Perspectives on Decision Making in E-Commerce based on Combined Game and Chaos Theories

Jeerana Noymanee*[1], Wimol San-Um[#2]

Electronic Government Agency (Public Organization) of Thailand , Bangkok, Thailand
[1]Jeerana.noymanee@ega.or.th

#*Intelligent Electronic System Research Laboratory, Thai-Nichi Institute of Technology, Bangkok, Thailand*
[2]wimol@tni.ac.th

Abstract **— This paper presents new paradigm on behaviours of decision making in E-commerce in Thailand through a perspective on game Theory and a chaos theory. As E-commerce is a multi-dimensional consideration, a single theory may not be sufficient for the overall perspective views in decision making. In this paper, game theory is suitable for decision making of E-commerce providers in order to set the strategy based on feedback information. However, chaos theory is suitable for describing customer decision making, especially the buying behaviors seems to be random in which the classical decision model cannot be described. The proposed new paradigm can be applicable for economics and managements in enterprise, especially business-tocustomer types of entrepreneurs.**

Keywords **— Random Behaviours, Customer Decision Making, Game Theory, Chaos Theory**

I. INTRODUCTION

The advancement in web-based technologies has continuously supported the growth of E-commerce in Thailand.Particularly, automation and delegation technologies have considerable effects on the future of E-commerce. Nowadays, the software has fully made E-commerce possible, for instance, the consumers can be able to conduct automated searches and consider price comparisons. These technologies can even perform decision making on behalf of individuals, negotiating with other programs, and participating in online markets. The opportunities to utilize the internet for business and comparison shopping have been increased significantly by technologies. In summary, an automated E-commerce creates new economics value not only by making business processes easier, but also by opening up new possibilities for market interactions.

According to the National Statistical Office (NSO) [1] of Thailand, information of percentage of E-commerce business by types of entrepreneurs has revealed in Figure 1. Most of Ecommerce businesses were entrepreneurs engaged in Business-to-Customer (B2C) with 79.7% and Business-to- Business (B2B) with 19.3%. For those engaged in Businessto-Government (B2G) without E-Government, it was only

about 1.0%. In terms of types of business, Figure 2 shows the percentage of E-commerce businesses. Considering the large scale of E-commerce businesses, it showed that the groups of industry were mostly travel, hotel and resort (24.0%), next were fashion industry, accessories and jewelry (23.3%), were on computer, electronic, appliance, and internet (19.2%), were service business (7.0%), were office equipment (4.99%), followed by automotive industry and products (4.1%), and other (17.5%), respectively.
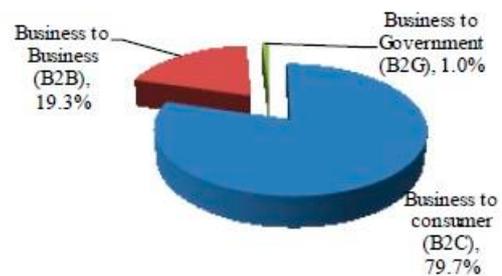

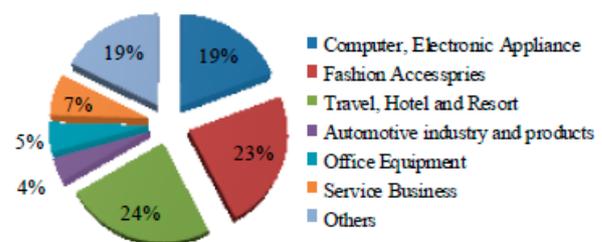Figure 1. Percentage of E-commerce Business by Types of Entrepreneurs.

Figure 2. Percentage of E-commerce Business by Types of Business.

