

Diffusion theory vs. today's ICT environment

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Abstract

Whether described as a network or information society, digital economy or convergence era; underlying each of these concepts is the evolution towards an environment in which information and communication technologies (ICT) and services dominate. Since the early 90's, today's ICT environment has undeniably been one of the fastest evolving markets. Within the scope of this paper we wonder to what degree the traditional theoretical framework for the study of the adoption and diffusion of ICT still holds in this profoundly changed environment. Based on a meta-analysis of adoption and diffusion studies, and empirical research on the adoption intention for DTV and UMTS, we learn that diffusion theory can still be a valuable framework for the study of adoption diffusion, on the condition that there is some necessary reorientation concerning the shape of diffusion patterns, segment profiles and adoption determinants.

Keywords: diffusion theory, ICT, diffusion pattern, segment profiles, adoption determinants

Introduction

A global phenomenon in today's society is the (potentially) unlimited access to and the massive use of information and communication technology services. As the creation, distribution, integration, use and manipulation of (digital) information has become a significant economic, political and cultural activity all over the world, we entered the information society. The importance of information technologies and their role in contemporary society has been subject to many works using a range of labels and concepts such as the post-industrial society (Bell, 1973), knowledge industry (Machlup, 1962) or network society (Castells, 1996; van Dijk, 1999). In its digital strategy, Europe has identified information technology as the main driver for becoming the most dynamic and competitive knowledge-based economy in the world. Hence, the European Commission considers ICT as key enabling technologies for achieving an inclusive European information society that promotes sustainable economic growth and greater social cohesion (CEC, 2010).

In establishing this inclusive information society European governments are being challenged by today's ICT environment that can hardly be compared to the times when Bell and others wrote their masterpieces. Owing to far-reaching globalisation, competition and convergence, ICT companies have ended up in an innovation spiral. Within this spiral, an increasing number of ICT products are launched in ever shorter time

intervals that cut down product life-cycles but fuel user adoption (Coutts et al., 2005). However, this exponential increase of ICT-related innovations is accompanied with an even faster increasing number of failing innovations. Each year, the ICT market is spoilt with hundred of high-tech start-up products that, despite having superior technology and promising returns, falter and fail (Moore, 2006; Slater & Mohr, 2006). On the one hand, there are the rapid technological advancements, confronting users with a broad range of multi-featured innovations succeeding each other at a pace they can barely follow (Montaguti et al., 2002). On the other hand, these superfast developments seem to be accompanied by a certain slowness of adoption and diffusion since an increasing number of these innovations fail to reach mass market (Cooper & Edgett, 2009). Hence, since the dawn of this new ICT environment in the mid '90's, this raises the more or less paradoxical question of *'how come it goes so slowly when it goes so fast?'* (Lennstrand, 1998a: 5).

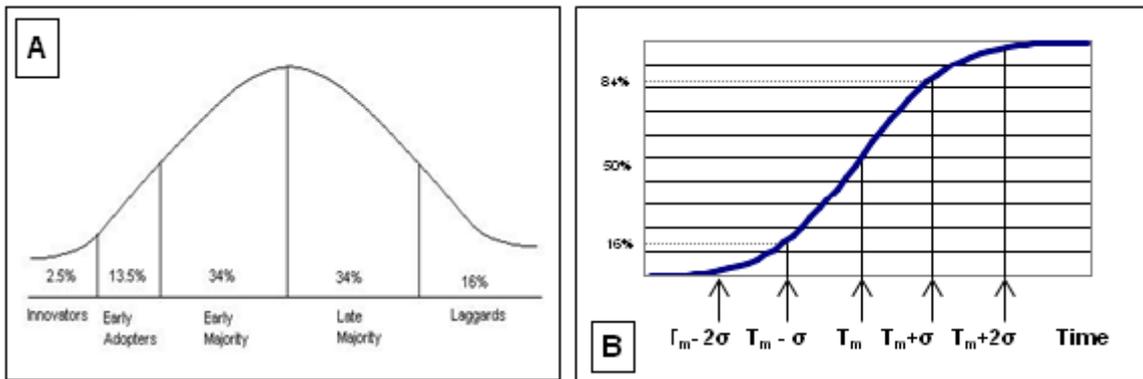
Irrespective of the cause of these market failures, whether it be the multitude of innovations and features overwhelming users with *'too much too soon'* (Sutherland, 1999), a lack of accurate prior-to-launch insight (Carayannis et al., 2003) or inefficient introduction strategies (Ottum & Moore, 1997, Roberts et al., 2005), adoption rates often stay far below the predicted patterns while *'an abundance of ICT-innovations is constantly struggling for market acceptance'* (Waarts et al., 2002: 412). Understanding the conditions for technology acceptance has become of vital importance not only for industrial and marketing purposes, but also for policy makers who should formulate effective measures in the light of overcoming the existing and even growing digital inequalities (Verdegem & Verhoest, 2009). As the rapidity of technological advances is resulting into certain slowness that takes the form of getting stuck after adoption by the so-called innovators and some early adopters, acquiring profound insights in the process of technology acceptance has become extremely important in view of the development of the inclusive information society.

