International Journal of Organizational Innovation

CONSTRUCTION OF THE OPTIMAL SALES MODEL FOR THE DIGITAL NAVIGATION SYSTEMS OF ONLINE TOURISM DATABASES

Lin, Tzu-Yao
PhD Student, Department of Business Administration, Nanhua University
Email: alex61206@gmail.com

Chang, Wei-Hsiung (Corresponding author)
Associate Professor, Department of Tourism Management, Nanhua University
Email: hector629@gmail.com

Chen, Miao-Sheng
Chair Professor, Department of Business Administration, Nanhua University
Email: mschen@mail.nhu.edu.tw

Abstract

This article aims to construct the optimal sales model for the digital navigation systems of online tourism databases. It is a broad concept that can quickly take on a precise form once their market position has been defined. We will investigate how the providers of information could earn a reasonable profit from tourism demanders and businesses within this systematic framework. We describe the supply-and-demand problem for online tourism databases from the perspective of the mechanism designer. Furthermore, we analyze the sensitivity of the optimal total reading time per unit of time of tourism demanders for each model parameter. These findings are important decision-making references for the mechanism designers of online tourism databases.

Key words: Optimal Sales Model, Online Tourism Database, E-Commerce, Tourism Marketing, Travel Industry

Background and Motivation

Recently, Taiwanese tour operators have collaborated with information providers to launch an application called "Journey On" with the digital navigation systems of online tourism databases, which provides interactive tourism information in real time. However, as each person has a different way of expressing spatial information, they tend to use different types of information or expressions to help a person reach their destination (e.g., landmarks, distance, direction, turns, indications, and walking distance) (Denis, Pazzaglia, Cornoldi, & Bertolo, 1999; Golding, Graesser, & Hauselt, 1996; Mark & Gould, 1995; Vanetti & Allen, 1988; Wright, Lickorish, Hull, & Ummelen, 1995; Chang, 2016). As a result, the general public now expects information to be transferred via human-machine interfaces that facilitate two-way communication and return a variety of information, rather than only textual media (Li & Chang, 2016).

The "Destination tours" model allows independent tourists (who are a rapidly growing part of the market) obtain a comprehensive set of services and experiences in their journeys, including food, lodging, travel, and entertainment (LionTech, 2017). The primary functions of the "Journey On" app are as follows: 1) "Tour selection," which provides smart, cross-domain tourism services by integrating all Taiwanese tourism resources; 2) "Hot tickets," which provides opportunities for group purchases of food, surprise prizes, tours, admission tickets, and hot spring baths (more than 10,000 "hot tickets" have been sold); 3) Personalized operating interface: The app uses a dynamic masonry layout for the selection of online products; 4) Real-time communications: Orders by consumers, tour operators, and stores are processed synchronously in real time, to minimize time- consuming back-and-forth communication; and 5) Electronic voucher verification: Users of this app can scan their electronic vouchers at store counters, which is fast and convenient, and eliminates any potential issues with changing it to cash or communication (LionTech, 2017).

Online tourism databases are publications that have a close relationship with time. Huang (2013) notes that all publications (regardless of whether they are weekly, monthly, or electronic) have an intimate relationship with time, and that all publications have a periodic nature. To understand this facet of online tourism databases, one must adopt the perspective of the guided person (i.e., the consumer). For example, certain tourism information or time-limited shopping ads should be published on the days when most consumers will receive their salaries (i.e., the days when the consumers have the most money). Online tourism databases with a fixed publication period can be obtained easily by tourism demanders, and they also allow businesses to plan and establish an integrated publication production line, which includes article writing, editing, proofreading, and delivery. This is the relationship between time and the publication of online tourism databases. Digital navigation systems based on online tourism databases are a very broad concept, but they will quickly take on a precise form once their market position has been defined.

Since digital navigation systems based on online tourism databases do not have a physical form, shop front, or sales representatives, most people will expect these systems to be sold cheaply, and they will be disappointed if this expectation is not met. Therefore, the sale of digital navigation information publications will require extremely patient sales personnel. Until digital navigation information publications become popular, their publishers should allow consumers to feel at ease and gain certain advantages, and also empathize with their consumers as much as possible, in order to establish the reputation of their brand and grow in popularity. As mentioned above, official tourism websites and business portals, if properly customizable and conducive to brand popularization, will be able to satisfy the complex needs of tourists.

