International Journal of Engineering & Technology, 8 (1.2) (2019) 142-145

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research paper

Development of A Physical Simulation Game in Global Supply Chain Issues

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Abstract

Development of a physical simulation game is an interactive method that can be used in the theoretical understanding of the global supply chain management, for academicians and also for industry practitioners. In this study, there are three objectives to be achieved, namely to identify the importance of supply chain game in understanding the theory of global supply chain, to develop a supply chain game with physical simulation method and to identify the effectiveness of the game to understand the theory of global supply chain. A physical simulation game then was designed and conducted among a group of university students. To facilitate researchers to obtain information, a questionnaire survey conducted on the participants before and after the game. There are two purposes of this survey, which is carried out to determine the participants' understanding about the theory of global supply chains and to identify the effectiveness of this physical simulation game. Regarding on the survey results, nearly 50% mean average response of the participants increased significantly was recorded. It shows that there is an increase understanding of the students about the given theory throughout this physical simulation game.

Keywords: *Global supply chain management; physical simulation game; survey*

1. Introduction

In recent years, the development of physical simulation game in educational teaching purposes has recently being explored, especially in understanding the theory of global supply chain management. Therefore, it is important to construct an effective method for this game so that the subject of Supply Chain Management is easy to be understood. The issues that included in this study are the factors that impact the global supply chain activities. Among these factors is the cost, market and competition and the availability of technology and infrastructure. To construct this physical simulation game, there are several games from previous researchers have been used as the concept of the game for example Beer Game, Beer Game Evolution, Cola Game, Wood Supply Game and International Trade Game. The Beer Game is one of the most popular simulation game that is used in managing the supply chains. It is a simulation of the flow of materials and information by computer, which involves four main entities in the supply chain which is manufacturers, distributors, wholesalers and retailers [1]. However, this method is too difficult to be used by undergraduate students who have no knowledge in Supply Chain Management theory [2]. Many scientists argue that the teaching of science, technology, engineering and mathematics should involve group activities and questioning among students so that it is more effective [3]. In addition, there are problems faced by the users through computer simulation methods. Most of these problems come from the intensive processing of a computer [4]. Furthermore, computer simulations are not specified their specific method or way which is it requires users to learn and understand before playing the simulation. Thus, with the development of this game perhaps that it can contributes to the effectiveness of teaching techniques, besides gives a better understanding of this theory to students and industry practitioners. For this particular study, it focuses on undergraduate students.

2. Background study

2.1. Types of physical simulation games

Based on the five games that have been investigated by previous researchers, they can be summed up in Table 1 where most of the games are developed related with previous studies in the same topic area. The main basis for the construction of this simulation game is the Beer Game that was founded in the 1950s by Jay Forrester [5]. This simulation game was designed to increase understanding in supply chain management. All five of the game is based on a physical simulation that aims to teach the concepts and theories that are presented in their objectives.

Table 1: Types of physical simulation games

Name	Objective	Parameter Used	Method of Analysis	Year of Development
Beer Game [5]	Beer Game strategy uses a teaching technique in supply chain management	-Reduce total cost -Management of inventory -Situations game is based on the reaction of the players (nonlinear) and the time delay	-Using inventory forms -Getting cumulative backorder from suppliers using Sheets	1950
Beer Game Evolution [6]	Risk management in understanding the strategies related to the behavior of players in facing the risk in the supply chain	-The cost provided by each player by the time -Stock amount -Order amount	-Analyze the range of maximum cost acquired by distributors, manufacturers and retailers by using a spreadsheet	2009
Cola Game [7]	Inventory management in the supply chain	- The impact of fluctuations in the demand for and cost of supply chain performance - The importance of doing work in collaboration and personal	- Measuring software gaming performance using ILP (Integer Linear Programming)	2008
Wood Supply Game [8]	Revealing about the dynamics of the supply chain (for timber and paper production)	-The cost of transportation in the procurement of wood -The cost of the supply chain that involves inventory, backlog and transportation	- Analyze the average demand, the average cost and standard deviation requests using Spreadsheet	2003
International Trade Game [9]	To help participants understand how trade affects the development of the country and to attract and discussions about world trade system in a fun and non-academic.	- Availability of technology - Availability of raw materials - Time to solve the problem	Group discussions	2002

2.1. Advantages and disadvantages of physical simulation game

Physical games in learning is now a trend, and can be seen as a tool in job training in the future. Hence, it is time to bring learning trends towards innovation. Table 2 shows the advantages and disadvantages of physical simulated games in learning.

