



MARKETING

# INVESTIGANDO OS FATORES QUE INFLUENCIAM A ADOÇÃO DE HDTV NO BRASIL

INVESTIGATING DRIVING FACTORS OF HDTV ADOPTION IN BRAZIL

 Daniel da Hora Alves Lima  
Banco Nacional de Desenvolvimento Econômico e Social

 Jorge Brantes Ferreira  
Pontifícia Universidade Católica do Rio de Janeiro

 Luis Fernando Hor-Meyll  
Pontifícia Universidade Católica do Rio de Janeiro

 Jorge Ferreira da Silva  
Pontifícia Universidade Católica do Rio de Janeiro

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Vieira de Oliveira

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## RESUMO

Três anos depois do lançamento da TV digital no Brasil, sua penetração ainda é pequena. O consumidor de conteúdo em alta definição tem sido principalmente assinantes de TV paga, em geral famílias com renda elevada, mas potenciais formadores de opinião. Para identificar estímulos e barreiras à adoção da TV por assinatura em alta definição (HD), quinze potenciais usuários foram entrevistados. Em seguida, um *survey* foi conduzido em amostra de 348 assinantes de TV paga que não contratavam pacotes HD. Os dados foram tratados por técnicas de *data mining* e árvore de decisão, identificando-se a relação entre atributos do serviço de HD percebidos e a intenção de contratá-lo. Os resultados sugerem que a disponibilidade de conteúdo em HD, recursos percebidos, renda familiar e a percepção de facilidade de uso da tecnologia têm impacto significativo na intenção de adoção de um serviço por assinatura de HDTV.

## PALAVRAS-CHAVE

Comportamento do consumidor. Difusão de inovações. Barreiras à adoção. HDTV. Inovadores.

## ABSTRACT

*This article examines how different factors affect the adoption intention by Brazilian consumers of HD pay-TV services. Fifteen interviews with potential users (high income individuals) were initially conducted to identify stimuli and barriers to adoption. A survey was then carried out on a convenience sample of 348 high income pay-TV subscribers, who did not subscribe HD services. Data mining and decision tree modeling were carried out to assess the relationship among perceived attributes of HD pay-TV services and their contribution to the intention to subscribe. Results present evidence that availability of high definition content, perceived resources, income and ease of use of the technology have significant impact upon an individual's intention to adopt HD pay-TV services.*

## KEYWORDS

*Consumer behavior. Diffusion of innovations. Barriers to adoption. HDTV. Innovators.*

## INTRODUCTION

Since 2003, when the Brazilian government spurred the introduction of digital TV in the country, many companies have invested considerable resources in the development of related technologies and services. Those firms sought returns on their investment through sales of products and content. In addition, expectation was created among consumers about the benefits that the technology would bring. The Brazilian digital TV standard was defined by government agencies in 2006 and digital

broadcasts, which enable the distribution of high-definition (HD) content, begun on December 2007. However, although the service is available today in twenty six major cities, potentially reaching sixty million consumers, its penetration is still very limited: estimates based on the sales of devices capable of presenting HD content indicated that only two million consumers had so far chosen to adopt the new technology (CHERMAN, 2009).

The sluggish pace of HDTV adoption has been the subject of studies conducted in many different countries: Weber and Evans (2002) reported slow adoption in

the USA and in the United Kingdom, even after seven years of the launch of the service, while Weerakkody (2003) and Feng *et al.* (2009) commented on low adoption rates in Australia and China, respectively. The fact that Brazil is still a developing country weighs against the diffusion of HDTV as well: in a study evaluating the diffusion of six categories of products in thirty one developed and developing countries (including Brazil), Talukdar, Sudhir, and Ainslie (2002) reported that developing countries usually need 17.6% more time than developed countries to reach the peak of the adoption curve.

Current literature (HOLANDA; AVILA; MARTINS, 2008; MENEZES *et al.*, 2005; SOUZA; SOUZA, 2009) suggests that socioeconomic and financial factors act as inhibitors of HDTV diffusion in Brazil, with particular importance given to the low available family income (total income minus expenses) and to the high perceived cost of the required equipment to experience high-definition content. Chan-Olsmted and Chang (2006) also explored the positive correlation between income and innovativeness, as far as HDTV adoption is concerned. However, given the varied availability of HD content and the many benefits or difficulties perceived by the consumer during set up and use, other factors may play key roles in defining the decision whether to adopt or not the technology.

