. In this aspect, SCC-X might be included as a kind of simulation rather than gaming.

FIG. 7
COMPANY BOARD OF SCC-X



Fundamental ideas

The basic idea is the same as SCC, following S-A-P-P cycle that Figure 2 shows.

- 1) Deliver (Sell) smartphones to the customers.
- 2) Procure (Pick) Mother Board (K), Display (W), and Accessories (RGBY) from a material bag.
- 3) Assemble items and build a smartphone.
- 4) Record the latest revenue, expenses, and cash balances in Table A, Product and Inventory status to Table C.
- 5) Repeat these activities twelve times and complete a year in a game.
- 6) Complete Table D (P/L) and E (B/S)

PHYSICAL ITEMS

Company Board

Figure 7 shows a student's company. Any items came in from bottom to up.

Raw Materials

(1) Item Bag

Materials are stored in non-transparent bags as shown in Figure 8. We hand-made them using a pillow cover. We prepared enough numbers of items (over 1,000 pieces of blocks) of the same number of each color inside.

FIG. 8
MATERIAL BAG



Figure 9 shows a raw material drawing. Student (left side) inserts his arm and grasps raw materials. On the right side, the teacher holds a bag to keep the secrets inside. Students can feel the numbers of dots (stars) on the blocks, but cannot see the color. It is the only risk and handicap that occurs in SCC-X. Students enjoy the thrills. In case they couldn't catch an adequate item, they visit other companies to negotiate to exchange, sell, buy, and get discount on required items. This process is the necessary steps of supply chain collaboration, and students will learn it through their communication and review on their experience.

(2) Materials

There are six colors of blocks, and they have four different types of structure as shown in Figures 10 to 13. To make a smartphone, Motherboard (Black, K), Display (White, W) and at least one accessory (Red, Green, Blue, and Yellow) are also required. In case the customer wants a product that consists of (K16, W16, R8, B8), students must find such materials by combining four different types of items. For example, (K(8+8), W(4+4+8), R(8), B(4+4)).

The color of the blocks has unique meanings as shown in Table 3.

Sheets

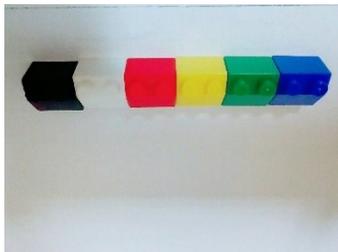
(1) Cash Flow Sheet (TABLE A)

Any business must seize its cash flow correctly. This chart is the same as other BASE-business games (Figure 14). In exact sheets, there are columns to calculate total revenue/tax on the rightmost.

**FIGURE 9
RAW MATERIAL DRAWING (SAMPLE)**



**FIGURE 10
TWO-STAR ITEMS
(APPROXIMATELY 10%)**



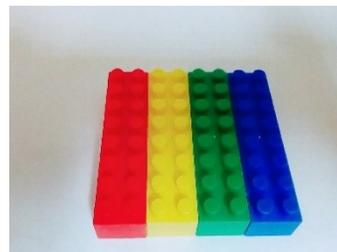
**FIGURE 11
FOUR-STAR ITEMS
(APPROXIMATELY 20%)**



**FIGURE 12
EIGHT-STAR ITEMS
(APPROXIMATELY 60%)**



**FIGURE 13
SIXTEEN-STAR ITEMS
(APPROXIMATELY 10%)**



**TABLE 3
LIST OF RAW MATERIALS**

Black (K) *	Motherboard	Required
White(W)	Display	Required
Red(R)	Accessory-Red	Depend
Blue (B)	Accessory-Blue	Depend
Yellow(Y)	Accessory-Yellow	Depend
Green(G)	Accessory-Green	Depend

