In search of broadband's tipping point – a conceptual model.

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Abstract
This paper proposes a conceptual model for the study of broadband adoption by drawing on literature from a range of academic disciplines and commercial research. Broadband has entered the start of the 'early majority' (Rogers 2003) adoption phase by mainstream consumers with approximately 25% of Australia's 7.6 million households currently having a broadband Internet connection. What takes a mainstream consumer from 'awareness' to the purchase of a broadband service? This is an important question, as it is the adoption by mainstream consumers which will provide the critical mass required to make it viable to deliver new government and commercial services via broadband.

The model proposed by this paper builds on the mature information systems models UTAUT (Venkatesh, Morris, Davis & Davis 2003) & TAM (Venkatesh & Davis 2000) used for studying technology adoption in the workplace, as well as the MATH (Brown & Venkatesh 2005) model developed for technology adoption in the home. Using a range of variables identified from across several disciplines, a working model is proposed specifically for the study of consumer adoption of interactive communications technologies (CAIT) like broadband Internet. The key constructs used in the CAIT conceptual model are: technology orientation; lifestyle motivations; perceived complexity; perceived usefulness; information sources and image. Departing from existing models, this paper theorises that these constructs are direct determinants of a consumer's desirability to adopt a technology and their purchase intention is moderated by perceived cost.

Once empirically tested using broadband adoption as the technology studied, the CAIT model may prove useful in studying adoption intention for digital television, Internet television, 3G mobile phones and other consumer technologies or services.

Key words: adoption, broadband, diffusion, communications technology, consumer behaviour, model, UTAUT, MATH, TAM, CAIT.

Introduction

Studying the diffusion and adoption of technology by consumers is an area which can benefit from insights from a range of traditional academic discipline areas including information systems, sociology, psychology, communication, marketing and consumer behaviour. Adoption models attempt to identify the key factors most likely to influence behavioural intention. The purpose of this paper is to propose a new model for the study of consumer adoption of interactive technologies (CAIT), like broadband Internet. It starts by reviewing existing technology adoption models to identify the key constructs likely to be important in broadband adoption by mainstream consumers and then proposes a theoretical model (CAIT) synthesised from the previous work.

Building from Rogers' innovation diffusion theory (IDT) (2003), Moore (2002) considers a 'chasm' exists between the first 16% (the 'innovators' & 'early adopters') of the potential adopting population and the next 68% (the 'early majority' & 'late majority') of 'mainstream' consumers. He describes the mainstream consumers as

'pragmatists' and this early majority of the mainstream phase is where broadband adoption in Australia is currently. With approximately 25%[1] of Australia's 7.6 million households having a broadband connection to the Internet; the key question for governments, telecommunications carriers, content providers, and those wanting to stimulate broadband adoption, becomes "what motivates a mainstream consumer to adopt broadband?"

For the purpose of the development of this model, broadband can be considered any 'always-on' Internet connection with a downstream speed of at least 200 kbps. This excludes some ISDN (Integrated Services Digital Network) connections which can run at 64 kbps or 128 kbps, but includes a range of technologies available to consumers for accessing broadband Internet including ADSL[2], cable, wireless & satellite.

The conceptual model proposed by this paper aims to describe and predict a consumer's behaviour in relation to the actual adoption process of deciding to install a broadband Internet connection. It is not attempting to describe and predict usage patterns of the broadband connection once established. This perspective is important when considering which existing literature will be relevant for the development of the CAIT model.

Literature overview

Work across several disciplines (Rogers 2003; Moore 2002; Bass 1969; Mahajan, Muller & Bass 1990) shows social factors and social influences have a stronger influence on mainstream consumers than the innovators or early adopters. Rogers' (2003) work from a sociology perspective is the best known of these and he describes five attributes of innovations which can be studied in trying to predict their rate of adoption. In addition Rogers describes a five stage process he calls the innovation-decision process. The second of these stages is 'persuasion', where the innovation's characteristics influence the next 'decision' phase of adoption or rejection.

The process from the persuasion to the decision stage in Rogers' (2003) innovation-decision process (see Figure 3) is the specific area of interest for this paper. In the popular press Gladwell (2002) has described this transition as the 'tipping point'. He outlines how some ideas and products spread like viruses or epidemics, while others fail to gain any traction. Moore (2002) describes technology 'mainstream' consumers as wanting the 'whole product', where the generic product fits with their expectations, but also provides the add-ons (peripherals, support, interoperability), as well as seeing some future potential for satisfying their growing needs. In developing a model of consumer adoption of technology, the idea of matching both current and perceived future needs is important. A more general view of consumer influence is provided by Cialdini (2001), a psychologist. He sees the six principle categories of influence as: reciprocation, consistency, social proof, liking, authority and scarcity. The principal of social proof is most relevant to informing the development of a model explaining why consumers adopt technology. Cialdini (2001, p.140) says people look at others they see similar to themselves to see what they are doing, particularly where the situation contains

[1] This figure is the author's extrapolated estimate based on the latest figures released by the ACCC in September 2005 which covered all broadband connections in Australia to the end of June 2005. It assumes 73% of all broadband connections are residential and the quarterly growth rate remains 18.8%, as it was for the first two quarters in 2005.

