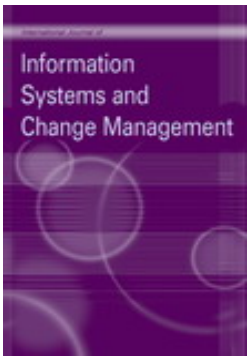


International Journal of Information Systems and Change Management

ISSN online: 1479-313X - ISSN print: 1479-3121
https://www.inderscience.com/ijiscm

The consideration factors of adopting location-based advertising push platform

Heng-Li Yang, Shiang-Lin Lin

DOI: 10.1504/IJISCM.2023.10056605

Article History:

Received:	17 April 2023
Last revised:	17 April 2023
Accepted:	23 April 2023
Published online:	13 September 2023

The consideration factors of adopting location-based advertising push platform

Heng-Li Yang*

Department of Management Information System,
National Cheng-Chi University,
64, Sec.2, Chih-Nan Rd., 116, Taipei, Taiwan
Email: yanh@nccu.edu.tw
*Corresponding author

Shiang-Lin Lin

Department of Information Management,
Fu Jen Catholic University,
No. 510, Zhongzheng Rd., Xinzhuang Dist.,
New Taipei City, Taiwan
Email: 146414@mail.fju.edu.tw

Abstract: The location-based advertising (LBA) service has gradually become a new advertising strategy for merchants. However, an emerging service will be widely adopted after the demands and expectations to the service are well comprehended to prevent the potential risk of adopting this service. In light of this, referring to the framework of technology-organisation-environment, the theory of diffusion on innovation, and the advertising effectiveness, this study categorised five consideration dimensions and 23 factors, and applied fuzzy analytic hierarchy process (FAHP) and collocated with decision-making trial and evaluation laboratory (DEMATEL) to analyse the considered factors when merchants assessing to migrate LBA push platforms. The results indicate that increasing profit, increasing customer flow rate, and improving flexibility for real-time promotion are the top three critical factors for merchants. Besides, the factors of obtaining exposure for product/service, increasing ad click-through rate, and prompting more customers to get membership do have high interrelationships with other factors.

Keywords: local-based advertising; advertising effectiveness; IT adoption; fuzzy analytic hierarchy process; FAHP; decision making trial and evaluation laboratory.

Reference to this paper should be made as follows: Yang, H-L. and Lin, S-L. (2023) 'The consideration factors of adopting location-based advertising push platform', *Int. J. Information Systems and Change Management*, Vol. 13, No. 3, pp.209–233.

Biographical notes: Heng-Li Yang is a Professor in the Department of Management Information Systems, National Cheng-Chi University in Taiwan. He was the Chairman of the Department. His research interests include virtual community, IT adoption, data and knowledge engineering, software engineering, knowledge management, technology impacts on organisations, etc. His papers appeared on *New Media & Society*, *Computers in Human Behaviour*, *Behaviour & Information Technology*, *Computers & Education*, *Information & Management*, etc.

Shiang-Lin Lin is an Assistant Professor in Department of Information Management, College of Management Fu Jen Catholic University in Taiwan. His research interests include consumer behaviour, blockchain, big data analysis and multi-criteria decision-making, etc. His papers appeared on *Computers in Human Behaviour*, *Service Business*, *International Journal of Mobile Communications*, etc.

This paper is a revised and expanded version of a paper entitled 'The Decision of building location-based advertising push platform' presented at International Conference on Intelligent Computing and its Emerging Applications (ICEA 2019), Tainan, Taiwan, 30 August–1 September 2019.

1 Introduction

Along with the growing of information technology, the types of adverting can be basically categorised into radio adverting, television advertising, traditional printed flyers, internet adverting, etc. (Buchwitz, 2018). Until recent years, after the birth of mobile technologies, various mobile advertising services have been derived (Choudhary, 2019). Following the current innovation and expansion of mobile technology and services, the nature of mobile advertising has transformed from short message service (SMS) advertising and multimedia messaging service (MMS) advertising to the latest trend of providing advertisements via various applications (APPs) on the mobile devices (Lin and Bautista, 2020). Since mobile devices can locate and track users' positions, a new advertising strategy named as location-based advertising (LBA) has been used to push advertisements to consumers based on their locations (Shin and Lin, 2016; Ketelaar et al., 2017; Shieh et al., 2019; Gutierrez et al., 2019; Molitor et al., 2020).

The early years of LBA is defined as any business activity that uses consumers' location information to convey marketing information on their mobile devices via advertising mediums (Bruner and Kumar, 2007). To date, LBA can be categorised to Bluetooth LBA, Wi-Fi LBA and GPS LBA according to the common build-in positioning components in a mobile device (Maghdid et al., 2019). Unlike the old-fashioned strategies that send advertisements randomly, any type of LBA that sends messages to targeted consumers based on their location provides higher exposure rate and consumers acceptance of the advertisements (Kunz et al., 2019). Recently, due to the popularity of mobile applications, more users have installed applications that support positioning functions for getting information related to their current locations (Bacile et al., 2014). By collecting the records obtained through LBA application services, merchants could effectively send relevant information through push advertising to consumers nearby based on their current location (Lin et al., 2016). For example, many consumers would do shopping through official applications of department stores. Based on their shopping records, the shops can send coupons which meet consumers' needs through their applications to potential shopper nearby to increase sales.

At present, many researches have proven that LBA service can effectively improve consumers' desires to click and even watch mobile advertisements in details (Mansoor et al., 2018; Souiden et al., 2019; Wang et al., 2019; Lin and Bautista, 2020). For merchants, obtaining the exposure of products or services is undoubtedly one of the major factors to create more profit and revenue. Therefore, the industry or the academia

fields are both paying high attentions to the LBA service (Hühn et al., 2017). The problem is, although the future for LBA seems promising, this emerging mobile application service is currently at the development stage. Actually, most of the current merchants have developed own official Apps and invited consumers to register membership in order to send advertisements related to sales promotion, product experience, and shopping points. However, most of the advertisements sent via the official Apps are not actual LBA, which means not many merchants have built a complete LBA push platform to send related information about their products and services. As a result, the population of mobile users who are willing to turn on mobile positioning functions, such as Bluetooth, Wi-Fi and GPS, to receive and watch LBA is small.

For many years, more and more researchers have applied various methods of scientific decision-making to explore issues related to mobile advertising. For instance, Lin and Yeh (2013) combined the fuzzy semantics with the analytic hierarchy process (AHP) method to explore the influencing factors of consumers' purchase willingness after reading SMS advertising. Besides, Chen et al. used the fuzzy Delphi method (FDM) to analyse the critical success factors for developing mobile advertising applications. The result indicated that user preferences, price, promotion, and product brand are significant importance factors for the success of mobile advertising (Chen et al., 2014). Moreover, Li et al. (2015) adopted AHP to analyse various mobile advertisements, such as pop-ups ads and banner ads embedding in free mobile Apps to find out the advertising effectiveness and privacy risks to consumers. In addition, Yang et al. applied fuzzy AHP method to examine the factors evaluated by consumers while considering to turn on the GPS functions for receiving location-based advertisements (Yang et al., 2019).

However, in terms of the current literatures, it is found that most of the studies are from the perspective of consumers to explore their attitudes towards mobile advertising. Nevertheless, not many studies were done to discuss and to analyse the key factors and effectiveness of LBA service based on a merchant's demands and perspectives. Generally, an emerging service will be widely adopted after the demands and expectations to the service are well investigated and comprehended to prevent the potential risk of adopting the new service. By using the systematic scientific decision-making method to explore the key consideration factors of a merchant assessing to migrate the LBA push platform, the industry could have a better understanding on this issue. In the light of it, this study applied the fuzzy analytic hierarchy process (FAHP) method and collocated with decision-making trial and evaluation laboratory (DEMATEL) method to explore the consideration factors a merchant would look over when assessing to migrate the LBA push platform. These two methods belong to multi-criteria decision making (MCDM) and are most suitable for decision-making analysis for dealing with multiple consideration dimensions and factors (Büyüközkan and Çifçi, 2012; Wang et al., 2015). These methods have been beneficial in the early research of SMS mobile advertising, but few studies have explored the consideration factors of the emerging LBA services.

2 Literature review

2.1 LBA service

LBA service is the novel application in mobile advertising, and a new form of advertising media which combines the internet with mobile technologies (Yang and Lin, 2019b). At an early stage of development, online and internet advertisements were delivered to consumers through e-mails as the push platform. These e-mails were generally referred to as spams due to their ineffectiveness to attract consumers (Denning, 1982). Later, new forms of internet advertising such as button ad, banner ad and pop-up were developed (Zeff and Aronson, 1999). However, either online advertisements or internet advertisements were running into a major flaw, which is their inability to accurately obtain the identities and preferences of consumers. Both of the two forms of advertisements basically reach consumers by pushing bulk advertising messages and have disturbed a large number of internet users (Cho and Cheon, 2004; Bell and Buchner, 2018).

