Development of Simulation Game for Teaching Strategic and Operational Aspect of Production System

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Abstract

Simulation game can help student to have better understanding about production system and teach collaboration in production system. This research develop new simulation game which model strategic and operational aspect of production system. The strategic aspect modeled are production capacity, supplier selection, and fleet size while operational aspect are issuing purchase order, releasing production order to workstation, and releasing delivery order. The new simulation game is played by a team consist of several players separated into purchasing, production, and distribution role. The game will be evaluated by assessing player strategies and questionnaire.

Keywords
Production system, simulation game, supply chain management, operation management

1. Introduction

1.1. Background

Currently, students have learned production management subject in class by using lecturing method. However, student understanding about production management can be further enhanced by putting their knowledge into practice by using simulation game. Moreover, production system in a company consists of several roles in several separated division like purchasing division, production division, and distribution division. These department and roles must collaborate in order to achieve the most efficient production system. Learning method that supports ability to teach collaboration is therefore needed.

This research uses simulation game approach in order to give better understanding the complexity of supply chain and marketing. Simulation game is combination between components of gaming such as competition, rules, teamwork, roles, and objective with virtual representation of world in simulation (Ellington, 1981) (O.Riis, 1995). Moreover, simulation game also have capability to teach the complexity system which comprise of multiple role (Duke, 1980). These combinations make simulation game become suitable to simulate the complexity of production system. Simulation game approaches simulates the challenge making a virtual environment of supply chain system, marketing, and take players into the various decision maker roles in company. As decision maker, players will face similar problem objective and limitation with the real world counterpart. In order to solve the problem, players must collaborate with another player and understanding the complexity of system and make strategies. After the players play the simulation game, player will have better understanding of production system through experience received and knowledge created in simulation game. The purpose of this research is developing a new simulation game, which have capability to teach production system in strategic, planning, and operational aspect.

1.2. Liletrature review

The use of simulation game for teaching operation management field was started in 1960 through beer game supply chain developed by Massachusetts Institute of Technology (MIT) (Forrester, 1961). Beer game models the supply chain of beer which is ranging from factory, distributor, wholesaler, and retailer. The main purpose of beer game is demonstrating a phenomenon in supply chain called bullwhip effect which caused by delayed information feedback in supply chain system (Herzog & Katzlinger, 2011). However, beer game did not emphasize more extensive supply chain learning concept. For example, there is no capacity constraint Beer Game (Anderson & Morrice, 2000) and demand is assumed mostly constant hence Beer Game cannot represent the dynamic of supply chain. Internet based supply chain simulation game (ISCS) is development of beer game. ISCS divides supply chain function into several functions: purchasing and fulfillment, production planning and production, regional distribution center (RDC) and local distribution center (LDC), and third party logistics (3PL) (Zhou, 2008). The ERPSim is simulation game, which emphasize on the learning of Enterprise Resource Planning (ERP) (Seethamraju, 2006). Players learn basic of operation management while learning how to apply operation management in ERP software. Simulation game is also has been implemented in business environment. One example of business simulation game is Bizsim (Han, Cai, Liu, & Wang, 2011). In Bizsim, a team will play as a company and take role as general manager, production manager, marketing manager, financial manager and human resources manager respectively to make business decisions like price, sales, product positioning, promotion, research and development budgets, production levels, and financing requirements. TU Delft has developed internet base supply chain simulation game named Distribution Game for teaching operation management especially in distributor company on supply chain network. The main job of distributor are buying product from the supplier through tender, maintain the amount of product in the storage, and sell the product through the tender process (Houten & Jacobs) & (Corsi, 2006).SBELP simulates international supply chain network. Players only play as a manufacturing company in this supply network. (Siddiqui, Khan, & Akhtar, 2008).In HECOpSim, several teams of students play as a separate and independent manufacturing company. Each team must fill their decision like number of purchases materials and number of assembly. (Pasin & Giroux, 2011)ECLIPS game addresses inventory management in multi echelon supply chain (Merkuryev & Bikovska, 2012).

Review of the existing simulation game showed that there are no simulation games, which models strategic and operational aspect of production system. Therefore, this paper discusses the new simulation game that model strategic and operational aspect of production system.