* K stands for Black, to separate with Blue

**FIGURE 14
CASH FLOW MANAGEMENT SHEET (TABLE A)**

BASE.SCC.X.ASS.Y1.EX				Company Number: 4				
Business Action (Star Based)				Previous	initiation	Jan	Feb	Mar
Selling						0	28	30
Assembling						28	30	30
Procurement					28	30	30	31
Remained stars				0	28	58	60	61
1. Revenue								
1.1 Operating Revenue								
(AA1)	Sales	(Units)				20	28	30
		Price	Total ☆×75			1,500	2,100	2,250
1.2 Finance Revenue								
(AB1)	Share Capital				3,000			
(AC1)	Debt				0			
Total Revenue					3,000	1,500	2,100	2,250
2. Expense								
(AD1)	Assemble	Price	Total ☆×20			560	600	600
(AE1)	Procure ITEMS	Price	Total ☆×40			1,200	1,200	1,240
(AG1)	Equipment Cost		Assemble Line: 1000/line		1,000			
(AH1)	Line Cost		Maintenance; 100/line-month			100	100	100
(AJ1)	Labor Cost		Employees: 20/person-month			20	20	20
(AK1)	Selling Expense		President: 50/month			50	50	50
(AL1)	Administrative Cost		(Number of Employees + President) × 20/month			40	40	40
(AM1)	Office Expense		(Number of Lines) × 100/month			100	100	100
(AN1)	Interest Expense		Debt × 0.01/month			0	0	0
(AP1)	Refund Debt							
(AQ1)	Inventory Cost		Total ☆×40	0	0	0	0	0
Total Expense				0	1,000	2,070	2,110	2,150
(Z)	Cash			0	2,000	1,430	1,420	1,520

(2) Order & Delivery Sheet (TABLE B)

Compare with other BASE business games, SCC-X is unique because it discloses customer’s demand in the future apparently. Students can plan what kind of item is required in what month. This policy is against teaching uncertainty and competitiveness but fits the nature of manufacturing; any product must satisfy specification previously defined; Salesperson visits a customer and receives the order, Office staff procures suitable materials, and factory engineers assemble by the due date. Figure 15 shows an example, to satisfy January and February Customers, they have already provided one twenty star product (K8, W8, R8) to be sold in January and raw materials (K8, W8, G8) to be assembled in January, be sold in February. Following SAPP Cycle (Figure 2), what students must do is to procure adequate items for March Customers, it is (K8, W4, B8).

**FIGURE 15
CUSTOMER’S ORDER SHEET (TABLE B)**

Table B Customer’s order sheet							
	K	W	R	G	B	Y	TTL
1	4	8	8				20
2	8	8		8			24
3	8	4			8		20
4	4	8				8	20
5	8	8	8	8			32
6	8	4		8	8		28
7	8	8			8	8	32
8	12	8	8			8	36
9	4	4	8		8		24
10	8	8		8		8	32
11	8	8	8		8		32
12	12	12		8		8	40

Despite the fact that demand is clear, it is not guaranteed players will be able to purchase correct items. It is easy to default if the company does not have the raw materials that are sold to the customer two months later. To avoid defaulting, Students must have adequate inventory, and they need to collaborate to exchange unnecessary items for required items.

Those transactions will be recorded by themselves on an Inventory Control Sheet (Sample is shown in Figure 16). In this case, in January, they have the least inventories (K8, W8, G8) to satisfy demands of customers in February, and procure the least inventories (K8, W4, B8) to meet demand of customers in March that table B shows. At this moment, the product is ready to be sold; materials are prepared to assemble in February. Of course, most of the cells are provided blank to students.

The set of numbers came from Table B, procured and recorded on the right side of Table C two months before the delivery date. The next month (February) numbers slide to the left side of Table C, but one row below. Meanwhile, players purchase a new material set. Students can confirm the fact on their company board. Following those processes parallel; they learn basic principles of manufacturing throughout their experiences.

(4) Profit and Loss Statement (Table D)

After one-year (12 months) when operations have been finished, we create a Profit and Loss Statement by using numbers from Table A, and Table C. Figure 17 shows an example.

FIGURE 16
INVENTORY CONTROL SHEET (TABLE C)

Table C Inventory Control Sheet														
Product(Ready to Sale)							Inventory (Ready to Assemble)							
K	W	R	G	B	Y	TTL	Month	K	W	R	G	B	Y	TTL
8	8		8			24	1	8	4			8		20
8	4			8		20	2	4	8				8	20
4	8				8	20	3	8	8	8	8			32
8	8	8	8			32	4	8	4		8	8		28
8	4		8	8		28	5	8	8			8	8	32
8	8			8	8	32	6	12	8	8			8	36
12	8	8			8	36	7	4	4	8		8		24
4	4	8		8		24	8	8	8		8		8	32
8	8		8		8	32	9	8	8	8		8		32
8	8	8		8		32	10	12	12		8		8	40
12	12		8		8	40	11							
							12							

FIGURE 17
INCOME STATEMENT (P/L, TABLE D)