Rogers' diffusion theory

The roots of these ubiquitous innovator and early adopter concepts lie in diffusion theory, of which Everett Rogers is considered to be the founding father.¹ The central assumption of the theory is that the penetration or diffusion of technology innovations follows a normal bell-shaped distribution pattern. In this diffusion pattern, the theory distinguishes between five adopter segments, for which the theory holds to fixed assumptions on their size, profiles and adoption determinants. According to Rogers (2003), innovativeness or the timing of one's adoption decision is assumed to be determined by the subjective perception of a set of product features (*relative advantage, complexity, compatibility, trialability and observability*). Innovators and early adopters, for example, are assumed to have a higher perception of

relative advantage than the majority segments and a lower complexity perception. The aggregation of adoption decisions for all individuals in a social system is assumed to result in a normal distributed diffusion pattern, in which innovators (2.5%), early adopters (13.5%), early majority (34%), late majority (34%) and laggards (16%) are distinguished. Aggregated cumulatively, diffusion is reflected in an S-shaped penetration pattern (Figure 1).

Figure 1: Non-cumulative bell-shaped (A) and cumulative S-shaped diffusion pattern (B)



For each of the adopter segments mentioned, diffusion theory also assumes typical demographic and psychographic profiles. Innovators, for example, are assumed to have a typically male, younger, upscale, more cosmopolitan and less dogmatic profile (Parasuraman & Colby, 2001; Green, 2002). Laggards, on the contrary, are assumed to be older, with a lower income, lacking curiosity, and socially more isolated (Weber & Evans, 2002). Whether these profiles are now formulated for five (Rogers, 1995; Moore, 2006), three (Veryzer, 2003; De Marez et al., 2008) or two earlier and later adopter segments (Wei, 2001), all authors using diffusion theory as framework stick to the assumption of fixed relationships between the profiling variables and a person's innovativeness. For the most recurrent profiling variables – socio-demographics – and the five adoption determinants, Table 1 summarizes these assumptions.

Table 1: Profile and determinant assumptions in diffusion theory

Socio-demographic profiles			Adoption determinants	
Profiling variable	Earlier adopters profile	Later adopters profile	Perceived innovation feature	Assumption
Gender	More male	More female	Relative advantage	The more an innovation is perceived as better than its alternatives or the idea it supersedes, the more innovative
Age	Younger	Older	Complexity	The more an innovation is perceived as relatively difficult to understand and use, the less innovative
Income	Higher income	Lower income	Trialability	The more there can be experimented with an innovation on a limited scale, the more innovative
Education	Higher education	Lower education	Compatibility	The more one perceives an innovation as consistent with the existing values, the more innovative
Household size	Two-income households	One-income households	Observability	The more the results of the (use of an) innovation are perceived to be visible to others, the more innovative
Job (status)	More job with higher status & prestige	More jobs with		

According to diffusionism, technological innovation and social progress in a given society are mainly determined by technology features. But this approach has been criticised for its *pro-innovation bias* and *ex post locus* (Li, 2004; Hartmann et al., 2006), its linearity in its assumptions on adoption decision processes (Tvede & Ohnemus, 2001), its lack of attention to the user and the innovation's specific context of use (Robertson, 1984; van de Wijngaert & Bouwman, 2009) and its lack of attention to non-users (Verdegem & Verhoest, 2009). As a consequence of this enduring wave of criticisms, Rogers (1983) and others felt induced to adjust their approach (e.g. by integrating post-adoption steps in the five step adoption decision process or by increasing emphasis on concepts as 're-invention'). Criticisms also induced the rise of new perspectives such as the social shaping of technology (SST) and domestication. In contrast to diffusionism, SST emphasises the importance of the social context in technology change, rather than seeing the latter as an independent force. Domestication then refers to the integration of technology in the daily patterns, structures and values of users (Silverstone & Haddon, 1996; Haddon, 2006). Although some rely on a more

social determinism (Bouwman et al., 2002), the domestication view should be seen from a mutual shaping perspective. One of the most compelling movements within SST is the actor-network theory (ANT), which strongly rejects technological as well as social determinism. It considers people, technologies and institutions alike as actors having equal potential to influence technological development (Callon et al., 1986; Latour, 1993). In addition, the human-computer interaction (HCI) tradition underwent some fundamental changes during the last decade. Originally focussing on computer engineering and human information processing, increasing emphasis has been put on the influence of culture, emotions and experience on technology design and development (Hassenzahl & Tractinsky, 2006). These critical approaches suggest that the adoption and use of technology are part of a more dynamic process and that they are context-dependent.

Despite the criticisms and convergence of alternative research perspectives, Rogers' diffusion theory remains a central basis for much research effort in ICT innovation and adoption as its terminology (innovators, early adopters, laggards etc.) and assumptions (segment sizes, segment profiles, adoption determinants) still provide a popular framework in media and communication studies as well as in the domain of business, management and marketing. However, as the theory is a starting point for many works within different disciplines, a scattered use of the approach is observed. Demographic profile assumptions are used for marketing purposes to select and target different types of adopter segments (Daghfous et al., 1999; De Marez et al., 2008), econometric diffusion models have the normal diffusion pattern as underlying premise for forecasting purposes (Bass, 1969), whereas social psychologists have used the determinant assumptions to develop innovativeness and personality scales (Assael, 2005; Goldsmith & Hofacker, 1991). The decades old assumptions of diffusion theory are still a fundament for a diversity of research in an severely changing ICT environment – albeit in a scattered and increasingly contested way. Within the context of this changing environment, this article aims to assess the strength or value of the integral theory that has been developed in the 1960s but whose assumptions on diffusion patterns, determinants, and segment sizes and profiles are still widely used for ICT adoption studies. The study then questions to what degree the theory and its three basic assumptions (remaining virtually unaltered in recent decades) still hold true in today's fast-evolving technology environment, and to what degree diffusion theory remains a reliable and valuable framework for the study of the adoption and diffusion of innovations. These research questions lead to the following hypotheses:

