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A LOGISTIC REGRESSION ANALYSIS TO EXAMINE FACTORS AFFECTING BROADBAND ADOPTION IN THE UK

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Abstract

Although the commonly used Internet Service Provider's business models based on price comparison may prove to be a successful strategy for organisations in the short term, it may be argued that a sustainable business model for the long term requires a detailed understanding of the various factors that may help ISPs in attracting future customers. This paper therefore examines the influence of a range of factors - including costs and resources - on the adoption of broadband within U.K. households. A survey research approach was utilised to examine the effect of a total of six constructs from attitudinal (utilitarian outcomes, hedonic outcomes), normative (social influence), control (self-efficacy and facilitating conditions resources) and demographic (age) categories on the behaviour of consumers when adopting broadband within U.K. households. Results indicate that all the aforementioned constructs, apart from hedonic outcomes, significantly influenced the adoption behaviour of consumers. In addition to a discussion of the findings, the paper outlines the contributions and limitations of the study and provides suggestions for future research activity.

Keywords: Broadband Adoption, Factors, Logistic Regression Analysis, Survey, U.K.

1 INTRODUCTION

Broadband is deemed to be the most significant evolutionary step since the emergence of the Internet. It is considered to be a technology that offers end-users fast and always-on access to new services, applications, and content with real lifestyle and productivity benefits (Sawyer et al 2003). International organisations such as the Organisation for Economic Co-operation and Development (OECD) regard broadband as being a vital means of enhancing competitiveness in an economy and for sustaining economic growth (BSG 2004, Crabtree 2003, OECD 2001, Oh et al 2003). According to a report from the United Kingdom Broadband Stakeholder Group, there are a number of ways in which a nation's economy and its citizens' lives can be positively impacted through the adoption and utilisation of broadband:

"…Societies that adopt, adapt, and absorb the benefits of broadband enabled ICT, services and applications quickly and deeply will achieve significant benefits in terms of productivity, innovation, growth and quality of life as well as significant competitive advantage over societies that don't…"(BSG 2004).

A recent report by the European Scrutiny Committee (April 2006) further emphasises the significance of broadband in aiding the development of nations by asserting that:

"The European Union must step up its efforts to encourage take-up of broadband services and stimulate further deployment, in particular in the less developed areas of the Union" (European Scrutiny Committee 2006).

Within the U.K. context, nationwide efforts by the U.K. government and increasing competition amongst the various Internet Service Providers (ISPs) have made broadband access widely available to consumers at affordable prices (Choudrie & Lee 2004). From the outset, ISPs focused heavily on the single issue of charging a monthly cost for broadband access in order to reach out to new customers.

A comparison of the different subscription packages offered by the various U.K. providers suggests that their marketing efforts use factors such as speed, download limit, duration of contract and monthly cost as means of attracting customers (See www.compare-uk-broadband.com). By doing so, ISPs make efforts in order to reduce their price in comparison to competitors. However, although this may prove to be a successful strategy in the short term, it can be suggested that a sustainable business model for the long term requires a detailed understanding of other factors, beyond those mentioned above, that may help ISPs to attract future customers. In light of this, the aim of this paper *is to examine the influence of various factors, including utilitarian outcomes, hedonic outcomes and perceived resources, on the adoption of broadband within U.K. households.*

It is recognised that studies examining the issue of demand constraints on the adoption and diffusion of broadband are only just beginning to emerge (Anderson et al 2002, Oh et al 2003, Stanton 2004) and are exploratory in nature (Choudrie & Dwivedi 2005, 2004b). Nonetheless, progress has been made in developing conceptual models in order to understand the diffusion of broadband adoption (Choudrie & Dwivedi 2004a). Furthermore, in order to test the conceptual model of broadband adoption and diffusion, a reliable survey instrument has also recently been developed and validated (Dwivedi et al 2006). Such constructs which have been developed and validated in previous studies in providing insights concerning the issue of broadband adoption within U.K. households.