Therefore, some information providers have constructed comprehensive keyword databases for the tourism industry by filtering and organizing the relevant spatial information, so that independent tourists may easily search for this information and satisfy their complex needs via the Internet. This has led to the emergence of businesses that seek to earn a reasonable amount of profit from tourism by satisfying the tourists' needs for customized spatial information.

Chen and Kao (1987) constructed relationships between organizational departments, hierarchy structures, and the corresponding information, and made use of real activities in organizations to demonstrate the process and methodology of their approach, through the use of fuzzy quantities. In this work, we will employ this approach to replace the two-sided supply-and-demand model with a three-sided production and sales model, in the context of the tourism industry. We will discuss how the three-sided production and marketing model will replace the two-sided demand and supply model in the tourism sector. First, we utilize a keyword database for the tourism industry, which is filled by various tourism businesses with their keywords. A classification mechanism will then be designed to organize the keywords into an information architecture. A questionnaire will then be designed for tourism demanders (tourists). Based on the demanders' responses, the information architecture will be filtered and reorganized to provide the starting/ending points, number of days, number of people, required arrangements, costs, season, transportation, landmarks, and cultural background of the tour. We will then investigate how the providers of this information could earn a reasonable amount of profit from tourism demanders and businesses within this framework. In other words, we will study tourism system informatization in the context of tourists who are solely reliant on smartphones and GPS systems like Google Maps, and are remotely guided by centralized spatial information systems that can access their location at any time.

Research Design and Methods

Research Framework and Procedures

This study focuses on applying the digital navigation systems of online tourism databases into developing the optimal sales model. The optimal sales model will be designed by expanding the conventional two-sided supply-and-demand model in microeconomics into a three-sided model that consists of tourism businesses, tourism demanders, and mechanism designers. By optimizing this model, we will then be able to determine the optimal price that should be paid by tourism demanders for each unit of reading time, and the optimal compensation to be paid to the authors for each unit of content that they provide to the online tourism database.

Analytical Method

The theory of supply and demand in microeconomics cannot be directly used for informatized tourism products, as this theory supposes that the seller's stock of products decreases with each product that is sold, which is not the case for information products. Therefore, if microeconomics theory is to be used to analyze the supply and demand problem in the context of online tourism databases, one must then redefine the price and quantity of these products. It is also necessary to expand the conventional two-sided supply-and-demand model into a three-sided model: the first party is the original supplier of products (tourism businesses), the second party is the ultimate user of the products (tourism demanders), and the third party is the designer who is responsible for publishing the online tourism database and designing the sales mechanism for the database (henceforth referred to as "mechanism designer"). In this work, we will describe the supply-and-demand problem for online tourism databases from the perspective of the mechanism designer.

The sales market for automatically published online tourism databases (APOTD) may be treated as the amalgamation of two buyer-seller markets. In the first buyer-seller market, the tourism business is the seller (who creates and provides the basic content according to specifications provided by the mechanism designer) while the mechanism designer is the buyer. In the second buyer-seller market, the mechanism designer is the seller while the tourism demander is the buyer. The price of the online tourism database will be calculated according to the time taken by tourism demanders to read the database on the internet (the time taken to read the table of contents and summary of the online tourism database will not be charged).

Results

From a marketing perspective, supply and demand in the tourism industry are related to each other by the demand function, p = f(x) or its reciprocal, x = $\bar{f}(p)$, where p and x are the price and quantity of the tourism product, respectively. In most cases, the demand curve slopes downwards from left to right. Therefore, any change in price is accompanied by an opposing change in quantity. However, the supply curve slopes upwards from left to right (the blue line in Fig. 1). Therefore, supply increases with increasing price. A typical set of demand and supply curves are shown in Figure 1.

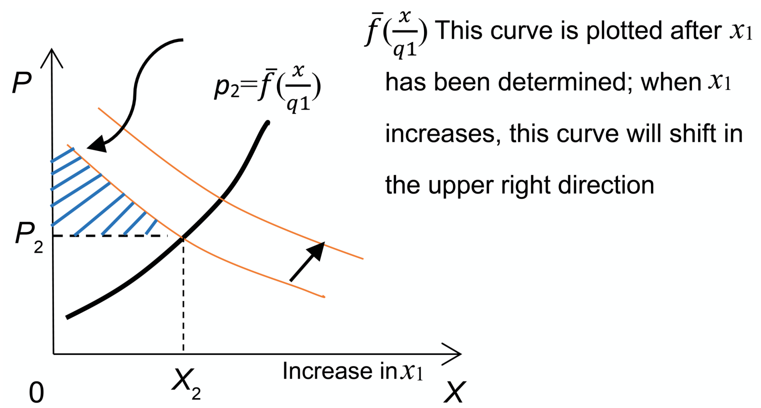

Figure 1 Typical market demand and supply curves
Source: Given and integrated by researchers of this study.

