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Nóra Nyirő

Acceptance and diffusion of media technology innovations

Ph.D. thesis

Supervisor:

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Department of Media, Marketingcommunication and Telecommunication

Thesis booklet

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1. Focus of the dissertation and research questions

The goal of the research is on one hand to discover and unveil the consumer appreciation of DVR technology related to digital television as an innovation, its perceived advantages and appealing proprieties for users as well as the factors influencing the acceptance of DVR technology. On the other hand, our research aims to observe the usage habits of DVR-owning households, the intensity of use, their changing behavior related to the watching and zapping of advertising, as well as the role DVR and television have in households. By observing people and households owning a DVR device we aim to have a deeper insight into changing usage habits, namely whether the advent of this technology within a household brings about a more active and more influential role of the viewer in a traditionally passive and receptive television consumption that can be considered a well-anchored daily routine. Our goal is to provide a general model for MediaTechnology Acceptance Model (MTAM) and our research ensures the first model test.

With the transforming media and media technology landscape, it is particularly interesting a question how, to what extend and by whom a transforming broadcast mass media will be accepted in a digital, convergent media environment. Thus we put digital television and within it, a specific technology, that of digital video recording into the focus of our research. Both our exploratory research phase and qualitative studies preceding our study confirm that the technology of digital video recording within digital television technology is a worthwhile focal point to our study.

Research question: What are the influencing factors of the acceptance of media technology innovations related to mass media, meaning television related technology innovations in our research?

Subquestions:

- Does the role and place of television as a medium change through digital technologies?
- Who are the lead users of the digital video recorder? How can they be described, what attributes do they have concerning the possession of other technological devices, their innovation orientation and demographic variables?
- Which are the factors preventing the diffusion of a media technology innovation?

2. Theoretical background

The dissertation has three theoretical pillars: diffusion of innovations (DOI), technology acceptance model (TAM) and the media uses and gratifications theory. The synthesis of the above mentioned theories ensures the theoretical background of our empirical study, in which we aim to integrate the similarities and common points of innovation of diffusion theory and the technology acceptance model, as well as incorporate the significant view point of media gratifications in case of media technologies.

In our dissertation we review several **theories on the diffusion of innovations**, which will serve as a theoretical framework for the diffusion of digital television and the relating technologies. We will review Roger's (1995) theory based partly on sociological and institutional theory, Bass's (1969) diffusion model and Hall's (2006) and Gatignon and Robertson's (1985) seminal review article. Next we will elaborate on Christensen's (1997) theory about disruptive technologies and on the model proposed by Ortt and Schoormans (2004) with three phases to describe the process of diffusion of information and communications technology. We will present Rogers's (1989) approach on the diffusion of communications technologies. On the subject of the entry and diffusion of innovations to households we will review the domestication theory of media technologies according to Haddon (2006).

The **Technology Acceptance Model** (TAM) is the most widely used theoretical framework for the study of technology acceptance. The foundations and the first model were developed by Davis (1989) as an extension of Ajzen and Fishbein's (1975) "Theory of Reasoned Action" specifically for the study of the user adoption of information technology and information systems. The technology acceptance model was originally designed to reveal and understand the use and acceptance of personal computers and software in a work environment. According to Davis's (1989) theory, the perceived usefulness (PU) and the perceived ease of use (PEOU) are two decisive criteria in the user acceptance and they directly affect the user attitude, which in turn determines the intention to use. Davis et al. (1989) modify the model of technology acceptance by finding that the mediating effect of attitude is negligible. Hence, they remove the latter variable from the model and propose the usage of the simpler technology acceptance model based on three main variables: perceived usefulness, perceived ease of use, intention to use. This model has been empirically validated several times by subsequent studies all of which have

focused on the three variables of perceived usefulness, perceived ease of use and intention to use (Szajna, 1996; Venkatesh, 2000; Venkatesh–Davis, 2000; Venkatesh–Morris–Davis 2003).