With the invention of cellphone in early 2000, SMS advertising came along, which can be seen as the earliest mobile advertising application (Lee, 2018). However, SMS advertising also disturbed its receivers by sending advertisements containing irrelevant information for consumers and massive spams (Barwise and Strong, 2002). In their study, Tsang et al. pointed out that most mobile user have negative perspectives toward SMS advertising as they do not feel comfortable to receive unattractive advertisements from a business without getting their permission (Tsang et al., 2004). In other words, the personalisation and customisation, as well as the timing and locations of sending advertisements, are key factors that influence consumers' perspectives on mobile advertising and their willingness to receive SMS advertisements (Xu, 2006; Merisavo et al., 2007).

In recent years, with the gradual popularisation of mobile device and wireless technology, consumers' preferences and their locations could be tracked more accurately, resulting in the LBA service to be a popular issue. Hühn et al. (2017) found that a consumer would have high perceived value for a mobile advertisement if it is sent by a nearby business. In addition, when consumers reach the location congruency with businesses mentioned in an advertisement, they are more willing to visit the stores and shop there (Ketelaar et al., 2017). However, LBA service has raised concerns about personal information and privacy leaking. More personalised LBA requires merchants to collect a large number of personal information and locations in order to send more relevant advertisements to the targeted consumers nearby their stores. It worries many consumers as they have been aware of the issue of personal privacy (Xu et al., 2011; Lee, 2015; Yang and Lin, 2017).

2.2 Fuzzy analytic hierarchy process

The AHP method is one of the most widely used MCDM method (Saaty, 1980). It is designed to help decision-makers to make the best decision when facing the problem which including multiple evaluation elements and feasible solutions (Keeney and Raiffa, 1976; Belton and Stewart, 2002). The advantage of AHP is that it simplifies complex decision-making problems into an evaluation hierarchy framework (Shee et al., 2003). This framework includes problem-solving elements of evaluation such as dimension,

factor, and feasible alternative and, thus lets decision makers to clearly see the relationships among levels (Nikou and Mezei, 2013). Through pairwise comparisons among significant elements in each level and assuring the consistency of results, the importance weights of all elements can be obtained and eventually help find out the best solutions for decision-making problems (Mahdavi et al., 2008).

Although traditional AHP can find the importance ranking among evaluation elements. However, human beings generally have a tendency not to follow the objective ranking and importance when deciding. This fact could lead decision maker leaning towards biased results when comparing the importance between two evaluation elements (Yang and Lin, 2019a). In the light of this, van Laarhoven and Pedrcyz (1983) proposed a new approach that combines fuzzy semantics with AHP (called FAHP) to solve above problem. FAHP allows decision maker to more accurately reflect the actual human thinking when they are evaluating the importance levels of pairwise comparison in the evaluation hierarchy. This overcomes the human shortcomings of being uncertain and subjective when making decisions, thereby reducing the likelihood of getting inaccurate results and providing decision-makers the best solutions more efficiently (Buckley, 1985). Different from traditional AHP, FAHP converts the data into triangular fuzzy numbers with more meticulous and complicated processing of arithmetic calculation, the steps are as follows.

Step 1 *Establishing the evaluation hierarchy framework.* First, we need to verify the decision-making problem to be evaluated, select the dimensions and factors for the target decision-making problem, so as to establish the evaluation hierarchy framework.

Step 2 *Conducting pairwise comparison of elements.* After the evaluation hierarchy framework has been built, the nine-level pairwise comparison will be conducted between each two elements by interviewees (Saaty, 2008). Then, we need to convert scores into triangular fuzzy semantic membership functions (Mon et al., 1994; Chiou and Tzeng, 2001; Hsieh et al., 2004). Table 1 lists the scale of pairwise comparison and the converted triangular fuzzy number.

Table 1 Scale of pairwise comparison and the converted triangular fuzzy number

Scale	*Definition*	*Triangular fuzzy number* $(\tilde{M}_{ij}) = (L_{ij}, M_{ij}, R_{ij})$
1	Equal importance	$\tilde{1} = (1, 1, 3)$
3	Moderate importance	$\tilde{3} = (1, 3, 5)$
5	Strong importance	$\tilde{5} = (3, 5, 7)$
7	Demonstrated importance	$\tilde{7} = (5, 7, 9)$
9	Extreme importance	$\tilde{9} = (7, 9, 9)$
2, 4, 6, 8	Intermediate values	$\tilde{x} = (x-1, x, x+1), x = 2, 4, 6, 8$

Step 3 *Building the pairwise comparison matrix.* On the upper triangle part of the pairwise comparison matrix A, we put the pairwise comparison score obtained by each expert for a group of elements made up of $A1, A2, \ldots, An$. Then, we

calculate and place the reciprocal of the pairwise comparison score at the relative position in the lower triangle part, namely, $a_{ij} = 1/a_{ij}$ where a_{ij} represents the importance of element i relative to that of element j. The matrix A is shown in formula (1):

$$A = \begin{bmatrix} 1 & a_{12} & \cdot\cdot & \cdot\cdot & a_{1j} \\ 1/a_{12} & 1 & \cdot & \cdot & a_{2j} \\ \cdot & \cdot & 1 & \cdot & \cdot \\ \cdot & \cdot & \cdot & 1 & \cdot \\ 1/a_{1j} & 1/a_{2j} & \cdot & \cdot & 1 \end{bmatrix} \tag{1}$$

Step 4 *Converting to the fuzzy positive reciprocal matrix.* Through obtaining the matrix A, we convert the score in the matrix A into the triangular fuzzy numbers $\tilde{M}_{ij}$ by using Table 1. In this way, the fuzzy positive reciprocal matrix M will be built. The matrix M is shown in formula (2), where $\tilde{M}_{ij} = (L_{ij}, M_{ij}, R_{ij})$ is the relative triangular fuzzy number of factor i to factor j, and $\tilde{M}_{ji} = 1/\tilde{M}_{ij}$:

$$M = \left[\tilde{M}_{ij}\right] = \begin{bmatrix} 1 & \tilde{M}_{12} = (L_{12}, M_{12}, R_{12}) & \tilde{M}_{13} = (L_{13}, M_{13}, R_{13}) & \cdot & \cdot & \tilde{M}_{1j} = (L_{1j}, M_{1j}, R_{1j}) \\ \tilde{M}_{21} = 1/\tilde{M}_{12} & 1 & \tilde{M}_{23} = (L_{23}, M_{23}, R_{23}) & \cdot & \cdot & \tilde{M}_{2j} = (L_{2j}, M_{2j}, R_{2j}) \\ \tilde{M}_{31} = 1/\tilde{M}_{13} & \tilde{M}_{32} = 1/\tilde{M}_{23} & 1 & \cdot & \cdot & \tilde{M}_{3j} = (L_{3j}, M_{3j}, R_{3j}) \\ \cdot & \cdot & \cdot & 1 & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & 1 & \tilde{M}_{ij} = (L_{ij}, M_{ij}, R_{ij}) \\ \tilde{M}_{j1} = 1/\tilde{M}_{1j} & \tilde{M}_{j2} = 1/\tilde{M}_{2j} & \tilde{M}_{j3} = 1/\tilde{M}_{3j} & \cdot & \tilde{M}_{ji} = 1/\tilde{M}_{3j} & 1 \end{bmatrix} \tag{2}$$

Step 5 *Calculating the triangular fuzzy weights.* After obtaining the overall triangular fuzzy numbers from matrix M, the respective triangular fuzzy numbers (i.e. L_i', M_i' and R_i') of each element are calculated by being the geometric mean. The triangular fuzzy numbers are shown in formula (3) to (5):

$$L_i' = GEOMEAN\left(L_{11}, L_{12}, L_{13}, \ldots L_{ij}\right) \tag{3}$$

$$M_i' = GEOMEAN\left(M_{11}, M_{12}, M_{13}, \ldots M_{ij}\right) \tag{4}$$

$$R_i' = GEOMEAN\left(R_{11}, R_{12}, R_{13}, \ldots R_{ij}\right) \tag{5}$$

Further, we sum up the triangular fuzzy numbers of n elements in the same matrix M, to obtain the sums triangular fuzzy numbers (i.e. L_i'', M_i'' and R_i''). Finally, we calculate the triangular fuzzy weights (W_i) of each element. The calculation of triangular fuzzy weights is shown in formula (6):

$$W_i = \left(L_i R_i'', M_i M_i'', R_i L_i''\right) \tag{6}$$

Step 6 *Defuzzification and normalisation.* When calculating the triangular fuzzy weights in the previous step, we de-fuzzy the triangular fuzzy weights of each element into a real number DW_i. Furthermore, in order to make the sum of all elements' DW_i in matrix M adding up to 1, it needs to conduct normalisation and

obtain the final weight DW_i' of each element. The calculations of defuzzification and normalisation are shown in formula (7) and (8):