[2] ADSL (Asymmetric Digital Subscriber Line) is a technology used to transmit digital information over the existing copper telephone lines and is the most common way people access broadband Internet in Australia.

uncertainty. Adopting a new technology is a situation which can be seen as containing uncertainty for many consumers. This idea of social proof or social influence is a common theme throughout the literature (Venkatesh, Morris, Davis & Davis 2003; Brown & Venkatesh 2005; Moore & Benbasat 1991).

There is a range of work in the marketing literature devoted to the communication channels used to inform decision making in the innovation diffusion process. The Bass (1969) model has formed the basis of much of this work which is well summarised by Mahajan, Muller & Bass (1990). The Bass model shows that interpersonal influences become more significant as we move through the adoption curve (see Figure 1). The Bass model assumes potential adopters are influenced by the mass media (external influence) and word of mouth (internal influence).

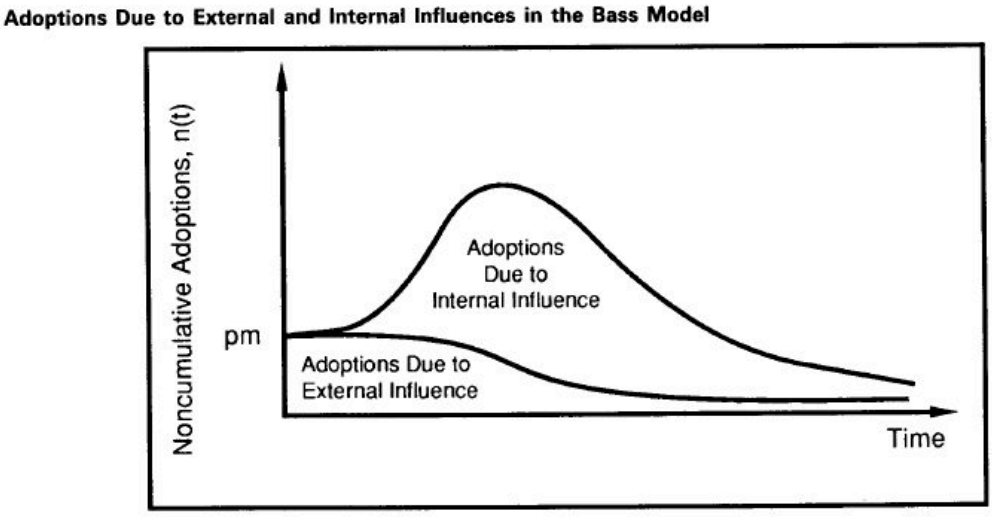

Figure 1 – Mahajan, Muller & Bass 1990, p.4.

In the information systems discipline over the past 20 years there has been a considerable body of research devoted to explaining individuals' intentions to adopt technology. The most mature of these streams of research is in the area of adoption in an organisational context. This field of research was brought together by Venkatesh et al. (2003) proposing the UTAUT (Unified Theory of Adoption & Usage of Technology). With their model explaining up to 70 percent of the variance in intention in an organisational setting, they speculated that "…we may be approaching the practical limits of our ability to explain individual acceptance and usage decisions in organisations" (p.471).

Recently Brown & Venkatesh (2005) have empirically tested and extended their Model of Adoption of Technology in Households (MATH), first proposed in 2001 (Brown & Venkatesh 2001). This model was developed and tested in the context of personal computer (PC) adoption in households and explains 74 percent of the variance in intention to adopt a PC for home use.

The choice of PC adoption is interesting in the context of the development of the MATH model. Around 75% (Infoplease 2005) of US homes have a PC, meaning the adoption cycle is well into the 'late majority' stage (Figure 2), with only the 'laggards' left to adopt. It is well documented that the 'late majority' & 'laggard' segments of the

adoption cycle have particular characteristics (Rogers 2003, p.284-285), so some caution needs to be exercised in assuming the application of the MATH (Brown & Venkatesh 2005) model across the adopting population segments.

