Modelling and Comparing Malaysian Hotel Website Diffusion

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Abstract

This study draws upon diffusion modelling, a coupled Bass Rogers model, to examine hospitality website adoption within Malaysia and across countries. The results suggest 38% of Malaysian hotels may never adopt a traditional website. Rather, these hotels may start with new online channels, such as social networking and communities, leapfrogging over those that adopted websites. Across countries, the results highlight the role of innovation and imitation in adopting websites. Malaysian and international chains hotels showed similar adoption related to innovation and imitation. For Swiss hotels, the influence of imitation was much stronger than for Malaysian and international chain hotels.

Keywords: Malaysian hotels, Bass-Rogers Model, Adopter categories, Website diffusion

1 Introduction

Few technologies have the scope and impact on businesses as digital technologies and the Internet do. Network values in Metcalfe's Law, cost and space reductions with Moore's Law, and converging technological devices help fuel explosive Internet growth (Hanson & Kalyanam, 2007). For over a decade scholars have investigated the Internet's widespread impact on business and society. Yet many business website studies have at least two limitations.

Firstly, the population often omits businesses late to adopt websites; the population is right-censored. Similar to non-respondents in survey research, omitting businesses yet to adopt websites gives an incomplete view of technology diffusion. Early hotel Internet studies investigated a hotel subset, the early to adopt, and may have examined just innovator and early adopter hotels (see for examples: Murphy, Forrest, Wotring, & Brymer, 1996; Siguaw, Enz, & Namiasivayam, 2000). Likewise, research on technology and innovation in developing economies should not always be grounded on theories derived from leading economies (Da Silveira, 2001). As argued by Zhu and Kraemer (2005, p. 62), theories developed in "mature markets and industrialised

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Businesses also face evolving digital communication methods and metrics (Hoffman & Fodor, 2010). Today's travellers rely on user-generated content for travel decision-making more so than published travel company information (Pan & Fesenmaier, 2006; Xiang, Gretzel, & Fesenmaier, 2009). Such rapid generational technology changes, as in eTourism, may lead to leapfrog effects (Kauffman & Techatassanasoontorn, 2009; Stremersch, Muller, & Peres, 2010). That is, the late adopters bypass early adopters in effective technology use (Davison, Vogel, Harris, & Jones, 2000). More concretely, some hotels may start a strong Facebook or Twitter presence rather than a traditional website (Anderson & Wolff, 2010).

The second limitation, poor estimates of total market size and adopter categories, compounds the incomplete view. Rogers (2003) models technology diffusion as a normal distribution across five adopter categories: *innovators*, the first 2.5% to adopt an innovation; *early adopters*, the next 13%; *early majority*, the next 34%; *late majority*, the next 34% and finally *laggards*, the last 16% to adopt. Yet, each adopter category differs in characteristics and innovation use (Hsu, Lu, & Hsu, 2007; Rogers, 2003). There is, however, little justification that Rogers' category sizes fit all products (Mahajan, Muller, & Bass, 1990). Rather, products may have abnormal adopter category distributions (Peterson, 1973).

A diffusion model that addresses these two limitations, the coupled Bass Rogers (BR), classifies adopter categories and estimates both, product growth and innovation diffusion (Peres, Muller, & Mahajan, 2010; Scaglione, Schegg, & Murphy, 2009; Stremersch, et al., 2010). Addressing limitations of some website adoption studies, this paper draws on a coupled BR model and Malaysian hospitality data to calculate total website adoption and adopter categories.

This paper begins with technology diffusion literature followed by the methodology to predict hotel website diffusion in Malaysia. The paper compares the Malaysian findings with Swiss hotels and international chain hotels to compare hospitality website adoption across countries. The study closes with conclusions, limitations and recommendation for future research. This supports Da Silveira's (2001) argument that research on technology and innovation in developing economies should not always be grounded on theories derived from leading economies. As argued by Zhu and Kraemer (2005, p. 62), theories developed in "mature markets and industrialised economies need to be re-examined in the context of developing countries, because these countries may have very different economic and regulatory environments".

2 Literature Review

2.1 Organisational Diffusion

An early diffusion academic, French sociologist Gabriel de Tarde at the turn of the 19th century discussed society's acceptance and rejection of innovations (Kinnunen, 1996). Diffusion research continued during the 1940s and 50s as independent studies in anthropology, education, public health and medical sociology, marketing, management, communication, and general sociology (Rogers, 2003). Everett M.