The framework for studying innovation adoption described by Rogers (1986) is largely coherent with that of the technology acceptance model, as both have technology use as the most important independent variable. Technology use is influenced by the decision to adopt (Rogers, 1986), i.e. by the intention to act in the technology acceptance model (Davis, 1989). Individual attributes or future impact from Rogers's approach can easily be suited into the technology acceptance model as moderating variables, or the future intention to use on an individual level. Factors of technology acceptance of a given product or technology appearing in Rogers's (1995), Hall's (2006) or generally in every framework in relation to innovation diffusion theory also have much in common with the technology acceptance model.

Perceived advantage or benefit (Rogers, 1995; Hall, 2006) may well be suited to perceived usefulness (PU) (Davis, 1989), complexity (Rogers, 1995) to perceived ease-of-use (PEOU) or compatibility (Rogers, 1995) to an often appearing element of perceived usefulness (PU) in the technology acceptance model, and thus can be integrated as common factors from the two frameworks. Even though trialability and observability (Rogers, 1995) do not appear in the technology acceptance models, these neither cannot be stated as relevant by dint of the different focus and methodology of the approach as these either focus on the study of actual users, or in case of non-users, they assume the presence of some kind of trialability and observability for the technology to be studied. In our study we focus on actual users of technology as well.

In our study, we examine how and from what sources technology users/adopters gather information about given possibilities following Bass's (1969) innovation diffusion model with the presupposition that though a group of early adopters constitute the focus of our study, even among them the first adopters, entrants will be those that will gain knowledge of the innovation mainly from corporate information and advertising appearing in mass media. Von Hippel et al. (1999) emphasize that we need to understand the lead users, so that the early adopters and innovators when we are examining the diffusion of innovations.

We can formulate a strong criticism of the applications presented beforehand of the technology acceptance model to media technologies, and more narrowly, to television

(mobile television [Shin, 2007; Choi, 2009, Jung – Perez-Mira – Wiley-Patton, 2009], IPTV [Ha – Yook, 2009]) as technology acceptance in these cases is characterized by a complex and underlying environment that cannot be simplified to the acceptance and use of one sole technology.

Both mobile television and IPTV comprise the acceptance and possibility of use of a number of technologies (that of mobile communications, digital television, digital video recording, electronic program guide, etc.), several new content services (video-on-demand, mobile broadcasting content, the notion of electronic program guide), thus consumer decision to purchase and the purchase itself lead to the use of a bundle of technology extended with content. As such, adoption is also presumably influenced by the price of this service, the cost of subscription to the service, the image and communicating efforts of the service provider and that of its competitors, the availability of the service, to mention only a few potential influence factors. Thus we believe that it is an oversimplification, in the case of acceptance of mobile television and IPTV to only use the framework of the technology acceptance model without any extensions. The present dissertation intently focuses on the use and acceptance of the specific technology of digital video recording, using both the technology acceptance model and innovation diffusion theory as a framework.

We think that we can model and use in a relevant way the technology acceptance model in case of media technologies through the integration of **uses and gratification** approach (Rubin, 1981; 1983; Katz et al., 1973) explaining the content consumption part of media use. However our approach stays complex, it is in coherence with Wirth et al. (2008) saying that only the theoretical backgrounds integrating more theories may help and further build the researches of communication and media technologies.