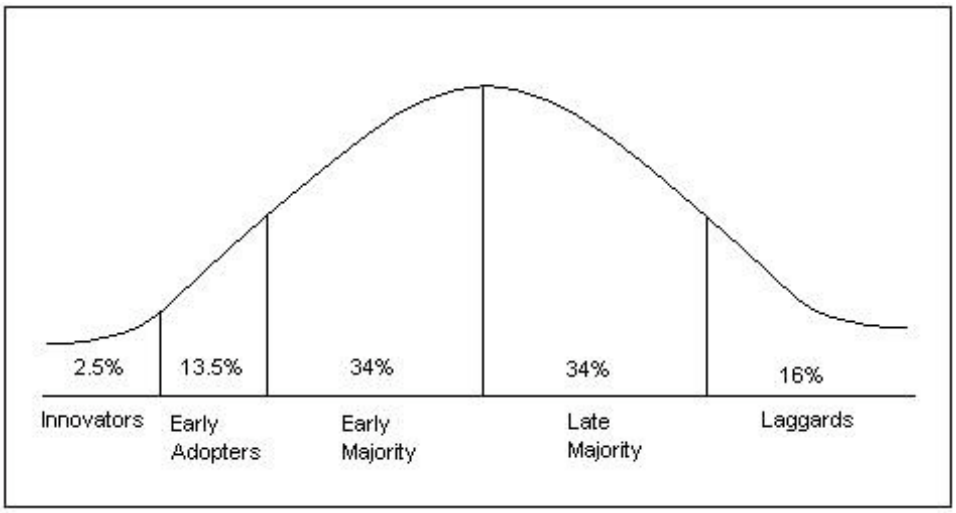

Figure 2: The non-cumulative diffusion of innovations by adopter category over time – Rogers 2003, p.281

The diffusion model views the whole innovation decision process as having five stages (Rogers 2003, p. 170) involving: knowledge; persuasion; decision; implementation; & confirmation.

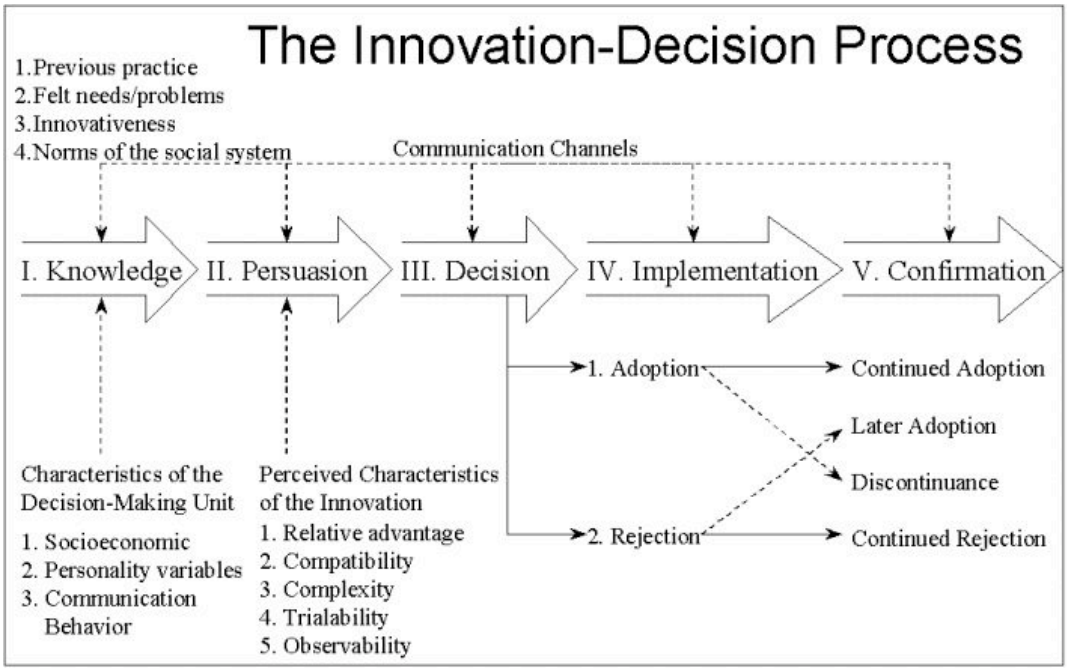

Figure 3: The Innovation-Decision Process – from Rogers 2003, p.170

For the purpose of developing the research model proposed here, we are interested in the key influences at the **persuasion** stage and how they translate into the **decision** phase of adoption or rejection. From Figure 3, it can be noted the five perceived characteristics of an innovation (relative advantage; compatibility; complexity;

trialability; & observability) identified by Rogers (2003) are important at the **persuasion** stage of the innovation-decision process.

Recently Choudrie & Dwivedi (2004) have proposed their own conceptual model for broadband adoption, use and impact. Only the adoption constructs they hypothesis are of interest in the context of this study. They identify the key constructs as: **attitude towards behaviour** (the perception towards broadband technologies); **subjective norms** (the social influences that may affect the intention to adopt broadband); and **perceived behavioural control** (the beliefs about having the necessary resources and opportunities to adopt broadband). Choudrie & Dwivedi's (2004) conceptual model is highlighted to show similar work is currently underway. As their model draws heavily on the work of Venkatesh and Brown (2001), the subsequent release of a quantitatively tested model by Brown & Venkatesh (2005) has meant the model proposed in this paper draws directly from the data in the updated primary source.

Key areas of the above literature relevant to developing the proposed conceptual model are discussed below to provide the reader with the background for the development of the constructs.

Development of the conceptual model from the literature

UTAUT (Venkatesh et al 2003) and MATH (Brown & Venkatesh 2005) provide a solid foundation from which to build a model for explaining the intention by consumer's to adopt broadband. UTUAT proposes four constructs as being significant in user acceptance and usage behaviour. These are moderated by four key moderators as shown in Figure 4.

