บทความวิจัย

ตัวแบบส่วนแบ่งการตลาดของบริษัทบริการส่งอาหาร

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รับบทความ: 21 สิงหาคม 2564 แก้ไขบทความ: 15 กันยายน 2564 ยอมรับตีพิมพ์: 15 กันยายน 2564

บทคัดย่อ

การวิจัยครั้งนี้มีวัตถุประสงค์เพื่อนำเสนอการสร้างตัวแบบเชิงคณิตศาสตร์ส่วนแบ่งการตลาดของบริษัทบริการส่งอาหารด้วยระบบสมการผลต่าง โดยเริ่มต้นจากการศึกษารูปแบบการวิเคราะห์ในรูปลูกโซ่มาร์คอฟแล้วแปลงเป็นระบบสมการผลต่าง เพื่อกำหนดค่าพารามิเตอร์ของตัวแบบได้มีการสุ่มตัวอย่างนักศึกษาจำนวน 121 คน เพื่อตอบแบบสอบถามเกี่ยวกับการกลับมาใช้บริการและความพึงพอใจการบริการของแต่ละบริษัท ข้อมูลทั้งสองด้านนี้จะนำมาพิจารณาคำนวณค่าพารามิเตอร์ของตัวแบบ มีการใช้โปรแกรมไพธอนเข้ามาช่วยในการคำนวณหาผลเฉลยของตัวแบบเพื่อวิเคราะห์พฤติกรรมส่วนแบ่งการตลาดระยะยาวของบริษัทบริการส่งอาหาร ซึ่งจากการกำหนดเงื่อนไขของส่วนแบ่งการตลาดที่แตกต่างกัน 3 เงื่อนไขพบว่า เมื่อผ่านไประยะยาวค่าส่วนแบ่งการตลาดจะลู่เข้าสู่สัดส่วนคงที่ค่าเดียวกันทั้ง 3 กรณี ซึ่งผลที่ได้นี้จะเป็นข้อมูลสารสนเทศเชิงคณิตศาสตร์ที่มีประโยชน์ให้กับบริษัทบริการส่งอาหารได้เตรียมพร้อมบริหารจัดการทั้งในแง่การตลาดและการบริการ

คำสำคัญ: ตัวแบบเชิงคณิตศาสตร์ ระบบสมการผลต่าง ส่วนแบ่งการตลาด

อ้างอิงบทความนี้
สุพจน์ สีบุตร. (2564). ตัวแบบส่วนแบ่งการตลาดของบริษัทบริการส่งอาหาร. **วารสารวิทยาศาสตร์และวิทยาศาสตร์ศึกษา**, 4(2), 164 - 171.

Research Article

Food delivery company market share model

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Received <21 August 2021>; Revised <15 September 2021>; Accepted <15 September 2021>

Abstract

The objective of this research is to present mathematical modeling of the market share of food delivery companies using a system of a difference equation. It starts from studying the analytical model in Markov chain form and then converts it into a system of a difference equation. To determine the parameters of the model, 121 students were randomly assigned to answer a questionnaire on service return and service satisfaction of each company. Both of these data are considered when calculating the parameters of the model. A python program was used to calculate the model's solution to analyze the long-term market share behavior of a food delivery company. According to the terms of the market share, 3 different conditions, it was found that over the long term, the market share will converge to the same constant ratio in all three cases. The result will be mathematical information that is useful for food delivery companies to be prepared to manage both in terms of market and service.

Keywords: mathematical models, system of difference equations, market share

Cite this article:

Seebut, S. (2021). Food Delivery Company Market Share Model. **Journal of Science and Science Education**, 4(2), 164 - 171.

Introduction

Mathematical modeling is an actual problematic activity in the form of a mathematical equation for easy analysis, research and subsequent operations. A mathematical model is generated after the process is complete and the descriptions associated with it provide useful information on the problem to be solved (Fox, 2011; Giordano, Fox and Horton, 2013; Albright & Fox, 2019).