$$DW_i = \frac{\{(WR_i - WL_i) + (WM_i - WL_i)\}}{3} + WL_i \tag{7}$$

$$DW_i' = \frac{DW_i}{\sum_{i=1}^{n} DW_i} \tag{8}$$

Step 7 *Determine priority of each consideration factor.* The above steps could yield the local fuzzy weight LW_i with dimensions *i* and the local fuzzy weight LW_j with factor *j* under dimension *i*. To obtain the global fuzzy weight GW_j of factor *j*, it requires to conduct the series of hierarchy. Then, the priority of each factor in the decision-making problem could be determined according to these global fuzzy weights. The calculation of global fuzzy weight is shown in formula (9):

$$GW_j = LW_i \times LW_j \tag{9}$$

2.3 Decision-making trial and evaluation laboratory

The AHP is necessary to assume that the consideration factors in different aspects must maintain independence from each other (Chang, 1996). However, in the real world, decision-making issues are much more complicated. There may also be mutual influences among various consideration factors of different consideration dimensions that affect decision-making. For example, when consumers consider receiving LBS advertising, 'accuracy of positioning' and 'privacy of personal location' could be two factors to be mutually evaluated. However, because these two consideration factors are obviously under different consideration dimensions in the evaluation hierarchy framework, it is impossible to pairwise compare these two factors directly. This may make the analysis results inaccurate, and less helpful for decision makers to make the most correct decision.

The DEMATEL method can effectively evaluate the mutual and causal relation among the consideration factors and acquire the complex causality in decision-making problems through matrix calculations (Chou et al., 2012). Also, this method can effectively support AHP to find out the interrelationship among consideration factors, and cover for the shortcomings of AHP analysis (Yang and Tzeng, 2011). The DEMATEL method was originally used to observe various complicated issues such as human race, famine, environmental protection, energy, etc. in the world (Fontela and Gabus, 1976). Since DEMATEL can effectively solve the complex decision-making problems by observing the structure of causal relations and the degrees of influence of among each factor, the practical applications of DEMATEL are getting extensive (Tzeng et al., 2007). The steps of applying DEMATEL method are described as follows:

Step 1 *Defining the correlation among factor.* First, we need to list the factors may affect the decision-making problem, and interview with the domain experts to determine the correlation between each of two factors.

Step 2 *Establishing direct relation matrix.* After collecting all of the factors, the interrelationship questionnaire will be further designed and delivered. The questionnaire scaling is 0 to 3 suggested by Fontela and Gabus (1976).

Afterwards, the direct relation matrix is established for the scores returned by the experts. As the decision problem with n factors, according to the degree of influence scores, we would establish an $n*n$ direct relation matrix, which represent as matrix Z in formula (10). Here, c_{ij} represent the degree of the factor c_i effect factor c_j.

$$Z = \begin{array}{c} \\ c_1 \\ c_2 \\ \vdots \\ c_n \end{array} \begin{array}{c} \begin{array}{cccc} c_1 & c_2 & \cdots & c_n \end{array} \\ \begin{bmatrix} 0 & c_{12} & \cdots & c_{1n} \\ c_{21} & 0 & \cdots & c_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ c_{n1} & c_{n2} & \cdots & 0 \end{bmatrix} \end{array} \tag{10}$$

Step 3 *Converting standardisation direct relation matrix.* Let $\lambda = 1 \Big/ \max_{0 \le j \le 1} \left(\sum_{j=1}^{n} c_{ij} \right)$, we multiply the score in the matrix Z by λ, and obtain the matrix X in formula (11).

$$X = \begin{array}{c} \\ c_1 \\ c_2 \\ \vdots \\ c_n \end{array} \begin{array}{c} \begin{array}{cccc} c_1 & c_2 & \cdots & c_n \end{array} \\ \begin{bmatrix} 0 & \lambda c_{12} & \cdots & \lambda c_{1n} \\ \lambda c_{21} & 0 & \cdots & \lambda c_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \lambda c_{n1} & \lambda c_{n2} & \cdots & 0 \end{bmatrix} \end{array} \tag{11}$$

Step 4 *Calculating direct/indirect relation matrix.* In order to understand whether two factors relate to each other indirectly, we apply formula (12) to produce a direct/indirect relation matrix T, where I is the identity matrix:

$$T = \lim_{k \to \infty} (I + X + X^2 + \cdots + X^k) = X(I - X)^{-1} \tag{12}$$

Step 5 *Calculating the prominence score of each factor.* Suppose c_{ij} is an interrelationship score of matrix T, where $i, j = 1,2, \ldots, n$, the sum of the column and row denote by D_i and R_i respectively. Among them, Here, D_i represents the total influence of factor i on other factors, and R_i represents the total influenced intensity of factor i that is influenced by other factors. The calculation of D_i and R_i are shown in formula (13) and (14). In addition, $D_i + R_i$ is called 'prominence' that represents the sum of influences strength of factor i including both the strength influencing other factors and the influences from other factors. $D_i - R_i$ is called 'relation' that divides factors into 'cause group' and 'effect group'. If $D_i - R_i$ is positive, it means the factor i dispatches the influence to other factors more than it receives, thus factor i belongs to the 'cause group'. On the other hand, if $D_i - R_i$ is negative, it means the factor i receives the influence from other factors more than it dispatches, thus factor i belongs to the 'effect group' (Tzeng et al., 2007).

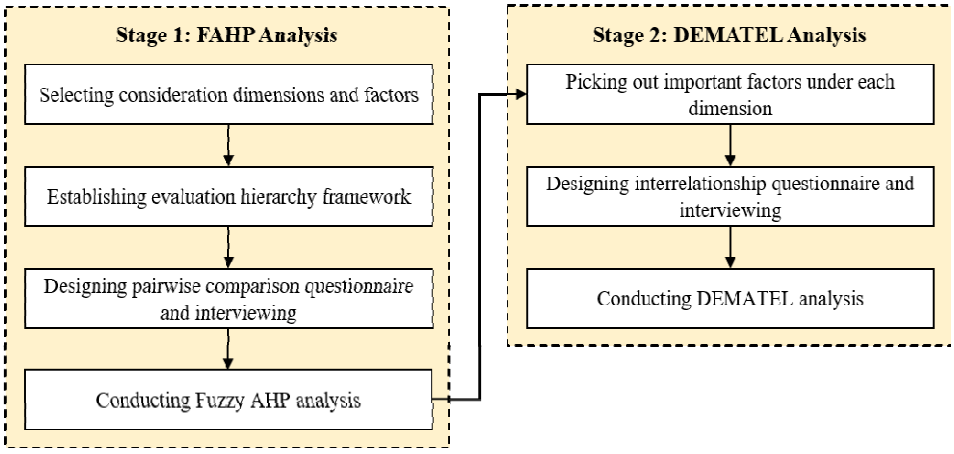
$$D_i = \sum_{j=1}^{n} c'_{ij} (i = 1, 2, \ldots.., n) \tag{13}$$

$$R_j = \sum_{i=1}^{n} c'_{ij} \, (j = 1, 2, \ldots, n) \tag{14}$$

3 Research methodology

This study mainly applied FAHP and DEMATEL methods to conduct two-stage interviews and to explore the positive and negative consideration factors a merchant would be concerned about when assessing to migrate an LBA push platform. In this study, the LBA is defined as a type of advertising medium involving any application, service, or activity, such as Bluetooth LBA, Wi-Fi LBA, GPS LBA, etc. that applies users' geographic information to deliver or improve marketing services. The research structure is shown in Figure 1.

Figure 1 Research structure (see online version for colours)



Stage 1 In this stage, the consideration dimensions and factors were selected based on relevant literature and market research, and thus the evaluation hierarchy framework would be further established. According to the framework, this study designed a pairwise comparison questionnaire and conducted interviews with experts, and then applied FAHP to analyse the whole replied questionnaire to find out the key consideration factors a merchant would be concerned about when assessing to migrate an LBA push platform.

Stage 2 According to the FAHP analysis result of the first stage, this study picked out the important consideration factors, which are those with higher local fuzzy weights under each dimension. Then, the interrelationship questionnaire was created and the expert that had participated in the first stage was interviewed again. Finally, the potential cause-effect relationships and interrelationships of each important consideration factor were analysed with DEMATEL method.

3.1 Selection of consideration elements

For merchants, The LBA push platform is undoubtedly an emerging information technology. Regarding the issue of organisation's innovative IT adoption, Tornatzky and Fleischer (1990) proposed the technology-organisation-environment (TOE) framework, and mentioned that when a firm-level faced with whether to adopt a new IT service, it must carefully assess the benefit creation and the costing payment from technology innovation and usage (Gangwar et al., 2014). Besides, the TOE framework also emphasises that both internal context of organisation and external environments of whole industry are also important impact elements that influence the adoption of innovative IT services by a firm (Chiu et al., 2017). The theory of innovation diffusion on also emphasised the internal characteristic and external characteristic of organisation as drivers for organisational adoption of innovation IT (Rogers, 2010; Oliveira and Martins, 2011). All the above theories of IT adoption provide an integral picture for business adoption of innovative IT (Zhu et al., 2004; Lin and Lin, 2008; Salwani et al., 2009; Wang et al., 2010), and give this study the reference framework for decision factors of migrating to LBA push platform.