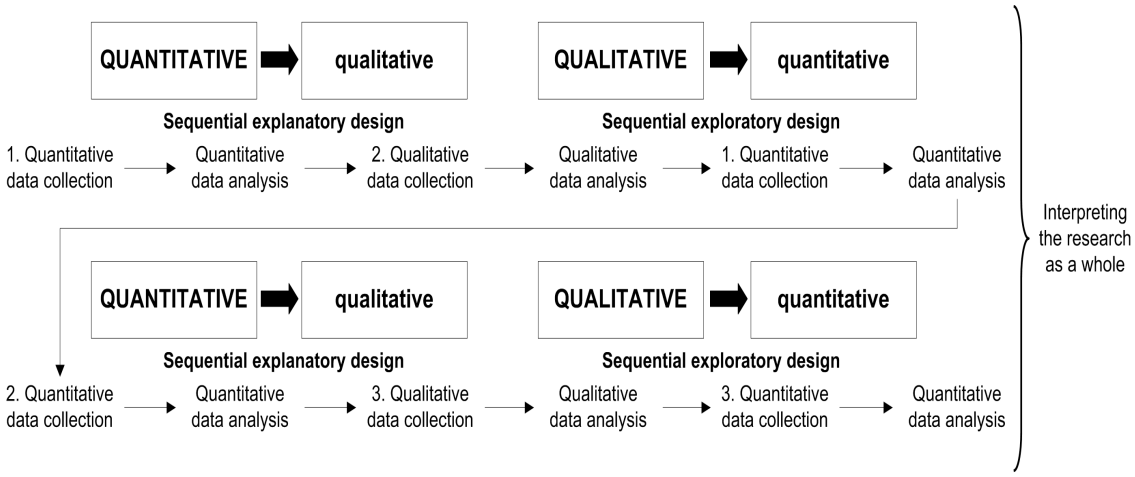
3. Methods used

A *mixed method research design* study is one that uses "qualitative and quantitative data collection and analysis techniques in either parallel or sequential phases" (Teddlie és Tashakkory, 2003. 11. o.). Denzin (2009, [1970]) states that we can strengthen a research study throught *triangulation* meaning the combination of different research methods.

Our dissertation base on Leech és Onwuegbuzie (2009) and Creswell et al. (2003)

is a fully mixed method, sequential research design, having quantitative dominant phases (see figure 3.1).

Figure 3.1. Sequential explanatory and exploratory research design of the present thesis, based on Creswell et al. (2003:225)



In Table 3.1 we present a summary of each research phase, their goal and sample size. The first exploratory survey related to the thesis took place in Fall 2008 conducted as part of a wider research focusing on video content consumption. In order to better understand the conclusion of this research and to better get acquainted with the users of DVR technology, we inserted a qualitative research phase, during which in-depth interviews were conducted with lead users of the technology. The methodology of interviewing was even more justified that these subjects were hard to reach in number and thus for a quantitative research, and that they could provide through their subjective points of view insights, experiences, stories, that other research methods would not reveal. Parallel to these in-depth interviews, focus group interviews were conducted with non-users and seldom-users of television technology that greatly helped revealing, understanding and analyzing the remaining aspects of audiovisual content consumption habits and platforms.

Following this phase, we proceeded to the translation and re-translation of existing scales in the literature, to the testing of our questionnaire and pre-testing of our research model within a survey including university students.

The final research model was tested on a sample composed of 18-69 year-old internet users in possession of a television set. This survey contributed to answering the

other research questions as well. To analyze the effects of technology diffusion and expert-validate the result of the empirical research we proceeded to expert interviews.

Table 3.1 Phases of the empirical research. Source: own table

Phase	Method	Aim	Methodology	Time	Sample
1.	QuaL	preparation of the penetration testing	market and academic experts; expert focus groups	September 2008	two focus groups with n=6 and 5 experts respectively
1.	QuanT	testing penetration in Hungary	online query (18-39 yrs, internet user, demogr. representative sample)	October 2008	n=1000 (incl. 40 owners of DVR sets)
2.	QuaL	analysis of lead users	semistructured personal interviews	April-May 2010	n=5 (from 5 households)
2.	QuaL	analysis of those turning away from television	3 focus groups (1 group of total rejecters, 1 seldom viewers, 1 mixed)	May 7th, 2010	n=8, 8, 10 persons, respectively
2.	QuanT	questionnaire, test of scales	online query (own questionnaire, through Google spreadsheets)	10-16th May, 2010	n=234, students in 1st year, Corvinus University of Budapest
3.	QuaL	expert validation of research results	semistructured expert interviews	September, November, 2010	service providers 2 interviewee + 1 secondary inter.
3.	QuanT	study of DVR acceptance, test of hypotheses	online query (18-69 yrs internet users)	14-21st November, 2010	n=500

4. Research results and discussion

The goal of the dissertation was to examine in one integrated research model the technology acceptance and media gratifications in case of a new media technology innovation. Based on the theoretical background our aim was to provide a general MediaTechnology Acceptance Model (MTAM).

4.1 The thesises of the dissertation and research results

We have tested our model and hypothesise in the third quantitative research phase. The hypothesises and the test results are summarized in table 4.1. The analysis was run with the help of SPSS 18.0 and AMOS 18.0 software.