This study was conceived to investigate driving factors affecting the adoption, by pay-TV subscribers, of HD services in Brazil. From an academic perspective, the results herein may shed more light on the process of diffusion of innovations in Brazil, particularly in the services

industry, where studies are still scarce (HEGEDUS, 2006).

As pay-TV subscribers are potential opinion leaders, understanding their perceptions and attitudes towards HD content (the main benefit of Digital TV that is currently available on a large scale in Brazil), may be relevant for many change agents (the government, TV set and set-top box manufacturers, HD content producers, TV networks) to improve public awareness. Increasing the number of HD viewers will produce economies of scale that will reduce costs of production. For content producers, it would encourage the production of even more content, at affordable final price. The combined effect will be an increasing uptake of the HD service, enabling the technology to more rapidly attain critical mass (ROGERS, 2003).

Public policy makers may also find some subsidies in this study for the development of additional actions to stimulate the penetration of HD content, services and associated products among the less affluent strata, the majority of the Brazilian population.

## DIFFUSION OF INNOVATIONS

"Diffusion is commonly used to describe the process by which individuals and firms in a society or economy adopt a new technology, or replace an older technology with a new one" (HALL, 2004, p.2).

Rogers (2003) considered diffusion as "the process by which an innovation is communicated through certain channels over time among the members of a social system. It is a special type of communication, in that the messages are concerned with new ideas" (p. 5).

Adoption by a consumer is his (her) first purchase of a product (including goods or services), or his (her) first use of an innovation (ROGERS, 2003).

One of the most common goals of using the diffusion of innovations theory in marketing is to create knowledge that can accelerate the rate of diffusion of a new product or service, thereby reducing the interval of time from its launching until it reaches the point of critical mass, when the rate of adoption becomes self-sustaining (ROGERS, 2003).

The efficiency of efforts related to launching a new product can be improved due to: (i) the identification of early adopters in the target market; (ii) indications of the nature and size of the potential market; (iii) the study of how to raise the degree of "innovativeness" of a population; and (iv) the indication of time to adoption for various population groups (MCDONALD; CORKINDALE; SHARP, 2003)

Rogers (2003) reviewed several studies on the adoption of innovations and conjectured that five characteristics could affect the rate of diffusion of a product or service. Nonetheless, these concepts are subjective and relate to individual perceptions of innovation, which influence the consumer's choice regarding whether or not to adopt it:

- *Relative Advantage*: the degree to which an innovation is perceived as superior to its predecessor;
- *Compatibility*: the degree to which an innovation is perceived by the adopter as similar to previous experience, beliefs, and value;
- *Complexity*: the degree to which an innovation is perceived as difficult to use;

- *Observability*: the degree to which the results of an innovation are visible to others;
- *Triability*: the degree to which an innovation may be experimented with on a limited basis;

In a meta-analysis which considered more than 105 articles, Tormatzky and Klein (1982) identified ten characteristics often exploited in studies on diffusion of innovations. Besides the five proposed by Rogers, cost, communicability, divisibility, profitability and social approval were considered. Tormatzky and Klein acknowledged, however, that the definitions for communicability resemble the concept of observability and that the concept of divisibility has similarities with triability. Furthermore, when examining the level of individual adoption of technologies, particularly in organizational settings, cost and profitability were not found to be relevant.

However, social approval — called "image" by Moore and Benbasat (1991) — proved to be relevant to the adoption decision. Rogers (2003) included this concept as part of the relative advantage, once the consumer looks for social prestige, status or enhanced image in a social system. Tormatzky and Klein (1982) noted that several authors believe that the construct image (or social approval) is sufficiently different from relative advantage, and should therefore be separately considered, measured and analyzed.

Other authors have also brought contributions to the study of diffusion of innovations, either by directly addressing the subject or by indirectly addressing related issues. If the five attributes

considered by Rogers (2003) can exert direct influence on the rate of adoption, other aspects, not directly related to the characteristics of an innovation, can also affect the perception of potential adopters, and, thereby, the rate of adoption.