Hypothesis 1: The bell-shaped, normal distribution pattern with its fixed-sized segments no longer holds true in today's ICT environment

Hypothesis 2: The socio-demographic adopter segment profiles no longer hold true in today's ICT environment

Hypothesis 3: The assumptions on adoption determinants no longer hold true in today's ICT environment

Research methodology

The research set-up used to answer these questions consisted of a comprehensive combination of desk and empirical research. The desk research not only comprised a critical evaluation of diffusion literature and a meta-analysis of studies on diffusion patterns and determinants for ICT adoption, but also a critical investigation of socio-psychological, sociological and marketing economics literature on the topic of ICT adoption and diffusion. Such a crossing of communication research boundaries has previously been encouraged by several prominent communication scholars as Haddon (2004) and Lin (2003: 345): *'In the evolving research arena of mediated communication technology adoption and uses, one of the most valuable developments involves the increased integration of distinct communication research traditions. This emerging fusion presents an unprecedented opportunity for communication researchers to share, confer, and challenge the 'native' tradition that each has followed'*. Steinfield (1998: 31) adds by even warning communication researchers against *'repeating the mistakes of their past and ignoring what superficially appears to be something more in the domain of technologists, economists, lawyers, and marketing researchers'*.

Table 2: Overview empirical studies

Case	N	Industry cooperation	Method	Familiarisation	Data collection
DTV	1005	Leading cable operator, offering DTV since '05	Face-to-face	Illustrations + test device + DVD	Professional recruitment centre
3G UMTS	1223	Leading mobile operator, first to introduce 3G in '05	Face-to-face	Illustrations + test device	Professional recruitment centre

Parallel with this literature research, two large-scale user surveys were conducted in 2004 (N: 2228), both representative for Flanders by age and gender. By means of 50-minute face-to-face interviews, these studies gauged adoption intentions for DTV (digital television) and 3G/UMTS (third generation mobile data services) prior to their launch in Flanders (Belgium). Thanks to the close cooperation with the leading cable and mobile operators, respondents were able to test DTV and 3G devices during a period ranging from four to twelve weeks, ensuring a better familiarisation of respondents and an improved reliability of the findings. Each of these studies aimed for a (prior-to-launch) segmentation forecast for DTV and 3G, based on the PSAP intention-based scaling method that has proven to be a reliable and valid (construct, concurrent as

well as predictive) instrument for prior-to-launch detection of the potential innovators, early adopters, majority and laggards segments (De Marez & Verleye, 2004; De Marez et al., 2008; Evens et al., 2010).² Only to date, as the investigated technologies have reached (3G) or have passed (DTV) the point of critical mass in Flanders, the predicted diffusion patterns can be validated by comparing them with the actual diffusion patterns of DTV and 3G in Flanders, which were provided by the telecommunications operators.

Diffusion theory: what about pattern assumptions?

As sketched out earlier, diffusion theory always assumes a symmetrical, bell-shaped pattern of five adopter segments with a more or less fixed size. In the beginning, diffusion patterns are assumed to have a slow start among a small group of innovators (2.5%), adding up to a first inflection point (16%), leading to steep growth towards the peak of mass market acceptance (50%). Once the innovation enters maturity, adoption rate starts to decrease. To date, these assumptions are still used normatively by many players in the ICT field (for research and policy as well as for strategic purposes), suggesting that diffusion will follow a predestined law-of-order. Criticisms on this assumption of continuous linearity and symmetry already induced pleas for more flexibility in pattern and segment size assumptions (e.g. Goldenberg et al., 2006), but the bell-shaped curve covering 100% of the population divided over five segments with fixed sizes remains a basic assumption for many studies.

In today's ICT environment, however, the increasing number of failing innovations does not comply with this predestined law-of-order. More and more innovations do not succeed in fulfilling the linear diffusion pattern towards majority and laggards (Mante-Meijer & Ling, 2003). Once the innovators and early adopters have adopted, many innovations are confronted with a slowing down at the moment one expects the steep growth towards the mass market. Relying on concepts as 'the saddle', 'the ravine' or 'chasm', Goldenberg et al. (2002, 2006), Lennstrand (1998b) and Moore (2006) tried to grasp this discrepancy between reality and theoretical diffusion patterns. Contrary to the linearity of the diffusion theory pattern, each of them refers to discontinuity in the diffusion process. Rogers (2003: 282), however, always denied the existence of such discontinuities in diffusion patterns: *'Pronounced breaks in the innovativeness continuum do not occur between each of the five categories, although some scholars claimed that a discontinuity exists between the innovators and early adopters versus the early majority, late majority and laggards. Past research shows no support for this claim of a 'chasm' between certain adopter categories.'* Also our findings (see Figure 2) support the discontinuity claim, in line with the previously mentioned authors.

