



ISSN:1991-8178

Australian Journal of Basic and Applied Sciences

Journal home page: www.ajbasweb.com

Pool Power Trading Simulator for IOS as an Educational Tool

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ARTICLE INFO

Article history:

Received 13 June 2015

Accepted 28 July 2015

Available online 5 August 2015

Keywords:

electricity market, pool market, energy exchange, electrical energy economics and planning, IOS, XCode, swift language

ABSTRACT

Electricity market has become one of the most important knowledge that can be adopted since everyone is using electricity. Several numbers of electricity market models has been proposed in various researches. Based on the general structure of a power system and market model, this paper presents a simulator of power exchange markets specifically pool market model. Trading system is developed for iOS devices. The purpose of developing the simulator is to assist and apply the education of electricity market among students and lecturers. By using Xcode tools with Swift programming language, the simulator should calculate the market clearing price, capacity, revenues and expenses of electricity market's participants. Therefore, everyone is able to nurture the knowledge regarding power trading market namely students and lecturers.

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To Cite This Article: Mohamad Fahmi Hussin, Ahmad Asari Sulaiman, Mohamad Huzaimy Jusoh, Shazrain Asyraf Suhaimi., Pool Power Trading Simulator for IOS as an Educational Tool *Aust. J. Basic & Appl. Sci.*, 9(25): 139-144, 2015

INTRODUCTION

In the study of electricity markets, it is assume that all generators and loads are connected to the same bus or that they are connected through a lossless network of infinite capacity. The complexities of the transmission and distribution networks are ignore for the moment and concentrate on the electrical energy trading (D. Kirschen and G. Strbac, 2004).

An electricity market is a system that involves the purchases and sales, through bids to buy, offers to sell and short-term trades. Generally, it is in the form of financial or contract swaps. Bids and offers use supply and demand principles to set the price. Long-term trades are contracts similar to power purchase agreements but it is considered private bilateral transactions between counterparties.

There are several types of electricity market model applied worldwide such as monopoly model, single buyer model, pool trading model, bilateral trading mode and hybrid model. These models (except monopoly model) are designed to promote a healthy competition environment (M. Y. Hassan et al, 2008). Out of numerous market models available, pool based electricity market is widely known electricity market (S. Chaitusaney, 2002).

The trading of electricity market becomes one of the competitions in various economic sectors development that satisfy the quality of societal life. In some country like Malaysia, electricity market is

monopoly and owned by government where the supply of electricity from generation, transmission and distribution is carried out by government. However, the disadvantage of monopoly model is the transparency of the system. This is because they no need to be efficient to survive since there is no competition. Investigation should be made to improve the system.

In accordance to the investigation of the problem, the presentation of the idea should grow in line with the technology. The development of technology in this era increased dramatically from time to time. Since the early phase of the invention and innovation of electronic gadgets, the relationship between technologies and education has become a large gap. Engineering student often encounter difficulties when they are dealing with economic theories and variables connected to their particular fields.

Therefore, the goals of this project is to analyze the most economic electricity market model for pool market, to develop iOS simulator that represent pool market model and to assist and apply the education of electricity market among students and lecturers.

Methodology:

The investigation of this electricity market model (pool market) had come out with the idea of making tools for education. This simulator was designed and developed for the most economic pool-model electricity market based on Swift language in

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XCode tools. It was built to calculate the market clearing price dispatching generation capacities for each participating generation company. This

simulator was developed specifically for IOS devices as an educational purpose.