Rogers' 1962 book, *Diffusion of Innovations* (DOI), the most cited work in innovation research (Jeyaraj, Rottman, & Lacity, 2006; Zhu & Kraemer, 2005), discusses adoption of innovations at the individual and organisational level. Rogers (2003, p. 12) defines an innovation as "an idea, practice, or object that is perceived as new by an individual or other units of adoption."

Organisational diffusion research, the focus of this study, examines characteristics related to the adoption and subsequent implementation of innovations. As Figure 1 shows, organisational diffusion studies comprise adoption and implementation research streams (Fichman, 2000; Rogers, 1962, 2003). Rather than adopting an innovation, implementation studies investigate organisational use of innovations. Adoption studies, far more popular than implementation studies, tend to focus on and model innovation diffusion rates and factors related to adoption (Fichman, 2004).

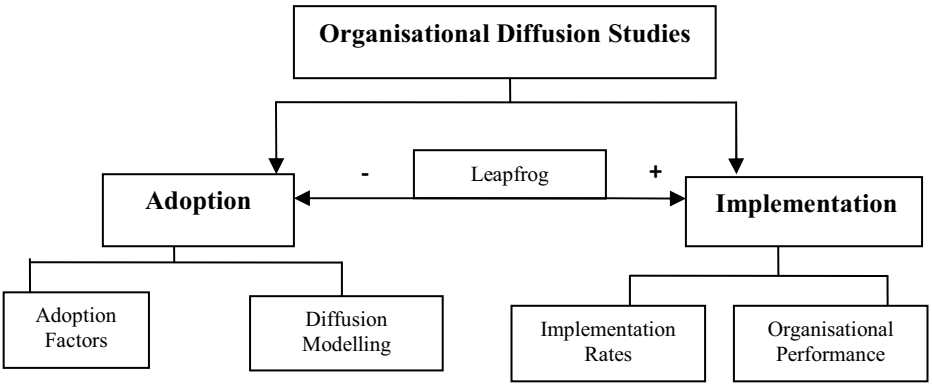

Fig.1. Organisational innovation diffusion studies

A meta-analysis of adoption studies identified three factors − organisational, innovation and environmental – common to the organisational adoption of an innovation (Jeyaraj, et al., 2006). Thanks in part to half a century of research, adoption factor studies seem to be reaching maturity. Most studies conclude that individuals and organisations with "greater innovation-related needs and abilities or the Right Stuff are more likely to adopt an innovation than those with less needs and abilities (Fichman, 2004, p. 315)".

2.2 Diffusion Modelling

Diffusion modelling studies examine market diffusion, adoption rates and adopter categories (Bass, 1969; Mahajan, et al., 1990). Internet diffusion follows an abnormal *distribution* due to complex and diverse economic, political, cultural, infrastructural and geographical factors (Andrés, Cuberes, Diouf, & Serebrisky, 2010; Kim, 2011), and adopter categories differ in technology implementation. At the individual level, American Online users categorised as innovators preferred content-based online information while laggards preferred interpersonal information (Stafford, 2003). Similarly, a study on multimedia message services found significant differences in perceived use between potential adopters and users (Hsu, et al., 2007).

At the organisational level, a study of medium-large US and Singapore firms found significant website design differences between early and late adopters (Teo & Pian, 2004). The early adopters, in addition to providing information, provided transactions, customer services and personalisation. The late adopter websites mainly provided information. As well, a study of top 1000 US and Taiwan companies found most Taiwanese companies online used their sites for presenting product information. The US companies gave information and also used their sites for customer relationship (Liao, To, & Shih, 2006).

Despite differences across adopter categories, there is a lack of theoretical support and few reliable and valid measures for adopter category constructs (Mahajan, et al., 1990). Nor is there justification for uniform adopter category sizes for all products. Many products have abnormal adopter category distributions (Hsu, et al., 2007; Peterson, 1973) and Roger's (2003) normal distribution underestimates many diffusion patterns (Mahajan, et al., 1990). Furthermore, recent IT studies show abnormal diffusion patterns across product generations, such as today's smart phones (Kauffman & Techatassanasoontorn, 2009; Stremersch, et al., 2010). These rapidly improving technologies enjoy a shorter takeoff period but similar overall growth relative to other technologies (Stremersch, et al., 2010).