Therefore, not accounting for this discontinuity may be very misleading when using the traditional bell-shape as a basis for innovation research, policy or management (Fidler, 1997; Moore, 2006). Diffusion theory may create the erroneous impression that technology markets experience continuous and smooth development once they are initiated, which can lead to false expectations and consequently to wrong marketing decisions (Goldenberg, 2002). A first take-off may be wrongly interpreted as the breakthrough towards the mainstream market, or a backsliding may wrongly be interpreted as the end of the innovation (Montaguti et al., 2002). The traditional diffusion pattern holds the risk of what Fidler (1997: 11) calls 'technomyopia': *'a phenomenon that causes us to overestimate the potential short-term-impacts of a new technology. And when the world fails to conform to the inflated expectations, we turn around and we underestimate the long-term-implications. First we over-shoot and then we under-shoot.'* In order to avoid such myopia, a modification of the diffusion pattern approach seems to be necessary.

Figure 2: Adoption forecast (A) and year by year penetration growth (B)

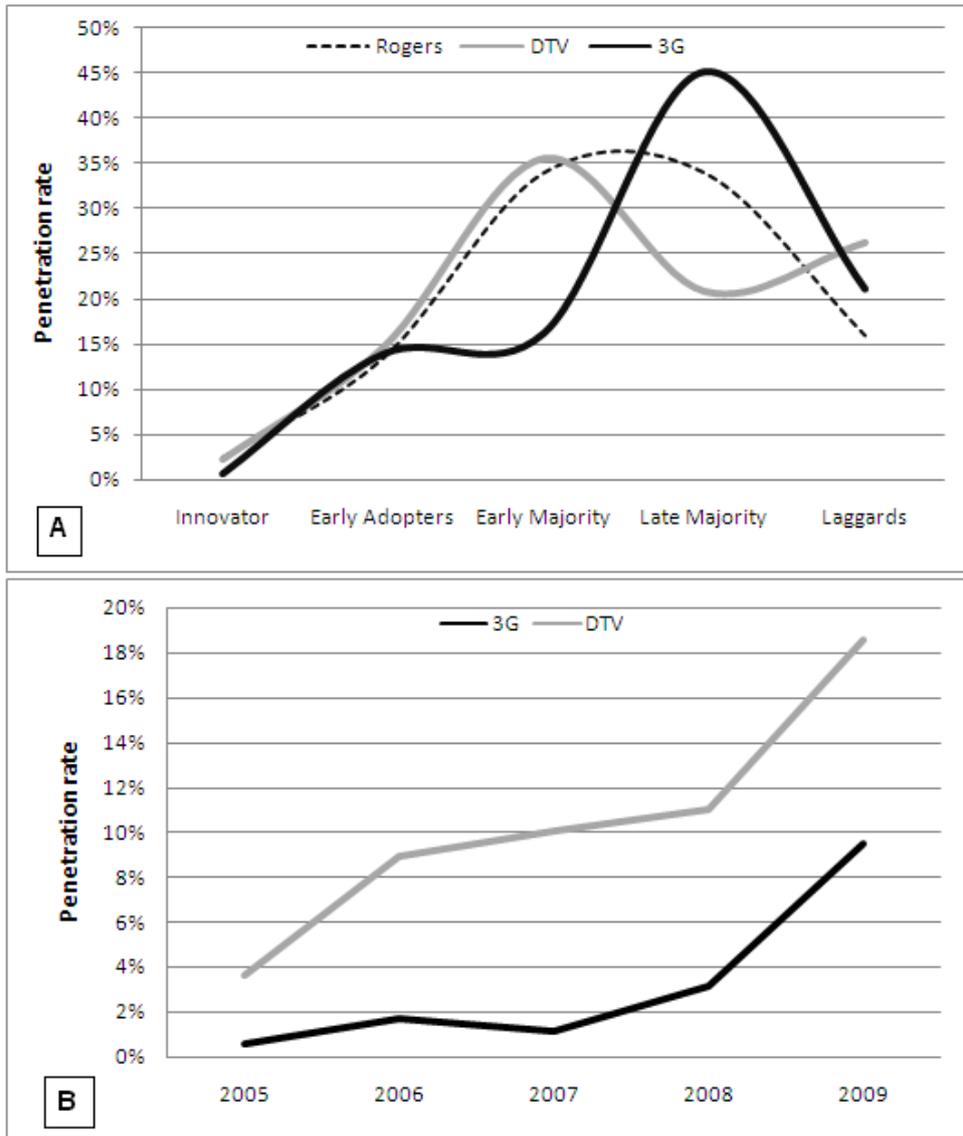


Figure 2 depicts the forecasted diffusion patterns in 2004, based on the PSAP scale that is not relying on diffusion theory's segment sizes to distinguish between adopter segments (Figure 2A); versus the actual yearly adoption rates (Figure 2B). The results support the discontinuity claim and illustrate a good match between actual and forecasted diffusion patterns. The latter allows to conclude that diffusion forecasts

based on methods not relying on diffusion theory assumptions (e.g. segment size) will provide more reliable results than methods relying on the theory's segment size assumptions and diffusion patterns. The latter would have only led to technomyopia.