However, the supply and demand theories of microeconomics cannot be directly applied to tourism databases, since the seller’s stock does not decrease with the number of sales. Therefore, the price and quantity of these products must be redefined, so as to allow microeconomics theory to be applied to digital tourism databases. Furthermore, the two-sided buyer and supply model must be expanded into a three-sided production and sales model (where the three parties are the tourism businesses, tourism demanders, and mechanism designers). As mentioned previously, we will describe the sales market for APOTD from the perspective of the mechanism designer.

The sales market for APOTD may be treated as the amalgamation of two buyer-seller markets. In the first buyer-seller market, the tourism business is the seller (who creates and provides the basic content according to specifications provided by the third party), while the mechanism designer is the buyer. In the second buyer-seller market, the mechanism designer is the seller while the tourism demander is the buyer. The price of the online tourism database should be calculated according to the time taken by tourism demanders to read the database on the internet (the time taken to read the table of contents and summary of the online tourism database will not be charged).

Mathematical Model

Symbol Definitions.

To ensure that the contents of the online tourism database will be maintained at a certain level of quality, and receive the endorsement of tourism demanders, the time spent by the tourism demanders in each part of the online tourism database must be inspected after the database has been published for a certain period of time. The parts that receive little reading time should either be improved or omitted from the database.

The price of the online tourism database for tourism demanders (i.e., the price in the second buyer-seller market) is defined as p_2. x_1 is the number of pages read by the tourism demanders, and x_2 is the time spent by the tourism demanders reading the online tourism database. The ratio between x_1 and x_2 (the reading rate of the online tourism database) will stabilize after the first edition of the online tourism database has been published for some time.

The relationship between p_2 and $\frac{x2}{x1}$ is $f(p_2) = \frac{x2}{x1}$, and it is called the demand function of the second market (tourism demanders). The ratio between the total reading time of the tourism demanders and the number of pages that were in the online tourism database is $\frac{x2}{x1}$, within some unit of time. In other words, it is the market reading rate of the online tourism database. The reading rate of an online tourism database is the sum of reading rates of all of its contents.

f: The demand function of the second

market, $f(p_2) = \frac{x2}{x1}$. The value of $f(p_2)$ decreases with increases in p_2.

$\bar{f}$: The reciprocal function of f, i.e., $p_2 = \bar{f}(\frac{x2}{x1})$

p_1: $p_1 = \theta p_2 f(p_2)$, $0 \leq \theta \leq 1$. This gives the increase in income (i.e., reading time by tourism demanders per unit of time, or $f(p_2)$) created by each unit of content ($x_1 = 1$). This income, $p_2 f(p_2)$, is paid by the tourism demanders to the mechanism designers, and a part of this income ($p_1 = \theta p_2 f(p_2)$, $0 \leq \theta \leq 1$) is given to the content authors.

T: The (average) lifespan of an online tourism database on the market.

c: The cost (borne by the authors) to create each unit of content for the online tourism database, before the database is constructed. If this cost is averaged across the life of the online tourism database, T, the content creation cost per unit of time is then $\frac{c}{T}$. If a discount calculation is performed with T/2, the cost per unit of time for each unit of content then becomes $\frac{c}{T}e^{rT/2}$, where $r \geq 0$ is the discount rate.

k: The consumables cost absorbed by the mechanism designer for each unit of reading time by the tourism demanders. This cost will initially be absorbed by the mechanism designer.

g: The function that relates the first-market price (the authors' compensation) p_1 (definition shown above) to x_1, such that $x_1 = g(p_1)$. x_1 increases with p_1.

$\bar{g}$: The reciprocal function of g, i.e., $p_1 = \bar{g}(x_1)$.