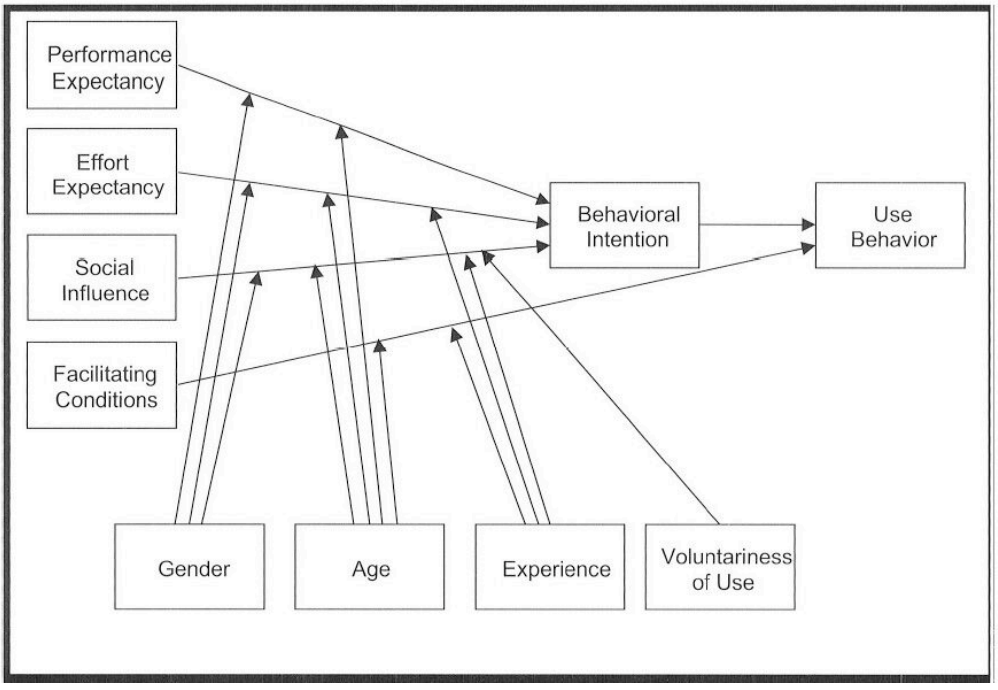

Figure 4: UTAUT (Unified Theory of Acceptance & Use of Technology) – Venkatesh et al 2003, p.447

The UTAUT constructs were developed by considering eight previous research theories of technology adoption and synthesising a model suitable for the organisational context. Given the maturity of this research model developed for individual technology adoption

in an organisational context, one pathway to developing a consumer adoption model would be to consider if the UTAUT model could be applied outside the organisational setting. It is worth noting the constructs in the UTAUT model may have been developed differently if it was theorised specifically for the consumer context where the need for an intervening step of purchasing the technology is required before you can use it. The perception of cost for a consumer would be highly likely to have an effect on purchase intention, while the role of voluntariness would seem unnecessary in a consumer setting. The UTAUT model has usage as the dependent variable; for the model proposed by this paper we are interested in purchase (or behavioural) intention as the dependent variable.

The definitions for the three constructs theorised by UTUAT to have a direct influence on behavioural intention are summarised below in Table 1.

Construct	***Definition***
Performance Expectancy	The degree to which an individual believes that using the system will help him or her attain gains in job performance.
Effort Expectancy	The degree of ease associated with use of the system.
Social Influence	The degree to which an individual perceives that important others believe he or she should use the new system.

Table 1 – UTAUT (Venkatesh et al 2003) construct definitions

While some slight modification of the wording would be required, the intent of the definitions for these three constructs would seem equally applicable in a consumer setting. Like the three constructs from the UTAUT model, Brown & Venkatesh's (2005) MATH model has behavioural intention as the dependent variable. It is based around three belief systems: attitudinal, normative and control. These are summarised in Figure 5.