In the field of mass communications, the advertising effectiveness generally includes the 'immediate effect' and the 'cumulative effect' (Bendixen, 1993; Eisend and Langner, 2010). The former is the short-term effect of advertisement (Lavidge and Steiner, 1961), which refers to the real economic benefits or losses that advertisers obtain from the sales of products or services promoted by advertising activities (Bemmaor and Mouchoux, 1991). Generally speaking, the immediate effect mainly refers to the marketing-related data collected through advertisements, such as customer flow rate, click-through rate, etc., which might further lead to actual sales activities (Zeff and Aronson, 1999). Thus, the immediate effect can be regarded as one of the tangible benefits of advertising (Hoffman and Novak, 1996). In contrast, the cumulative effect is the long-term effect of the advertisement (Lavidge and Steiner, 1961). It refers to the accumulation of various psychological effects that advertising may bring to consumers. For example, a consumer may have a good impression and reputation on the products or brands after frequently receiving the positive advertisements from the businesses (Palda, 1965). In other words, the cumulative effect is highly involved with the intangible benefit of advertising (Novak and Hoffman, 1997).

For merchants, when facing whether to establish an LBA push platform, the primary consideration should be what benefits the LBA service can bring to the organisation and the cost required (Levinson, 1994). Therefore, based on the classification of the advertising effectiveness by researches mentioned above, this study picked three dimensions out, which are '*tangible benefits*', '*intangible benefits*', and '*cost considerations*'. Besides, considering to adopt an innovative technology or service, merchants need to assess the maturity of internal existing information system, as well as the proficiency level of the external IT suppliers (Simonsson et al., 2010). In view of this, two more dimensions were included, namely, '*external proficiency (outsourcing)*' and '*internal maturity (self-development)*'. By analysing the five dimensions mentioned above, this study selected 23 consideration factors and defined each of them according to situations a merchant would be concerned about when assessing to migrate an LBA push platform. The definitions of each factor are shown in Table 2.

Table 2 Definition of consideration factors

Dimension	*Consideration factor*		*Definition*
D1 Tangible benefits	C1.1	Increasing customer flow rate	A merchant can use LBA service to attract nearby customers to visit its store and further make purchases.
	C1.2	Attracting customers to experience a product/service	A merchant can use LBA service to motivate more nearby customers to visit its store and further experience products and services.
	C1.3	Prompting more customers to get membership	A merchant can use LBA service to prompt more customers to apply for membership.
	C1.4	Increasing profit	A merchant can use LBA service to attract nearby customers to purchase its product/service, thereby increase profit.
	C1.5	Increasing ad click-through rate	A merchant can use LBA service to attract more nearby customers to click on the ads of its products and services.
D2 Intangible benefits	C2.1	Improving flexibility for real-time promotion	A merchant can use LBA service to push various ads such as e-coupon, sales promotion and trial information based on customers' location.
	C2.2	Enhancing customer relationship management	A merchant can use LBA service to obtain nearby customers' basic information, and then push related ads to customers so as to enhance customer relationship management.
	C2.3	Getting extra platforms for shopping	A merchant can use LBA service to allow nearby consumers to click and watch advertisements, then complete online pre-order/payment before visiting the store to experience service/pick up the goods.
	C2.4	Acquiring customers' information	A merchant can use LBA service to instantly obtain nearby customers' information regarding their age, gender, preferred product/service, spending, etc., and to push customised ads to their mobile devices.
	C2.5	Developing business reputation	A merchant can use LBA service to create the reputation of top technology application among customers.
	C2.6	Obtaining exposure for product/service	A merchant can use LBA service to obtain products' or services' exposure.
	C2.7	Creating critical mass	A merchant can use the LBA service to push mission rewards to nearby customers, and allow them to help forward ads information to others, thereby create a critical mass effect.

Table 2 Definition of consideration factors (continued)

Dimension		*Consideration factor*		*Definition*
D3	Cost considerations	C3.1	Cost of constructing basic equipment	Cost for constructing and/or renting basic equipment of LBA service such as Bluetooth publisher and data server.
		C3.2	Cost of advertising	Cost for advertisement space and design plus the fee paying to advertising companies.
		C3.3	Cost of App development	Cost for developing LBA applications.
		C3.4	Cost of labour	Cost for various personnel expenses including the fees for consulting, Ads update, customer service, etc.
		C3.5	Cost of maintenance	Cost for maintaining software and hardware of LBA service.
D4	External proficiency (outsourcing)	C4.1	Maturity of mobile technology	Whether the hardware/software of mobile technology in the market is mature for a merchant adopting LBA service.
		C4.2	IT ability of external suppliers	Whether the IT companies in the market are professional to well provide technical support for a merchant to adopt LBA service.
		C4.3	Proficiency level of external ad companies on operating LBA	Whether the mobile advertising design and marketing companies in the market are skilled to operate LBA for a merchant adopting LBA service.
D5	Internal maturity (self-development)	C5.1	Acceptance of internal management for innovation	Whether the internal senior managements of an organisation are willing to accept new technology for adopting LBA service.
		C5.2	Computerisation of internal organisation	Whether the internal organisation are well-computerised (e.g. IT professionals and IT equipment) for adopting LBA service.
		C5.3	Capability of internal marketing crew on using LBA	Whether the internal marketing staffs of an organisation is capable to operate LBA application smoothly.

Based on all selected consideration dimensions and factors, this study explored the "consideration factors that merchants are concerned about when assessing to migrate LBA push platforms" as the research objective, and establishes an evaluation hierarchy framework as shown in Figure 2.

Figure 2 Evaluation hierarchy frameworks (see online version for colours)

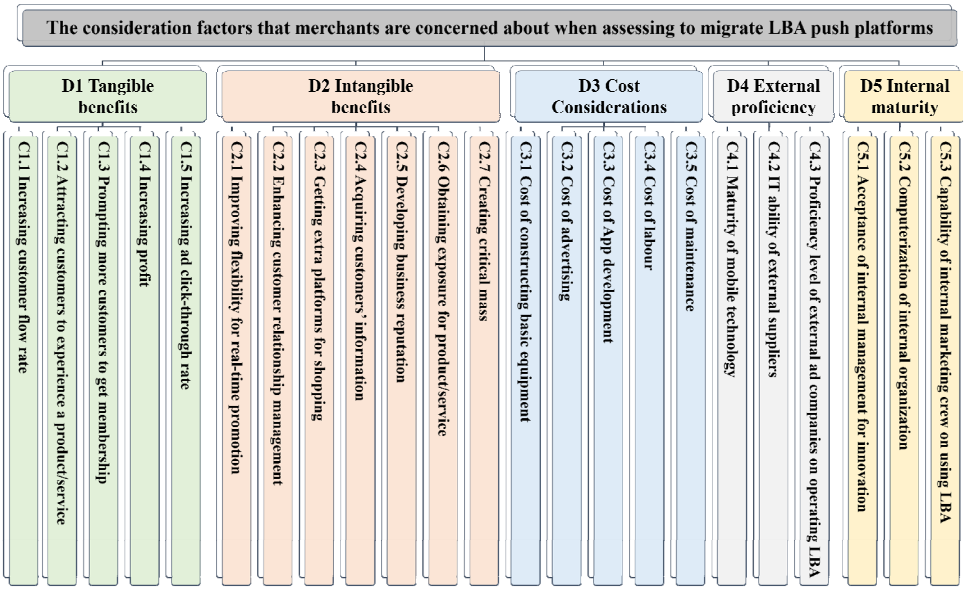


Table 3 Definitions of sub-factor under maturity of mobile technology

Sub-factor		*Definition*
C4.1.1	Battery life	The battery life of mobile devices is long lasting to support consumers to keep Bluetooth/GPS on prolongedly to receive LBA information.
C4.1.2	Screen size	The screen size of mobile devices is large enough to present the complete content of LBA for consumers.
C4.1.3	Accuracy of positioning	The positioning of mobile devices is accurate to allow consumers to properly receive LBA information such as activities about products/services offered by nearby shops.
C4.1.4	Navigation	The navigation function of the mobile device can guide consumers to the shops that provide LBA information to purchase products or experience services.
C4.1.5	Accuracy of grasping the information of nearby consumers	The LBA service can accurately filter and judge nearby consumers' age, gender, preferences etc., so as to push personalised ads about products/services/activities to their mobile devices.
C4.1.6	Supportability of various payment channels	The LBA service can be combined with a variety of mobile payment technologies, so that consumers can finish the payment right after clicking on an advertisement.