Having introduced the topic of interest, this paper now proceeds to offer a discussion on predictive constructs in Section 2. Section 3 presents a brief discussion of the research methodology adopted in this study. The findings are then presented in Section 4 and subsequently discussed in Section 5. Finally, Section 6 provides conclusions including research contributions, limitations and future research directions drawn from this research.

2 BROADBAND ADOPTION CONSTRUCTS

The constructs included in this study were adapted and modified from the conceptual model of broadband adoption (Dwivedi 2005). This model is derived from the model of technology adoption in households (Venkatesh & Brown 2001). The proposed conceptual model assumed that the dependent variable 'broadband adoption' is influenced by several independent variables that include the attitudinal (utilitarian outcomes and hedonic outcomes), normative (social influence), control factors (self-efficacy and facilitating conditions resources) and demography (age). A detailed discussion and justification for including the aforementioned constructs are provided below and definitions of each of the constructs are summarised in Table 1.

Constructs	Definitions of constructs and sources
Utilitarian Outcomes (UO)	It is the extent to which broadband internet usage enhances the effectiveness of household activities such as, undertaking office work at home, children's homework, information or product search and purchase and home business (Venkatesh & Brown 2001).
Hedonic Outcomes (HO)	Hedonic outcomes are defined as the pleasure derived from the consumption, or use of broadband Internet. For example, the entertainment potential of the Internet via offerings such as, online radio, streaming audio and video, electronic greetings, online games, online casino (Venkatesh & Brown 2001).
Social influences (SI)	Social influences are defined as the perceived influences from friends and family to subscribe to and use (or not to subscribe and use) broadband Internet services (Taylor & Todd 1995, Venkatesh & Brown 2001).
Self-efficacy (SE)	Self-efficacy is defined as the perceived ability or skill to operate computers and the Internet (narrowband or broadband) without the assistance of others (Taylor & Todd 1995, Venkatesh & Brown 2001).
Facilitating Conditions Resources (FCR)	Facilitating conditions resources is defined as the perceived level of resources when subscribing to broadband (Taylor & Todd 1995, Venkatesh & Brown 2001).

Table 1. Definition of the behavioural constructs included in this study

Venkatesh and Brown (2001) proposed and validated the utilitarian outcomes factor that can be used to examine the adoption and usage of technology in a household setting. Utilitarian outcomes are the extent to which using a PC enhances the effectiveness of routine, household activities, such as budgeting, homework and work (Venkatesh & Brown 2001). It has been suggested that broadband can offer a more flexible lifestyle (BSG 2004). For instance, many people subscribe to broadband in order to work at home instead of travelling to the office; broadband can assist children with their homework, and many more household activities can be performed conveniently using the faster access of Internet offered via broadband. Therefore, it is expected that the greater the perception of broadband's usefulness for work or household related activities, the more likely that broadband technology will be adopted in the home.

The Venkatesh and Brown (2001) study found that hedonic outcomes is one of the factors that influences PC adoption in the home. Venkatesh and Brown (2001) defined hedonic outcomes as pleasure derived from PC use; for example, games, fun and entertainment. Heijden (2004) described hedonic information systems as self-fulfilling and strongly connected to the home and leisure activities, focused on the fun aspect of using information systems, and encouraged prolonged rather than productive use (Heijden, 2004). Empirical findings from the Venkatesh and Brown (2001) study established that when adopting a technology, the role of entertainment (PC games, Video games) was important as a factor for consideration on the consumer decision-making process (Venkatesh & Brown 2001). Previous studies suggest that the entertainment potential of a PC offers a possibility to escape reality and become immersed in a new environment. Such characteristics are consistent with a hedonic perspective (Foxall, 1992, Venkatesh & Brown 2001). Hence, the entertainment potential of a PC is much more enhanced by the advent of the Internet: it offers the opportunity of playing online games,

downloading music and video, chat and sending online messages. However, this potential was severely hampered by the slow speed of dial-up Internet. The barrier of slow speed was overcome by broadband technology, which offered benefits in terms of data, faster download speeds and streaming capabilities to Internet users; hence more convenient and compelling environments. Recent studies (Lee et al 2003, Lee & Choudrie 2002) suggest that one of the most important factors that was responsible for broadband adoption in South Korea was the PC bang phenomenon. Similarly, a study by Anderson et al (2002) suggests that broadband users are more likely to use the Internet for fun and entertainment in comparison to narrowband users. Considering the entertainment potential that broadband offers, it is expected that individuals who perceive broadband as a good entertainment medium will also be likely to adopt the technology.