The decision to adopt a new technology requires awareness that it exists, an understanding of its concept and information as to the technology's suitability to the contextual circumstances of the potential adopter (HALL, 2004; ROGERS, 2003). The potential adopter's degree of awareness can be influenced by some factors related to the offerer, such as efforts made by change agents (GATIGNON; ROBERTSON, 1985; HALL, 2004).

The influence can also be exerted by the potential adopters themselves, on account of their degree of access (accidental or intentional) to mass media and interpersonal channels (ROGERS, 2003), as well as to their ability to process received information and to understand the innovation concept (HIRSCHMAN, 1980; ROGERS, 2003).

### **Perceived Risk**

Perceived risk may also influence the adoption decision. As far as consumer goods are concerned, the purchase of a new product tends to represent a situation never before experienced by the consumer; therefore, perceived risks may affect his (her) decision as to whether to adopt or not the product.

Some authors considered that perceived risk is a bi-dimensional construct, composed by the importance of the negative consequences that the

decision could entail and the probability that some (or all) of these consequences would actually occur (CUNNINGHAM, 1967).

However, after analyzing many works on the subject, Mitchell (1999) alerted that recent studies confirmed a significant association between uncertainty and consequences. Therefore, the two basic components could not, in fact, be considered as distinct dimensions, hence confirming the pioneering vision of Bauer (1960): given that consumers' cognitive ability is limited, it would be inconceivable that they could consider more than a scant few consequences of their actions, since it would be very difficult to anticipate such consequences with a high degree of certainty.

In fact, the average consumer has limited information, has performed little experimentation, and has a memory that cannot be trusted. When dealing with completely new purchases, consumers' ability to assess risk accurately is virtually nil (MITCHELL, 1999). Instead of considering perceived risk as a combination of probability and consequence of loss, Stone and Winter (1987) preferred to define it as merely a subjective expectation: the more the consumer is sure of the loss, the greater the perceived risk.

Perceived risk is manifested in several ways. Jacoby and Kaplan (1972) proposed a five-dimension model, comprising physical, psychological, social, financial, and performance risks. An added dimension — the risk of time loss — was included by Roselius (1971). The model with those six dimensions was assumed throughout this study.

### Perceived Resources

Another important factor influencing the adoption of an innovation is the financial capacity of the potential adopter. Lin (1998) proposed the concept of "perceived resources" as the consumer's perception of the question "can I afford to buy this product?" when considering purchasing a new product and bearing in mind his available financial resources (DUPAGNE; DRISCOLL, 2009).

Some people with the financial resources required to adopt an innovation may decide not to do so because they do not perceive it as a priority. In contrast, other individuals who may wish to adopt the innovation, and consider it a priority, elect not to do so because they feel they cannot afford it (LIN, 1998).

### FACTORS AFFECTING THE ADOPTION OF HDTV IN THE WORLD

One important reason for the low adoption of HDTV in Australia was the small perceived relative advantage due to the high price of HDTV sets (an economic factor – WEERAKKODY, 2003). The scant available programming, which would best exploit the HD format compared to the established standard TV base (especially sports and drama), a non-economic reason, not specifically linked to HD, was another paramount factor found by Weerakkody.

Five years after the launch of HDTV in Australia, the most common reasons cited by adopters for take-up (better image quality) and by non-adopters for non-take-up (unappealing cost/benefit) were related to relative advantage (WEERAKKODY, 2007). The price of service subscription (an economic factor)

was identified by Baaren, Wijngaert e Huizer. (2008).

After a review of several studies conducted in the U.S. during the early years of HD broadcasts in the country, Rhodes (2004) found that HDTV was not perceived as better than the standard TV. Respondents of a study conducted by Chan-Olmsted and Chang (2006) also failed to see HDTV as substantially better than their current TV. In Holland, however, the lack of content was identified as a major barrier to the adoption (BAAREN; WIJNGAERT; HUIZER, 2008).

The lack of understanding of the concept (how to use it and how it works) was mentioned in several studies, also reviewed by Rhodes (2004), as one of the main barriers to the adoption of HDTV in the U.S. Not only was the degree of understanding low but, in many cases, the core ideas had been misunderstood, or their names were not recognized—often a fault of vendors who, through ignorance, misinformed their customers.