Hence, the results also suggest that the bell-shaped diffusion pattern with its fixed-sized segments indeed needs some revision for some, but not necessarily all technology innovations. As Figure 2A shows, the penetration of DTV in Flanders was forecasted to more or less follow the assumed normal distribution pattern (only the laggard segment is overrepresented compared to Rogers' theory), while the diffusion pattern of 3G technology was forecasted as a 'double peaked diffusion pattern' with a clear 'chasm' or discontinuity after the early adopters.³ Figure 2B shows that by the end of 2009, digital television in Flanders crossed the 50% penetration threshold, while 3G has a penetration rate of about 16%. In the 3G case, an initial peak of earlier adopters is followed by a backsliding in the number of additional adoptions. Contrary to the steady growth of DTV in Flanders, 3G struggles to cross the chasm between earlier adopters and mainstream market. The comparison between the forecasted and the actual diffusion patterns derived from data provided by the operators (until Q4 2009), show striking similarities proving the predictive validity of a methodology (PSAP) that is not blindly based on the diffusion theory's assumptions regarding fixed segment sizes.

With regard to the evaluation of diffusion theory's value, this allows us to draw a twofold conclusion. On the one hand, prior-to-launch diffusion forecasts that are based on traditional assumptions with regard to fixed segment size and diffusion pattern may be very misleading. The typology of segments remains very valuable and reliable, but not if they are based on fixed segment sizes and symmetric diffusion patterns. Elaborating on these diffusion patterns on the other hand, the results also suggest a modification to at least a 'double peaked diffusion pattern'. Some even plead for a multiple peaked pattern (Ward et al., 2003), but the most important thing is to account for the discontinuity between earlier adopters and later adopters as it warns of a slowing down in the incremental number of new adoptions over time (Golder, 2004; Loch & Huberman, 1999). The best case scenario (e.g. 2G-GSM) is that there is hardly any slowing down; the worst case scenario (e.g. WAP) is that the innovation does not succeed in crossing the chasm to the majority. Compared to the 'single peaked' bell shape, such a double-peaked pattern seems a more adequate reflection of today's ICT environment (Goldenberg, 2006).

In today's ICT environment we plead for a more flexible diffusion pattern in terms of a 'double-peaked' curve, but also in terms of segment sizes. Following earlier criticisms on the fixed 2.5/13.5/34/34/16% ratio of segment sizes (see Carter, 1998; Mahajan et al., 1990; Bass, 1969; Van den Bulte & Joshi, 2007), we suggest a pattern that allows for flexible segment sizes. As is also illustrated by the forecasted and the actual adoption rates of DTV and 3G in Flanders, it would be naïve to assume that innovators always

consist of 2.5% of the market, just as it is not realistic to assume that 100% of the population can be assigned to one of the five adopter segments. Therefore, on top of more flexibility in pattern and segment size, we also suggest to account for a sixth segment of 'out of potentials'. In the cases of DTV and 3G the PSAP calibration heuristic assigned respectively 26.8% and 66.3% as 'out of potentials', of which it could never be expected to have any potential. Given these insights, hypothesis 1 is accepted.

Diffusion theory: what about segment profile assumptions?

As the diffusion theory holds to a fixed segment size, it also assumes a certain profile or archetype for each adopter segment (cf. Table 1). A main purpose of (research on) these characteristics of adopter categories is to provide a basis for the detection and selection of typical innovator, early adopter, majority or laggard respondents (Lin & Jeffres, 1998; Oxley & Nancarrow, 2003) as well as for segmentation, forecast and targeting communication purposes. In their study gauging the potential of fixed-line broadband Internet for example, Jeffres and Atkin (1996: 319) are convinced that '*diffusion theory can provide profiles on those who are relatively early in adopting the service*'. When it comes to targeting innovators, marketing communications handbooks suggest that messages should '*be targeted at relatively young people, with a high level of income, education and social status*' (Fill, 2009: 61). Consequently, marketers and communication specialists prefer archetypes or sets of profile assumptions to select and target the different types of adopter segments. These profile assumptions have been formulated for different types of variables including personality traits, media use/ownership, and particularly socio-economical and socio-demographic variables (Kang, 2002; Moore, 2006).

In today's fragmented media market, however, it seems that traditional mass media approaches need to make way for a more differentiated and personalised approach of (micro)segment targeting (Tvede & Ohnemus, 2001; Bilchev & Marston, 2003). Given the fast-evolving ICT-centric society, effectiveness of the diffusionist archetypes has been questioned as they have become too inconsistent to remain reliable as a base for efficient targeting and discriminating between adopter segments (De Marez et al., 2008). Therefore, we investigated to what extent these profiles and assumptions still hold true in the contemporary ICT environment. To verify hypothesis 2, we combined (a) a meta-analysis of studies on adoption segment profiles for DTV and 3G, and (b) empirical research on the adoption intention for DTV and 3G in Flanders.

Meta-analysis of adoption segment profiles

The meta-analyses focuses on research whose object of study is the adoption intention for ICT innovations,

television and mobile Internet services in particular, and the assumption of at least one socio-demographic variable. The majority of these studies still finds a confirmation of the assumed profile or relationship between socio-demographic variables and intention-based innovativeness (e.g. Ahn, 2001; Mahajan et al., 1990) without any critical comment. Even in meta-analyses such as those of Dutton et al. (1987) and Ricci (2000), the traditional demographic profile of adopters is confirmed although some find little impact of socio-demographics on attitude and adoption intention (Vishwanath & Goldhaber, 2003). Nevertheless, an increasing number of studies show inconsistency with the assumed adopter profiles for ICT innovations. Even Rogers started questioning the universally applicable 'young profile' of the earlier adopters in his latest editions, since research results were no longer always able to underpin the assumption. While containing a selected overview of television and mobile Internet adoption studies, Table 3 clearly shows the growing inconsistency of profile assumptions.