2.3 Modelling Innovation Diffusion

Given limitations with Roger's (2003) model, studies develop data and innovation-specific adopter categories (Mahajan, et al., 1990). Diffusion models such as Peterson (1973), Bass (1969) and Stremersch et al., (2010) also fit abnormal distributions. Rather than adopter categories based on given percentages, their categories are geographically and innovation specific. The coupled Bass and Rogers diffusion model, "has the dual advantages of allocating adopter categories based on actual data and reflecting two coefficients—innovation and imitation—that influence adoption (Scaglione, et al., 2009, p. 626)."

Bass (1969) improved Rogers (1962) model by quantifying two factors that drive individual and organisational adoption, *innovation* driven by external channels such as mass communication and *imitation* driven by internal communication such as word of mouth. Equation 1, below, shows the Bass function (1969) for the growth of a new product.

$$\frac{dN(t)}{dt} = \left[p + q\frac{N(t)}{m} \right](m - N(t)) \qquad (1)$$

N(t) is the cumulative number of adopters at time t, m is the total market adoption, parameters p and q, the coefficients of innovation and imitation, respectively (Bass, 1969).

2.4 The Bass Rogers Model

Mahajan et al. (1990) used Rogers' bell-shaped adopter categories and Bass' parameters to develop the Bass Rogers (BR) model. The three inflection points in Figure2 below–T1,T and T2–set the adopter categories in the BR model (Mahajan et al., 1990; Mahajan, Muller, & Wind, 2000). Up to T1, the adoption rate increases rapidly and delineates Early Adopter and Early Majority categories. From T1 to the

peak T, the highest adoption rate, the adoption rate continues to rise, but at a slower rate. T separates the Early Majority and Late Majority. From the peak, T, the adoption rate decreases slowly until T2, when the rate slows to a crawl. T2 separates the Late Majority and Laggards. Figure 2 shows these inflection points and adopter categories for Malaysian hotels.

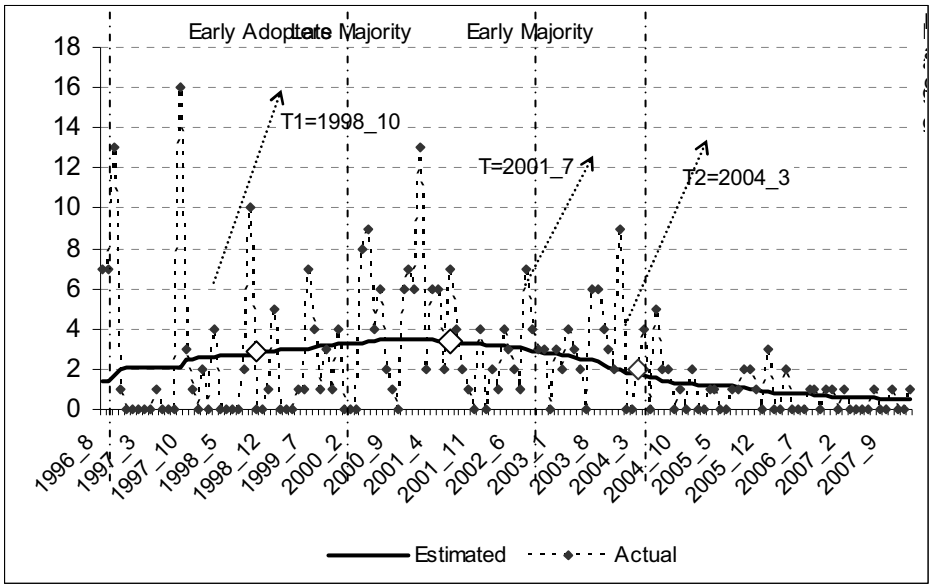

Fig.2. Malaysian BR model estimates, monthly adoption

2.5 Innovation and Imitation

The innovation coefficient *p* suggests the propensity of an initial purchase in the first time interval, up to T1 (Schmittlein & Mahajan, 1982). The imitation coefficient *q*, reflects the propensity of an initial purchase in the second time period, from T1 to T. The second time interval is driven by [$p+qN(t)/m$]. This latter probability is an addition of the probability of adopting by innovation (*p*) plus the probability of adopting by imitation. As *p* is constant, the probability of adopting by imitation is proportional to the total number of adopters before ($N(t)/m$). With pure innovation, p=1, Equation 1 is an exponential function. With pure imitation, q=1, Equation 1 is a logistic function (Meade & Islam, 2006).