2. New Simulation Games

This research design new simulation game, which simulates strategic, tactical, and operational problem of production system. The learning aspect in this game is achieved by introducing strategic, planning, and operational problem of production system to the student and solving theses problem in order to reach maximal profit. Players, which may either students or professional, must create strategic decision like production capacity, production facility location, and choosing supplier. Planning and operational decision is merged in this game. The operational decisions made by the players are production order to works station, purchase order to supplier, delivery order to warehouse and retailer. All of them are made through planning process like inventories policies and production planning but they are not inserted into the model. The goal of this game is maximizing profit by minimizing production and backlog cost and maximizing revenue created through sales.

2.1. Game Model

The model of the game consists of supplier and customer played by computer, purchasing, production, and distribution role played by players. In supplier system, there are three raw material supplied by several suppliers. In production role, there are two final product produced in two sequential workstation. In distribution role, there are 2 distribution region: local and export region. Distribution is handled by truck in local region, while export region is handled by ship or plane (

Figure 1). This game is built by using Powesim then converted into cloud simulation named Forio (

Figure 2) which make the simulation accessible by using web browser and specify which variable can be alter by assigned role.

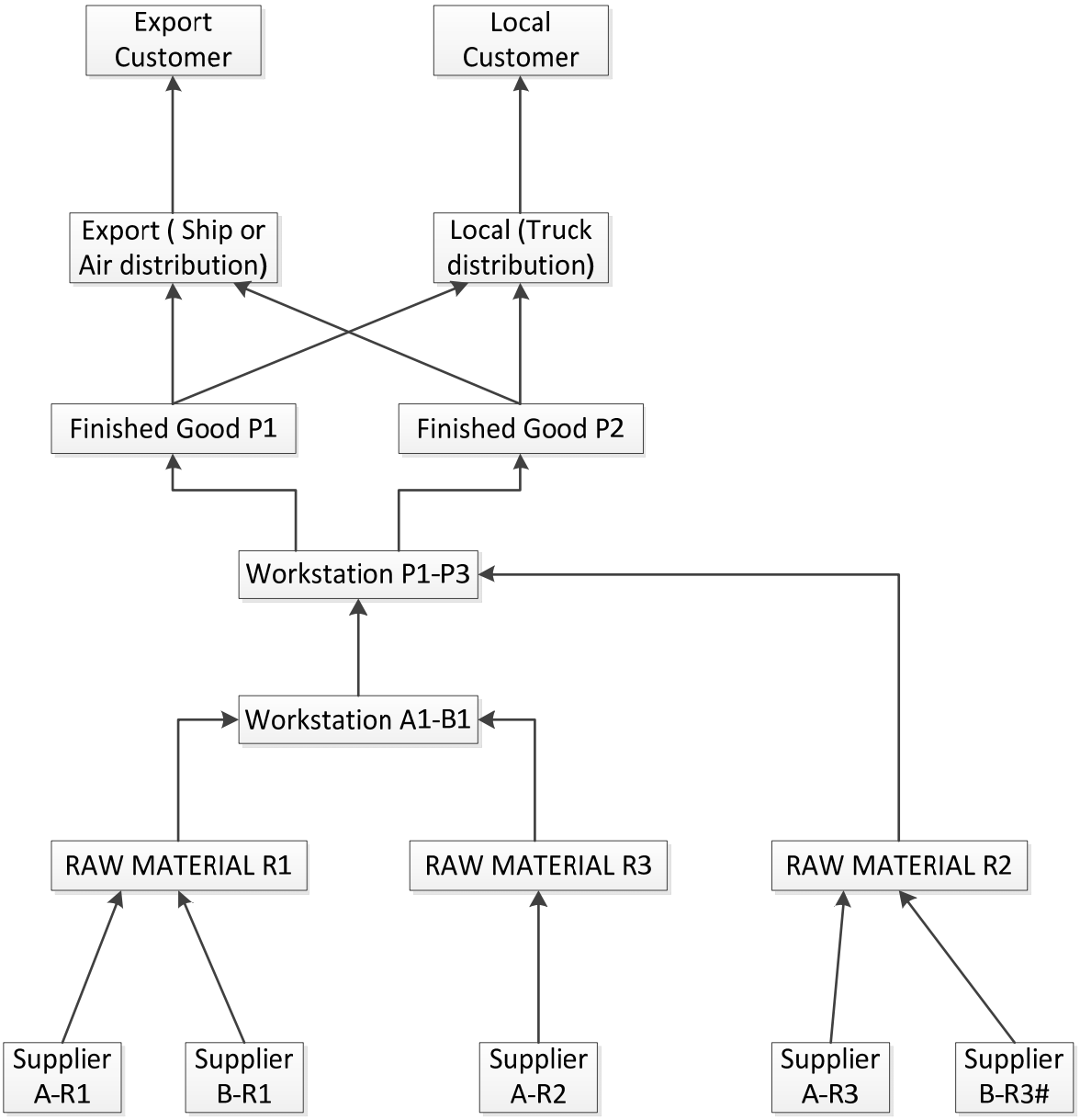
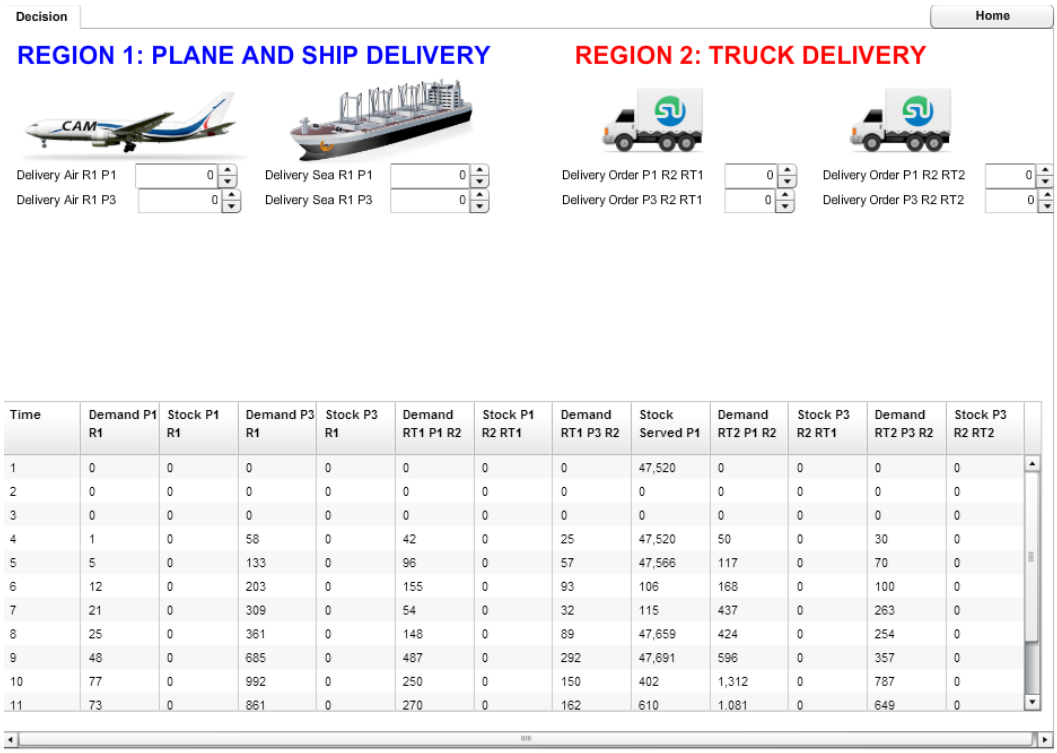