3.2 Selection of sub-factor under maturity of mobile technology

Since LBA provides consumers with advertising information at right time and right place, the mobile technology's software and hardware specifications and maturity would determine the effectiveness of advertising after merchants migrate LBA push platforms (Malhotra and Malhotra, 2013). Indeed, there are many inherent limitations of mobile

devices, such as small display of screen, small capacity of battery, limited resources of computation, etc. (Billi et al., 2010). Therefore, in this study, 'C4.1 maturity of mobile technology' was further analysed and divided into six sub-consideration factors, as shown in Table 3.

4 Research analysis and result

4.1 Pairwise comparison questionnaire design and interview

This study designed the pairwise comparison questionnaires based on the evaluation hierarchy framework (Figure 2) and conducted interviews with experts. The scale of the questionnaire is 1 to 9 pairwise comparisons (Table 1) developed by Saaty (1977), which guided interviewees to compare targeted dimensions and factors. The questionnaire participants were mainly merchants intended to migrate LBA push platforms or those who had developed and launched their own mobile advertising applications. A total of 20 interviewees participated in the face-to-face interview. The average length of interview for each interviewee was 30 minutes. Detailed demographic information of the interviewees is shown in Table 4.

Table 4 Demographic information of interviewees

Item	*Type of store*	*Count*	*Percentage*
Merchant category	Convenience store	1	5%
	Electronics/home appliances store	7	35%
	Department store	4	20%
	Supermarket	2	10%
	Shopping district	3	15%
	Food court	2	10%
	Drug store	1	5%
Whether the own mobile advertising applications has been adopted	Yes	5	25%
	No	9	45%
	Under assessing	6	30%

4.2 FAHP analysis

4.2.1 Local fuzzy weights of consideration elements

Based on the advice by Saaty, each questionnaire was evaluated by testing whether the consistency index (*C.I.*) and consistency ratio (*C.R.*) values of each question were less than or equal to 0.1 in order to verify the responded answers meet consistency (Saaty, 1990). Once a question did not pass the inconsistency test, the respondent was requested to take the questionnaire once again and his/her responded scores would be adjusted.

When all the questionnaires passed the inconsistency test, the responded scales were analysed with FAHP so as to calculate the triangular fuzzy number of local from each dimension and factor. After the calculation process of defuzzification and normalisation, the local fuzzy weights of each dimension and factor were obtained as shown in Table 5.

Table 5 Local fuzzy weight and related ranking of dimensions and factors

Consideration dimension and factor		*Local fuzzy weight*	*Related ranking*
D1	Tangible benefits	0.3806	1
D2	Intangible benefits	0.2212	2
D3	Cost considerations	0.1508	3
D4	External proficiency (outsourcing)	0.1248	4
D5	Internal maturity (self-development)	0.1226	5
C1.1	Increasing customer flow rate	0.3004	2
C1.2	Attracting customers to experience a product/service	0.1282	5
C1.3	Prompting more customers to get membership	0.1315	4
C1.4	Increasing profit	0.3081	1
C1.5	Increasing ad click-through rate	0.1318	3
C2.1	Improving flexibility for real-time promotion	0.2236	1
C2.2	Enhancing customer relationship management	0.1450	4
C2.3	Getting extra platforms for shopping	0.1070	6
C2.4	Acquiring customers' information	0.1171	5
C2.5	Developing business reputation	0.1606	2
C2.6	Obtaining exposure for product/service	0.1508	3
C2.7	Creating critical mass	0.0958	7
C3.1	Cost of constructing basic equipment	0.2148	2
C3.2	Cost of advertising	0.3316	1
C3.3	Cost of App development	0.1944	3
C3.4	Cost of labour	0.1321	4
C3.5	Cost of maintenance	0.1271	5
C4.1	Maturity of mobile technology	0.3437	1
C4.2	IT ability of external suppliers	0.3400	2
C4.3	Proficiency level of external ad companies on operating LBA	0.3163	3
C5.1	Acceptance of internal management for innovation	0.3097	3
C5.2	Computerisation of internal organisation	0.3505	1
C5.3	Capability of internal marketing crew on using LBA	0.3398	2

4.2.2 Global fuzzy weights and overall ranking of consideration factors

Next, this study multiplied the local fuzzy weights of each factor and its related dimension to obtain the global fuzzy weights for each consideration factor in the whole evaluation hierarchy framework. However, since the numbers of consideration factors under different dimensions were different, the factors should be further weighted differently when calculating the global fuzzy weights (Yang and Lin, 2019a). For example, there are seven factors under the dimension D2, thus, the global fuzzy weights of these factors would be obtained after further multiplying by 7. Similarly, the global fuzzy weights of D3 factors would be obtained after further multiplying by 5 since there are five factors under the dimension D3. Finally, the factors were ranked in importance

according to their weighted global fuzzy weights of normalisation. The analysis results are shown in Table 6.

Table 6 Global fuzzy weight and overall ranking of consideration factors

Consideration factor		*Global fuzzy weight*	*Weighted global fuzzy weight*	*Overall ranking*
C1.4	Increasing profit	0.1143	0.1185	1
C1.1	Increasing customer flow rate	0.0488	0.1156	2
C2.1	Improving flexibility for real-time promotion	0.0501	0.0700	3
C1.5	Increasing ad click-through rate	0.1173	0.0507	4
C1.3	Prompting more customers to get membership	0.0501	0.0506	5
C3.2	Cost of advertising	0.0495	0.0505	6
C2.5	Developing business reputation	0.0321	0.0503	7
C1.2	Attracting customers to experience a product/service	0.0237	0.0493	8
C2.6	Obtaining exposure for product/service	0.0259	0.0472	9
C2.2	Enhancing customer relationship management	0.0355	0.0454	10
C2.4	Acquiring customers' information	0.0334	0.0366	11
C2.3	Getting extra platforms for shopping	0.0212	0.0335	12
C3.1	Cost of constructing basic equipment	0.0324	0.0327	13
C2.7	Creating critical mass	0.0500	0.0300	14
C3.3	Cost of App development	0.0293	0.0296	15
C5.2	Computerisation of internal organisation	0.0199	0.0261	16
C4.1	Maturity of mobile technology	0.0192	0.0260	17
C4.2	IT ability of external suppliers	0.0429	0.0257	18
C5.3	Capability of internal marketing crew on using LBA	0.0424	0.0253	19
C4.3	Proficiency level of external ad companies on operating LBA	0.0395	0.0239	20
C5.1	Acceptance of internal management for innovation	0.0380	0.0230	21
C3.4	Cost of labour	0.0430	0.0201	22
C3.5	Cost of maintenance	0.0417	0.0194	23

Table 7 Related ranking of sub-factor under maturity of mobile technology

Sub-factor		*Local fuzzy weight*	*Related ranking*
C4.1.5	Accuracy of grasping the information of nearby consumers	0.3921	1
C4.1.3	Accuracy of positioning	0.2222	2
C4.1.6	Supportability of various payment channels	0.1775	3
C4.1.4	Navigation	0.1061	4
C4.1.1	Battery life	0.0735	5
C4.1.2	Screen size	0.0286	6

4.2.3 Analysis of mobile technology maturity

In addition, this study requested interviewees to evaluate the importance of pairwise compare for six sub-factors under the 'C4.1 maturity of mobile technology' factor to

understand what maturity levels reached by mobile technologies are highly concerned about by merchants when considering to migrate LBA push platforms. The results are shown in Table 7.

4.3 DEMATEL analysis

4.3.1 Selection of important factor under each dimension

To understand the interrelationship as well as the mutual influence degree among the highly important consideration factors under different dimensions, the factors with higher local fuzzy weights from the FAHP analysis results were selected to be further analysed with DEMATEL method.

In this stage, the selection rules of consideration factor were either

1 in the FAHP analysis results, the overall ranking of the factor was within the top 10 in the whole evaluation hierarchy framework

2 under each dimension, the local fuzzy weight of the factor was larger than a threshold value, which is obtained by dividing 1 by the total number of factors under the dimension.

For example, there are three consideration factors under the dimension D5, and any factor under the dimension D5 has a local fuzzy weight larger than 0.3333 (i.e. the quotient of dividing 1 by 3) would be selected at this stage. Five factors were selected owing to the rule (2). In total, 15 consideration factors were selected for the stage of DEMATEL analysis, as shown in Table 8.

Table 8 Selection of important consideration factor for DEMATEL analysis

Dimension	*Threshold value*	*Selection of factor*	*Local fuzzy weight*	*Overall ranking in Table 6*
D1	0.2000 (1/5)	C1.1	0.3004	2
		C1.2	0.1282	8
		C1.3	0.1315	5
		C1.4	0.3081	1
		C1.5	0.1318	4
D2	0.1429 (1/7)	C2.1	0.2236	3
		C2.2	0.1450	10
		C2.5	0.1606	7
		C2.6	0.1508	9
D3	0.2000 (1/5)	C3.1	0.2148	13
		C3.2	0.3316	6
D4	0.3333 (1/3)	C4.1	0.3437	17
		C4.2	0.3400	18
D5	0.3333 (1/3)	C5.2	0.3505	16
		C5.3	0.3398	19

Note: The denominator in 'threshold value' column represents the number of consideration factors included in the dimension.