In comparison to global scale, the average income for E-commerce of 20% comes from Asia and Pacific. In other word, this region has potentially shown a rapid growth of E-commerce. Thailand has been recognized as the highest growth of E-commerce in South-East Asia. Based on the report in the year 2013 [1], the value of E-commerce in Thailand is 473.3 Million Dollars and it is expected to be approximately 700 Million Dollars in 2016. Such a growth in E-commerce is due to the capability of accessing to internet, i.e. 33 million people in Thailand now. In addition, the important factor

influencing the growth in E-commerce is the growth in smart phone market. In 2013, the growth rate of using smart phone is 132%, and 92% of Thai people always use the mobile phone. The statistics also indicates that 51% of Thai people make a business operation through E-commerce. Such numbers clearly explain that the impacts of E-commerce have aroused business developers to accelerate strategy for maximum benefits.
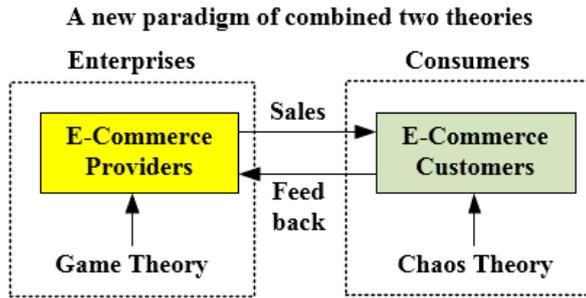

Figure 3. The proposed new paradigm of combined game theory and chaos theory.

According to such a rapid growth in E-commerce in Thailand, there is a significant need on a tool for decision making process for both E-commerce providers and customers. This paper therefore presents combined theories as a new paradigm for decision making. Game theory will be applied for enterprises, but the chaos theory will be applied for customers. A clear concept of this paper is to provide a new paradigm on E-commerce management theories from the viewpoints of both business providers and the consumers.

II. LITERATURE REVIEWS

On the one hand, game theory has extensively been studied for strategic decision making. In particular, the game theory is the mathematical models of conflict and cooperation between intelligent rational decision makers. Some papers relating game theory on decision making are as follows. Fernando Bernstein and et al. [2] has presented that consumers are generally better off with clicks-and-mortar retailers. If firms align with pure E-tailors to reach the online market, a prisoner's dilemma-type equilibrium may arise. Daewon Sun and et al. [3] have studied the properties of the optimal format to sell a product through the internet. Elliot Anshelevich and et al. [4] proposed progresses in prove bounds on the prices of anarchy and stability. Jing Yu and Bin Xu [5] have proved a numeric simulation that their proposed formulas can perfectly well reflect the realistic practice of merger and acquisition.

In addition, Yu Xiong [6] presented that both the dealer and the supply chain may benefit from the manufacturer's encroachment. Ursula F. Ott [7] indicates that there is considerably more potential for its refinements to be related to topics of uncertainty and dynamics in strategic interactions in International business. Qihui Lu and Nan Liu [8] presented the numerical analysis of the supplier and the retailer which are worse off in the Nash game than in the Stackelberg games. Wooje Cho and et al. [9] showed that in the duopoly market, even when customers are uninformed about quality, an investment-equilibrium exists. Finally, Salma Karray and Simon Pierre Sigué [10] have studied the properties of a partnership between a complementary product and independent product which is optimal when the price effect of the complementary product is large.

On the other hand, chaos theory is the study of dynamical system behaviours which are highly sensitive to initial conditions. Chaos theory has been applied for economics in variety of matters. Mouck [11] presented the capital markets research and real world complexity). Guégan [12] focused on the use of dynamical chaotic systems in economics and finance, and presented statistical tools which can be useful in practice to detect the existence of chaotic behaviour inside real data sets. Barbora Volná [13] presented the existence of chaos in the plane R2 and its application in the fundamental macroeconomic equilibrium model called IS-LM model. In addition, Akio Matsumoto [14] has summarized in details regarding attractors, bifurcations and chaos, i.e. nonlinear phenomena in economics. As a result from considerations on both game theory and chaos theory, such two theories have strength in order to apply in E-commerce system as a new paradigm.
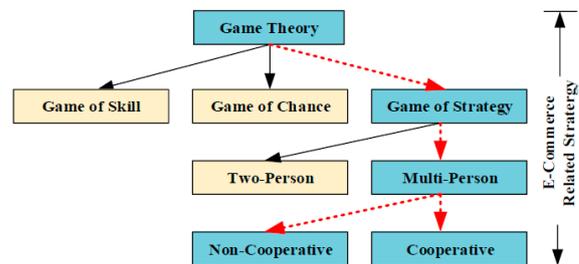