Construction of the Model

β_1, β_2 and β_3 are the weights that represent the benefit per unit of time of the authors, tourism demanders, and mechanism designer, respectively. To maximize the benefit per unit of time of all three parties, the mechanism designer must find the (p_1, p_2) pair of values (or (x_1, x_2) pair of values) that maximizes the benefit function, π. This may be mathematically expressed as:

$$\text{Max } \pi(x_1,x_2)= \omega_2\left[\int_0^{x_2} \bar{f}\left(\frac{x}{x_1}\right) dx - \bar{f}\left(\frac{x_2}{x_1}\right)x_2\right]+ \omega_1\left[\bar{g}(x_1) - \frac{ce^{\frac{T}{r2}}}{T}\right] x_1+\omega_3\left[\bar{f}\left(\frac{x_2}{x_1}\right) - \bar{g}(x_1)\frac{x_1}{x_2} - k\right] x_2 \quad (4.1)$$

where

$$p_2 = \bar{f}\left(\frac{x_2}{x_1}\right) \quad (4.2)$$

$$p_1 = \bar{g}(x_1) = \theta p_2 \cdot \frac{x_2}{x_1}$$

(4.3)

The relationship between p_1 and p_2 and x_1 and x_2 is described by Equations (4.2) and (4.3).

The first, second, and third terms of the objective function $\pi(x_1, x_2)$ are: $\beta_2 \times$ (benefit for the tourism demanders (consumer surplus), $\beta_1 \times$ (benefit of the tourism businesses), and $\beta_3 \times$ (benefit of the mechanism designer).

In the above, $\bar{f}\ \frac{x2}{x1} x_2$ is the area of the rectangle in Fig. 1 $[\int_2^q \bar{f}(\frac{x}{x1})\, dx - \bar{f}(\frac{x2}{x1})\ x_2]$ is the area shaded by diagonal lines, which represents the consumer (tourism demander) surplus; it is essentially the difference between the price that the tourism demanders are willing to pay $(\int_2^x \bar{f}(\frac{x}{x1})\, dx)$ and the actual price they paid $(\bar{f}(\frac{x2}{x1})\ x_2)$.

If we let $\beta_1 = \beta_2 = 0$ and $\beta_3 = 1$, the model above then becomes a decision model that only considers the benefits of the mechanism designer.

The Optimal Solution

In the following, $\bar{f}$ and $\bar{g}$ represent the reciprocal functions of f and g (see Sections 4.2 and 4.3 for their definitions), i.e., $p_1 = \bar{g}(x_1)$ and $p_2 = \bar{f}(\frac{x2}{x1})$. By letting $\theta = \frac{p1p2}{f(p2)} = \frac{\bar{g}(x1)}{\bar{f}(\frac{x2}{x1}) \cdot \frac{x2}{x1}}$, the objective function (π) may then be rewritten as follows:

$$\pi = \beta_2[\int_0^{x_2} \bar{f}(\frac{x}{q_1})\, dx - \bar{f}(\frac{x_2}{x_1})x_2] + \beta_1[\bar{g}(x_1) - \frac{ce^{\frac{T}{r^2}}}{T}]\, x_1 + \beta_3[\bar{f}\left(\frac{x_2}{x_1}\right) - \bar{g}(x_1)\frac{x_1}{qx_2} - k]x_2$$

$$= \beta_2 \int_0^{x_2} \bar{f}(\frac{x}{x_1})\, dx + (\beta_3 - \beta_2)\, \bar{f}\left(\frac{x_2}{x_1}\right) x_2 + (\beta_1 - \beta_3)\, \bar{g}(x_1)x_1 - \beta_1 \frac{ce^{\frac{T}{r^2}}}{T}\, x_1 - \beta_3 k x_2 \quad (4.4)$$

Assuming that an optimal solution does exist, let (x_1^*, x_2^*) be the optimal solution of this model. The first- and second-order conditions that must be satisfied by (x_1^*, x_2^*) are then as follows. The first-order condition:

$$0 = \frac{\partial}{\partial_{q_1}} \pi(x_1, x_2)\, |_{(x_1^*, x_2^*)}$$

$$= \beta_2 \int_0^{x_2} \bar{f}'(\frac{x}{x_1}) \cdot \frac{-x}{x_1^2}\, dx \quad |_{(x_1^*, x_2^*)}$$

$$-\ (\beta_3 - \beta_2)\,\bar{f}'\left(\frac{x_2}{x_1}\right)\frac{x_2^2}{x_1^2}\ |_{(x_1^*,x_2^*)} +$$

$$(\beta_1 - \beta_3)[$$

$$\bar{g}'(x_1)x_1 + \bar{g}(x_1)]\ |_{(x_1^*,x_2^*)} - \beta_1 \frac{ce^{\frac{T}{r^2}}}{T}$$