For the purposes of this research, social influence from friends, colleagues/peers and family members that takes the form of a conversation, messages and assists in forming perceptions of broadband adoption is considered to be a primary influence (Venkatesh & Brown 2001). Considering the findings from previous studies (Venkatesh & Brown 2001, Taylor & Todd 1995), this research assumes that if broadband adopters are influenced by their social networks with positive messages, they are more likely to have a strong behavioural intention to adopt broadband.

The South Korean government's vision recognised an affordable monthly cost of broadband for middle-income households as one of the most important factors that led to the high rates of adoption (Choudrie & Lee 2004, Lee & Choudrie 2002). An exploratory study on broadband adoption in the U.K. also suggests that a high monthly cost is a major barrier that is inhibiting the adoption of broadband in households (Dwivedi et al 2003). Therefore, it is expected that if the perceived cost of obtaining broadband is high and perceived resources are low, then adoption will be slow.

Since the use of broadband also requires using a PC and the Internet, the ease or difficulty of use and requisite knowledge of a PC and Internet use are expected to have an impact upon broadband adoption. The South Korean government deployed a variety of promotion policies (Choudrie & Lee 2004; Lee & Choudrie 2002). "The Ten Million Program" was designed to boost Internet use amongst housewives, the elderly, military personnel, farmers and excluded social sectors such as low-income families, the disabled and even prisoners. This promotion of providing PC and Internet skills in the year 2000 contributed towards the adoption of the Internet. A total of 4.1 million new online users, including one million housewives, occurred as a result of such initiatives (Choudrie & Lee 2004; Lee & Choudrie 2002). Therefore, it is expected that household users with basic PC and Internet skills or, in other words, with higher self-efficacy are more likely to adopt broadband.

3 RESEARCH METHODOLOGY

This research adopted the survey approach to examine the factors affecting consumer adoption of broadband. The survey instrument for this study was developed in a number of stages comprising exploratory survey, content validity, pre-test, pilot test and confirmatory survey (Moore & Benbasat 1991, Straub et al 2004). Although it is not possible to describe the research approach, reliability and validity from the exploratory study, content validity, pre-test, pilot test and confirmatory survey within this paper, the full methodological details and findings of these stages are available in an earlier study on the development and validation of the survey instrument (Dwivedi et al 2006).

Nationwide data on the adoption of broadband was randomly collected from the citizens of the U.K. The U.K.-Info Disk V11 that contained 31 Million Electoral Register records- the addresses of U.K. citizens- was considered as the sample frame for this research due to the fact that it possesses the recognised characteristics of a good sample frame such as comprehensiveness, accuracy, adequacy, and up-to-date and non-duplicated information (Fowler 2002, Rice 1997).

Prior to the dissemination of the final questionnaire, a pilot study was conducted in order to determine the response rate and learn of any discrepancies within the questions, which included determining whether the format of the questionnaire and the questions was suitable. Additionally, the time

required for completing the questionnaire was established. The questions utilised were grouped into the following two categories: (1) multiple type questions examining the demographics of the respondents, and (2) Likert scale questions to assess the perception of the adopters and non-adopters of broadband. The pilot questionnaire was delivered via post to a total of 200 randomly selected participants from the U.K.-Info Disk V11 in December 2004. A total of 40 replies were obtained from the respondents within the specified duration. The majority of the respondents reported that the questionnaire was easily understandable and required 10 to 15 minutes for completion. Additionally, the majority of the respondents validated the content of the questionnaires, although minor changes to the final design of the questionnaire were undertaken based upon the received feedback, and a final questionnaire was developed. The pilot test also helped to confirm the reliability of the items; the findings obtained from the pilot test demonstrated an acceptable level of reliability for all the constructs.