Figure 4. A diagram showing the taxonomy of game theory that relates to E-commerce system.
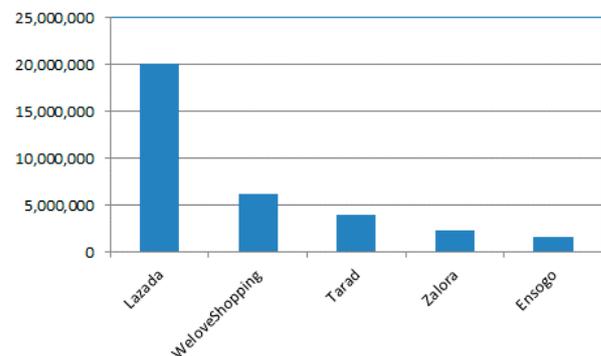

Figure 5. the ranking of E-Commerce in Thailand by page visits in January 2015[15].

III. PROPOSED CONCEPTUAL MODEL

Figure 3 depicts the proposed conceptual model as a new paradigm of combined game theory and chaos theory. The new scenario focuses on the application of game theory to enterprises and chaos theory to customer behaviors, respectively. With reference to Figure 3, game theory reveals that it is suitable for E-commerce providers in order to set the strategy based on feedback information. However, the chaos theory is suitable for describing the customer decision making, especially the buying behaviors seems to be random in which the classical model cannot be described.

A. Proposed Game Theory for E-Commerce Providers

Figure 4 demonstrates the diagram showing the partial taxonomy of game theory that relates to E-commerce system. Nowadays, there have been a number of E-commerce providers and therefore the game theory should focus on the game of strategy in which multi-person are involved. The commonly-known Prisoner's Dilemma (two-person) might not be suitable to be applied to the current situation of Ecommerce business as a number of providers have incredibly increased. This is due to the significant increase in smart phone markets and therefore people tend to purchase goods and services via mobile phone (M-Commerce), which is a novel existence in E-commerce markets. As for a concrete demonstration, Fig.5 shows the first five ranking of Ecommerce in Thailand by page visits in January 2015 [15]. According to Fig.5, the value of E-commerce in Thailand has been increasing dramatically reflected by amount of money flows. The application of game theory in multi-person system should consider on cooperative and non-cooperative strategies among competitors. Comparisons on advantage and disadvantages are as follows.

In terms of cooperative strategy, the customer base can be increased and therefore the channel for public relation can correspondingly be increased. The cooperative strategy helps support each other in terms of strength and weakness of each firm. Therefore, the brand is stronger and more creditable. In addition, the target of cooperative strategy in E-commerce system is clearer and hence no conflicts happen among competitors. Most importantly, cooperative strategy in Ecommerce significantly reduces the operation costs. For non-cooperative strategy, on the other hand, the operation and marketing strategy is deftness and flexible. Therefore, the decision making is faster, following the market trend. The enterprises can response to the real need of the target without any consideration from other companies. In addition, the firms can play the "price war" which can gain the maximum benefit for the own firm. In conclusion of game theory for Ecommerce in Thailand, it seems to be that the non-cooperative strategy is more suitable due to the Thai culture which has a low completion. Additionally, Thai people are still concern about the monopoly market due to social space which still exists in Thailand.