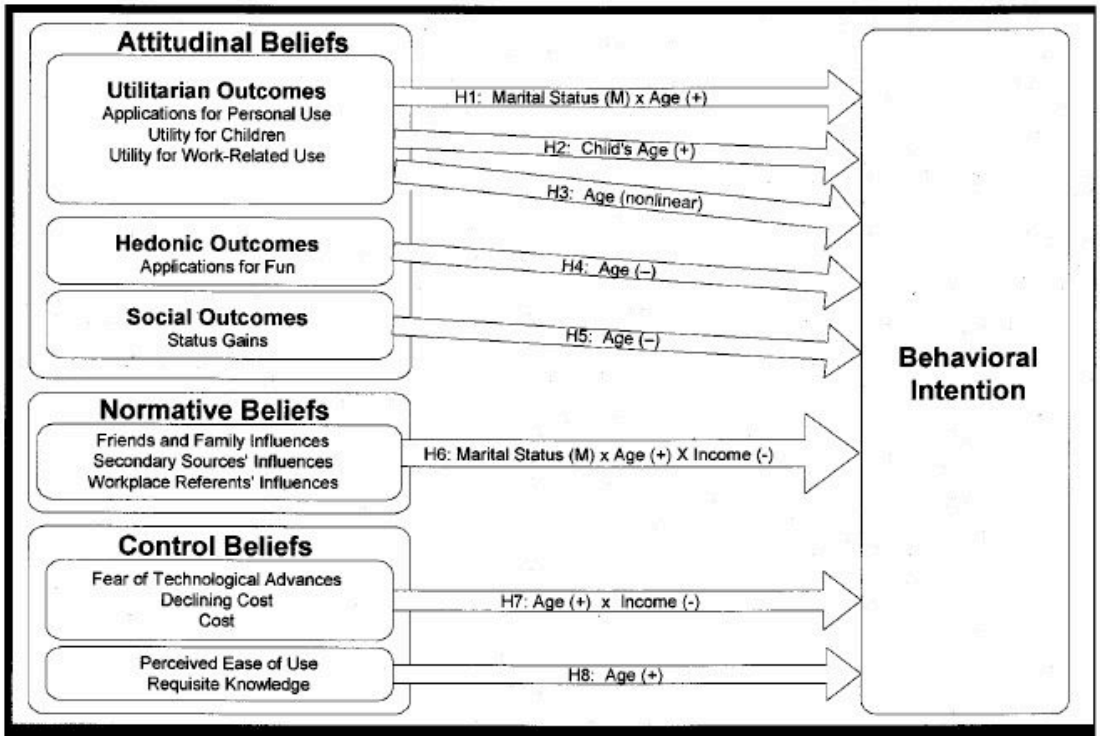

Figure 5: MATH (Model of Adoption of Technology in Households) – Brown & Venkatesh 2005, p.405

UTAUT (Venkatesh et al 2003) and MATH (Brown & Venkatesh 2005) tend to group current motivations and perceived future benefits in the same constructs. The **performance expectancy** construct from UTAUT is a perception of future benefit. A number of authors have used similar concepts in their models. Rogers' (2003) uses the term **relative advantage**, while in his technology adoption model (TAM) Davis (1989) called a similar concept **perceived usefulness**; the name we will adopt for the model proposed here. In contrast, MATH's **hedonic outcomes** and **utilitarian outcomes** are more measures of current motivations and behaviour in the consumer's existing lifestyle. The proposed model in this paper has l**ifestyle motivations** as measure of the primary motivations for the consumer's current behaviour, while a separate construct, **perceived usefulness,** will measures the perceived future benefit for consumers by adopting the technology. McDonald, Corkindale & Sharp (2003) found prior behaviour and/or perceived utility are strong predictors for early adopters in particular.

The construct **lifestyle motivations** is similar to Rogers' (2003) **compatibility** perception and builds on Forrester Research's Technographics model which segments the consumer population on three axis: primary motivation, income & technology optimism/pessimism (Modahl 2000). Forrester's Technographics model uses these three constructs to map 10 segments of the US population in relation to technology adoption (see Figure 6).