Table D Income Statement (P/L)		
1. Sales Revenue	(AA1)	_____
2. Cost of Goods Sold		
2.1 Product Cost	(CA1)	_____
2.2 Line Cost	(AH1)	_____
2.3 Labor Expense	(AJ1)	_____
2.4 Depreciation Expense	(CL1)	_____
2.5 Selling Expenses	(AK1)	_____
2.6 Administrative Expenses	(AL1)	_____
2.7 Office Expenses	(AM1)	_____
Income from Operation _____		
4. Other Expense and Loss		
4.1 Interest Expense	(AN1)	_____
Income before Income Tax _____		
5. Tax		
5.1 Income Tax Expense	(DQ1)	_____
(Income before Income Tax x 0.4)		
Net Income for this year (DU1) _____		

(5) Balance Sheet (TABLE E)

To finalize, students must compile a Balance Sheet and confirm the two numbers in the bottom are the same. Following BASE business game's tradition, all calculations are required to be completed by pencil and calculator, not by computer (Figure 18).

**FIGURE 18
BALANCE SHEET (B/S, TABLE E)**

Table E Balance Sheet (B/S)					
Asset			Liability		
1. Current Assets			1. Current Liabilities		
1.1 Cash	(AZ1)	_____	1.1 Tax Payable	(DQ1)	_____
1.2 Inventory #2			2. Non Current Liabilities		
Smartphone	(CS1)	_____ (ES1)	2.1 Long-term Debt	(CV1)	_____
Motherboard	(CM1)	_____ (EM1)			
Display	(CD1)	_____ (ED1)			
Battery	(CB1)	_____ (EB1)			
2. Non Current Assets					
Remained Machine Value	(CT1)	_____	Total Liabilities _____		
			Equity		
			1. Share Capital	(AB1)	_____
			2. Retained Earnings	(CU1)	_____
			Total Equity(EG1) _____		
Total Assets _____			Total Liabilities and Equity _____		
			ROE		
			(CU1 / AB1+CU1)	(EH1)	_____

Sales

Like SCC and other BASE business games, players can sell smartphones that are already assembled in previous months every month at (Star x 75). Compared with SCC, the customer is fixed, and there is no competition. The teacher will play the role of consumers, which means to walk around, inspect, and collect products. If players can't satisfy the requested spec, your customer doesn't receive anything. Over spec or less-spec products cannot be sold, instead, have to be delivered to junk shops (Star x 40). Sales Revenue should have to be recorded in Table A, Line (AA) with numbers of stars indicated in brackets.

Assembling

(1) General Rules

Smartphones must include at least one Mother board (K), at least one Display (W) and at least one Accessory that consists of four colors ((R)ed, (G)reen, (B)lue, and (Y)ellow). They can't have more than two lines in this game.

[Example]

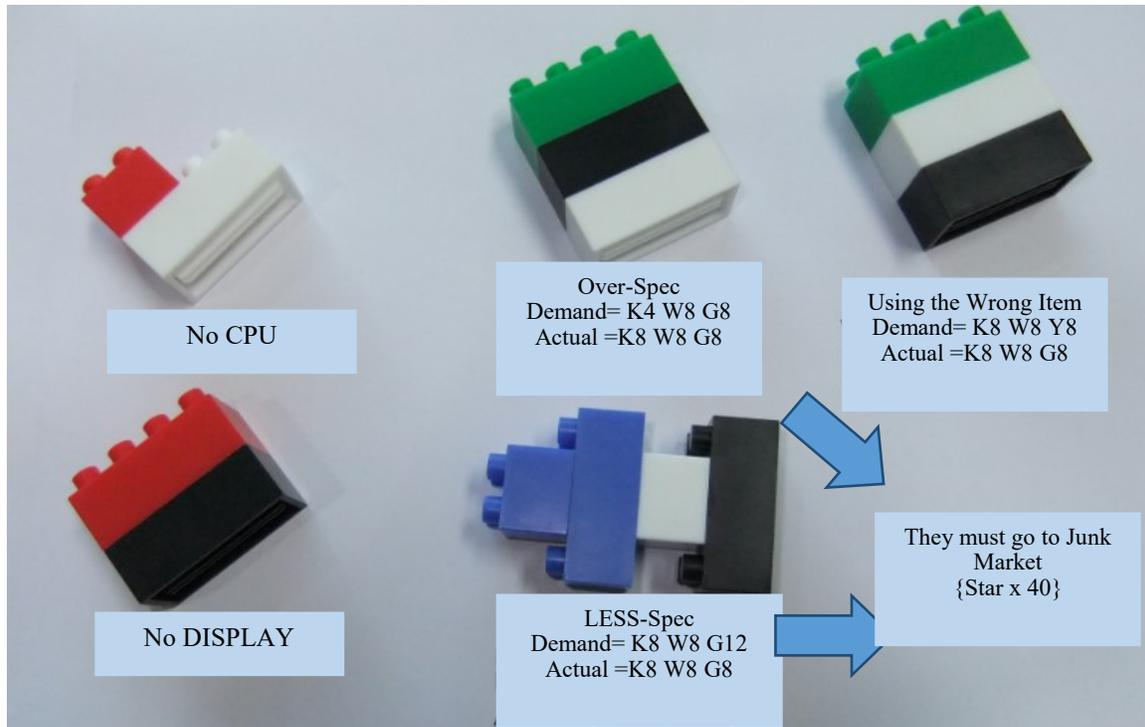
On Month X, Customer demands [K8, W8, G8].
Student procures [K8, W8, G8] by Month {X-2}.
Student assembles [K8, W8, G8] by Month {X-1}.
Then, Student can sell [K8, W8, G8] on Month X.