(4.5)

$$0 = \frac{\partial}{\partial_{q_2}} \pi(x_1, x_2)\ |_{(x_1^*,x_2^*)}$$

$$= \beta_2 \bar{f}(\tfrac{x_2}{x_1})\ |_{(x_1^*,x_2^*)} + (\beta_3 - \beta_2)[$$

$$\bar{f}'\left(\frac{x_2}{x_1}\right)\frac{1}{x_1}x_2 + \bar{f}(\tfrac{x_2}{x_1})]\ |_{(x_1^*,x_2^*)} - \beta_3 \mathrm{k}$$

$$= \beta_3 \bar{f}(\tfrac{x_2}{x_1})\ |_{(x_1^*,x_2^*)} + (\beta_3 - \beta_2)$$

$$\bar{f}'\left(\frac{x_2}{x_1}\right)\frac{x_2}{x_1}\ |_{(x_1^*,x_2^*)} - \beta_3 \mathrm{k} \qquad (4.6)$$

Second-order condition:

$$\frac{\partial^2 \pi(x_1^*, x_2^*)}{\partial x_i^2} \leq 0 \quad , i=1,2 \qquad (4.7)$$

$$\begin{vmatrix} \frac{\partial^2 \pi(x_1^*, x_2^*)}{\partial x_1^2} & \frac{\partial^2 \pi(x_1^*, x_2^*)}{\partial x_1 \partial x_2} \\ \frac{\partial^2 \pi(x_1^*, x_2^*)}{\partial x_2 \partial 1} & \frac{\partial^2 \pi(x_1^*, x_2^*)}{\partial x_2^2} \end{vmatrix} \geq 0 \qquad (4.8)$$

If the mechanism designer decides that the benefits of the tourism demanders and tourism businesses are equally important, these benefits may then be summed to form a quantity called "societal surplus". The goal is then to maximize the weight for societal surplus, β, and the mechanism designer's benefit, $(1 - \beta)$. This is equivalent to letting $\beta_1 = \beta_2 = \beta$ and $\beta_3 = 1 - \beta$.

In this case, $\bar{f}$ and $\bar{g}$ may be assumed to be linear functions. The optimal solutions of the $\bar{f}$ and $\bar{g}$ are then as follows:

Suppose that the definitions of $\bar{f}$ and $\bar{g}$ are:

$$p_1 = \bar{g}(x_1) = r_1 \cdot x_1,\ \ r_1 > 0;$$

$$p_2 = \bar{f}\left(\frac{x_2}{q_1}\right) = r_2 \frac{x_2}{x_1} + l_2 \qquad (4.9)$$

where $\frac{x_2}{q_1} \leq \frac{l_2}{-r_2}$, $l_2 > 0$ and $0 < r_2$, because $p_2 = 0$ must correspond to a positive demand.

Substituting Equation (4.9) with Equation (4.5) yields:

If (x_1^*, x_2^*) exists, i.e., $x_1^* > 0$ and $\frac{l_2}{-r_2} x_1^* > x_2^* > 0$ (see Equation (4.9), then

$$0 = \frac{\partial}{\partial q_1} \pi(x_1, x_2)\ |_{(x_1^*, x_2^*)}$$

$$= \beta \int_0^{x_2^*} r_2 \frac{-x}{x_1^{*2}} dx - (1 - 2\beta) r_2 \frac{x_2^{*2}}{x_1^{*2}} +$$

$$(2\omega - 1)[r_1 x_1^* + r_1 x_1^*] - \beta \frac{ce^{\frac{T}{r^2}}}{T}$$

$$= \frac{-\omega r_2 x_2^{*2}}{2 \cdot x_1^{*2}} - (1 - 2\beta) r_2 \frac{x_2^{*2}}{x_1^{*2}} + (2\beta -$$

$$1)2 r_1 x_1^* - \beta \frac{ce^{\frac{T}{r^2}}}{T} = \left(\frac{3\beta}{2} - 1\right) r_2 \frac{x_2^{*2}}{x_1^{*2}} +$$

$$(2\beta - 1)2 r_1 x_1^* - \beta \frac{ce^{\frac{T}{r^2}}}{T}$$

(4.10)