Evidence of poor knowledge and misunderstanding about HDTV in the U.S. market was also reported by Chan-Olmsted and Chang (2006) and Atkin *et al.* (2003). Being aware of the existence and having an understanding of HDTV were some of the best predictors of the intention to adopt it in the United States (CHAN-OLMSTED; CHANG, 2006). Also in the Netherlands, knowledge and understanding of HDTV were predictors of the perceived usefulness of the technology (BAAREN; WIJNGAERT; HUIZER, 2008).

In a study conducted in Australia, 25% of respondents said they knew little about HDTV, even five years after the national rollout of the service (WEERAKKODY,

2007): it turned out that, in the early years of implementation, retailers had not been well trained to answer consumers' questions, thus creating misunderstanding and confusion about the concepts (WEERAKKODY, 2003).

HDTV does seem to be a complex concept, with benefits that remain unclear to many (CHAN-OLMSTED; CHANG, 2006): Weerakkody (2003), for example, discusses the Australian consumer's confusion regarding the implementation of HDTV in the country; Dupagne and Driscoll (2009), too, observed that complexity could be a powerful deterrent acting against the adoption of communication technologies such as HDTV.

It seems that the HDTV construct complexity encompasses both the complexity related to difficulty of use and the complexity related to the difficulty of understanding the technology. In this study, complexity has this dual scope of meaning.

It also appears that consumers consider it risky to invest money in the subscription of HDTV services (CHAN-OLMSTED; CHANG, 2006), which is consistent with some studies that Mitchell (1999) cites, showing that products that cost more are perceived as riskier than more affordable or more convenient ones.

The most obvious characteristics of HDTV – its sound and picture quality – are related to observability and triability (BAAREN; WIJNGAERT; HUIZER, 2008): to better communicate the advantages of a TV set, change agents usually display HD content to demonstrate its image sharpness and sound quality (BAAREN; WIJNGAERT; HUIZER, 2008). The two

factors were considered jointly in this article.

The factors highlighted here are included in several models found in the literature. For example, Rogers (2003) found that relative advantage, observability, and triability are positively related to the rate of diffusion, whereas complexity was negatively related to diffusion. Hirschman (1980), Saaksjarvi (2003), Rogers (2003) and Hall (2004) mentioned that the degree of knowledge was positively related to the diffusion rate, while Ostlund (1974), Peters and Venkatesan (1973), Labay and Kinnear (1981) and Fliegel and Kivlin (1966) presented cases where the perceived risk was negatively related. Lin (1998), Dupagne (1999), Chan-Olmsted and Chang (2006) and Dupagne and Driscoll (2009), on the other hand, reported on studies that indicate that perceived features relate positively to the intention to adopt innovations.

#### THE ROLE OF DEMOGRAPHIC VARIABLES

One of the first studies on the estimated demand for HDTV conducted in Brazil examined socioeconomic factors that could affect its diffusion (MENEZES *et al.*, 2005). Unlike other social classes, higher income consumers showed the same expected rates of adoption, regardless the price level assigned to HD television sets, a result that suggests that these consumers would not be affected by price.

In another study on diffusion curves of various innovative, durable goods, including TVs, a price drop did not emerge as a factor encouraging the spread of their diffusion processes (HEGEDUS, 2006). However, we should exercise caution in such considerations on the

influence of price on the diffusion process, since opinion leaders have, in general, higher socioeconomic status than other consumers (ROGERS, 2003). So, although innovations may begin to diffuse into lower income strata, their propagation will depend on being adopted by higher social levels, from where waves of imitation will tend to surge on to other socio-economic classes (TARDE, 1903).

Hegedus (2006) emphasized the important role played by higher-income classes in the process of diffusion of durable innovations in Brazil, pointing that the behavior of these consumers may serve as a bellwether of behavior of other income strata, affecting also the intensity of diffusion. Furthermore, he discovered that the higher the purchasing power, the faster the adoption of goods. It is therefore possible that the diffusion of HDTV commences within the upper socioeconomic classes.

Studies in other countries reinforce the existence of a positive link between income and innovativeness (DICKERSON; GENTRY, 1983; LABAY; KINNEAR, 1981; LI, 2004; LIN, 1998; MAHAJAN; MULLER; SRIVASTAVA, 1990; MARTINEZ; POLO; FLAVIAN, 1998) for various categories of products (GATIGNON; ROBERTSON, 1985). As far as HDTV is concerned, studies conducted in the United States (DUPAGNE, 1999) presented empirical evidence of relationship among income, knowledge, interest and intention to adopt converters for high-definition broadcast, while Chan-Olsmed and Chang (2006) found that income can be a good predictor of HD-ready TV sets purchase.