Table 9 Direct/indirect relation matrix describing interrelationship among factors

Factor	*C1.1*	*C1.2*	*C1.3*	*C1.4*	*C1.5*	*C2.1*	*C2.2*	*C2.5*	*C2.6*	*C3.1*	*C3.2*	*C4.1*	*C4.2*	*C5.2*	*C5.3*	D_i
C1.1	0.05	0.17	0.12	0.19	0.05	0.02	0.02	0.18	0.17	0.01	0.03	0.00	0.00	0.00	0.00	1.01
C1.2	0.06	0.07	0.16	0.18	0.05	0.02	0.02	0.17	0.17	0.01	0.03	0.00	0.00	0.00	0.00	0.95
C1.3	0.16	0.22	0.12	0.24	0.14	0.13	0.14	0.24	0.23	0.03	0.11	0.00	0.00	0.00	0.00	1.75
C1.4	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.09
C1.5	0.21	0.25	0.21	0.27	0.10	0.16	0.10	0.24	0.25	0.07	0.13	0.00	0.00	0.00	0.00	1.97
C2.1	0.23	0.26	0.22	0.29	0.21	0.07	0.13	0.27	0.26	0.12	0.15	0.00	0.00	0.00	0.00	2.21
C2.2	0.18	0.21	0.19	0.23	0.07	0.04	0.03	0.21	0.21	0.09	0.04	0.00	0.00	0.00	0.00	1.50
C2.5	0.18	0.20	0.19	0.22	0.14	0.04	0.03	0.11	0.20	0.02	0.05	0.00	0.00	0.00	0.00	1.38
C2.6	0.19	0.22	0.19	0.24	0.18	0.06	0.03	0.22	0.12	0.05	0.15	0.00	0.00	0.00	0.00	1.65
C3.1	0.05	0.06	0.05	0.06	0.14	0.13	0.02	0.06	0.06	0.02	0.05	0.00	0.00	0.00	0.00	0.70
C3.2	0.12	0.14	0.09	0.14	0.16	0.14	0.03	0.13	0.12	0.02	0.04	0.00	0.00	0.00	0.00	1.14
C4.1	0.01	0.01	0.01	0.02	0.03	0.02	0.01	0.01	0.01	0.12	0.07	0.00	0.05	0.04	0.01	0.42
C4.2	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.11	0.01	0.00	0.00	0.00	0.09	0.33
C5.2	0.02	0.02	0.02	0.02	0.04	0.03	0.02	0.02	0.02	0.11	0.10	0.00	0.00	0.00	0.11	0.55
C5.3	0.04	0.05	0.04	0.05	0.08	0.07	0.11	0.05	0.05	0.02	0.06	0.00	0.00	0.00	0.00	0.63
R_i	*1.53*	*1.89*	*1.63*	*2.17*	*1.40*	*0.97*	*0.69*	*1.97*	*1.90*	*0.82*	*1.02*	*0.00*	*0.05*	*0.04*	*0.21*	-

4.3.2 Interrelationship questionnaire design and interview

After selecting the important consideration factors under each dimension, this study further developed a scoring matrix of the interrelationship among those factors as a questionnaire for subsequent DEMATEL analysis. Then, the interrelationship questionnaire interview was conducted by interviewing the merchants who had participated in the previous stage AHP questionnaire interview in order to ensure the consistency of the two-stages analysis results. The average duration of an interview for each interviewee was 45 minutes, and the rating scale of 0~3 (the greater the number is, the higher mutual influence is) designed by Fontela and Gabus (1976) was adopted in the interview.

4.3.3 Prominence ranking of important consideration factors

Based on the interview results of the interrelationship questionnaire, this study collected the scores given by all interviewees, and established the direct/indirect relation matrix of the interrelationship among these selected consideration factors as shown in Table 9.

Each score in the direct/indirect relation matrix represents the degree of mutual influence between two factors. The higher the score is, the greater the relevance between two factors. Moreover, the higher the score of prominence ($D_i + R_i$), the more substantial the factor is to the overall decision-making problem. In other words, it would have a greater overall impact to the merchants' concern on assessing to migrate LBA push platforms. The result of DEMATEL analysis is shown in Table 10.

Table 10 Prominence score and ranking of important consideration factor

	Important consideration factor	D_i	R_i	*Prominence score* ($D_i + R_i$)	*Prominence ranking*
C2.6	Obtaining exposure for product/service	1.65	1.90	3.55	1
C1.5	Increasing ad click-through rate	1.97	1.40	3.38	2
C1.3	Prompting more customers to get membership	1.75	1.63	3.38	3
C2.5	Developing business reputation	1.38	1.97	3.35	4
C2.1	Improving flexibility for real-time promotion	2.21	0.97	3.18	5
C1.2	Attracting customers to experience a product/service	0.95	1.89	2.84	6
C1.1	Increasing customer flow rate	1.01	1.53	2.54	7
C1.4	Increasing profit	0.09	2.17	2.25	8
C2.2	Enhancing customer relationship management	1.50	0.69	2.19	9
C3.2	Cost of advertising	1.14	1.02	2.16	10
C3.1	Cost of constructing basic equipment	0.70	0.82	1.52	11
C5.3	Capability of internal marketing crew on using LBA	0.63	0.21	0.84	12
C5.2	Computerisation of internal organisation	0.55	0.04	0.58	13
C4.1	Maturity of mobile technology	0.42	0.00	0.42	14
C4.2	IT ability of external suppliers	0.33	0.05	0.38	15

5 Conclusions

The LBA is still an emerging and developing application among mobile services and, as a result, the population of consumers willing to receive and click on location-based advertisement is small. However, some researches have pointed out that the service of LBA could increase consumers' willingness to click and read location-based advertisements effectively. Thus, it is indispensable to clearly understand the pros and cons before a merchant sets up its LBA push platforms for the further promotion and development of the LBA service in the future.

5.1 Implications for academia

This study built an evaluation hierarchy framework to explore consideration factors that merchants would be considered while adopting LBA service. In addition, FAHP and DEMATEL methods were applied to analyse the critical consideration factors, and to understand what the important factors under each dimension have interrelationships on one another. The establishment of evaluation hierarchy framework and research results by this study could be used by future researchers to do variance analysis on the consideration factors from merchants of different merchant type, such as department store, shopping mall, food court, etc. while assessing to adopt LBA service platforms.

5.2 Implications for practice

In this study, the following contributions are made to practice. First, the results of FAHP analysis in Table 6 indicate that the factors of 'C1.4 increasing profit (0.1185)', 'C1.1 increasing customer flow rate (0.1156)', 'C2.1 improving flexibility for real-time promotion (0.0700)', 'C1.5 increasing ad click-through rate (0.0507)', and 'C1.3 prompting more customers to get membership (0.0506)' are the top five key consideration factors for a merchant to adopt LBA push platforms. Among them, four factors are under the dimension of 'tangible benefits', which means that the most important consideration factor for merchants to migrate LBA push platform is whether the LBA service could get substantial benefits from their investment. Besides, Table 7 implies that most merchants are convinced that the 'C4.1.5 accuracy of grasping the information of nearby consumers (0.3921)' and the 'C4.1.3 accuracy of positioning (0.2222)' of mobile devices are the two factors necessary for mobile technology maturity requirements, even affect the successful promotion of LBA service.

Second, the results of DEMATEL analysis indicate that three consideration factors with higher overall ranking in AHP analysis stage, such as 'C1.5 increasing ad click-through rate (overall ranking as 4, prominence ranking as 2), 'C1.3 prompting more customers to get membership (overall ranking as 5, prominence ranking as 3)' and 'C2.1 improving flexibility for real-time promotion (overall ranking as 3, prominence ranking as 5)' do have higher influence scores (D_i). Indeed, in Table 10, they are three most influential factors. It indicates when a merchant seeks to improve the key performance index of different operation section (e.g., profit, customer flow rate, business reputation,

marketing exposure) by migrating LBA push platform, it has to make consumers willing to join as a member and desiring to click the local based advertisements. Through this way, merchants could push various real-time promotional ads about own products and services for consumers based on their location, such as e-coupon, sales promotion, trial information, etc.

Third, Table 10 also reports three most influenced factors with high influenced score (R_i), namely, 'C1.4 increasing profit', 'C2.5 developing business reputation', and 'C2.6 obtaining exposure for product/service'. It indicates that through LBA, merchants seek to obtain more exposure for product/service, give positive impressions of their brands to consumers, finally to make more profit. It is essential for LBA providers to make every effort to improve the exposure of products or services in the market to deepen the impression of the merchants on the consumers, so that they will be more willing to receive and watch LBA, and eventually be elicited to shop in the stores.