Table 2: Advantages and disadvantages of physical simulation games in education

Advantages	Disadvantages
• More flexible	• Require cost of development
• Increase the motivation of participants	• Require a creative participants background
• Able to achieve the education goals	• Require time to understand the situation of the game

Source: Yann 2016 [10]

3. Methodology

A new physical simulation game is developed for this study after the literature review is done. In the meantime, the survey sheet is made based on the related theory. Then, the physical simulation game is performed on selected students from the Department of Mechanical and Materials Engineering. Within this game, a questionnaire before and after the game is given. This questionnaire is necessary to test the effectiveness of the physical simulation game on the understanding of students about the theory of global supply chain management and divided into three sections: Section A, Section B and Section C. Section A is on students' knowledge of the global supply chain management theory. Section B covers the effectiveness of the physical simulation game. These two sections need to be answered by the players, which are the students. The final section, Section C relates to the challenges faces during the preparation before the games start, during the game is on session and after the game ended. This section must be answered by the instructors or the organisers. After that, the information from the survey questionnaires are analysed using Minitab software. Analysis of these data is focus on the mean value of the answer scales given by respondents when answering the questionnaire. Based on the results, discussions on the improvements to the physical simulation game is made. Finally, conclusions and recommendations for the future researchers is built at the end of this research project.

4. Results and discussion

This section will discuss the results of the research that have been obtained from the questionnaires and physical simulation games that have been conducted. Both of these methods are conducted to measure the level of understanding of the students about the theory to be presented. Analysis will begin by reviewing the students' understanding of global supply chain management theory before and after the game. The analysis will use the mean value of the Likert scale on before and after the game runs. The Likert scale is used to measure the degree of consent, disagreement and the neutral level of the students towards a fact. Hence, to measure the frequency of responses given by respondents, the mean of each question should be evaluated [10].

4.1. Level of understanding on global supply chain management theory

Figure 1 shows the result changes is increasing for overall questions in Section A. Following this result, it can be tested whether this improvement is significant or not by getting the p-value of each question. Table 3 shows the p-value obtained from Minitab software. To

obtain the probability value, this analysis has used statistical methods using two sample t test. This test can be used to determine whether two means of a different groups differs significantly or not without setting min value.

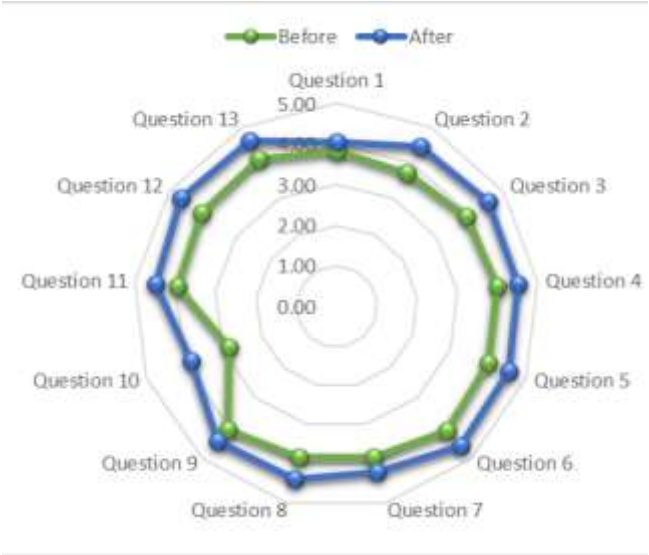

Fig. 1: Mean difference of the answers before and after for question in Section A

Table 3 : Comparison of the mean with the p-value before and after the game for the questions in Section A

	Before	After	p-value
Question 1	3.83	4.06	0.530
Question 2	3.72	4.44	0.011
Question 3	3.89	4.56	0.025
Question 4	4.00	4.50	0.052
Question 5	4.00	4.56	0.182
Question 6	4.11	4.61	0.062
Question 7	3.83	4.22	0.205
Question 8	3.83	4.39	0.053
Question 9	4.06	4.44	0.092
Question 10	2.83	3.83	0.020
Question 11	3.94	4.50	0.013
Question 12	4.06	4.67	0.021
Question 13	4.11	4.61	0.027

Based on the pie chart in Figure 2, it shows that 46% of the questions has increased significantly and 54% percent of the questions have not increased significantly. It shows that almost 50% of the theoretical questions that were asked to the students experienced a significant increase. Thus, it shows that there is increased understanding of the given theory by the students after playing the physical simulation game.