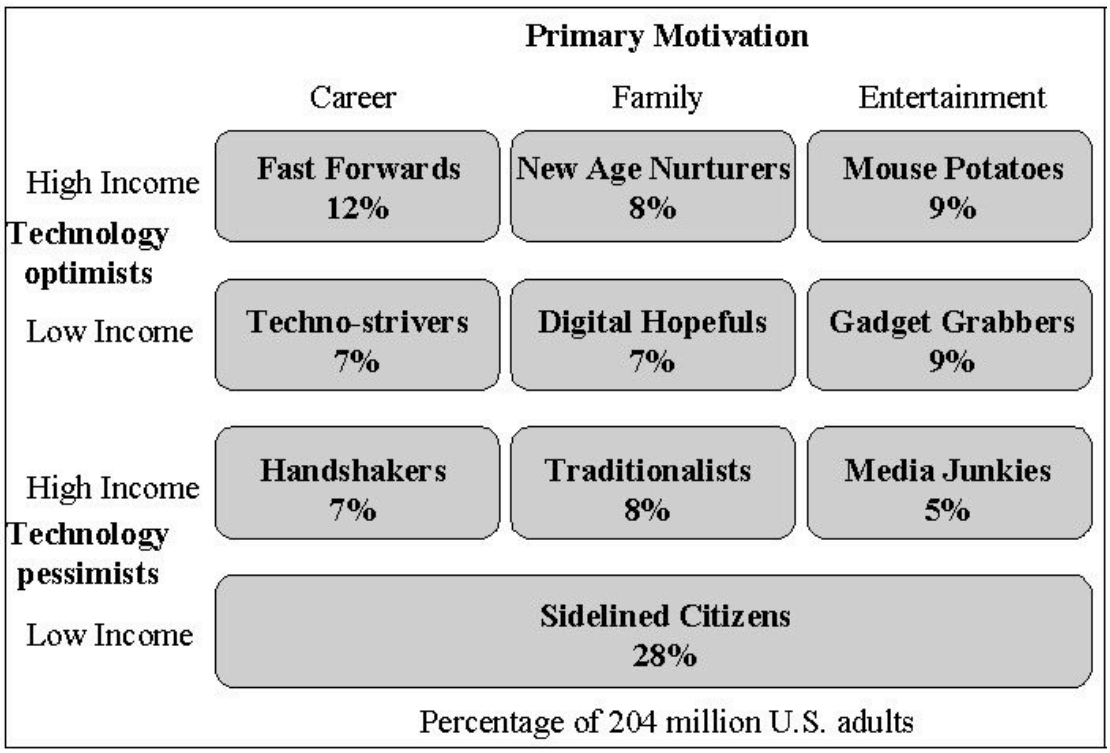

Figure 6: Forrester Research Technographics segments of U.S consumers – from Modahl 2000, p.6

The CAIT model proposed here views an individual's general orientation towards technology as a distinct construct from their perceptions of understanding and using the specific technology itself. CAIT uses **technology orientation** to describe an individual's optimistic or pessimistic attitude about technology, described as **self-efficacy** by Compeau & Higgins (1995). **Perceived complexity** is a separate construct in the proposed CAIT model measuring to what degree an innovation is perceived as difficult to understand and use. There is some debate in the academic literature as to whether **attitude** (sometimes called **anxiety** or **self efficacy**) towards using technology is a direct determinant of **behavioural intention**, or has an indirect affect mediated by constructs such as **perceived ease of use** (Venkatesh 2000). UTUAT (Venkatesh et al 2003) models attitude towards using technology as an indirect determinant of **behavioural intention** fully mediated by **effort expectancy**. In contrast other studies have found similar constructs to attitude as significant as direct determinants of behavioural intention (Davis et al. 1989; Fishbein & Ajzen 1975; Compeau & Higgins 1995; Compeau, Higgins & Huff 1999). Brown & Venkatesh's (2005) MATH model includes **fear of technological advances** and **perceived ease of use** as direct determinants of behavioural intention. The concept of an inbuilt technology orientation or general fear (or otherwise) of technological advances is supported by psychologist Cialdini (2001) who sees modern society as presenting a wealth of information and choices, and this "cognitive overload" (p.240) means consumers have to resort to shortcuts in their decision making about complex purchases such as technology items.

An **information sources** construct is proposed for the CAIT model to extend the **normative beliefs** construct from the MATH model (Brown & Venkatesh 2005) and the **social influence** construct from UTAUT (Venkatesh et al. 2003), by incorporating Rogers' (2003) IDT **trialability** concept. While social influence is important for mainstream consumers, they also source information from secondary sources like the

media and from first hand experience. The relative strength of these internal and external information sources changes during the diffusion process (Bass 1969).

Venkatesh et al. (2003) incorporate **image** into their **social influence** construct. Like the MATH model (Brown & Venkatesh 2005), the CAIT model proposed here distinguishes between the concept of using your social networks as sources of information (**information sources**) and Moore & Benbasat's (1991, p.195) definition of **image** as the perception of how an individual perceives their status being affected in their social system.

All of these constructs discussed so far are modelled in CAIT as direct determinants of **adoption desirability**, in keeping with the theoretical foundation stated earlier of building the research model on the key influences at the **persuasion** stage of Rogers' (2003) innovation-decision process (Figure 3). The next stage of Rogers' model, the **decision stage**, is where the adoption or rejection decision is made. For a consumer product or service, cost will play a role at this stage of the innovation-decision process.

Cost in another area of the literature where there is debate on the best way to incorporate this concept. Some models such as Forrester's Technographics (Modahl 2000) use **income**, while the MATH model (Brown & Venkatesh 2005) has **cost** and **declining cost** as direct determinants of behavioural intention. Moore & Benbasat (1991, p.194) view cost as a secondary attribute saying it is how the consumer considers price relative to their disposable income that is important. Incorporating this view into the CAIT model, we propose **perceived cost** acts as a moderating variable between **adoption desirability** and **purchase intention**.

The Consumer Adoption of Interactive Technology (CAIT) conceptual model and research propositions

After synthesising the key research from across several disciplines, the theoretical CAIT model in Figure 7 is proposed as a vehicle for studying broadband adoption and more broadly consumer adoption of interactive technologies.