(2)Assembling smartphones

Customer's requests two months ahead are displayed in Table B. Students combine blocks physically.

All products must contain at least one black, White, and selected colors within {Red, Green, Blue, or Yellow}. Figure 19 shows examples of failed products.

FIGURE 19
EXAMPLE OF FAILED PRODUCTS



\$20/stars are charged to complete assembly. For example, if a player manufactures an eight-star smartphone, the player has to pay \$160, and record in ((AD) Assembling Cost). Students can produce only one smartphone per month.

Procurement

We display Customer's orders in Table B. Following the SAPP cycle; it takes at least two months to complete purchasing, manufacturing, and Sales. For example, if a customer in May requests {K8, W8, B12}, you have to purchase K8, W8, and B12 at least in March. The number of picks is the number of stars meaning the quality. There are four different types of blocks, which mean two stars, four stars, eight stars or 16 stars materials. Items are stored in a non-transparent bag (Figure 8), and students can pick from the bag with his/her arm (Figure 9). Seeing inside of the bag is strictly prohibited. Students can select pieces he/she wants to purchase. Students can return any parts to the bag, or be able to keep it for the future. It is not sure whether students can catch specific materials when he/she wants to buy. They must keep in mind at least their inventories or maintain good relationships with other groups. We had an idea to charge inventory costs to refrain from depositing raw materials and try to encourage collaboration, (Figure 16, raw (AQ1)) but it has not been decided yet because of we afraid of there being a time shortage. Students record All processes of procurement activities recorded in Table A and Table C.

Payment

Payment should be recorded in Table A, Line AD to AQ. If a student sells a product, he/she should record (AA1) Sales raw. If he/she assembled, he/she has to pay 20 /star. For example, if a student completes 20 stars smartphone, assembly cost is 200. Record it in (AD1). If you bought items, record in (AE1). Record (lots) to show the number on the upper line is required. About the

fixed cost, we used the same number as SCC as shown in Table 4. After calculation of revenue, we withdraw the expense, and we confirm the cash balance. This vertical proof is required for all groups.

**TABLE 4
FIXED COSTS OF SCC-X**

(AH1)	Line Cost	Maintenance; 100/ line-month	100
(AJ1)	Labor Cost	Employees: 20/ person-month	60
(AK1)	Selling Expense	President: 50/ month	50
(AL1)	Administrative Cost	(Number of Employees + President) x 20/ month	80
(AM1)	Land Expense	(Number of Lines) x 100/ month	100
(AN1)	Interest Expense	Debt x 0. 01/ month	60

EVALUATIONS

The development of SCC-X was started around 2013 and is continuing. Despite the fact that the final version is not yet available, it is already used in real lectures. In this chapter, we are going to introduce our results of a questionnaire on understandings before and after the game session. Two trials used the same question sets, one is in a Japanese university, and the other one is a Thai University.

Miyazaki International College, Japan

This session was held on December 9, 2015, at the School of Fine arts, in Miyazaki International College (MIC). Target students were second-year students who had mostly no experience to study this kind of business story. It was a 1 hour and 40-minute session, and 15 out of the 19 students answered both the before and after questionnaire. Since limited time was previously noticed, I prepared a shorter course (Jan, Feb, Mar, Apr, May, skip Jun to Sep, then, Oct, Nov, Dec). Despite its short time, comparing the score before and after, we can see significant growth in student Knowledge. As for the knowledge, there were significant differences between before and after, except Q8. (Table 5)

The following figure illustrates, a clearer picture of the average values of the above statements (Figure 20).