Table 3: Meta-analysis on segment profile assumptions*

Author(s)	Technology	Gender	Age	Income	Education	Household
Dupagne et al. (1991)	HDTV	C	C	C	C	C
Albarran & Umphrey (1994)	Cable TV		NC	C		NC
Dupagne (1999)	HDTV	NC	NC	NC	NC	
Kang (2002)	Digital cable TV		NC	NC	NC	NC
Atkin et al. (2003)	Digital TV	NC	NC	NC	NC	
Li (2004)	Digital cable TV	NC	C	C	NC	
Lin (2004)	Webcasting	NC	C	NC	NC	
Chan-Olmsted & Chang (2006)	Digital terrestrial TV	NC	NC	C	C	NC
Hung et al. (2003)	WAP	C	C	NC	NC	NC
Kim et al. (2005)	Mobile Internet	NC	NC			NC
Okazaki (2006)	Mobile Internet	NC	NC	NC		NC
Wei (2006)	Wireless Internet	NC	C		NC	
Agarwal (2007)	Mobile Internet	NC	NC			
Akiyoshi & Ono (2008)	Mobile Internet	NC	C	C	C	
Mito & Hiroshi (2008)	Mobile Internet	NC	C		NC	NC
Evens et al. (2010)	Wireless Internet	C	C	C	C	C

* C: confirmed, NC: not confirmed

Research findings

Also when looking at the relation between user variables and innovativeness for the two technologies investigated (DTV & 3G), our findings (Table 4) reveal that socio-demographic variables seem to have lost their consistency to describe and predict adopter segments. Gender assumptions, for example, were confirmed in the 3G case but for DTV no significant relation could be found between gender and innovativeness. The assumptions of higher income and better education among the more innovative on the other hand were only confirmed for DTV. Both for DTV and 3G, assumptions on age, job (status) and household size still seem reliable and valid.

Table 4: Segment profile assumptions*

Technology	Gender	Age	Income	Education	Household size	Job (status)
Digital television (DTV)	.612	.000*	.000*	.046*	.000*	.000*
Mobile Internet (3G)	.001*	.000*	.145	.568	.024*	.029*

* Chi² tests are marked with an asterisk were found statistically significant ($p < .05$)

The meta-analysis and the empirical findings both reveal that socio-demographic and socio-economic profile variables can no longer be considered as strong discriminators between adopter segments. The prominent presence of non-significant relations suffices to question the consistency and reliability of the profile assumptions, and to conclude that the latter are not automatically holding up anymore in today's ICT environment. Therefore, hypothesis 2 is confirmed.

Diffusion theory: what about determinant assumptions?

As traditional demographic characteristics lost value over the years as segment differentiator, attitudinal adoption determinants (subjective perceptions of innovation characteristics and personality traits), have been put forward as the alternative (Plouffe et al., 2001). Diffusion theory builds on a set of five innovation characteristics (relative advantage, complexity, compatibility, trialability and observability), often serving as a basis for communication strategies when introducing innovations or as the framework for innovation scales (Goldsmith & Hofacker, 1991; Moore & Benbasat, 1991; Parasuraman & Colby, 2001; Roehrich, 2004). Such scales consist of a set of Likert statements gauging for attitudes towards the innovation. In

Goldsmith and Hofacker's *Domain Specific Innovativeness* (DSI) scale for example (6 statements), trialability is operationalized in the statement *'I will not buy a new ... if I haven't tried it yet'*. In Moore and Benbasat's scale *'I believe that ... is cumbersome to use'* measures the complexity determinant. Based on these scales, each respondent ends up a total innovativeness score, consequently often used to segment populations into innovators, early adopters etc. In this context, fixed adopter segment size assumptions come into play. The highest 2.5% of the innovativeness scores are then often considered as the innovators for the technology, the following 13.5% as the early adopters, the next 34% as the early majority etc. (Oxley & Nancarrow, 2003).

Over the years, the increasing attention for such attitudinal determinants resulted in a considerable yet cluttered extension of the original set of five adoption determinants. The convergence with social psychology theories such as the Theory of Reasoned Action (TRA) (Fishbein & Ajzen, 1975), Technology Adoption Model (TAM) (Davis, 1989), Theory of Planned Behavior (TPB) (Ajzen, 1991) and Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003) in particular, led to an extremely valuable increase in (research on) adoption and determinant models. Some only consider one or two extra determinants (Holak & Lehmann, 1990), while others consider eight (Plouffe et al., 2001), ten (Choi et al., 2003) or more determinants. Clearly, adoption decisions seem to be determined by more factors than the original five initiated by Rogers' diffusion theory. Among the additional determinants we find perceived cost, perceived enjoyment, reliability (innovation-related characteristics), voluntariness, image, etc.. Although this fragmentation may not improve the comparability of research findings, the main concern for scholars involved in research on adoption determinants and decision processes is the lack of overview of relevant determinants for ICT adoption (Hadjimanolis, 2003). Consequently, the question arises to what degree the assumptions on adoption determinants are still useful to predict adoption of today's ICT innovations. Therefore, in order to tackle this research question, (a) a meta-analysis of determinants for DTV and 3G adoption has been conducted, and (b) an extended meta-model of forty-two determinant statements has been developed as an operationalization of seventeen determinants, and applied to the diffusion process of DTV and 3G in Flanders.