Figure 1 Scope of the Game



Time	Demand P1 R1	Stock P1 R1	Demand P3 R1	Stock P3 R1	Demand RT1 P1 R2	Stock P1 R2 RT1	Demand RT1 P3 R2	Stock Served P1	Demand RT2 P1 R2	Stock P3 R2 RT1	Demand RT2 P3 R2	Stock P3 R2 RT2
1	0	0	0	0	0	0	0	47,520	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0
4	1	0	58	0	42	0	25	47,520	50	0	30	0
5	5	0	133	0	96	0	57	47,566	117	0	70	0
6	12	0	203	0	155	0	93	106	168	0	100	0
7	21	0	309	0	54	0	32	115	437	0	263	0
8	25	0	361	0	148	0	89	47,659	424	0	254	0
9	48	0	685	0	487	0	292	47,691	596	0	357	0
10	77	0	992	0	250	0	150	402	1,312	0	787	0
11	73	0	861	0	270	0	162	610	1,081	0	649	0

Figure 2 Forio Simulation

2.2. Player Decision

There are two classification of decision created by the players: strategic phase and operation phase decision. Strategic phase is decided once on the beginning of simulation while operation decision is decided on every period the game is running.

A. Strategic Phase
   Player must make blanket purchase order, fleet size, and production capacity. Blanket purchase order comprise of commitment to buy certain number of material from selected supplier. If the bought material from supplier is outside the margin, player will get some financial penalties. Production capacity is the limit of production for each workstation.
B. Planning and Operation Phase
   There three roles in this game: purchasing, production, and distribution. Purchasing role must select issuing purchase order on every period to supplier in order to buy material required for production. Production role must release production order on each workstation in order to produce the product. Distribution role must release delivery. order for each region and selection appropriate transportation method.