Apart from these extreme cases, the sum and ratio of *q* and *p* suggest the shape of the diffusion curve. The sum controls the dispersion. The ratio $q/p > 1$ indicates a bell shaped non-cumulative adoption and S-shaped cumulative adoption. The bigger the ratio, the more pronounced the S-shape (Meade & Islam, 2006). Shapes of the S curves and *q/p* ratios help compare adoption across countries.

Van den Bulte and Stremersch's (2004) analysis of *q/p* ratios across 28 countries and individual adoption of 52 consumer durables found, among other aspects, a positive relationship between the *q/p* ratio and income inequality. The bigger a country's income inequality, the more that innovation rather than imitation drove adoption.

Likewise, the bigger a country's income equality, the more that imitation rather than innovation drove adoption

At the organisational level, a study of German banks showed that relative to non-interactive innovations, the diffusion of interactive innovations (i.e. Electronic Funds Transfers and home banking for private customers) was slower until reaching a critical mass of adopters. The S-Shape for the non-interactive innovations was more pronounced than for interactive innovations. As shown in Figure 3 shows, critical mass makes the innovation valuable, and once reaching critical mass, the adoption rate accelerates.

Critical mass is less an objective number of adopters and more the perceived number of adopters. If individuals have similar resistance/attraction, namely the *threshold*, to the innovation based on the objective number of critical mass' adopters, the innovation will never launch, but individuals and organisations have different threshold of resistance to innovation adoption (Mahler & Rogers, 1999).

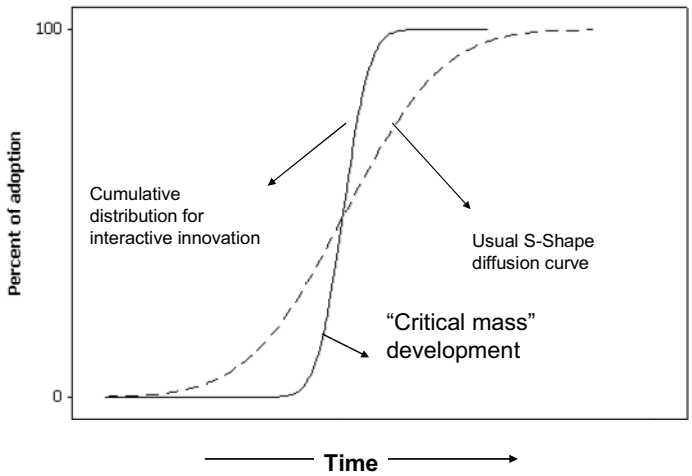

Fig.3. Cumulative distribution for *interactive* (solid line) and *non-interactive* (dotted line) innovations based on (Mahler & Rogers, 1999)

Nonlinear least square (NLS), a popular method to estimate parameters *p* and q, can have problems with a correctly specified model (Van den Bulte & Lilien, 1997). Even if the NLS estimates converge in probability to the estimated parameter value, they may be biased. There is no way to exclude that the estimation differs systematically from the parameter. A second problem with estimating Bass parameters is available observations. Censored data has only partial information available. As censored data decreases, the estimated coefficient of imitation (*q*) decreases whereas *p* and *m* increase (Van den Bulte & Lilien, 1997, p.242).

The estimated final market size, *m*, merits cautious interpretation. The calculated eventual penetration a new technology may seriously underestimate the potential market. Furthermore, the technology will evolve and may die.

2.6 Leapfrogging Across Technology Generations

A 2010 article in the magazine *Wired* argues that the web is dead. "Over the past few years, one of the most important shifts in the digital world has been the move from the wide-open Web to semi closed platforms that use the Internet for transport but not the browser for display (Anderson & Wolff, 2010)." Future Internet use, business and individual, may shift to applications for social networking or peer-to-peer sharing rather than the traditional website. As the eventual use of an innovation takes about 30 years to mature (Fidler, 1997), tourism and hospitality website studies may be examining an endangered species.