McDonald, Corkindale e Sharp (2003) suggested that one of the criteria to identify potential adopters of an innovation

is to identify those with greater ability to have access to the innovation. Classes with higher income would be better able to afford HDTV sets.

Rogers's diffusion theory (2003) points in this direction. Even cautioned that economic factors do not provide a full explanation of innovative behavior, Rogers admitted that wealth and innovativeness are strongly related. Indeed, several socio-economic characteristics of innovators show relationships with income levels: innovators tend to have more years of formal education, higher literacy levels, and greater upward social mobility (not only to the social level immediately above, but to even higher levels, too). Besides these factors, the wealthy can absorb losses due to product failures, corresponding to a smaller portion of their disposable income, which means they tend to perceive less financial risk (DICKERSON; GENTRY, 1983).

Although Rogers (2003) didn't consider any influence of age differences between early and late adopters, other empirical studies posit a negative link between age and innovativeness (DANKO; MACLACHLAN, 1983; LABAY; KINNEAR, 1981; LIN, 1998; REAGAN, 1987; LI, 2004). This negative relationship was also found in studies involving HDTV (ATKIN; NEUENDORF; JEFFRES *et al.*, 2003; DUPAGNE, 1999).

## METHOD

In order to evaluate which factors were most influential in the adoption process of HDTV, a survey was conducted among subscribers of pay-TV in Brazil who did not yet have any HD services enabled. The variables to be measured were selected from studies found in the literature and

were also mentioned during the interviews carried out with fifteen pay-TV consumers during the initial exploratory phase of the study, which sought to identify potential innovation attributes that could be connected to the intention of subscribing to HDTV services.

The interviewees were 25 - 65 years old, high-income consumers. Content analysis showed that knowledge about the technology, relative advantage, complexity, observability, triability, perceived quantity of available HD content, perceived risk, perceived resources and some demographic variables could affect the intention to adopt.

### Questionnaire Design

Some studies present specific scales developed to measure the perception of attributes of innovations, whether related to information technology in organizations (MOORE; BENBASAT, 1991), communication technologies (DUPAGNE; DRISCOLL, 2009) or specifically related to HDTV (CHAN-OLMSTED; CHANG, 2006; DUPAGNE, 1999). A four-point Likert scale, developed and tested in Brazil (BARRETO; HOR-MEYLL, 2006), was used to measure the perceived risk. The adoption intention was measured on a 5-point scale ranging from 1 (*definitely will not order*) to 5 (*definitely will order*). Table 1 shows the constructs and the scales to measure them.

**TABLE 1 – Constructs and Scales**

<b>CONSTRUCT</b>	<b>SCALE</b>
Relative Advantage	Dupagne (1999)
Complexity	Chan-Olmsted and Chang (2006)
Observability and Triability	Dupagne and Driscoll (2009)
Perceived Risk	Barreto and Hor-Meyll (2006)
Perceived Resources	Dupagne and Driscoll (2009)
Variety of High Definition Content	Adapted from Dupagne (1999)
Adoption Intention	Dupagne (1999)

In the questionnaire design, several criteria were respected to minimize survey and non-response errors (DILLMAN; BOWKER, 2001). The phrasing of each item and the questionnaire structure were submitted to three different pre-tests, with samples of 20, 40 and 87 participants. After each pre-test, some items were refined, re-evaluated or even dropped to improve the scales' reliability.

The final version contained 39 items, including demographic measures and filter questions. The questionnaire was then posted on a website and accessed through a link sent by e-mail to the respondents.

### Sample

The sample included only pay-TV subscribers who were not subscribers of

any HD service and that were members of the highest income classes, in which the presence of pay-TV subscribers would be more likely. This choice reflected two assumptions: (i) price and disposable income may not be the only variables that influence the diffusion of HDTV and (ii) wealthier classes tend to adopt innovations earlier, which reinforces the importance of understanding this segment's perceptions of the subject.

Due to limited available resources, a convenience sample was chosen and, to obtain a reasonable number of valid questionnaires that would ensure the reliability of the analysis, snowball sampling was employed. This technique is recommended to reach a specialized population (AAKER; KUMAR; DAY, 2004), in this case pay-TV subscribers without HDTV services. Each respondent was asked to forward the questionnaire to friends and acquaintances that had the same characteristics.