Fowler (2002) has suggested that a prerequisite for determining a sample size should be an analysis plan. The analysis for this study required performing principal component analysis (PCA) and regression analysis. It has been suggested that in order to perform such statistical analysis with rigour, the sample size should be above 300 (Stevens 1996). Therefore, keeping the statistical analysis plan in mind, it was estimated that the total sample size of 1600 should be adequate for obtaining a minimum of 300 responses. As with the pilot questionnaires, the final questionnaires were distributed via post together with a covering letter and a self-addressed, prepaid return envelope to 1600 household consumers in the U.K. in the period between January and March 2005.

3.1 Response rate and non-response bias

Of the 1600 administered questionnaires, 358 usable replies were received within the specified period of January 2005 to March 2005. Thus, a response rate of 22.37 percent was obtained. To test whether the characteristics of the respondents from the original responses were similar to the non-respondents, a *t*-test was conducted for the demographics (age and gender), the type of Internet connection at home, and a number of key constructs. The findings are illustrated in Table 2. The *t*-test on demographics and all key constructs showed no significant differences between the respondents and non-respondents (Table 2). It emerged that all variables produced non-significant results in terms of non-response bias; this suggests that it is less likely that the findings were affected due to non-response bias.

Variables	***T***	**Df**	***p***
Age	.766	355	.444
Gender	.557	353	.578
RA	.377	356	.707
UO	-.996	356	.320
HO	.845	356	.398
SE	.072	356	.942
FCR	-1.079	356	.281

Table 2. t -test to examine non-response bias

3.2 Data analysis

The dependent variable, which measures consumers' broadband adoption behaviour, is categorical in nature and is represented by 'Yes' or 'No'. 'Yes' is equal to 1 if the respondent possesses broadband and 'No' is equal to 0 if they do not have broadband. It was also possible to employ the Ordinary Least Squares Regression to fit a linear probability model. However, the limitation of the linear probability model is that it may predict probability values beyond the 0.1 range; therefore, the logistic regression model was found more appropriate to estimate the factors which influence broadband adoption behaviour (Greene 1997).

4 FINDINGS

Of the 358 respondents, 308 (86%) had Internet access at home and 50 (14%) did not. Of the 308 (86%) respondents who possessed Internet access at home, 101 (32.8%) had a narrowband connection and the remaining 207 (67.2%) respondents had a broadband connection.

4.1 Logistic Regression Analysis

A logistic regression analysis was performed with 'broadband adoption' as the dependent variable and utilitarian outcomes, hedonic outcomes, social influence, self efficacy, facilitating conditions resources and age as the predictor variables. A total of 358 cases were analysed and the full model was considered to be significantly reliable (χ^2 (6, N = 358) = 100.666, p < .001) (Table 3). This model accounted for between 25.6% and 34.5% of the variance in broadband adoption (Table 4), and 84.5% of the broadband adopters were successfully predicted (Table 5). However, only 59.3% of the predictions for the non-adopters were accurate. Overall, 74.1% of the predictions were accurate (Table 5).

	Chi-square	df	Sig.
Model	100.666	6	.000

Table3. Omnibus Tests of Model Coefficients

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	360.030(a)	.256	.345

Table 4. Model Summary

Observed		Predicted		
		Broadband Adoption		Percentage Correct
		No	Yes	
Broadband Adopters and Non Adopters	No	83	57	59.3
	Yes	31	169	84.5
Overall Percentage				74.1

Table 5. Classification Table

Table 6 illustrates the coefficients, Wald statistics, associated degrees of freedom and probability values for each of the predictor variables. This shows that all variables except hedonic outcomes reliably predicted broadband adoption. The values of the coefficients reveal that each unit increases in UO and the FCR score is associated with an increase in the odds of broadband adoption by a factor of 1.86 (B=.625) and 1.75 (B=.562) respectively (Table 6). This means that usefulness of broadband (UO) has a maximum and a larger part in explaining actual adoption than cost and perceived income (FCR). The third largest variance in adoption behavior is explained by self-efficacy (SE) of consumers, which is followed by age of consumers (Table 6). 24.6% of total variance was accounted for by the social influence (SI) construct.