Substituting Equation (4.9) with Equation (4.6) yields

$$0 = \frac{\partial}{\partial q_1}\pi(x_1,x_2) \mid_{(x_1^*, x_2^*)}$$

$$= (1-\beta)\left(r_2 \frac{x_2^*}{x_1^*} + l_2\right) + (1 - 2\beta) r_2 \frac{x_2^*}{x_1^*} - (1-\beta)k$$

$$= (2-3\beta) \times r_2 \frac{x_2^*}{x_1^*} + (1-\beta)(l_2 - k)$$

(4.11)

Equation (4.7) then gives

$$0 \geq \frac{\partial^2 \pi(x_1, x_2)}{\partial x_1^2} \mid_{(x_1^*, x_2^*)}$$

$$= (2-3\beta) r_2 \frac{1}{x_1^*} \quad (4.12)$$

Therefore, $\beta \leq \frac{2}{3}$ (since Equation (4.9) states that r_2 is a negative number).

When $\beta \leq \frac{2}{3}$

$$x_2^* = \frac{1}{(3-2\beta)r_2}(1-\beta)(l_2-k)x_1^* \quad (4.13)$$

Based on Equation (4.9), the parameters must satisfy the following inequality:

$$\frac{l_2}{-r_2} > \frac{1}{(3-2\beta)r_2}(1-\beta)(l_2-k) \quad (4.14)$$

By substituting Equations (4.10), (4.11), and (4.12) to the second-order condition (Equation (4.8)), one obtains:

$$0 \leq \begin{vmatrix} \frac{\partial^2 \pi(x_1^*, x_2^*)}{\partial x_1^2} & \frac{\partial^2 \pi(x_1^*, x_2^*)}{\partial x_1 \partial x_2} \\ \frac{\partial^2 \pi(x_1^*, x_2^*)}{\partial x_1 \partial x_2} & \frac{\partial^2 \pi(x_1^*, x_2^*)}{\partial x_2^2} \end{vmatrix}$$

$$= \begin{vmatrix} (2-3\beta) r_2 \frac{x_2^{*2}}{x_1^{*3}} + (2\beta-1)2r_1 + & (2-3\beta) r_2 \cdot \frac{-x_2^*}{x_1^{*2}} \\ (2-3\beta) r_2 \cdot \frac{-x_2^*}{x_1^{*2}} & (2-3\beta) r_2 \cdot \frac{1}{x_1^*} \end{vmatrix}$$

$$= \frac{(2-3\beta)^2 r_2^2}{x_1^{*2}} \begin{vmatrix} \frac{x_2^{*2}}{x_1^{*2}} + \frac{(2\beta-1)2r_1 x_1^*}{(2-3\beta)r_2} & \frac{-x_2^*}{x_1^*} \\ \frac{-x_2^*}{x_1^*} & 1 \end{vmatrix}$$

$$= \frac{(2-3\beta)^2 r_2^2}{x_1^{*2}} \cdot \frac{(2\omega-1)2r_1 x_1^*}{(2-3\beta)r_2} \quad (4.15)$$

Based on Equations (4.9) and (4.13)

$$\gamma_1 > 0\ , \gamma_2 < 0\ , \beta \leq 23 \quad (4.16)$$

According to Equation (4.15), the condition for the optimal solution (x_1^*, x_2^*) to exist is $\beta \leq 12$, which implies that the weight for the mechanism designer's benefit $(1-\beta)$ is greater than that of the tourism demanders and tourism businesses (societal surplus), β. Substituting Equation (4.13) with Equation (4.10) yields:

$$0 = \left(\frac{3\beta}{2} - 1\right) r_2 \frac{1}{(3\beta-2)^2 r_2^2} (1 - \beta)^2 (l_2 - k)^2 + (2\beta - 1)(2r_1 x_1^*)$$

$$= \frac{1}{2(3\beta-2)r_2}(1-\beta)^2(l_2-k)^2 + (2\beta-1)(2r_1x_1^*) \quad (4.17)$$

x_1^* may then be obtained using Equation (4.17) (as shown in Equation (4.18)), and x_2^* may be obtained by substituting x_1^* into Equation (4.12) (as shown in Equation (4.19)).