### Data Collection

The e-mail with the link to the questionnaire contained instructions and recommendations for participation, along with a note of appreciation for the collaboration.

Due to the snowball technique, it was not possible to know how many people were invited to participate; neither was it possible to determine the response rate. However, 690 questionnaires were started and 519 (75%) were completed. Three hundred forty eight questionnaires were considered as valid (*i.e.*, respondents were pay-TV services users who reported not having previously subscribed to HDTV services) and submitted to the analysis.

## DATA ANALYSIS AND DISCUSSIONS

Demographic data showed an even divide between male and female, most of whom (92%) had at least college education. Ages varied from early twenties to above 60 years old, with 39% in the 26 to 35 age group and 23% in the 36 to 45 group. 75% of the sample has an average household income above US\$ 3,000 (R\$5,000). Being well-educated, affluent and cosmopolitan, the sample characteristics match the profile of early adopters (ROGERS, 2003).

### Modeling Procedures

Given the presence of missing data and due to the fact that many of measured variables showed skewed or otherwise badly shaped distributions, data mining procedures (LINOFF; BERRY, 2004; WITTEN; FRANK; HALL, 2011) were employed to identify which attributes were most important in predicting the adoption intention of HD services. Among many different data mining modeling procedures available (such as neural networks and logistic regressions), decision trees were chosen due to their ability to clearly explain which variables participated in the model and their order of importance in predicting the target. The fact that decision tree models (differently than regressions or neural networks) are resilient to missing values, have no restricting data assumptions and welcome categorical data as well as numeric variables was also desired (WITTEN; FRANK; HALL, 2011). Nonetheless, during early modeling stages, neural networks and logistic regressions were also tested, but proved to be less accurate than decision trees in outofsample analysis,

probably due to the data issues pointed out earlier.

A binary target variable was needed to estimate a decision tree, intrinsically a classification model. This variable was created by taking the adoption intention, measured through a five point scale, and assigning all answers "1" and "2" (which included the phrase *I will NOT subscribe to a HDTV service*) to one class and the remaining answers ("3", "4" and "5"), which showed some degree of desire to subscribe to HDTV services, to the other class. The new binary variable had two values: zero (representing consumers that showed no intention to adopt HDTV) and one (representing consumers that did express some intention to subscribe). The potential non-adopters corresponded to 64.6% of the sample, while the potential adopters represented 35.4%.

Decision tree modeling was carried out having as inputs all the measured variables (relative advantage, complexity, observability, triability, perceived resources, perceived risk, quantity of HD content and demographic information). Nevertheless, due to the nature of decision

tree modeling and the relative importance attributed to each of the input variables during the iterative fitting of the best decision rules, only the inputs deemed most relevant to characterize the target classes appear in the final results (in this case, quantity of HD content, income, perceived resources, and difficulty to use). The other input variables, although included in the model, did not contribute significantly to a better classification of the target's classes (adopters and non-adopters). To ensure stability and the generalization of the final model, ten-fold cross-validation was employed (WITTEN; FRANK; HALL, 2011).

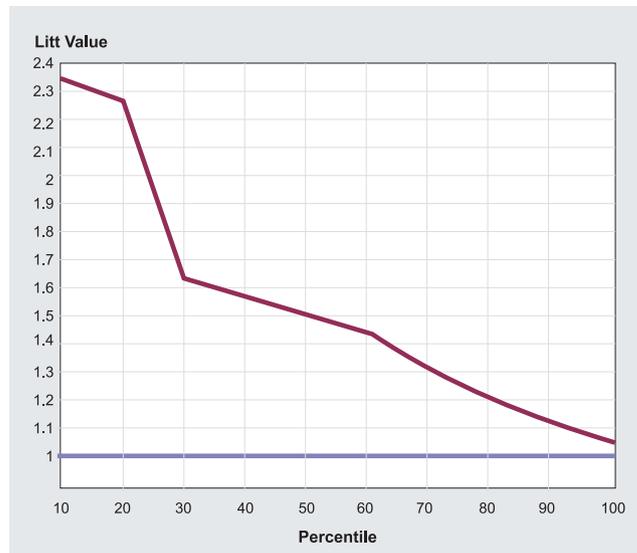
After parameter optimization and the testing of different tree architectures, a final model was obtained, providing a satisfactory prediction of the adoption intention. Most importantly, the decision tree algorithm was able to choose among all available inputs those that showed greater predictive power in relation to the consumer's adoption intention of HDTV services. The accuracy of the final model (22% total misclassification rate for outofsample observations) is depicted by.