2.3. Game Organization

Production Management game will be played by a least team consists of 4-6 players. 1-2 players will be assigned on each role. Communication between players will be done through cloud spreadsheet and group chat. The game will be led by game instructor who brief and debrief player, coach player, and supervise the running of the game.

The Game will be played into two sessions. In the first session, player will be introduce about the overview of the game l, purpose and the scope of the game, the roles on the game, decisions for each role, and issues on each role. After that, players will run the game. On the next phase, player will reflect their action and events on the game. Then player will reformulate their strategies based on their reflection. The last phase is evaluation.

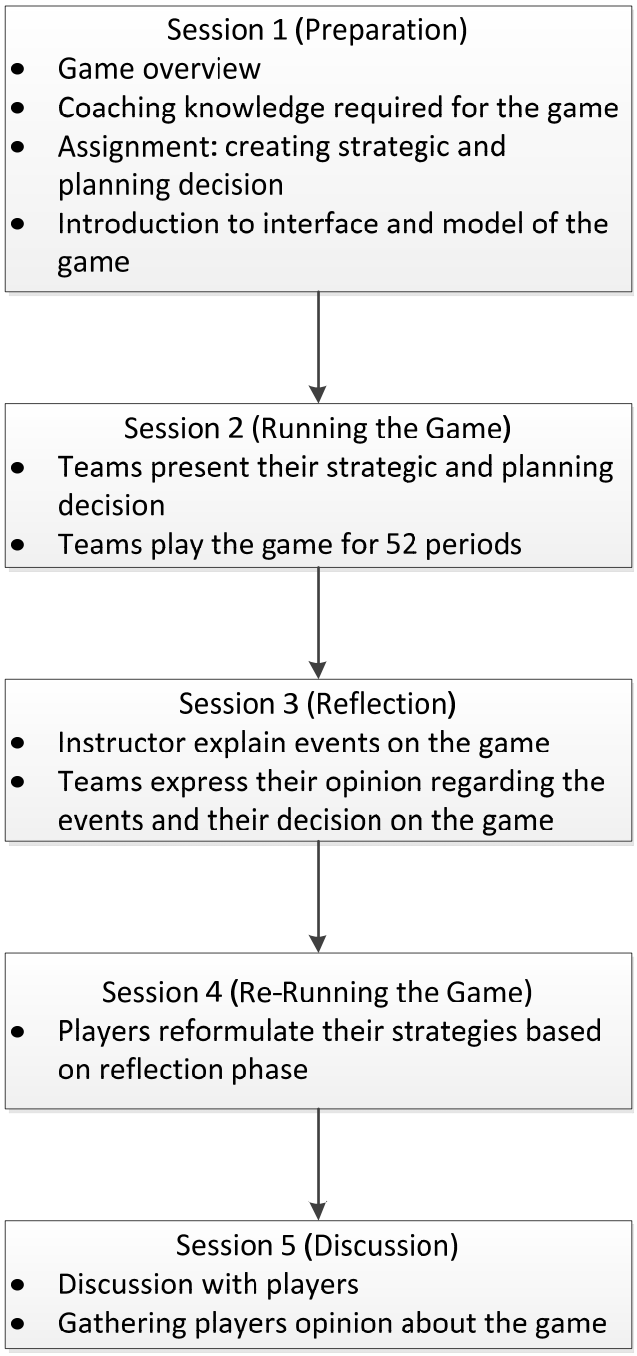


Figure 3 Organization of the Game

3. Proposed Evaluation Method

This is ongoing research. The simulation game itself in under testing phase and will be tried to student on September. There are two evaluation methods will be used: likert scale and observation. In likert scale, we measure player feedback regarding the ability of this game to teach production system. If player scored 1 means very disagree, while 5 means very agree. In order to support the likert scale, player strategies and in game process will be observed and compared with theoretical study. If players have used tools or knowledge from theoretical study on

their strategies and in game process, then It can be concluded that player have learn production system therefore the game is success.

4. Conclusion

The purpose of this research is developing a new simulation game, which have capability to teach production system in strategic, planning, and operational aspect. The strategic aspect is developed by modeling production capacity, supplier selection, and fleet size while operational cover issuing purchase order, releasing production order to workstation, and releasing delivery order. The new simulation game is played by a team consist of several players separated into purchasing, production, and distribution role. The simulation will be evaluated by using likert scale and observation.

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Biography

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