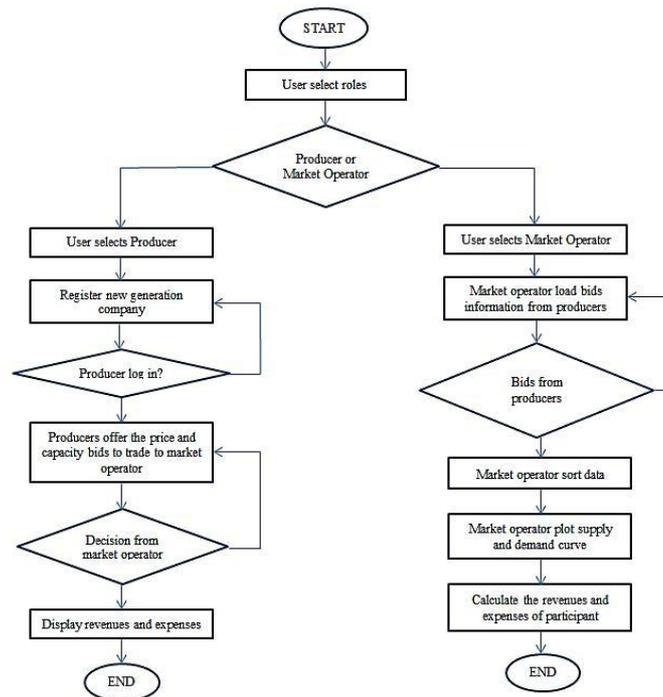


Fig. 1: Flow Chart of the Simulation

Figure 1 shows the process of the simulation as the simulator was run. Based on the flow chart, developer make two different processes with different functions. In order to ensure the simulator run smoothly and systematic, several tools should meet the requirement.

For this project, MacBook Air 11-inch was used. It was released in mid-2011. The operating system of the MacBook is OS X Yosemite version 10.10.3. This version met the requirement since the minimum requirement is OS X Mountain Lion version 10.8.

In developing and designing the simulator, developer has to choose suitable software to be installed and used. XCode tools had been chosen. For this project, the latest version of XCode tool was used, which is version 6.3.1 with iOS SDK 8.3. This tool allows the developer to create an app using Objective-C and Swift languages. This project had been developed using Swift language. Swift language is the latest and upgrade version of Objective-C.

To start the project, developer select "Create a new Xcode project". In this section, developer can design any project with given interface and link the interface with coding directly. If for instant,

developer wants to just play or test the coding, this tool allows developer to do so by selecting "Get started with a playground". In order to develop an app for iOS devices, developer must choose "Single View Application" as the template. There are various types of templates that can be chosen but other template will appear in different style and not suitable for the apps development (Chris, 2013).

After choosing the template, developer must fill in the details of the project. Developer must give the product name, organization name, organization identifier, language used and compatible devices for the product to be installed. This is to protect the products and developer's copyright.

As the project has been created, developer proceeds with designing and coding of the application. Developer designs the product in storyboard. The storyboard is the graphical user interface where all the input and output of the product can be customize and linked to each other through view controller with various type of interface. Figure 2 shows the example of the input and output of the product linked to each other.

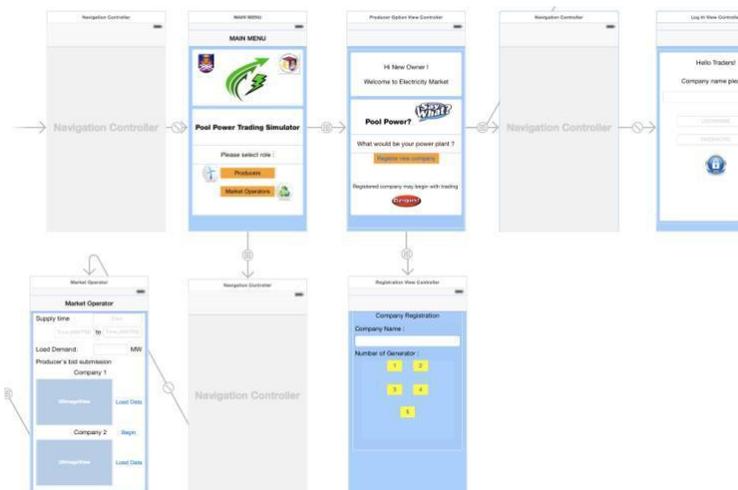


Fig. 2: Xcode Storyboard

Linking the view controller must be done carefully. It might be error occur if it is taken for granted. Developer must make sure every view controller must have their names and identifiers to avoid the error. In one view controller, there are many functions that can be done and linked by coding.