B. Proposed Chaos Theory for E-Commerce Customers

Customer behaviour is generally defined as activities that people undertake when obtaining, consuming and disposing of products and services. The businesses around the world recognize the consumer that is no longer the king, but rather a partnership. In essence, analysis of customer behaviours helps firms to know directly the impact of bottom line profits. The Consumer Decision Process (CDP) model is therefore a roadmap of consumers' minds that marketers and managers can use to help manage products, communications, and sale decisions. Typically, the one-time decision of a traditional model involves five-stage considerations, i.e. problem recognition, information search, alternative evaluation, purchase decision, and post-purchase behaviour. However, such a model is a one-time decision, which is contrast to the current situation where a number of E-commerce providers are available with high competition.

This work therefore focuses on the random decision making of customers through the use of chaos theory. The chaos theory studies behaviours of dynamical systems which has high sensitivity on initial conditions. In other words, a response particularly referred to as the butterfly effect. Small differences in initial conditions results in dramatically diverging outcomes for such dynamical systems, rendering long-term prediction impossible in general. As for the sake of simplicity for understanding, the typical logistics map is demonstrated through the iteration $X_{n+1} = rX_n(1-X_n)$ where r is a control parameter. Figure 6 shows the bifurcation diagram of the Logistics Map and the Positive Lyapunov Exponent, indicating chaotic state. There are three cases for consideration of customer decision making as follows; First, the stable state (a straight line) indicates the customers that really loyal to the brand. This group of customers will decide to buy products and services only the brand that they prefer. Therefore, it is relative hard to change their behaviors to buy form other companies. In order to gain benefits from this group, the cooperative strategy among enterprises would be an alternative to expand the customer base.

Second, the period doubling state (Bifurcating) indicates the customers that are not really loyal to the brand. They might compare only some important factors such as prices and promotions. This group of customer should be realized by the enterprises as they are one of major groups that can be hold as a customer base.
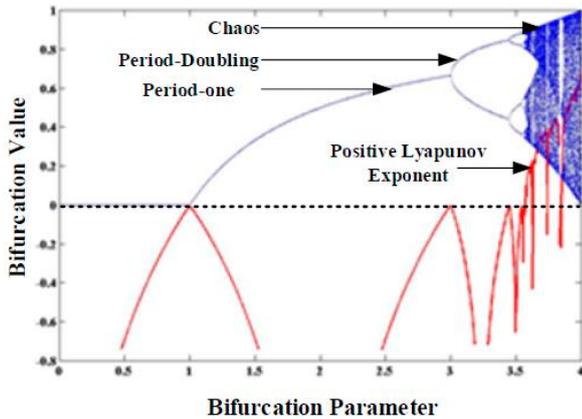
Figure 6. Bifurcation diagram of the Logistics Map and the Positive Lyapunov Exponent, indicating chaotic state

Figure 7. Examples of one customer who randomly buying products and services in different companies.

Last, the chaotic state indicated by the thick area represent the group of customers that truly random buy goods and services without any considerations on brand and prices. Emotions and Public Relations (PR) are important factor to arouse this group of customers without any reasons. The viral marketing also affects the customer decision making in a random way. This group of customer is relatively difficult to handle due to they have no specific target and not loyal to any brand. Figure 7 shows the examples of one customer who randomly buying products and services in different companies. It can be seen from Figure 7 that this customer buy 100 items with different companies modelled by the logistic map. It is apparent that most Thai people tend to have this kind of buying behaviours and it is chaotic behaviours.

IV. CONCLUSIONS

This paper has presented the novel paradigm on a decision making in E-commerce in Thailand using a game Theory for the E-commerce business developers and a chaos theory for customer decision making. As E-commerce is a multi-dimensional consideration, a single theory may not be sufficient for the overall perspective views. For game theory, it is revealed that it is suitable for providers to set the strategy based on feedback information, which can be whether cooperative or non-cooperative strategies. However, the chaos theory is suitable for describing the customer decision making, especially the buying behaviours seems to be random in which the classical model of classical decision model cannot be described. Bifurcation diagram of the Logistics Map and the Positive Lyapunov Exponent were also demonstrated. The proposed new paradigm can be applicable for managements in enterprises, especially Business-to-Customer types of entrepreneurs.

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