	B	Wald	df	Sig.	Exp(B)

UO	.625	15.160	1	.000	1.868
FCR	.562	23.963	1	.000	1.755
SE	.343	5.110	1	.024	.709
AGE	-.270	6.482	1	.011	.764
SI	.246	8.431	1	.004	.782
HO	.004	.002	1	.963	1.004
Constant	-4.409	13.970	1	.000	.012

Table 6. Variables in the Equation

5 DISCUSSION

The findings from the logistics regression analysis have suggested that age, utilitarian outcomes, social influence, facilitating conditions resources and self-efficacy comprise factors that directly affect consumer adoption of broadband. This is similar to findings that examined adoption of PC (Venkatesh & Brown 2001). However, in contrast to an earlier study (Venkatesh & Brown 2001) on PC adoption, this study suggests that hedonic attribute of broadband does not play a significant role in encouraging consumer adoption of broadband. A possible reason for the non significant effect of the hedonic outcomes construct could be the legal restriction against freeloading of music from the Internet (Anderson 2000, Bhattacharjee et al 2003, Cowen 2004, Premkumar 2003). The restriction is likely to reduce the impact on consumers' attitudes towards using broadband for entertainment purposes. Freeloading and peer-to-peer online sharing of music is considered similar to software piracy (Bhattacharjee et al 2003) and considered as life threatening to the music industry (Premkumar 2003). Since the early stages of high-speed Internet diffusion, digital freeloading of music has become a cause for concern for regulators and lawmakers in the United Kingdom and the rest of Europe (Anderson 2000). The sensitivity of the piracy issue became evident when the music industry across the Europe, including the U.K., sued hundreds of consumers who were engaging in sharing music files on the Internet (Cowen 2004). A study that examined the relationship between regulations, information technologies and human behaviour found that regulation did affect the human behaviour of file sharing in peer-to-peer applications (Mlcakova & Whiteley 2004). Therefore, such legal regulation might inhibit consumers to realise the entertainment potential of broadband. This was considered to be a plausible reason for why hedonic outcomes had a non significant effect on adoption behaviour.

5.1 Predictive ability

It is possible to compare the predictability of broadband adoption constructs to guiding models such as the Technology Acceptance Model (TAM), Theory of Planned Behaviour (TPB) and Decomposed Theory of Planned Behaviour (DTPB). This is because dependent constructs such as behaviour and the structure of the broadband adoption model are similar to TAM, TPB and DTPB. Table 7 illustrates the comparison of previous studies for the adjusted R^2 obtained for behavioural construct. The comparison clearly demonstrates that the broadband adoption model performed as well as the previous studies. Adjusted R^2 for behaviour varied between 0.32 (Davis et al 1989) to 0.51 (Davis 1989); the adjusted R^2 for this study was found to be 0.345, which suggests the appropriate level of explained variance. This means that the independent variables considered in this study are important for understanding consumers' broadband adoption behaviour.

Study	Theory	Adjusted R^2 for Behaviour
Davis et al (1989)	TAM	0.45
Davis et al (1989)	TRA	0.32

Davis (1989)	TAM	0.51
Taylor & Todd (1995)	DTP	0.34
Taylor & Todd (1995)	TPB	0.34
Taylor & Todd (1995)	TAM	0.34
Current Study	TPB + DTPB + MATH	0.35
Recommended level (Straub et al 2004)	---	0.40 or above

Table 7. Comparison of Adjusted R^2 obtained from this study from previous studies

5.2 Contributions to industry and policy

The findings of this research generate a number of issues that may assist both policy makers and ISPs for understanding consumer adoption of broadband. For example, it is recognised that facilitating conditions resources is the second most important factor in terms of influencing adoption behaviour. This has implications for both ISPs and policy makers. For instance, ISPs have to think about more consumer centric services and alternative price plans so that all consumers who want to subscribe broadband to be able to do so. Policy makers have to provide alternative places for broadband access where lower income groups or those who cannot afford it can use it, which may help to encourage the overall adoption and diffusion of broadband within U.K. households.