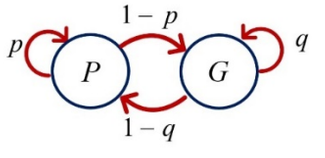
The Markov chain is a mathematical tool that applies probability theory by studying the behavior or probability of operating a situation. Past and future situations are considered independent of each other. When we know the current situation that is, if the current situation is known, there is no need for additional information about the past situation to predict the future. This process reduces the amount of data even more so that we can study or make predictions about the situation in the future. For this reason, the Markov chain is applied in many fields. (Zhang & Zhang, 2009; Andrieu, Doucet and Holenstein, 2010; Vasanthi, Subha and Nambi, 2011; Svoboda & Lukas, 2012; Myers, Wallin and Wikström, 2017; Bidabad & Bidabad, 2019; Yu & Sato, 2019; Seebut, 2020).

For the study of market share of business competitors of the same type The Markov chain has been applied to consider the market share. This has yielded good results (Kassa, Abrham and Seid, 2017). This study examines and analyzes the market share of food delivery companies in the form of a Markov chain model. The model helps to know the market trend of each food delivery company that they should plan their customer service and increase their market share by some tactic.

However, it was found that analyzing the behavior of mathematical models with the Markov chain is not convenient for the study of interested cases and long-term consideration of the model's behavior. because it is in a form that cannot substitute variables and has an immediate solution This problem can be solved by converting the Markov chain to a system of differential equations instead (Seebut, 2020). This method allows to immediately find the result of the solution in the case of interest by substituting variables.

Modeling

For the study of market share of food delivery companies, two food delivery companies with major competitors Food Panda and Grab food were selected. The market share of food delivery behaviors between Food Panda and Grab Food was determined using the Markov diagram as follows:



Set to

p is probability of customers returning to Food Panda service.

q is probability of customers returning to Grab Food service.

P is the state of the Food Panda service selection ratio.

G is the state of the Grab Food service selection ratio.

To determine the p and q parameters, 121 customers were sampled to answer questionnaires about each company's return to service and service satisfaction. The results of the analysis are as shown in Figure 1.

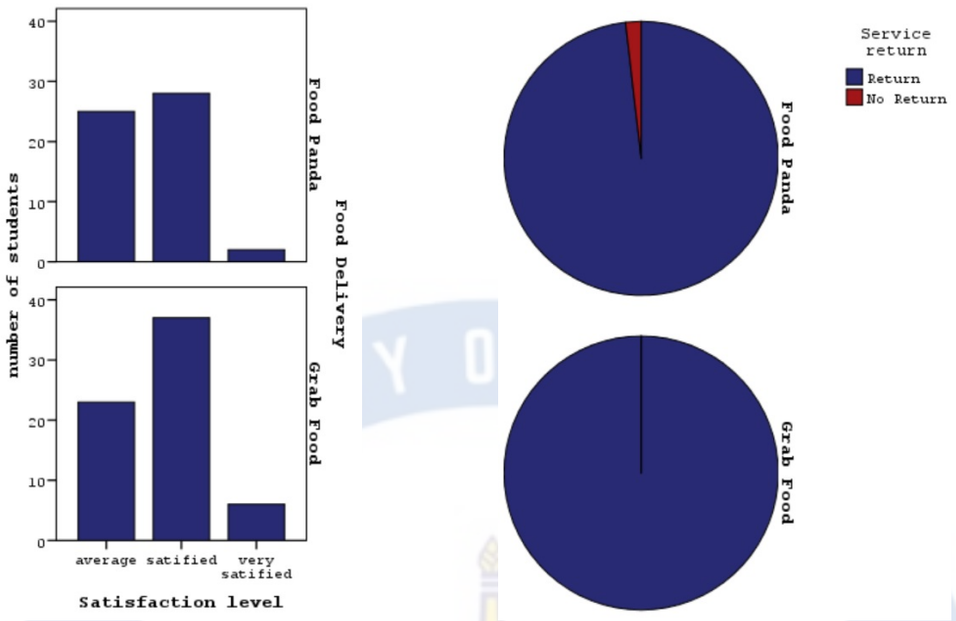


Figure 1. A bar chart showing customer satisfaction and a pie chart showing the percentage of return for each food delivery company.

The result can be considered for the parameters p and q as follows.

Consider the information obtained from a survey of Food Panda costumers.

According to the Food Panda customer satisfaction survey, the average score is 3.5818, so the average score ratio is 3.5818/5.