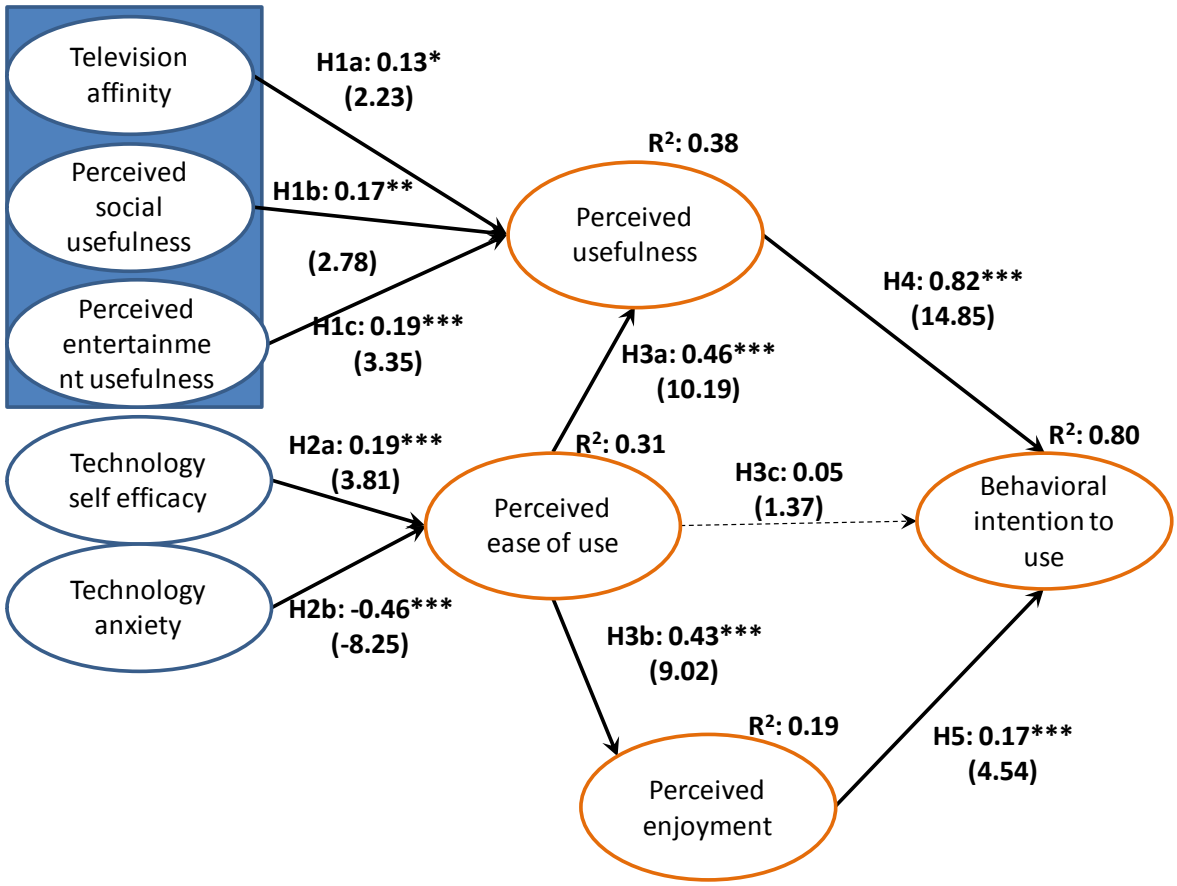
Table 4.1. The hypothesises of the dissertation and the results of hypothesis test