Meta-analysis of adoption determinants

Table 5 contains an overview of studies on adoption determinants for both television and mobile Internet services, and maps the original five adoption determinants (diffusion theory) extended with five other decision factors that are regularly used in adoption studies for these technologies. The meta-analysis demonstrates that, in general, the assumed relationships in terms of positive or negative correlations between determinants and adoption decisions are confirmed in the most of the studies. However, between

and even within television and mobile Internet a lot of inconsistencies seem to appear (e.g. complexity and trialability). Which is again supportive for the assumption that diffusion theory should be revised, and that an individual product-level is more appropriate than a domain- or technology-specific level for the analysis of technology innovation diffusion.

Table 5: Meta-analysis on determinant assumptions*

Authors	Technology	Relative advantage	Complexity	Compatibility	Trialability	Observability	Innovativeness	Perceived cost	Voluntariness	Image	Enjoyment
Li (2004)	Digital cable TV	C	C				C				
Chan-Olmsted & Chang (2006)	Digital terrestrial TV	C	NC	C	NC	C	C	C		C	
De Marez et al. (2008)	Mobile TV	C	NC	NC	C	C	C	C	NC	C	C
Hung et al. (2003)	WAP	C					C	C	NC		
Lu et al. (2005)	Wireless Internet										
Wang (2006)	Mobile Internet	C	C					C			
Wei (2006)	Wireless Internet	C	C	C		C	C			C	
Agarwal (2007)	Mobile Internet			C				NC	NC		C
Hsu et al. (2007)	Mobile Internet	C	C	C	NC	NC			C	C	
Kuo et al. (2009)	Mobile Internet	C	C					C			

* C: confirmed, NC: not confirmed

Research findings

In the DTV and 3G cases the extended meta-model of determinants was operationalized in a set of forty-two Likert statements representing seventeen adoption determinants. In first instance, each of these statements was correlated (Pearson) with one's innovativeness in order to check the assumed relationship. This correlation analysis confirms the assumed relationships for most determinants, as well for DTV as for 3G. Hence, the results suggest that the majority of assumptions still hold up in today's new media landscape and are similar with those of the meta-analysis on determinant studies, which confirmed the assumed relationship as long as the focus is on the statistical correlation between determinants and innovativeness. However, depending on the product being investigated, there often appear to be

differences in the confirmed assumptions and their significance. Again, this suggests that a product-specific approach and operationalization may be preferable to a domain-specific approach.

Table 6: Correlation and regression analysis of determinant assumptions*

Determinant	Item	Correlation analysis		Regression analysis	
		DTV	3G	DTV	3G
Compatibility	7	.539*	.512*	-.040	-.017
	30	.135*	.033	.016	.008
	39	.162*	.179*	-.009	.025
Cost	1	-.338*	-.336*	-.084*	-.064*
	5	-.156*	-.151*	-.015	-.032
Tangibles	25	.171*	.204*	.007	-.008
	43	.096			
Relative advantage	11	.470*	.425*	.020	← → .049*
	17	.457*	.491*	.057*	← → .027
	23	.496*	.541*	.030	← → .128*
	27	.349*	.252*	.019	
	35	.458*	.468*	.112*	
	36	.517*	.487*	.011	
	40	.544*	.529*	.135*	.095*
Trialability	28	.081	.105*	.010	.009
	41	-.041	-.031	-.036	.005
Observability	12	.183*	.148*	.061*	.055*
	24	.377*	.354*	.065*	← → .019
Enjoyment	4	.472*	.391*	.072*	← → .009
	13	.408*	.311*	-.011	.000
	14	.533*	.464*	.072*	← → .040
Complexity	8	-.264*	-.273*	-.052*	← → -.038
	18	-.315*	-.337*	-.019	-.014
	20	-.369*	-.262*	-.001	← → -.054*
	29	-.430*	-.393*	-.10*	← → -.034
Reliability	21	.155*	.147*	-.002	.012

	31	.213*	.219*	.016	.023
Innovativeness	6	.549*	.535*	.181*	.171*
Opinion leadership	15	.414*	.399*	.009	.005
	3	.026	.049	.002	.012
Product knowledge	19	.275*	.223*	.012	.006
Image	33	.274*	.249*	.006	.002
	38	.235*	.206*	.005	.029
Control	42	.069*	.052	.020	.021
Social influence	2	.349*	.314*	.087*	.076*
	9	.374*	.367*	-.012	.079*
	10	.367*	.398*	.030	.000
	32	.060	.096	.010	.057*
	34	.281*	.305*	.015	.034
	37	.118*	.112*	-.029	.024
Marketing	26	.036	.099*	.009	-.025
Willingness to pay	22	.593*	.566*	.148*	.136*

* Values marked with an asterisk were found statistically significant ($p < .05$)

When regressing the items to one's innovativeness to check for their explanatory and predictive power, less confirmation for the assumed relationships between determinants and innovativeness was found. The regression analysis gives only thirteen and twelve significant predictors for a person's innovativeness in the DTV and 3G cases. Only seven items provide predictive power for both technologies (including relative advantage, observability and cost). With an R^2 of 51% and 45% in the DTV and 3G regression models, the meta-model of adoption determinants gives a fairly moderate degree of explained variance; but significantly better when compared with other, less extensive prediction models. Tested on the same data samples for DTV and 3G, the original model of five determinants resulted in a respective R^2 of 41.9% and 39%, a model with eight determinants (Plouffe et al., 2001) resulted in an R^2 of 43.6% and 39.4%, and for the nine-determinant model of Choi et al. (2003) R^2 was 46.7% and 40.9%.