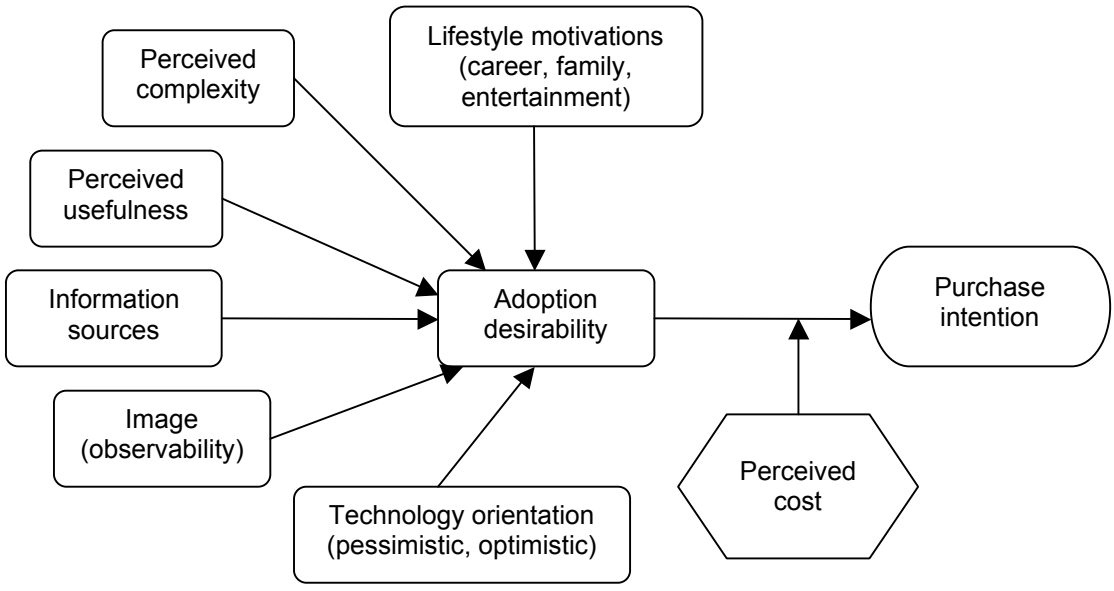

Figure 7 – Consumer Adoption of Interactive Technology (CAIT) working model

A range of constructs are used from the models discussed in the earlier literature review. Some of these are measuring similar concepts, but using different terminology. Table 2 summarises the constructs in the proposed model and identifies their origins.

Construct	***Definition***	***Theory or source***
Lifestyle motivations (Career, family, entertainment)	*the degree to which an innovation is perceived as consistent with the existing values, part experiences, and current needs of potential adopters (Rogers 2003, p.15)* Socio-economic motivations Current behavioural measure	Rogers 2003 – *Compatibility* Modahl 2000 – *Primary motivation* Brown & Venkatesh 2005 – *Utilitarian & Hedonic outcomes* McDonald, Corkindale & Sharp 2003
Perceived usefulness	*the degree to which a person believes using the innovation is an improvement over the technology it supersedes* Performance expectations	Rogers 2003 – *Relative advantage* Venkatesh & Davis 2000 – *Perceived usefulness* Lin 2003 – *Use factors* Venkatesh et al. 2003 – *Performance expectancy*
Technology orientation (Pessimistic, optimistic)	*an individual's optimistic or pessimistic feeling about technology* Self efficacy (character trait) Individual attitude towards technology	Modahl 2000 Brown & Venkatesh 2005 – *Control beliefs* Lin 2003 - *Adoption factors* Compeau & Higgins 1995 – *Self-efficacy*
Perceived complexity	*the degree to which an innovation is difficult to understand and use (Rogers 2003, p.16)* Perception of effort expectancy for using technology Perception of the attributes of the technology itself	Rogers 2003 - *Complexity* Venkatesh & Davis 2000 – *Perceived ease of use* Lin 2003 - *Technology factors* Brown & Venkatesh 2005 – *Control beliefs* Venkatesh et al. 2003 – *Effort expectancy*
Information sources	*the degree to which social influence, advertising, published reviews and exposure to a technology influence the development of an individuals normative beliefs* Social Influence Advertising Reviews Exposure/Trialability	Rogers 2003 - *Trialability* Brown & Venkatesh 2005 – *Normative beliefs* Mahajan, Muller & Bass 1990 Venkatesh et al. 2003 – *Social influence*
Image	*the degree to which use of an innovation is perceived to enhance one's image or status in one's social system (Moore & Benbasat 1991, p.195)*	Rogers 2003 - *Observability* Moore & Benbasat - *Image* Brown & Venkatesh 2005 – *Social outcomes*
Moderator: Perceived cost	*an individual's perception of cost (Moore & Benbasat 1991, p.194)*	Moore & Benbasat 1991 Brown & Venkatesh 2005 – *Cost, Declining cost*

Table 2 – Summary of CAIT construct definitions

The key constructs are listed below in Table 3 with preliminary propositions outlining their underlying reasons for inclusion in the proposed model.