Finally, the results of this study indicate that the top 10 consideration factors in overall ranking (Table 6) are identical with those in prominence ranking (Table 10) though two rankings are different. This points out extremely that these ten critical consideration factors have absolute influence and significance on merchants when assessing to migrate LBA push platform. The above findings are useful for merchants in the ubiquitous information society.

5.3 Limitations and future research

Despite the meaningful findings of this study, there are several limitations. First, the interviewees need to spend a lot of energy and time to answer questions on the interrelationship questionnaire in the stage of DEMATEL analysis. To lower their loading to complete the questionnaire and prevent them from giving responses that cause biased results in this study, only the most important consideration factors from each dimension were selected for the follow-up DEMATEL analysis instead of all factors being chosen. This way might neglect certain factors not included in DEMATEL analysis but with high prominence degree.

Second, the purpose of this research is to explore the complete consideration factors of all types of merchants intended to migrate the LBA push platform. However, different types of stores may have different ways of running business and making profits and, hence have very different considerations and objectives for using LBA service from each other. As a result, it is suggested that future research can further categorise merchants according to their business types before analysing their considerations for migrating LBA push platforms.

Acknowledgements

The authors would like to thank the Ministry of Science and Technology, Taiwan, for financially supporting this research under Contract No. MOST 107-2410-H-004-097-MY3.

References

Bacile, T.J., Ye, C. and Swilley, E. (2014) 'From firm-controlled to consumer-contributed: consumer co-production of personal media marketing communication', *Journal of Interactive Marketing*, Vol. 28, No. 2, pp.117–133.

Barwise, P. and Strong, C. (2002) 'Permission-based mobile advertising', *Journal of Interactive Marketing*, Vol. 16, No. 1, pp.14–24.

Bell, R. and Buchner, A. (2018) 'Positive effects of disruptive advertising on consumer preferences', *Journal of Interactive Marketing*, Vol. 41, No. 1, pp.1–13.

Belton, V. and Stewart, T.J. (2002) *Multiple Criteria Decision Analysis: An Integrated Approach*, Springer, New York.

Bemmaor, A.C. and Mouchoux, D. (1991) 'Measuring the short-term effect of in-store promotion and retail advertising on brand sales: a factorial experiment', *Journal of Marketing Research*, Vol.28, No. 2, pp.202–214.

Bendixen, M.T. (1993) 'Advertising effects and effectiveness', *European Journal of Marketing*, Vol. 27, No. 10, pp.19–32.

Billi, M., Burzagli, L., Catarci, T., Santucci, G., Bertini, E., Gabbanini, F. and Palchetti, E. (2010) 'A unified methodology for the evaluation of accessibility and usability of mobile applications', *Universal Access in the Information Society*, Vol. 9, No. 4, pp.337–356.

Bruner, G.C. and Kumar, A. (2007) 'Attitude toward location-based advertising', *Journal of Interactive Advertising*, Vol. 7, No. 2, pp.3–15.

Buchwitz, L.A. (2018) 'A model of periodization of radio and internet advertising history', *Journal of Historical Research in Marketing*, Vol. 10, No. 2, pp.130–150.

Buckley, J.J. (1985) 'Fuzzy hierarchical analysis', *Fuzzy Sets and Systems*, Vol. 17, No. 3, pp.233–247.

Büyüközkan, G. and Çifçi, G. (2012) 'A novel hybrid MCDM approach based on fuzzy DEMATEL, fuzzy ANP and fuzzy TOPSIS to evaluate green suppliers', *Expert Systems with Applications*, Vol. 39, No. 3, pp.3000–3011.

Chang, D.Y. (1996) 'Applications of the extent analysis method on fuzzy AHP', *European Journal of Operational Research*, Vol. 95, No. 3, pp.649–655.

Chen, P.T., Cheng, J.Z., Yu, Y.W. and Ju, P.H. (2014) 'Mobile advertising setting analysis and its strategic implications', *Technology in Society*, Vol. 39, No. 2014, pp.129–141.

Chiou, H.K. and Tzeng, G.H. (2001) 'Fuzzy hierarchical evaluation with grey relation model of green engineering for industry', *International Journal of Fuzzy Systems*, Vol.3, No. 3, pp.466–475.

Chiu, C.Y., Chen, S. and Chen, C.L. (2017) 'An integrated perspective of TOE framework and innovation diffusion in broadband mobile applications adoption by enterprises', *International Journal of Management, Economics and Social Sciences*, Vol. 6, No. 1, pp.14–39.

Cho, C.H. and Cheon, H.J. (2004) 'Why do people avoid advertising on the internet?', *Journal of Advertising*, Vol. 33, No. 4, pp.89–97.

Chou, Y.C., Sun, C.C. and Yen, H.Y. (2012) 'Evaluating the criteria for human resource for science and technology (HRST) based on an integrated fuzzy AHP and fuzzy DEMATEL approach', *Applied Soft Computing*, Vol. 12, No. 1, pp.64–71.

Choudhary, M. (2019) 'Mobile marketing: mobile advertising strategy', *Journal of the Gujarat Research Society*, Vol. 21, No. 14, pp.337–345.

Denning, P.J. (1982) 'ACM president's letter: electronic junk', *Communications of the ACM*, Vol. 25, No. 3, pp.163–165.

Eisend, M. and Langner, T. (2010) 'Immediate and delayed advertising effects of celebrity endorsers' attractiveness and expertise', *International Journal of Advertising*, Vol. 29, No. 4, pp.527–546.

Fontela, E. and Gabus, A. (1976) *The DEMATEL Observer*, Battelle Geneva Research Center, Geneva, Switzerland.

Gangwar, H., Date, H. and Raoot, A.D. (2014) 'Review on IT adoption: insights from recent technologies', *Journal of Enterprise Information Management*, Vol. 27, No. 4, pp.488–502.

Gutierrez, A., O'Leary, S., Rana, N.P., Dwivedi, Y.K. and Calle, T. (2019) 'Using privacy calculus theory to explore entrepreneurial directions in mobile location-based advertising: identifying intrusiveness as the critical risk factor', *Computers in Human Behavior*, Vol. 95, No. 2019, pp.295–306.

Hoffman, D.L. and Novak, T.P. (1996) 'Marketing in hypermedia computer-mediated environments: conceptual foundations', *Journal of Marketing*, Vol. 60, No. 3, pp.50–68.

Hsieh, T.Y., Lu, S.T. and Tzeng, G.H. (2004) 'Fuzzy MCDM approach for planning and design tenders selection in public office buildings', *International Journal of Project Management*, Vol. 22, No. 7, pp.573–584.

Hühn, A.E., Khan, V.J., Ketelaar, P., van't Riet, J., Konig, R., Rozendaal, E., Batalas, N. and Markopoulos, P. (2017) 'Does location congruence matter? A field study on the effects of location-based advertising on perceived ad intrusiveness, relevance & value', *Computers in Human Behavior*, Vol. 73, No. 2017, pp.659–668.

Keeney, R.L. and Raiffa, H. (1976) *Decisions with Multiple Objectives: Preferences and Value Trade-Offs*, John Wiley Sons, Inc., New York.

Ketelaar, P.E., Bernritter, S.F., van't Riet, J., Hühn, A.E., van Woudenberg, T.J., Müller, B.C.N. and Janssen, L. (2017) 'Disentangling location-based advertising: The effects of location congruency and medium type on consumers' ad attention and brand choice', *International Journal of Advertising*, Vol. 36, No. 2, pp.356–367.

Kunz, W.H., Heinonen, K. and Lemmink, J.G. (2019) 'Future service technologies: is service research on track with business reality?', *Journal of Services Marketing*, Vol. 33, No. 4, pp.479–487.

Lavidge, R.J. and Steiner G.A. (1961) 'A model for predictive measurements of advertising effectiveness', *Journal of Marketing*, Vol. 25, No. 6, pp.59–62.

Lee, S.A. (2018) 'Enhancing customers' continued mobile app use in the service industry', *Journal of Services Marketing*, Vol. 26, No. 6, pp.680–691.

Lee, Y.C. (2015) 'Factors influencing effects of location-based EMS advertising: different situational contexts for both genders', *International Journal of Mobile Communications*, Vol. 13, No. 6, pp.619–640.

Levinson, J.C. (1994) *Guerrilla Advertising: Cost-Effective Techniques for Small-Business Success*, Houghton Mifflin Harcourt, Boston.

Li, J., Fei, H. and Jin, W. (2015) 'Mobile advertising security risk assessment model based on AHP', in *Proceeding of 2015 International Symposium on Computers & Informatics*, January, pp.1970–1978.

Lin, H.F. and Lin, S.M. (2008) 'Determinants of e-business diffusion: a test of the technology diffusion perspective', *Technovation*, Vol. 28, No. 3, pp.135–145.

Lin, L.Z. and Yeh, H.R. (2013) 'A perceptual measure of mobile advertising using fuzzy linguistic preference relation', *Iranian Journal of Fuzzy Systems*, Vol. 10, No. 5, pp.25–46.