Furthermore, those late to adopt a technology may leapfrog early adopters in effective technology use (Davison, et al., 2000). For some individuals, organisations (Amir, 2004; Gallagher, 2006; Hobday, 1995; Rosenkranz, 1997) and countries (Gray & Sanzogni, 2004; Rosenkranz, 1997; Steinmueller, 2001), being late to adopt has advantages. This leapfrog effect accelerates technology implementation in industries such as manufacturing, aviation, energy and health (Amir, 2004; Gallagher, 2006; Hobday, 1995; Rosenkranz, 1997). For developing nations - Thailand, Egypt, and Malaysia - technology leapfrogging helps narrow productivity and output gaps, and helps reduce research and development costs (Gray & Sanzogni, 2004; Steinmueller, 2001). The following methodology models website diffusion in a developing country, Malaysia, as a preliminary step towards investigating leapfrogging.

3 Methodology

The data stemmed from an Internet adoption study of all 540 hotels registered with the Ministry of Tourism Malaysia (Hashim, Murphy, Purchase, & O'Connor, 2009). As the Ministry database provided no website or email addresses, keying the 540 hotel names into Google and Yahoo returned 315 hotel urls and 10 closed hotels. The 530 operating hotels ranged from 10 to 1,234 rooms, 39% were chain affiliated and 42% had one or two stars, followed by 28% with three stars and 30% with over three stars.

As the BR model requires time-series data, this study used website age from the Wayback Machine (www.archive.org). This online tool showed a significant positive correlation between website age and domain name age ($r=.933$, $p<.001$) for Malaysian hotels (Murphy, Hashim, & O'Connor, 2007). Gathering the website age from the Wayback Machine yielded 305 hotel website ages from the 315 hotel websites. Password-protected, dynamic sites and owner exclusion requests help explain the 10 hotels without a website age. The remaining 305 hotels had an average age of five years and age range in 2007 from seven months to over nine years.

BR parameters p, q and their ratio q/p help compare an innovation's diffusion across countries (Van den Bulte & Stremersch, 2004). For cross country evaluations, this research takes Scaglione, Steiner, Schegg, & Murphy's (2005) analysis of Swiss hotels' adoption of domain names and international chain hotels retrieved from hotelsmag.com in July 2006 (Scaglione, Ismail, Trabichet, & Murphy, 2010).

4 Results and Discussion

4.1 Malaysian Hospitality Website Adoption and Adopter Categories

This study classified adopters using the coupled BR model (Scaglione, et al., 2009) and the 305 Malaysian hotels with website age. The authors estimated Bass model parameters using two nonlinear regressions, which both replace continuous time by discrete periods (Lilien & Rangaswamy, 2002). These two estimations use SAS Institute V9.2 routines Proc nlin and Proc Model (SAS Institute Inc., 2011). Calculations for the total market, namely all hotels that will adopt websites at the end of the diffusion process were 316.9 (std=13.6), 316.9 (std=12.8), respectively for Proc nlin and Proc Model. The results converge on 317, but omit the 10 hotels with an unknown website age, for a total market size of 327 websites or 62% of the 530 hotels. Table 1 shows Rogers' (2003) proposed adopter category percentages, BR estimates and the observed adoption.

Table 1. Market Size and Adopter Categories for Malaysian Hotels

	Rogers	BR limits	BR estimate	Observed	Average website age (days)	Hotels actual	BR hotels eventual
Innovators	2.5%	0.2-2.8%	2.2%	2.2%	4248	7	7
Early Adopters	13.50 %	9.5-20%	15.5%	15.5%	3962	49	49
Early Majority	34%	29.1-32.1%	32.6%	32.6%	2942	103	103
Late Majority	34%	29.1-32.1%	33.5%	33.5%	2035	106	106
Laggards	16%	21.4-23.5%	16.1%	12.7%	1004	40	51
Total	100%	100 %	100%	96.2%		305	317
Adopters without Wayback age							10
Final Total Adopters							327
Total							530

Table 1 shows that the percentage of B-R categories follows the theoretical values except for Late Majority and Laggards. For Late Majority, the estimate (33.5%) is 1.4% higher than the upper value of the BR theoretical limit of (32.1%), which is acceptable in terms of model estimation errors. The case of Laggards is in the opposite direction, 40 actual adoptions and 51 eventual adoptions. This difference shows that the diffusion has not stopped.