**TABLE 2 - Confusion Matrix for the Final Model**

Actual Target	Predicted Target	
	0	1
0	80.43%	28.00%
1	19.57%	72.00%

The lift chart presented in Figure 1 indicates that, if the consumers in the sample were ordered in a descending fashion by the adoption probability predicted by the model, the decision tree would be able to identify 2.4 times more adopters than would a random sample of 10% of consumers. This result

emphasizes how well the model fits to the sample. Even more, given that the final model showed an accuracy (78%) nearly one fourth better than what would be expected by chance (64.6%), its performance can be considered good (HAIR *et al.*, 2009).

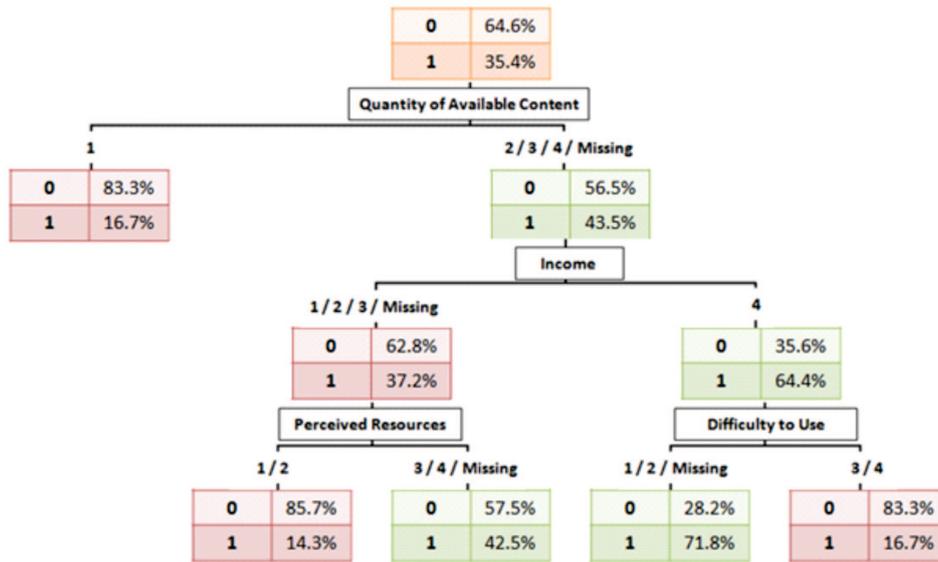


**FIGURE 1 - Lift chart for the Final Model**

### Importance of Input Variables

Once the model accuracy was considered satisfactory, attention can be devoted to the classification rules it yields and the identification of variables that influence the adoption intention. In the divideandconquer algorithm used by a decision tree (WITTEN; FRANK; HALL, 2011), the variable that contributes most to the distinction of the two classes

is allocated to the first split. Following a descending order of importance, subsequent variables that show any contribution to the division of the target in more homogenous groups appear in the next levels, until no more variables are deemed useful in distinguishing the two classes of the target variable. The complete tree diagram is shown in Figure 2.



**FIGURE 2 - Decision Tree Diagram**

The most important variable was the perception of *availability of high definition content*, particularly the variety of currently available content. The availability of HD content goes along with the consumer’s perceived relative advantage, when he mentally compares HDTV to standard TV. If specific content that enhances the advantages of the new technology is not readily perceived as available, the consumer probably will not choose to adopt the service.

Closely looking at this split, it is possible to note that, if a consumer perceives that almost no content is available in HD format (since answer “1” was chosen), the chance of not adopting the service grows from 64.8% at the root node to 83.3% at the tree leaf. On the other hand, if he (she) perceives that a variety of HD content is available (answers “2”, “3” and “4”) or have not answered the item (missing value), the

adoption chance increases from 34.4% to 43.4% in the next node.