As mentioned above, self-efficacy is also an important factor that influences consumers' behavioural intentions to adopt broadband, which brings to the forefront policy-related issues. This suggests that there is a need to equip citizens with the skills to use computers and the Internet. Since utilitarian outcomes is an important factor for explaining adoption behaviour, it is important to integrate more content and applications for the purpose of household and entertainment utility. By obtaining results such as those afforded by this research, the reasons for slow adoption can be explored and appropriate measures can be developed and implemented so that they can be overcome. For example, age has a negative influence on adoption behaviour which means that people in the older age groups are less likely to adopt broadband and the possible reasons for that could be: (i) insufficient resources, i.e. lack of income to subscribe to broadband; (ii) lack of skills to operate a computer and the Internet; and (iii) lack of awareness about the potential benefits of broadband adoption. Therefore, the key challenge for policy makers is to implement ways of involving older and elderly citizens into the mainstream information society.

As discussed before, broadband service providers may face two key challenges. First, there are consumers who cannot afford the current price plan. Therefore, the ISPs may consider providing alternative price plans in order to create a mass-market demand, which is an issue currently being emphasised. Second, some of the consumers with a high annual household income may also be reluctant to subscribe to broadband due to a lack of compelling content; hence, the challenges to the ISPs are to integrate content and applications and make them apparent to the ordinary members of the public. The ISPs may overcome these challenges by offering differential price plans and segment specific broadband subscription packages. For example, the ISPs can differentiate within the offered subscription price ranges depending upon factors such as the income levels and needs of the users. Further ideas of fulfilling this challenge are as follows. First, with an increasing demand in the lower income segments and those with fewer needs for broadband, ISPs may offer price plans that can compete with the current price plan of un-metered narrowband. Currently, there is a price gap between the two packages; therefore, a low price plan of un-metered narrowband may be an inhibiting factor for broadband adoption in the segments with lower incomes and fewer needs. Second, since cost is not a factor for consideration when segmenting between the higher income and occupation levels, it should be offered in broadband packages with even faster speeds and appealing content. Such packages may assist in illustrating the clear benefits of broadband over narrowband to consumers of higher incomes and occupation levels, and provide them with added reasons for subscribing to broadband.

6 CONCLUSIONS

The following main conclusions are drawn from this research: a total of six constructs from attitudinal (utilitarian outcomes, hedonic outcomes), normative (social influence), control (self-efficacy and facilitating conditions resources) and demographic (age) categories were expected to influence the behaviour of consumers when adopting broadband within U.K. households. All these constructs, except hedonic outcomes, were found to significantly influence consumers' behaviour. In terms of the size of the effect of the five constructs that contributed significantly to the adoption, utilitarian outcomes exhibited the largest, and social influence demonstrated the least variance. Facilitating conditions resources explained the second largest variance, which was followed by self efficacy. The fourth strongest construct was age and the fifth was social influences. This research presents one of the initial efforts towards understanding the adoption behaviour of broadband within U.K. households.

6.1 Research limitations and future research directions

This study provides a snapshot of the adoption behaviour of broadband within U.K. households. The findings may therefore change as technology becomes established and consumers become more experienced in its use. However, as this research has a limited completion timeframe, it is not possible to conduct further data collection in order to observe the effect of time on adoption behaviour. The findings would also have been reinforced if the research had been longitudinal in design. By undertaking a longitudinal study, the elimination of any variables could achieve anomalies in the obtained results.

This study focused upon utilising a quantitative approach that may have limited the ability of this research when attempting to obtain an in-depth view of household technology adoption. The questionnaire findings would have been strengthened if it had been possible to supplement them using interviews. However, due to time and resources constraints, it was not possible to conduct both qualitative and quantitative research. With regards to adoption in the future, this research intends to examine whether the findings obtained from this study are specific to U.K. households or whether the results will be the same across other countries. This would require a cross-cultural approach when understanding broadband adoption.

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