**FIG. 20
AVERAGE VALUES OF THE QUESTIONNAIRE ITEMS
(BEFORE/AFTER PLAYING SCC-X IN MIC)**

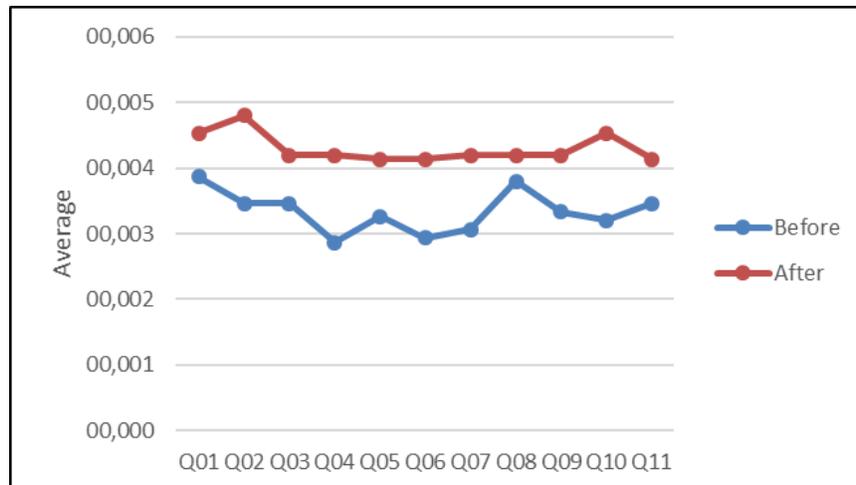


TABLE 5
COMPARABLE KNOWLEDGE TEST RESULT BEFORE/AFTER PLAYING SCC-X IN MIC

N = 15		Before		After		t-value	p (two-tailed)
		Average	S. D.	Average	S. D.		
Q01	President is always busy because he/she has to watch everything in the firm.	3. 866667	1. 266667	4. 533333	0. 409524	-3. 56753	0. 003091424
Q02	At the beginning of the company, cash decreases rapidly.	3. 466667	0. 980952	4. 8	0. 314286	-5. 2915	0. 0001139
Q03	In manufacturing, the initial investment is much more expensive than in the service industry.	3. 466667	1. 409524	4. 2	0. 742857	-2. 5825	0. 021703791
Q04	It is difficult to find materials required for demand.	2. 866667	0. 980952	4. 2	0. 6	-4. 1833	0. 000919942
Q05	Delivery date is an absolute promise.	3. 266667	1. 495238	4. 133333	0. 695238	-2. 69401	0. 017460366
Q06	There is uncertainty in material supply.	2. 933333	1. 066667	4. 133333	0. 838095	-4. 29407	0. 000742011
Q07	There is uncertainty in markets	3. 066667	1. 638095	4. 2	0. 742857	-3. 37123	0. 004566965
Q08	It is important to share production plans with your customers.	3. 8	0. 6	4. 2	0. 742857	-1. 3817	0. 188716492
Q09	Continuous relationships with suppliers is important to sustain the company	3. 333333	1. 095238	4. 2	0. 314286	-2. 82723	0. 013439847
Q10	Inventory control is the fundamental idea of manufacturing.	3. 2	0. 885714	4. 533333	0. 409524	-3. 69575	0. 00239743
Q11	To avoid a shortage of product, we have to keep adequate inventory.	3. 466667	0. 695238	4. 133333	0. 552381	-3. 16228	0. 006920653

Thammasat University (TU), Thailand

This session was held in November 2015 at the Faculty of Science and Technology, Thammasat University. Targeted students were second-year students who belonged to the Bachelor of Science Degree Program in Applied Statistics. It was 3 hours x 2. We played a demonstration conducted by the teacher for a year in a game, and they played themselves for a year in a game. 37 out of 50 students answered both the before and after questionnaire. It also showed remarkable growth in knowledge after the session. As for the insight, there were significant differences between before and after, except Q7. However, Q7 is a common question with SCC, and as we explained, SCC-X has no competition in the market. Therefore, we can evaluate that SCC-X has enough teaching effectiveness. (Table 6)