The percentage of costumers who would like to use Food Panda again in the survey was 98.20%.

Consider the value

$$p = \left(\frac{3.5818}{5}\right)\left(\frac{98.20}{100}\right)$$

$$p = 0.7035$$

Consider the information obtained from a survey of Grab Food costumers.

According to the Grab Food customer satisfaction survey, the average score is 3.7121, so the average score ratio is 3.7121/5.

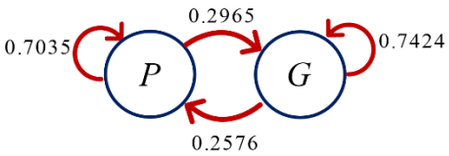
The percentage of costumers who would like to use Grab Food again in the survey was 100%.

Consider the value

$$q = \left(\frac{3.7121}{5}\right)\left(\frac{100}{100}\right)$$

$$q = 0.7424$$

Substituting the values of $p = 0.7035$ and $q = 0.7424$ gives a new Markov diagram as follows:



From the Markov chain diagram, an equation can be written to analyze the proportion of market share for each company in time nth using the following the system of difference equation:

$$P_{n+1} = 0.7035\,P_n + 0.2576\,G_n$$
$$G_{n+1} = 0.2965\,P_n + 0.7424\,G_n \qquad (1)$$

System of equation (1) can be converted into a matrix

$$\begin{bmatrix} P_{n+1} \\ G_{n+1} \end{bmatrix} = \begin{bmatrix} 0.7035 & 0.2576 \\ 0.2965 & 0.7424 \end{bmatrix} \begin{bmatrix} P_n \\ G_n \end{bmatrix}$$

Let

$$P_n = a\lambda^n, G_n = b\lambda^n$$

Substituting back into the system of equation we get that

$$\begin{bmatrix} a\lambda^{n+1} \\ b\lambda^{n+1} \end{bmatrix} = \begin{bmatrix} 0.7035 & 0.2576 \\ 0.2965 & 0.7424 \end{bmatrix} \begin{bmatrix} a\lambda^n \\ b\lambda^n \end{bmatrix}$$

$$\begin{bmatrix} a \\ b \end{bmatrix} \lambda^{n+1} = \begin{bmatrix} 0.7035 & 0.2576 \\ 0.2965 & 0.7424 \end{bmatrix} \begin{bmatrix} a \\ b \end{bmatrix} \lambda^n$$

$$\begin{bmatrix} a \\ b \end{bmatrix} \lambda = \begin{bmatrix} 0.7035 & 0.2576 \\ 0.2965 & 0.7424 \end{bmatrix} \begin{bmatrix} a \\ b \end{bmatrix} \quad (2)$$

Let

$$v = \begin{bmatrix} a \\ b \end{bmatrix} \text{ and } M = \begin{bmatrix} 0.7035 & 0.2576 \\ 0.2965 & 0.7424 \end{bmatrix}$$

From the system of equation (2) we get that

$$M\overline{v} = \lambda\overline{v}$$

$$(M - I\lambda)\overline{v} = \overline{0}$$

$$\det(M - \lambda I) = 0$$

Applying knowledge of linear algebra will be

The eigenvalue $\lambda_1 = 1$ corresponds to the eigenvector $v_1 = \begin{bmatrix} 0.8688 \\ 1 \end{bmatrix}$.

The eigenvalue $\lambda_2 = 0.4459$ corresponds to the eigenvector $v_2 = \begin{bmatrix} -1 \\ 1 \end{bmatrix}$.

The general solution of the system of difference equation is

$$P_n = 0.8688c_1 - c_2(0.4459)^n$$
$$G_n = c_1 + c_2(0.4459)^n \quad (3)$$

Solution with python program

Considering the model's solution in the system of equation (3), the study is divided into 3 cases as follows:

Case 1 set the initial conditions $(P_0, G_0) = (1, 0)$.