The second most important variable was income. This split shows that consumers in the highest income category have a greater chance (64.4% compared to 37.2%) of adopting HDTV than consumers with lower income or that did not inform their income (missing value). This result is in accordance with the literature (MENEZES *et al.*, 2005; ROGERS, 2003).

Interestingly, when content is deemed available and money is not an issue (following the split with high income), the innovation complexity (indicated here by its difficulty of use component) becomes the defining attribute of adoption. In this case, if the technology is perceived as difficult to use (answers “3” or “4”), non-adoption rate rises sharply from 35.6% to 83.3%, suggesting that the complexity can be a major barrier to adoption. On the other side, if the innovation is seen

as friendly and easy to use, consumers display greater desire to adopt it, with adoption rates rising from 64.4% to 71.8%.

Now, considering the other split from income, it is seen that, if their monthly household income is less than \$10,000, consumers will evaluate their perceived resources (i.e. financial means available to acquire the service compared to the intrinsic perceived value of the innovation). If they are evaluated as low, chances of adoption will drop from 37.2% to 14.3%. Otherwise, if perceived resources are evaluated as high, or not informed (missing value), the probability of adoption rises slightly, from 37.2% to 42.5%, indicating that, even though the consumer might be in a situation of low income, they perceive value or prioritize the evaluated innovation.

## CONCLUSIONS

This study not only revealed factors that might play a role in the consumer's decision to adopt HDTV services in Brazil, but also their relative importance in the decision process. Due to the hierarchical nature of decision trees, resulting in classification rules that follow a specific order, different profiles of consumers, with higher or lower chances of adoption, can be inferred. Affluent consumers, with a positive view towards content availability (a positive scenario), might be dissuaded from adopting the technology if they perceive it as too complex or difficult to use. Likewise, even if HD content is seen as available, income and perceived resources can play a defining role in the final decision, clearly leading the consumer down the path of non-adoption if these variables exhibit low

levels. The availability of HD content was identified as the most important aspect in the adoption process, as consumers that do not perceive content as available demonstrated very low intention to adopt the service.

The evidences here presented can help the planning of governmental agencies, pay-TV networks and other players in the HDTV industry, by highlighting important issues that prevent a faster rate of adoption of HDTV technology (low availability of content, income of target market, difficulty to use, perceived resources). By knowing in advance the influence these factors exert on the consumer's decision process, change agents can intervene in the right places.

Government actions aiming at the diffusion of digital television have been based on fiscal incentives, such as the reduction of PIS and COFINS for converters, and in financing the productive chain. Such actions may be supplemented by other agents of change, to increase the adoption rate (ROGERS, 2003). In addition, the lack of knowledge about terms and characteristics of high definition technology suggests that the diffusion campaigns sponsored by the SBTVD Forum should be expanded.

Higher socio-economic classes, who are generally pay-TV subscribers, are formed by individuals who are respected in various social hierarchies. Due to their socio-economic profile, these classes tend to have a high concentration of innovators. Achieving critical mass for pay-TV HD services among these classes will create a market composed by trusted opinion leaders, building up demand that could stimulate an increase in the amount of available HD content, which

would favor further diffusion among other classes.

Besides testing the findings of this work in other settings, particularly other countries with different HDTV policies and in different stages of its implementation, future research could explore other constructs related to the diffusion of innovations and technology acceptance (such as perceived ease of use, perceived usefulness, social norms, emotions, etc.) and evaluate their importance and role in defining the adoption of HDTV. Also, bigger and more representative samples could be collected to further validate the results here presented.

The data mining approach here adopted, via the utilization of decision trees to assess the relevance/importance of variables, also constitutes a contribution,

since such methods are rarely used in academic studies. Finally, given the many studies about the diffusion of HDTV around the world (BAAREN; WIJNGAERT; HUIZER, 2008; CHAN-OLMSTED; CHANG, 2006; DUPAGNE; DRISCOLL, 2009; RHODES, 2004; WEERAKKODY, 2007), this paper can contribute to the literature, with an assessment of perceptions of Brazilian consumers in regard to the adoption of this particular technology.

The convenience sample and the web-based data collection could have biased or distorted the results, thus limiting the generalization of the conclusions. Although the data mining modeling techniques are fairly robust to many kinds of data issues, they would benefit from larger data sets, to guarantee more accurate estimates of the splits of a decision tree and more certain classification rules. 

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