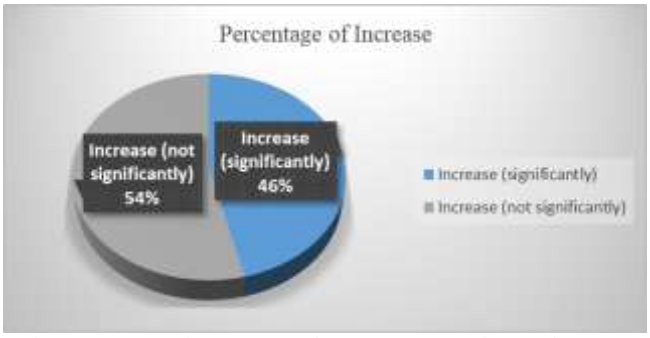

Fig. 2: Pie chart of the percentage of increase significantly or not significantly for questions in Section C

4.2. Effectiveness of physical simulation games

Table 4 shows the mean average of the answers to the survey questions in Section B. The mean average of the answers given shows that this physical simulation games can help the students understand the theory of global supply chain management. It shows they also agree that this game is reasonable to be applied to the other theories. Furthermore, they feel the game is interactive and also it can help to increase their focus on learning. They give positive feedbacks on the remaining questions which are the theory taught in the simulation game is easier to be understood than daily lectures, they are more interested applying theory in this physical simulation game compared to the normal theoretical and this simulation games need to be added by some improvements.

Table 4: Mean average of the answers to survey questionnaire in Section B

	Mean
Question 1	4.56
Question 2	4.61
Question 3	4.56
Question 4	4.39
Question 5	4.67
Question 6	4.72
Question 7	4.61

4.3. Challenges faced

Table 5 shows the mean average of the answers to the survey questionnaire in Section C. From this section, the questions were about the challenges faced by the organizers to carry out this physical simulation game. Based on the mean average of the answer to question 1 that is 3.80, it shows some respondents agreed that the game consume a little bit costs, but the cost is not too high. Next, for the second question, the mean average of the answers is 2.80 shows a simulation game does not require a large numbers of committee.
Next, the mean average of the answers to questions 3 and 4 are 4.20 and 4.60 indicates the respondents agreed that there were time constraints and the game requires initial setup before it is executed. For question 5, the mean average answer is 2.40 which it shows that the respondents did not agree that the physical simulation game is conducted over the given period. While for questions 6 and 7, their mean average responses are 4.80 and 4.40. This indicates the respondents agreed that the organizers can gain new experience from organizing the physical simulation game and this game should be added by some improvements for future use.

Table 5: Mean average of the answers to survey questionnaire in Section C

	Mean
Question 1	3.80
Question 2	2.60
Question 3	4.20
Question 4	4.60
Question 5	2.40
Question 6	4.80
Question 7	4.40

5. Conclusions

As a conclusion, based on the results of this study it shows that the physical simulation game has indirectly help the students improve their understanding on the theory of global supply chain management. This is because almost 50% of the p-values in question Part A that was answered is increasing significantly. Despite the advantages gained by the participants, there are some constraints. For example, the constraints of time, cost and initial setup. However, the organization of this game has given a new experience to the organizers. It is also quite easy because it does not require a large number of committee. Thus, there are three proposed improvements to this physical simulation game. Firstly, there is the need of creating a lego prototype using the same set of lego. The aim is to reduce the time taken by participants during the construction of lego model in this physical simulation game. Second is to provide time for students to understand the situation of the game. This is because every student has a different learning curve. Lastly, it needs a well preparation by the organizers beforehand. In this case, a thorough preparation by the organizers is needed to make this physical simulation games run smoother, and more interactive.

Acknowledgement

The authors gratefully acknowledge use of the services and facilities of the Department of Mechanical and Materials Engineering, Faculty of Engineering & Built Environment at the Universiti Kebangsaan Malaysia (National University of Malaysia), funded by MOHE Grant FRGS/2/2013/SS05/UKM/02/6 and AP-2015-015.

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