To write the code, developer must be very knowledgeable in the language command. Every function has their own code of writing and these codes are very sensitive. A simple sign or capital /small letter can cause error to the project. Developer must be aware of the warning symbols that appear when there is error spotted in the coding. A good and successful coding will have no warning symbols

appeared.

RESULTS AND DISCUSSION

All results were presented for iOS devices namely iPhones and iPads. Xcode has provided the platform for hand on simulator. For this project, developer selects iPhone as the platform.

As the simulator run, developer creates an option for user to choose the role of playing in electricity market. The options are producers and market operators. These two organizations play an important role in electricity market. Each of them has their own function and responsibilities. Figure 3 shows the main menu interface of the simulator.



Fig. 3: Main Menu of the Application

In playing the roles in electricity market, users must first understand the basic concept of the market and how they are related. For “Producers” role, developer insert a little bit of explanation on what is pool power market. Developer believes that a short

briefing as an introduction would help the users namely students and lecturers to make role playing better (K. Houghton et al, 2014).

Next, developer identify whether the producer is a new user or regular user. In electricity market,

producers own Generation Company. Therefore, developer wants to know the producer's company has been registered or not. New producers would have to register new generation company in order to begin with trading since trading electricity needs a company that can produce electricity.

For a new company owner, the registration needs information of the company to confirm that the company is registered. Among the information needed are company name, number of generators, generator capacities, type of generators, username and password. The number of generator button is link up to five units where detail information of each number of generator selected by the user should be fill up.

Developer create different user interface in order to get different input data according to the number of generator selected. As an example, if the user selects "1" number of generator, there will be an option for one generator that should be filled up. If the user selects "2" number of generator, there will appear option for two generators and so on up to five number of generator. User as the new owner of the company should submit the detail information of

generator capacities and type of generator that produce electricity. This is because the amount of maximum electricity produced by different type of generator plays an important role in the electricity market. During trading, producers cannot bid power more than what they generate. Theoretically, if load demand of electricity is higher than generation, there will be breakdown. Therefore, in order to avoid breakdown occur, developer create an input option for generator capacities and type of generator.

Next, the input amount of capacity is sum up and display the total capacities of one's company generate. Developer creates username and password field to ensure the security of the system.

After producer register, they may proceed with trading. Before start the trading process, producers must log in into their account. Producers must key in their company name, username and password that they had been registered. The system only recognizes and allows the registered company to be logged in. This is because the system wants to maintain its security based on the registration submitted earlier. Figure 4 shows the log in page user interface where all text fields must be filled.

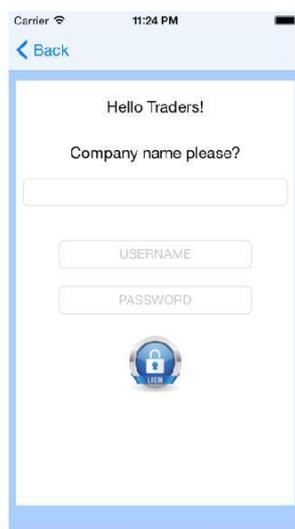


Fig. 4: User Log in Page

As the producers logged in, the owners of generating companies submit bids to supply a certain amount of electrical energy at a certain price for a certain period under consideration of market operators. These bids were submitted to the market operators. Figure 5 represents the bids submission detail where generating companies compete on prize to supply electricity.

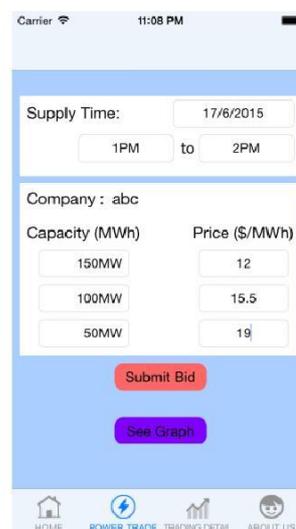


Fig. 5: Bidding Process

For "Market Operators" role, developer create an interface where the bids submission details from the companies can be loaded to perform analysis. In this role, market operator has to set the supply duration and the load demand that was forecasted according to customer's demand. Figure 6 shows the market operators interface