Apart from more in-depth analysis on these determinants, this already allows to conclude that determinant assumptions still hold up in today's ICT environment (hypothesis 3), as long as it concerns the assumed correlation with a person's innovativeness. When it comes to predicting and explaining this innovativeness or discriminating between adopter segments, adoption determinants cannot guarantee satisfactory quality. In other words, prior to the launch of innovations, adoption determinants do not seem to be a reliable

alternative for forecasting or segmentation purposes anymore. Post-launch, on the contrary, they remain a valuable set of variables for the description or explanation of adoption decision processes, or research envisioning input for communication purposes. The extension from five to seventeen determinants may be a valuable contribution to the latter type of research, since no such overview of relevant determinants has so far been produced.

Discussion

For decades, Rogers' diffusion theory has been the main starting point for much research activities in the ICT innovation and adoption domain, and still provides a widely used framework for forecasting purposes, service and infrastructure requirements, business modelling and policy measurements. Due to profound transformations in the ICT environment, however, questions have arisen about the validity of the assumptions of diffusion theory in today's complex technology ecosystem. Although the theory has been frequently updated, criticisms for its lack of attention to use contexts gave rise to new user research paradigms such as the domestication approach. While some consider the adoption and domestication approach too much as competitive frameworks for the same research area, they should be seen rather as complementary sides of the same innovation coin (Boczkowski, 2004). Therefore, relying on the distinction between 'adoption diffusion' and 'use diffusion' (Shih & Venkatesh, 2004), a first delineation to make with regard to the theory's value in today's ICT environment, is that whereas Rogers' diffusion theory should be used for gaining insights in an innovation's potential in terms of penetration pattern, adoption determinants and segment profiles, domestication research should lead to a better understanding of the actual usage and the context wherein the technology is adopted.

Apart from the above-mentioned and everything but new discussion how to position diffusion theory in the current media and ICT research strand, this paper focussed on the value of the decennia-old diffusion theory and questioned to what extent the assumptions underlying this traditional theoretical framework still hold true in the profoundly changed ICT ecosystem. Some of these assumptions regarding diffusion patterns, segment profiles, segment sizes and adoption determinants still function as common ground for many purposes such as prior-to-launch forecast assessments, innovation and personality scale development, introduction strategies for ICT innovations and even marketing communication campaigns. Based on the combination of meta-studies and empirical research (N: 2228) regarding the diffusion process of digital television and mobile Internet services, it has been argued that a profound reorientation of diffusion theory is inevitable for using it as a framework for future research on diffusion processes of information

technologies (also see Peres et al., 2010). With regard to the research question and the three hypotheses, the following suggestions for reorientation or adjustment are formulated:

1. The traditional bell-shaped diffusion pattern is too misleading and should be adjusted to (at least) a double-peaked pattern in which a first peak of earlier adopters can be expected for almost every innovation, and the second peak of mass market adoption is not considered as an evident continuation. Future research is needed for the more elaborate specification and underpinning of this, but it seems advisable to take discontinuity and more flexible segment sizes into account. Such reorientation will certainly have its impact on business models and forecast methodologies that use the normal and fixed segment size distribution as a basis.
2. The assumed socio-demographic segment profiles should no longer be used as a starting point for communication, targeting or segmentation purposes. Research reveals a 'double inconsistency': on the one hand studies in which theoretical assumptions can no longer be confirmed, on the other hand differences between information technologies in the confirmed assumptions. Especially in marketing communications and public policy a methodological impact is that these profiling variables have become unreliable as a segmentation criterion, and that measurements as well as campaigns fail to reach to the intended target groups.
3. With regard to the adoption determinants, a similar inconsistency can partially be detected, but the major problem is the too narrow and domain-specific approach. The latter should be extended and become more product-specific in today's ICT environment. In addition, adoption determinants can no longer be used for predictive purposes. Regarding the extension, this article tried to contribute with a meta-model of seventeen determinants. Initial findings reveal a better but still moderate explanatory power for this model, but it certainly requires further research and validation. The domain, for which this reorientation has the greatest implications, is that of methodology. Innovation scales should be operationalized more broadly and more product-specific, but this will make the implementation of these scales far more difficult and scattered.

To conclude, we can confirm that diffusion theory is still a valuable framework for research on media and information technologies as long as the scope of the research is adoption diffusion and account is taken of the reorientations concerning the shape of diffusion patterns, segment profiles and adoption determinants.

Notes

1. The first edition of Rogers' (1931-2004) *Diffusion of Innovations* appeared in 1962. New editions were published with a decade-like regularity. The fifth and last edition dates from 2003.
2. The method is referred to as the product specific adoption potential (PSAP) scale and assumes a distinct penetration pattern of each ICT innovation.
3. Figures 2A and 2B compare the forecasted diffusion patterns (in 2004) and the actual diffusion patterns (end of 2009) for DTV and 3G in Flanders.

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