Hypothesis	**Acceptance**
H1a: Television affinity will positively affect the perceived usefulness of the digital video recorder.	Accepted
H1b: Perceived social usefulness of television will positively affect the perceived usefulness of the digital video recorder.	Accepted
H1c: Perceived entertainment usefulness of television will positively affect the perceived usefulness of the digital video recorder.	Accepted
H2a: Technology self-efficacy will positively affect the perceived ease of use of the digital video recorder.	Accepted
H2b: Technology anxiety will negatively affect the perceived ease of use of the digital video recorder.	Accepted
H3a: Perceived ease of use of the digital video recorder will positively affect the perceived usefulness of the digital video recorder.	Accepted
H3b: Perceived ease of use of the digital video recorder will positively affect the perceived enjoyment of the digital video recorder.	Accepted
H3c: Perceived ease of use of the digital video recorder will positively affect the behavioural intention to use of the digital video recorder.	Refused
H4: Perceived usefulness of digital video recorder will positively affect the behavioural intention to use of the digital video recorder.	Accepted
H5: Perceived enjoyment of digital video recorder will positively affect the behavioural intention to use of the digital video recorder.	Accepted
H6*: The television viewing motivations and gained gratifications are defined mainly by the content and not by the technology, so that there is no difference between the television gratifications of digital subscribers and analogue subscribers.	Accepted

*H6 hypothesis was tested separately from our model.

As we had 500 sample and 25 measured variables we analysed the goodness of fit of our model based on Hair et al. (2010) criterions. The results of model test are the followings: chi-square = 769,94 (df=261); GFI = 0,89; TLI = 0,93; CFI = 0,94; RMSEA = 0,063. Based on the results the fit of our model is acceptable.

Figure 4.1. A model showing causal paths and R^2 for applying TAM, Source: own figure



Bold lines are indicating significant pathes ($p<0.05$), the dashed line is indicating the insignificant path
*** $p<0.001$; **$p<0.01$; *$p<0.05$, t values in parantheses

To assess the significance of direct, indirect and total effects of predictor variables on dependent variables the decomposition of effects analysis was conducted. To idendify the significance of indirect effects we used Sobel-test and bootstrapping. We could identify low but significant indirect effect between technology self-efficacy and perceived usefulness (R^2=0,09) and higher but negative indirect effect between technology anxiety and perceived usefulness (R^2=-0,21). Similar the technology self-efficacy (R^2=0,08) and technology anxiety (R^2=-0,20) had significant indirect effect on perceived enjoyment. The highest indirect effect was identified between perceived ease of use and behavioural intention to use, which is not surprising after getting a low and insignificant direct effect. So the effect of perceived ease of use on behavioural intention to use is mediated by perceived usefulness and perceived ease of use. Television affinity (R^2=0,10), Perceived social usefulness (R^2=0,14) and perceived entertainment usefulness (R^2=0,16) also had significant indirect effect on behavioural intention to use through perceived usefulness.

Before testing our last (H6) hypothesis we run a confirmatory factor analysis based on television gratifications. After defining the relevant factor structure we run variance analysis. In our sample we could identify 303 digital subscribers and 178 analogue subscribers / non-subscribers besides 19 do not know answers. As the sample size of the two subsamples was highly different and the Levene test showed homoscedasticity in case of company gratification factor we used the robust Welch d test in our analysis and run a random 178 subsample of digital subscribers comparison as well with F and Welch d test. We could not identify any significant difference between the two groups, $p>0,135$ in each case.

Based on the lead user interviews (2^{nd} qualitative phase) we aimed to identify an audience open to digital video recorder technology who are at the same time heavy television content consumers. However the professional interviews could not identify the characteristics of digital video recorder users based on demographic approach. To identify the characteristics of digital video recorder owners we made binominal logistic regression. Our goal was to examine the demographic and technology profile of digital video recorder owners, to check whether we can forecast the DVR ownership based on these classical segmentation data. If yes, than we can provide a well identifiable and targetable audience for the service and technology providers.

As the model estimation based on the whole sample was not good we made the analysis for the digital television subsample as well in order to have a better regression model. Because of the number of estimated parameters we analysed separately the demographic and technology characteristics. We used Enter method in order to be able analyse the independent variables together based on their collective effect. The results of the logistic regression test are summarized in table 4.2.

The only acceptable regression model was the one among digital subscribers based on technology ownership, but only one independent variable had significant effect, the ownership of previous analogue recorder technology, videocassette recorder (VCR). We could not identify demographic or a clear technology profile of DVR owners. So we suggest using VCR ownership as orientation for sales purposes, but we have to discover other motivational, attitude or personality based characteristics of DVR owners and users.