4.2 Comparing Hospitality Website Diffusion

Table 2 below shows a comparison of the BR estimates for Malaysian, Swiss and international chain hotels, listed by the date when adoption peaked, T. The first sector to peak was international chain hotels, in September 2000. The Malaysian hotels

followed almost a year later, in July 2001, and the Swiss hotels hit their maximum adoption rate another seven months later in February 2002. The inflection points T1 and T2 tend towards symmetry around the peak T for international and Malaysian hotels; Swiss hotels show an asymmetric distribution around T. International chain hotels lagged about 28 months from T1 to T and 26 months from T to T2. For Malaysian hotels the first lag is 34 and the second 33 months. Swiss hotels differ, with 62 and 22 months respectively. Thus, Swiss hotels shows a slower diffusion process before the maximum peak of adoption will be reached than the others and at least comparable or higher speed after it. Moreover, Swiss hotels are the one that reach the maximum peak the latest in time, 8 months after Malaysian hotels and 17 months after international hotels chains.

Table 2. Comparative BR model coefficients and adoption dates

Sector	Time range	T1	T	T2	*p*	*q*	*q/p*	Source
International hotel chains	Dec-96 Feb-07	Jun 98	Sep 00	Nov 02	.0043	.0455	10.7	hotelsmag. com (July 2006)
Malaysian hotels	Nov-96 Jun-08	Oct 98	Jul 01	Apr 04	.0037	.0364	9.85	this paper
Swiss hotels	Oct-96 Feb-06	Jan 97	Feb 02	Nov 01	.0038	.1381	36.8	(Scaglione, Steiner, Schegg, & Murphy, 2005)

The comparison shows $q/p > 1$, suggesting an S-shaped cumulative distribution as in Fig 3, across all three sectors. Malaysian and International chains have comparable q/p ratios, 9.85 and 10.7 respectively, whereas the Swiss is three times greater. All three sectors had similar coefficients of innovation (p), but the Swiss hotels had over triple the coefficient of imitation (q) relative to Malaysian and international chain hotels. The Swiss hotel's asymmetric adoption distribution curve and their highest q/p ratio suggest concerns about competitive pressure, imitation, driving adoption relative to Malaysian and international chain hotels. The Swiss hotels lagged in the formation of a critical mass of adopters relative to the Malaysian and International chain hotels. As a result, the Swiss early majority hotels took three times longer to adopt than did the Swiss late majority category. Critical mass and imitation may have played a more important role for Swiss hotels relative to the Malaysian and international chain hotels.

5 Conclusion and Recommendations

5.1 Academic Implications

Comparing Malaysian hotels Internet diffusion with Swiss and international chain hotels provides a holistic view of Internet diffusion process. In addition, replicating studies into other geographical areas provides insights and helps increase the

generalisability of previous findings and theory on Internet diffusion. This study adds to diffusion literature by identifying total market size and adopter categories using BR model. All three sectors adopted websites at about the same time, yet critical mass and imitation seemed to hinder the early adoption rate and accelerated the late adoption of Swiss hotel websites. The results suggest that 38% of Malaysian hotels may never adopt traditional websites.

5.2 Business Implications

As the Internet becomes essential for operational and strategic purposes (Bai, Law, & Wen, 2008; Nasution & Mavondo, 2008) hotels without the Internet face competitive disadvantages. This study shows that 38%, over one in three Malaysian hotels will never have a website similar to today's traditional websites. However, to ensure the hotels benefit from the technology, the decision to adopt necessitates long and short term planning. However, web usage continues to evolve. These never-to-adopt Malaysian hotels may leap over their colleagues and start their Internet presence with new applications such as a Wordpress blog, Facebook fan page or Googlepage rather than a traditional website. Swiss hospitality sector shows a higher level of parsimony in this adoption those Malaysian hotels.

6 Limitations and Future Research

One limitation of this study is no complete hotel list, rather a census of the 540 hotels registered with the Ministry of Tourism Malaysia. Extending and comparing the population to other locations, particularly developing countries, could improve the generalisability of the results. Future research could also examine other factors relating to Internet leapfrogging such as system legacy (LaRose, 2009) and cloud computing (Knorr & Gruman, 2008). In addition, the analyses rely on the website age provided by the Wayback Machine site. As some sites do not provide access, future research could ask hotels for the website age. Future research could also examine the role of other country-level variables such as Internet users, the evolution of overnights, and Gross Domestic Product as exogenous variables in the *Bass model* (Bass, Jain, & Khishnan 2000; Scaglione, Schegg, Steiner, & Murphy, 2005). This latter research will shed light on the different dimension in the perception of critical mass and allow comparisons across countries.

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