When $(P_0, G_0) = (1, 0)$ is substituted into the model according to the system of equations (3) to determine the values c_1 and c_2, this initial conditional market share model is

$$P_n = 0.4649 + (0.5351)(0.4459)^n$$
$$G_n = 0.5351 - (0.5351)(0.4459)^n \quad (4)$$

Case 2 set the initial conditions $(P_0, G_0) = (0.5, 0.5)$

When $(P_0, G_0) = (0.5, 0.5)$ is substituted into the model according to the system of equations (3) to determine the values c_1 and c_2, this initial conditional market share model is

$$P_n = 0.4649 + (0.0351)(0.4459)^n$$
$$G_n = 0.5351 - (0.0351)(0.4459)^n \quad (5)$$

Case 3 set the initial conditions $(P_0, G_0) = (0,1)$

When $(P_0, G_0) = (0,1)$ is substituted into the model according to the system of equations (3) to determine the values c_1 and c_2, this initial conditional market share model is

$$P_n = 0.4649 - (0.4649)(0.4459)^n$$
$$G_n = 0.5351 + (0.4649)(0.4459)^n \quad (6)$$

Consider numerical solutions to summarize the long-term behavior of the model as in the system of equations (4), (5), and (6) by writing a Python program to help calculate it. Figure 2 shows an example of Python code used to calculate the numerical solution of a system of equations (4).

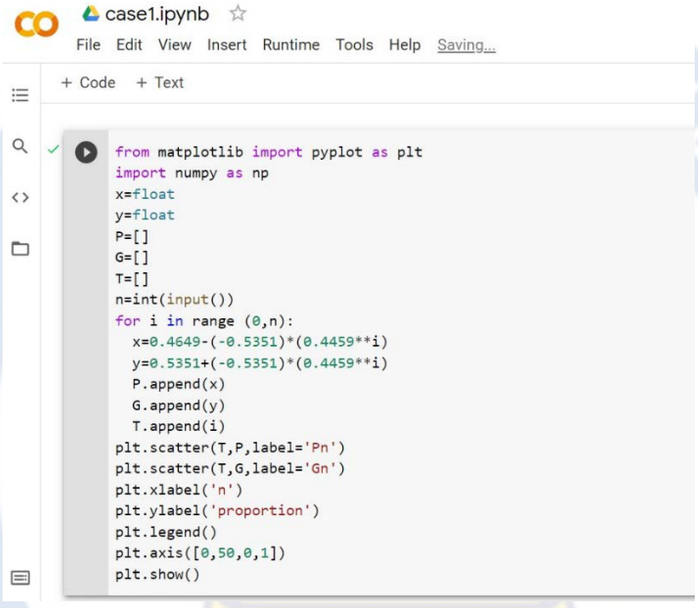


Figure 2. The Python code to calculate the numerical solution of a system of equations (4).

Long-term behavior of solutions

From the operation of mathematical modeling on a system of difference equations, the solution in each case of the initial value can be determined by substituting the value n, where $0 \le n < \infty$. The solution can be summarized as follows.

In case of initial value $(P_0, G_0) = (1,0)$

It means that the proportion of the initial market share n=0, customers choose all Food Panda services. The model analysis results show that the long-term market share behavior will converge to the value of (0.4649,0.5351) as shown in Fig. 3a. The results in the graph show that over time, the share of market share between food delivery choices between Food Panda and Grab Food was 0.4649 : 0.5351. Although initially the ratio was 1 to 0, which means that initially 100% of customers opted for Food Panda, over time, 46.49% of customers opted for Food Panda and 53.5% opted for the service. of Grab Food.

In case of initial value $(P_0, G_0) = (0.5, 0.5)$

It means that the proportion of the initial market share n=0, customers choose to use the services of Food Panda and Grab Food, each half or equal. The model analysis results show that the long-term market share behavior will converge to the value of (0.4649,0.5351) as shown in Fig. 3b. The results in the graph show that over time, the share of market share between food delivery choices between Food Panda and Grab Food was 0.4649 : 0.5351. Although initially the ratio was 0.5 to 0.5, which means that 50% of customers choose Food Panda and Grab Food for the same amount, over time, 46.49% of customers opted for Food Panda and 53.5% opted for the service of Grab Food.

In case of initial value $(P_0, G_0) = (1,0)$

It means that the proportion of the initial market share n=0, customers choose all Grab Food services. The model analysis results show that the long-term market share behavior will converge to the value of (0.4649,0.5351) as shown in Fig. 3c. The results in the graph show that over time, the share of market share between food delivery choices between Food Panda and Grab Food was 0.4649 : 0.5351. Although initially the ratio was 0 to 1, which means that initially 100% of customers opted for Grab Food, over time, 46.49% of customers opted for Food Panda and 53.5% opted for the service of Grab Food.