Table 4.2. Binominal logistic regression results summary, Source: own research

Independent variables	Sample	Model signf. (Chi2 szign.)	Cox & Snell R^2	Nagel-kerke R^2	Hosmer Lemeshow (signf.)	Est. goodness (%)***	Significant independent variables
Demographic characterstics*	Total	0,451	0,056	0,097	0,82	84,8 (1,4) vs. 84,8	no children (p=0,07; B = 24,163) 18-29 years (p=0,08; B=2,730) Budapest (p=0,09; B=2,905)
	Digital subscribers	0,08	0,12	0,183	0,07	77,7 (9,3) vs. 77,6	18-29 years (p=0,07; B=3,608) 40-49 years (p=0,06; B=3,142) Budapest (p=0,01; B=3,557)
Technology background**	Total	0,005	0,072	0,126	0,05	85,4 (5,5) vs. 84,8	having VCR (p=0,03; B=2,539) having Smartphone (p=0,09; B= 0,593)
	Digital subscribers	0,014	0,105	0,161	0,06	79,2 (15,4) vs,77,6	having VCR (p=0,01; B=2,498)

*(gender, age, settlement, education, children, family status, size of the household, income)

**(number of TV sets, VCR, DVD, smart phone, mobile phone, PC, Laptop/notebook)

*** first number shows the goodness of model estimation, in parenthesis the identified percentage of DVR owners; vs initial percentage of owner non-owner share

4.2. Main conclusions and implications

Our research confirmed that viewers' attitude towards the medium has a determining effect on the perceived usefulness of the technology. Therefore we suggest to extent the technology acceptance model with this attitude as an individual factor in the context of media technologies. A main conclusion of the research phases preceding the test of our model was that the integration of this relation into our model is justified. We confirmed this extension during the test of our model on a large sample query. Our results confirmed that the technology acceptance model was indeed a useable and useful theoretical framework in explaining consumer intention to use DVR devices.

Results confirm the relevance of joining uses and gratification theory with the technology acceptance model. Social and enjoyment usefulness determining perceived usefulness were identified as significant explanatory variables using a classic gratification scale. Thus our results confirm those of preceding studies in the field (Zhang – Mao, 2008; Ha – Yook, 2009; Jung et al., 2009). An important result of our research is the test and confirmation of the relevance of the original uses and gratifications variables, which were tested and validated several times in other fields of research, whereas in the case of both

television and other media types researchers until now mostly used own or edited scales.

Our study, in accordance with previous research results (Venkatesh, 2000; Hong et al., 2002; Venkatesh – Bala, 2008; Zhang – Mao, 2008) confirmed that individuals' self-determination on how they are able to use a given technology does influence the perceived ease of use of the technology. Thus we can say that the more individuals feel capable of using a given media technology, the more they perceive it easy to use. Apart from Zhang and Mao (2008), no known research has been conducted on this relationship in the case of media technologies, even though it may have an effect on technology acceptance, irrespective of the goal of usage (work or entertainment). Therefore an important result of our study is to confirm the important role of individual variables in the study of complex situations of technology acceptance.

Technological anxiety does reflect individuals' attitudes in which our results tally with the results of other studies in the field (Venkatesh, 2000; Venkatesh – Bala, 2008), all of which found a significant negative relationship. Thus the higher an individual's anxiety from a technology i.e. the more they dread using a new technology, the less they perceive it easy to use. As the relationship between technological anxiety and perceived ease of use has not yet been studied in the context of communications and media technologies, our results give an important indication as to the future use of these variables.

As a conclusion, our research model included five individual attributes, all of which turned out to be relevant. Results show that those people who are more attracted to television and lend a greater social and entertainment usefulness to this medium also found more useful a related technological innovation (DVR). Just like individual gratification attributes, the intrinsic ability (self efficiency) and emotional attachment (technological anxiety) both related to technology usage had a considerable effect on user perception of the given technological innovation.

All but one of our hypotheses related to the technology acceptance model's fundaments were supported. We verified (in concordance with international academic literature) that the more individuals find a media technology enjoyable, the more it is likely that they will eventually use it in the future and therefore the more likely technology acceptance will arise. We also verified that the more users consider the given technology easy to use, the more useful and enjoyable they will find it.