Conclusion and Recommendations

The following conclusions were derived from the discussion above: By assuming that the demand function (f) and supply function (g) are linear functions (see Equation (4.9)), and that the importance of the mechanism designer's benefit is greater than that of the tourism demanders and tourism businesses (see Equation (4.16)), an optimal solution for x_1^* and x_2^* then exists, as shown in Equations (4.18) and (4.19).

$$x_1^* = \frac{(1-\beta)^2(l_2-k)^2}{(2\beta-1)2r_1 2(3\beta-2)r_2} \quad 4.18)$$

$$x_2^* = \frac{1}{(3\beta-2)r_2}(1-\beta)(l_2-k)x_1^* \quad (4.19)$$

Based on Equations (4.18) and (4.19), one may then obtain the optimal solution for (p_1^*, p_2^*), since $p_1^* = r_1x_1^*$ and $p_2^* = r_2\frac{x_2^*}{x_1^*} + l_2$ (see Equation (4.9)), as well as the optimal θ value: $\theta^* = r_1x_1^*/((r_2\frac{x_2^*}{x_1^*} + l_2)(\frac{x_2^*}{x_1^*}))$. This result may be used to examine how the optimal solution changes with each model parameter; a sensitivity analysis is shown below.

According to Equation (4.18): (1) The optimal quantity of digital navigation information provided by the tourism businesses, x_1^*, decreases with increases in the slope of the supply function, r_1 ($r_1 > 0$). (2) x_1^* decreases with decreases in the slope of the demand function, r_2 ($r_2 < 0$). (3) x_1^* increases with increases in the upper limit of the mechanism designer's per unit benefit, ($l_2 - k$) (note: l_2 is the upper limit of p_2, the price per unit of reading time for tourism demanders).

Equation (4.19) may be used to analyze the sensitivity of the optimal total reading time per unit of time of the tourism demanders, x_2^*, to each model parameter. These findings are important decision-making references for the mechanism designers of online tourism databases.

In the future, it would be worthwhile to investigate the properties of (x_1^*, x_2^*), (p_1^*, p_2^*), and θ^* when presented with non-linear demand and supply functions, e.g., quadratic f and g functions.

In summary, the construction of the

optimal sales model for the digital navigation systems of online tourism databases is an ongoing project and will be a trend in future research.

References

Chang, H. H. (2016). The study of tourist's preferences towards wayfinding directional descriptors. *Journal of Tourism and Leisure Studies,* 22(2), 123-149.

Chen, M. S., & Kao, W. K. (1987). On organization design from an informational approach. *Journal of Policy and Information, 11*(2), 67-77.

Denis, M., Pazzaglia, F., Cornoldi, C., & Bertolo, L. (1999). Spatial discourse and navigation: An analysis of route directions in the city of Venice. *Applied Cognitive Psychology,* 13(2),145-174. doi:10.1002/(SICI)1099-0720(199904)13:2<145::AID-ACP550>3.0.CO;2-4

Golding, J. M., Graesser, A. C., & Hauselt, J. (1996). The process of answering direction-giving questions when someone is lost on a university campus: The role of pragmatics. *Applied Cognitive Psychology*, 10(1), 23-39. doi:10.1002/(SICI)1099-0720(199602)10:1<23::AID-ACP357>3.3.CO;2-8

Huang, W. L. (2013). Construction of the network editor and optimal sales model. Ph.D. thesis of Nanhua University, unpublished, Chiayi County.

Li, E. Y., Chang, F. K. (2016). Design factors of museum mobile navigation systems for smartphone app. *Journal of Tourism and Leisure Studies*, 22(1), 61-94.

LionTech (2017). https://itunes.apple.com/tw/app/journey-on-%E6%97%85%E9%80%94%E4%B8%AD/id1049251394?l=zh&mt=8

Mark, D. M., & Gould, M. D. (1995). Wayfinding directions as discourse: A comparison of verbal directions in English and Spanish. *Journal of Cross-Cultural and Interlanguage Communication*, 11(3), 267-292. doi: 10.1515/mult.1992.11.3.267

Vanetti, E. J., & Allen, G. L. (1988). Communicating environmental knowledge: The impact of verbal and spatial abilities on the production and comprehension of route directions. *Environment and Behavior*, 20(6), 667-682. doi: 10.1177/0013916588206001

Wright, P., Lickorish, A., Hull, A., & Ummelen, N. (1995). Graphics in written directions: Appreciated by readers but not by writers. *Applied Cognitive Psychology*, 9(1), 41-59. doi: 10.1002/acp.2350090104