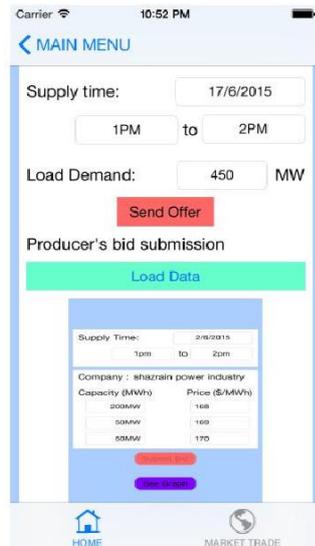


Fig. 6: Market operators interface

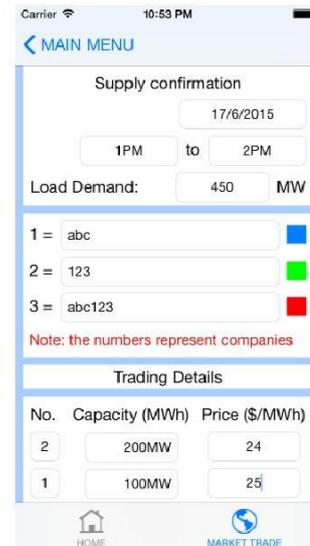


Fig. 7: Trading Details Interface

From the bids submission of the companies, market operator performed analysis and sort the bids ascending order based on price. Figure 7 shows the trading details interface where the bids of the companies are arrange in ascending order based on price.

By observing figure 8, these bids are ranked in order of increasing price. From this ranking, a curve showing the bid price as a function of the cumulative

bid quantity can be built. This curve is deemed to be the supply curve of the market. The bar chart represents the supply curve. Green color indicates the supply from company 1 while Blue and Red color indicate the supply from company 2 and company 3 respectively. Market operator determines successful bids and the market price and the result were sent back to the producers.



Fig. 8: Bar Chart Represents the Supply Curve

Figure 9 shows the theoretical supply and demand curve. Green color line represents the bids of the generation companies to supply electricity and red color line represents the load demand which in this case is set by market operator. As we compare the results, developer manages to plot the supply curve in term of bar chart. For demand curve,

developer has to forecast the demand and set it as constant by calculation in the Xcode coding. The results of the calculation appear in a view controller. This is due to the limitation of the project. Further investigation on plotting a graph using swift language should be performed (EWEA and I. E. Europe, 2014).

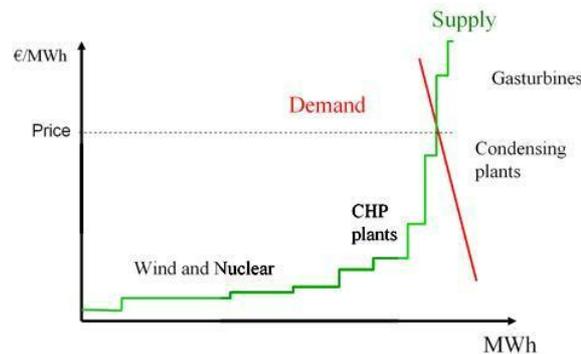


Fig. 9: Theoretical Supply And Demand Curve

Conclusion:

Research and study are common words as a student. However, relating the theoretical study in social environment is the key factor in becoming a great student. The investigation on electricity market model is one of the studies that can be implemented in education especially for electrical engineering students. This project manages to analyze the most economic electricity market model specifically in pool market. Besides that, it is an opportunity to develop a simulator for iOS device based on the selected pool market model in order to assist and apply the education of electricity market among students and lecturers.

Future Recommendation:

The recommendation of the project in the future is developing a pool market model simulator for Android devices. Moreover, the simulator can be further developed for other electricity market model for both iOS and Android devices. Although there are some pros and cons between these two operating systems, minimizing the error in the system and turning the cons perception into pros would be great. Engineers are problem solver.

ACKNOWLEDGEMENT

We would like to thank Research Management Institute for the financial support in this research under the grant 600-RMI/DANA 5/3/REI (8/2014).

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