Thus our results confirm that perceived ease of use has a positive effect on perceived usefulness, as proposed by other studies in the fields of work-related

technologies (Davis, 1989; Venkatesh, 2000; Venkatesh – Bala, 2008), communications and media technologies (eg. Van der Heijden, 2004) and specifically in the context of television (eg. Jung et al., 2009). Even though a number of related studies do not assess this very relationship or do not find a significant relationship we still propose, according to our findings and the remaining theoretical background, to integrate perceived ease of use into a media technology acceptance model.

The relationship between ease of use and perceived enjoyment has only been studied twice in the context of the technology acceptance model applied for entertainment technologies (Van der Heijden, 2004). This study identified a positive significant relationship between the two variables, just like our study. Even though few other studies verified the relationship between ease of use and enjoyment value, based on our results, we believe it important to employ enjoyment value in a model focusing on media technology acceptance.

Even though relating theory, as well as the results of our previous research phases emphasize the role of the ease of use, we were unable to find any study on technology acceptance in the context of television where perceived enjoyment value was included in the theoretical model. Therefore we suggest a further testing of this relationship, even more that for example, Van der Heijden (2004) in his study found a significant effect.

Nevertheless, according to our literature review and own research, perceived usefulness and perceived enjoyment seem to be the two determining factors as for the future intention to use a media technology, and these two factors moderate the effect of perceived ease of use as well. The positive effect of perceived usefulness fits perfectly into the literature on technology acceptance, as it is a determining element of the original model (Davis, 1989).

As the effect of enjoyment value on technology acceptance has not yet been studied in the context of technologies related to television, this relationship accounts for an important added value of our research. When comparing perceived enjoyment value for an online environment and for a television environment, a conclusion for developing a media technology acceptance model is that perceived enjoyment value by all means has a role in technology acceptance and has an effect on the future intention of use. The strength of this effect however varies according to the type of medium and the given content. Therefore we believe that perceived usefulness and perceived enjoyment value appear to be the two most determining factors in a technology acceptance model for media technologies. Along the

varying type of media and content, the explanatory power of each diminishes at the expense of the other, i.e. when enjoyment value has a greater role, the sole usefulness diminishes, and vice versa.

A presupposition during our first quantitative and second qualitative research phases was that technological evolution does not affect gratifications sought from content consumption. This hypothesis related to our subquestions was confirmed, as no significant difference could be observed between gratifications of analog viewers and digital subscribers. It seems that earlier gratification studies (Rubin, 1983; Katz et al., 1973) still depict well the individual utilities of television as a medium.

Our research focused on a micro-level individual acceptance behavior. However, as a result of our wide-range data collection we can comment on innovation diffusion literature. As Mahajan et al. (2010) in their theoretical article on innovation diffusion suggest, it is important that researchers assess a macro-level study of innovation diffusion following an understanding of factors of individual acceptance. As asserted before, according to Christensen's (1997) criteria, we do not consider DVR a disruptive technology. At the same time we believe that in this case too a supply-side assistance of technology diffusion is more likely to be identified, which according to Markides (2006) is characteristic of disruptive technologies. The diffusion of DVR technology both in Hungary and in the world can be characterized by a slow start and a current period of growth which is constant although far from radical – contrarily to the description of the diffusion of communications technologies by Ortt and Shoormans (2004). Von Hippel (1994) suggests a focus on lead users, which we followed in our second qualitative and third quantitative research phases. From the results that followed, we believe that a niche segment of users can clearly be identified for whom comfort functions offered by DVR devices are important and to which they are attached to. However we believe that the penetration of this technology will not, or will very slowly reach 100 per cent as a result of the surrounding multimedia environment.

Based on our result we succeeded in establishing the foundations of a media technology acceptance model as our integrative research model connecting the technology acceptance model with the individual variables of gratification theory proved to give a robust explanation of the future intention of use of the studied media technology.

Our research has a methodological significance as well, as we had recourse to a mixed-method (hybrid) research model and assessed our research questions through

triangulation which allowed a more complex methodology in the search for patterns in consumption, use and acceptance in a growingly complex media and technology environment. Few academic works on technology acceptance and innovation diffusion have used a mixed-method approach or data and/or methodological triangulation.

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6. Publications related to the topic of the dissertation

Book chapter

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