The following figure illustrates a clear picture about the average values of the above statements. (Figure 21)

FIG.21
AVERAGE VALUES OF THE QUESTIONNAIRE ITEMS
(BEFORE/AFTER PLAYING SCC-X ON TU)

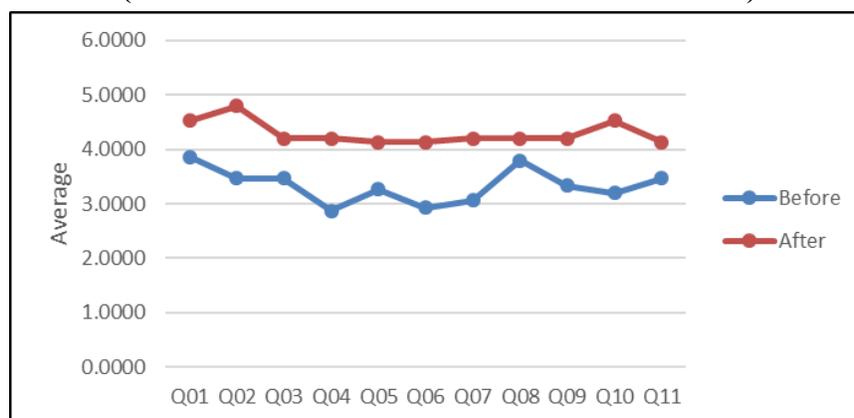


TABLE 6
COMPARABLE KNOWLEDGE TEST BEFORE/AFTER PLAYING SCC-X ON TU

		Before		After		t-value	P (two-tailed)
		Average	S. D.	Average	S. D.		
Q01	President is always busy because he has to watch anything in the firm.	3. 216216	0. 618619	3. 972973	0. 415916	-4. 32335	0. 000116137
Q02	At the beginning of the company, cash decreases rapidly.	3. 351351	0. 400901	4. 054054	0. 33033	-6. 46641	0. 00000017
Q03	In manufacturing, the initial investment is much more expensive than in the service industry.	3. 405405	0. 581081	3. 945946	0. 719219	-3. 23498	0. 002608906
Q04	It is difficult to find materials required for demand.	3. 189189	0. 824324	4. 054054	0. 552553	-4. 064	0. 000250005
Q05	Delivery date is an absolute promise.	3. 405405	1. 081081	4. 216216	0. 618619	-3. 89651	0. 000407331
Q06	There is uncertainty in material supply.	3. 27027	0. 869369	4	0. 555556	-3. 51842	0. 001195835
Q07	There are uncertainties in the market.	3. 891892	0. 765766	4	0. 5	-0. 70225	0. 487041215
Q08	It is important to share production plans with your customers.	3. 594595	4. 054054	0. 581081	0. 552553	-2. 8268	0. 007628183
Q09	Continuous relationships with suppliers is important to sustain the company	3. 459459	1. 144144	4. 216216	0. 674174	-3. 43072	0. 001526474
Q10	Inventory control is the fundamental idea of manufacturing.	3. 594595	0. 636637	4. 27027	0. 424925	-3. 80021	0. 000537755
Q11	To avoid a shortage of product, we have to keep adequate inventory.	3. 351351	0. 845345	4. 108108	0. 487988	-3. 73057	0. 000656467

CONCLUSIONS

This paper presented the author's knowledge and showed the origin and detail of the SCC-X game and applied SCC-X to the lectures in 2015. The teaching effectiveness of SCC-X was investigated with the responses to questionnaires by students.

1. Learning from existing SCC, SCC-X was created from different aspects to let students understand the importance of Supply Chain Collaboration more deeply. Those games may follow-up together.
2. SCC-X is a useful tool for teaching and learning. Most results of questionnaires show that the understanding of related knowledge was improved.

We still have remaining topics. SCC has a second stage called SCC-2, where students will change to the role of supplier, and assembler within three years of operation in the game. SCC-X has no idea to extend such kind of communication, instead, is based on simulating the correct procedures of manufacturing depending on the customer's demands. However, without close interaction, the game is not fun. A way to overcome this problem should be considered. Meanwhile, SCC-X is flexible. For example, we can replace table B (Figure 17) into various "Customer's demand cards" and permit students to exchange the card, not only trading materials. By utilizing this flexibility, we can improve SCC-X to contribute to future Engineer's education.

REFERENCE

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