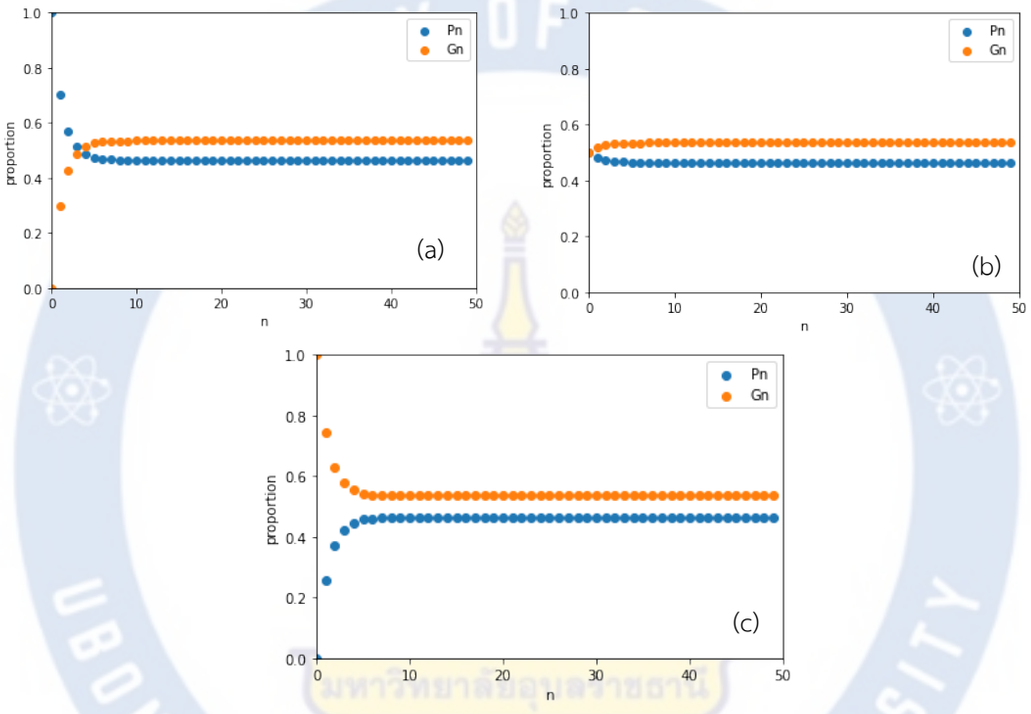


Figure 3. The proportion of market share between Food Panda and Grab Food, where (a) the initial value $(P_0, G_0) = (1,0)$, (b) the initial values $(P_0, G_0) = (0.5,0.5)$, and (c) the initial value $(P_0, G_0) = (0,1)$.

Summary

Results from considering a system of difference equation related to food delivery service selection. To illustrate the long-term behavior of food delivery service choices in the future as a result of model interpretation, three initial conditions were studied and considered, with values (1,0), (0.5,0.5), and (0,1), all of which could explain what case (1,0) means customers initially choose to use all Food Panda services, case (0.5,0.5) means that customers initially choose Food Panda and Grab Food with equal proportions, and case (0,1) means that customers initially choose all Grab Food. As a result, it appears that in all three cases, when considering the long-term behavior of choosing a food delivery service from the model, the solution converged to the point (0.4649,0.5351) same in all cases.

It can be interpreted that if one customer is wanting to choose a food delivery service. The likelihood of a customer choosing Food Panda with a probability of 0.4649 and the likelihood of a customer choosing Grab Food with a probability of 0.5351 or can be interpreted as a proportion of the two companies' market share. This can be used to predict the customer that the n^{th} market share has 100 customers who want to choose food delivery service. From this model, it is predicted that the number of customers (100)(0.4649) = 46 people choose Food Panda and the number of customers (100)(0.5351) = 54 People choose Grab Food, where this mathematical intelligence has the effect of preparing and improving the services of the two

companies in order to effectively serve their customers and to come up with various strategies to increase their company's market share.

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