CAIT construct definition	***Related Propositions***
Lifestyle motivations "the degree to which an innovation is perceived as consistent with the existing values, part experiences, and current needs of potential adopters" (Rogers 2003, p.15).	**P1:** The stronger the perception that using the innovation will match existing values and needs, the more likely it is to be adopted.
Perceived usefulness the degree to which a person believes using the innovation is an improvement over the technology it supersedes (Davis 1989, Rogers 2003).	**P2:** The stronger the perception the technology offers improved benefits over the existing technology, the more likely the innovation is to be adopted.
Technology orientation – an individual's optimistic or pessimistic feeling about technology (Modahl 2000).	**P3:** The more optimistic a person is about technology, the more likely they are to adopt innovations. **P4:** The more pessimistic a person is about technology the less likely they are to adopt innovations.
Perceived complexity - "the degree to which an innovation is difficult to understand and use" (Rogers 2003, p.16)	**P5:** The stronger the perception a technology is perceived as complex, the less likely it is to be adopted. **P6:** The stronger the perception a technology is difficult to use, the less likely it is to be adopted. **P7:** The perception of complexity to use will have a stronger influence on the adoption decision than the perception of the complexity of the technology itself.
Information sources - the degree to which social influence, advertising, published reviews and exposure to a technology influence the development of an individuals normative beliefs (Brown & Venkatesh 2005, Rogers 2003)	**P8:** Social influence will be the most significant information source in the adoption decision for mainstream consumers.
Image - "the degree to which use of an innovation is perceived to enhance one's image or status in one's social system" (Moore & Benbasat 1991, p.195).	**P9:** The more mobile and visible the innovation, the stronger the influence of image in the adoption decision. **P10:** Image will not be a significant factor in the adoption of broadband services in the home.
Perceived cost -an individual's perception of cost. This is a secondary attribute as it is how the consumer considers price relative to their disposable income that is important (Moore & Benbasat 1991, p.194).	**P11:** The higher the perceived cost, the less likely a consumer will adopt broadband.

Table 3 – Propositions related to CAIT constructs

Discussion

The subtle differences in the context used for the development of the models reviewed earlier in this paper is important in considering those constructs most appropriate for the proposed model. While the UTAUT (Venkatesh et al. 2003) is a comprehensive model building on a long tradition of research into technology adoption, it was conceptualised for the organisational context and is designed for the study of intention and usage. The recent release of Brown & Venkatesh's (2005) updated MATH model presents an opportunity to further explore the adoption of technology by consumers in households in a discipline dominated by workplace studies.

The CAIT model proposed by this paper theorises that a consumer builds a view of the desirability of adopting a technology like broadband Internet and perceived cost moderates their purchase intention. This is an alternative view to existing consumer adoptions models like MATH (Brown & Venkatesh 2005), who view cost as a direct determinant of behavioural intention.

It is interesting to note the **perceived complexity** construct has a negative influence on adoption and a pessimistic **technology orientation** may have the same effect. It could be reasonably argued these constructs are related, that is, a person with a pessimistic orientation is likely to perceive technology to be highly complex. While this has some intuitive basis, the constructs are conceptualised as distinct to clearly distinguish between a consumer's general self-efficacy or judgement of their orientation towards technology, and their perception of the characteristics and ease of use of the specific technology under study.

Limitations

The model proposed here has been conceptualised for the study of adoption desirability and purchase intention by consumers of broadband Internet. The constructs are measuring perceptions and are self-reported by the participants. Any research work formulated using this model will need to be aware of self reporting bias towards social desirability. That is, it is human nature to portray ourselves in a positive light, so careful consideration is required when formulating scales for any direct questions to measure these constructs in a future quantitative instrument (Fisher 1993).

A generalised model by definition has to be conceptualised at an abstract level. All the specific external and internal influences an individual may have cannot be accounted for in a parsimonious model. For example if broadband is not available where a person lives, this will be the deciding factor in their purchase intention. The models used in developing this paper where drawn from research undertaken in Western developed countries and cultural factors may be significant in both developing countries and other regions of the world.

The context and role of the particular technology under study should not be underestimated. Constructs which seem logical for broadband, may not automatically apply in the context of mobile phones for example.

Future research

While this model has been conceptualised from existing studies across a range of disciplines, only Choudrie & Dwivedi (2004) have specifically considered broadband as a technology when developing their conceptual model. The next phase of this research

should involve a qualitative study to examine what consumers say are the important issues when considering adopting broadband. This would provide some verification for the constructs used and identify any weaknesses in the conceptual model.

Once this qualitative research is completed, an improved model could be conceptualised and then empirically tested to ascertain its validity in explaining broadband adoption across the general population. If the model proved useful in the broadband context, it could be used as the basis of a model for other technologies such as digital television, 3G mobile phones, voice over IP and other consumer technologies. The inclusion of age and gender as potential moderators of the constructs may prove a useful addition to the generalised model and would provide valuable information of differences if tested across various technologies.

Conclusion

The CAIT (Consumer Adoption of Interactive Technology) model developed in this paper has drawn on work across several disciplines to inform the development of a technology adoption model specifically conceptualised for consumers. It theorises that consumers develop an **adoption desirability** which is moderated by perceived cost to reach their **purchase intention**. Future qualitative research will enhance the model before it is empirically tested on broadband Internet adoption. CAIT offers a framework for researchers to use when they are seeking empirically test and validate consumer's adoption of a range of interactive technologies like Internet television, 3G mobile phones and digital television.

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