Lin, T.T. and Bautista, J.R. (2020) 'Content-related factors influence perceived value of location-based mobile advertising', *Journal of Computer Information Systems*, Vol. 60, No. 2, pp.184–193.

Lin, T.T.C., Paragas, F. and Bautista, J.R. (2016) 'Determinants of mobile consumers' perceived value of location-based advertising and user responses', *International Journal of Mobile Communications*, Vol. 14, No. 2, pp.99–117.

Maghdid, S.A., Maghdid, H.S., HmaSalah, S.R., Ghafoor, K.Z., Sadiq, A.S. and Khan, S. (2019) 'Indoor human tracking mechanism using integrated onboard smartphones Wi-Fi device and inertial sensors', *Telecommunication Systems*, Vol. 71, No. 3, pp.447–458.

Mahdavi, I., Fazlollahtabar, H., Heidarzade, A., Mahdavi-Amiri, N. and Rooshan, Y. (2008) 'A heuristic methodology for multi-criteria evaluation of web-based e-learning systems based on user satisfaction', *Journal of Applied Sciences*, Vol. 8, No. 24, pp.4603–4609.

Malhotra, A. and Malhotra, C.K. (2013) 'Exploring switching behavior of US mobile service customers', *Journal of Services Marketing*, Vol. 27, No. 1, pp.13–24.

Mansoor, R., Zhang, J., Hafeez, I., Nawaz, Z. and Naz, S. (2018) 'Consumer attitude towards different location based advertisements types and their impact on purchase intention', *Journal of Management Information and Decision Sciences*, Vol. 21, No. 1, pp.1–19.

Merisavo, M., Kajalo, S., Karjaluoto, H., Virtanen, V., Salmenkivi, S., Raulas, M. and Leppäniemi, M. (2007) 'An empirical study of the drivers of consumer acceptance of mobile advertising', *Journal of Interactive Advertising*, Vol. 7, No. 2, pp.41–50.

Molitor, D., Spann, M., Ghose, A. and Reichhart, P. (2020) 'Effectiveness of location-based advertising and the impact of interface design', *Journal of Management Information Systems*, Vol. 37, No. 2, pp.431–456.

Mon, D.L., Cheng, C.H. and Lin, J.C. (1994) 'Evaluating weapon system using fuzzy analytic hierarchy process based on entropy weight', *Fuzzy Sets and Systems*, Vol. 62, No. 2, pp.127–134.

Nikou, S. and Mezei, J. (2013) 'Evaluation of mobile services and substantial adoption factors with analytic hierarchy process (AHP)', *Telecommunications Policy*, Vol. 37, No. 10, pp.915–929.

Novak, T.P. and Hoffman, D.L. (1997) 'New metrics for new media: toward the development of web measurement standards', *World Wide Web Journal*, Vol. 2, No. 1, pp.213–246.

Oliveira, T. and Martins, M.F. (2011) 'Literature review of information technology adoption models at firm level', *Electronic Journal of Information Systems Evaluation*, Vol. 14, No. 1, pp.110–121.

Palda, K.S. (1965) 'The measurement of cumulative advertising effects', *The Journal of Business*, Vol. 38, No. 2, pp.162–179.

Rogers, E.M. (2010) *Diffusion of Innovations*, 4th ed., Simon and Schuster, New York.

Saaty, T.L. (1977) 'A scaling method for priorities in hierarchical structures', *Journal of Mathematical Psychology*, Vol. 15, No. 3, pp.234–281.

Saaty, T.L. (1980) *The Analytic Hierarchy Process*, McGraw-Hill, New York.

Saaty, T.L. (1990) 'How to make a decision: the analytic hierarchy process', *European Journal of Operational Research*, Vol. 48, No. 1, pp.9–26.

Saaty, T.L. (2008) 'Decision making with the analytic hierarchy process', *International Journal of Services Sciences*, Vol. 1, No. 1, pp.83–98.

Salwani, M.I., Marthandan, G., Norzaidi, M.D. and Chong, S.C. (2009) 'E-commerce usage and business performance in the Malaysian tourism sector: empirical analysis', *Information Management & Computer Security*, Vol. 17, No. 2, pp.166–185.

Shee, D.Y., Tzeng, G.H. and Tang, T.I. (2003) 'AHP, fuzzy measure and fuzzy integral approaches for the appraisal of information service providers in Taiwan', *Journal of Global Information Technology Management*, Vol. 6, No. 1, pp.8–30.

Shieh, C.H., Xu, Y. and Ling, I.L. (2019) 'How location-based advertising elicits in-store purchase', *Journal of Services Marketing*, Vol. 33, No. 4, pp.380–395.

Shin, W. and Lin, T.T.C. (2016) 'Who avoids location-based advertising and why? Investigating the relationship between user perceptions and advertising avoidance', *Computers in Human Behavior*, Vol. 63, No. 2016, pp.444–452.

Simonsson, M., Johnson, P. and Ekstedt, M. (2010) 'The effect of IT governance maturity on IT governance performance', *Information Systems Management*, Vol. 27, No. 1, pp.10–24.

Souiden, N., Chaouali, W. and Baccouche, M. (2019) 'Consumers' attitude and adoption of location-based coupons: the case of the retail fast food sector', *Journal of Retailing and Consumer Services*, Vol. 47, No. 2019, pp.116–132.

Tornatzky, L.G. and Fleischer, M. (1990) *Processes of Technological Innovation*, Lexington books, Lexington, MA.

Tsang, M.M., Ho, S.C. and Liang, T.P. (2004) 'Consumer attitudes toward mobile advertising: an empirical study', *International Journal of Electronic Commerce*, Vol. 8, No. 3, pp.65–78.

Tzeng, G.H., Chiang, C.H. and Li, C.W. (2007) 'Evaluating intertwined effects in e-learning programs: a novel hybrid MCDM model based on factor analysis and DEMATEL', *Expert Systems with Applications*, Vol. 32, No. 4, pp.1028–1044.

Van Laarhoven, P.J.M. and Pedrcyz, W. (1983) 'A fuzzy extension of Saaty's priority theory', *Fuzzy Sets and Systems*, Vol. 11, Nos. 1–3, pp.229–241.

Wang, C.S., Yang, H.L. and Lin, S.L. (2015) 'To make good decision: a group DSS for multiple criteria alternative rank and selection', *Mathematical Problems in Engineering*, Vol. 2015, No. 1, pp.1–15.

Wang, W., Li, G., Fung, R.Y. and Cheng, T.C.E. (2019) 'Mobile advertising and traffic conversion: the effects of front traffic and spatial competition', *Journal of Interactive Marketing*, Vol. 47, No. 2, pp.84–101.

Wang, Y.M., Wang, Y.S. and Yang, Y.F. (2010) 'Understanding the determinants of RFID adoption in the manufacturing industry', *Technological Forecasting & Social Change*, Vol. 77, No. 5, pp.803–815.

Xu, D.J. (2006) 'The influence of personalization in affecting consumer attitudes toward mobile advertising in China', *Journal of Computer Information Systems*, Vol. 47, No. 2, pp.9–19.

Xu, H., Luo, X., Carroll, J.M. and Rosson, M.B. (2011) 'The personalization privacy paradox: an exploratory study of decision making process for location-aware marketing', *Decision Support Systems*, Vol. 51, No. 1, pp.42–52.

Yang, H.L. and Lin, S.L. (2017) 'The evaluation factors of adopting SoLoMo services: the hybrid fuzzy MCDM approach', *Service Business*, Vol. 11, No. 3, pp.601–629.

Yang, H.L. and Lin, S.L. (2019a) 'Applying fuzzy AHP to analyse the critical factors of adopting SoLoMo services', *International Journal of Mobile Communications*, Vol. 17, No. 4, pp.483–511.

Yang, H.L. and Lin, S.L. (2019b) 'The decision of building location-based advertising push platform', in *Proceeding of 2019 International Conference on Intelligent Computing and its Emerging Applications (ICEA 2019)*, August-September, pp.110–114.

Yang, H.L., Lin, S.L. and Chang, J.Y. (2019) 'Would you turn-on GPS for LBA? Fuzzy AHP approach', in *Proceeding of 2019 International Conference on Machine Learning and Cybernetics (ICMLC 2019)*, July, pp.1–5.

Yang, J.L. and Tzeng, G.H. (2011) 'An integrated MCDM technique combined with DEMATEL for a novel cluster-weighted with ANP method', *Expert Systems with Applications*, Vol. 38, No. 3, pp.1417–1424.

Zeff, R.L. and Aronson, B. (1999) *Advertising on the Internet*, 2nd ed., John Wiley & Sons, Inc., New York.

Zhu, K., Kraemer, K.L., Xu, S. and Dedrick, J. (2004) 'Information technology payoff in e-business environments: an international perspective on value creation of e-business in the financial services industry', *Journal of Management Information Systems*, Vol. 21, No. 1, pp.17–54.