

## High Definition Pay TV in Brazil: Investigating Driving Factors for Adoption

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### ABSTRACT

Apart from free-to-air (standard television) transmissions to mobile devices, the only feature that digital television can currently offer in Brazil is HD (high-definition) content, mostly to high-income users that are pay TV subscribers. The sluggish pace of digital TV adoption has been the subject of studies in many different countries: Weber and Evans (2002) reported slow adoption in the USA and in the United Kingdom; Weerakkody (2003) and Feng *et al.* (2009) comment on low adoption rates in Australia and China. Others (Menezes *et al.*, 2005; Holanda, Avila, and Martins, 2008; Souza and Souza, 2009) suggest that socioeconomic and financial factors act as inhibitors of its diffusion in Brazil, highlighting the importance of low available family income and the high perceived cost of the required equipment. This article examines how different factors affect the adoption intention of HD pay TV services by Brazilian consumers. These factors and their relation to adoption intention are included in several models found in the literature: Rogers (2003) - observability, triability and complexity; Hirschman (1980), Saaksjarvi (2003), Rogers (2003), Hall (2004) - degree of knowledge; Ostlund (1974), Peters and Venkatesan (1973), Labay and Kinnear (1981), Fliegel and Kivlin (1966) - perceived risk; Lin (1998), Dupagne (1999), Chan-Olmsted and Chang (2006), Dupagne and Driscoll (2009) - perceived features. Fifteen interviews with potential users were carried out to identify stimuli and barriers to adoption. A survey was conducted on a convenience sample of 348 pay TV subscribers, who were not subscribers of HDTV services. Snowball sampling was chosen to obtain a reasonable number of valid questionnaires that would ensure the reliability of the analysis. The questionnaire was posted on a website, to where respondents were directed via an email. Data mining and decision tree modeling were used to assess the relationship among perceived attributes of HD pay TV service and their contribution to the intention to subscribe to the service. Different profiles of consumers, with higher or lower chances of adoption, could be inferred from results: affluent consumers with a positive view toward content might be dissuaded from adopting the technology if they perceive it as too complex or difficult to use. Even if HD content is seen as available, income and perceived resources can play a defining role in the consumer's final decision. The availability of digital/HD content is the most important variable in the adoption process, and consumers that do not perceive content as available have very low intention to adopt the technology.

## INTRODUCTION

In December 2009, two years after the launch of digital TV transmissions in Brazil, the service was available in twenty six major cities, potentially reaching sixty million consumers. Nonetheless, estimates based on the sales of digital converter boxes and devices capable of presenting digital content painted a different picture: only around two million consumers had chosen to adopt the new technology up until that point (Cherman, 2009). The sluggish pace of digital TV adoption has been the subject of studies 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) comment on low adoption rates in Australia and China, respectively. The fact that Brazil is still a developing country weighs against the diffusion of digital TV 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 on the subject (Menezes *et al.*, 2005; Holanda, Avila, and Martins, 2008; Souza and Souza, 2009) suggests that socioeconomic and financial factors act as inhibitors of digital TV 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 equipment required to experience digital content. Chan-Olsmed and Chang (2006) also explore the positive correlation between income and innovativeness in regard to digital TV adoption. However, given the varied availability of digital content and the many benefits or difficulties perceived by the consumer during the set up and use of the service, other factors may play key roles in defining the decision whether to adopt the technology.

Therefore, seeking to better understand the diffusion of digital TV services among mainstream consumers, this study aims to explore the driving factors behind the adoption of digital pay TV with HD content with respect to subscribers in Brazil. Such comprehension could help authorities and sector firms that offer the service (TV set and set-top box manufacturers, HD content producers and TV networks) to improve public awareness, thereby increasing uptake of the service and enabling the technology to attain critical mass more rapidly (Rogers, 2003). From an academic point of view, the study aims to further the research about the diffusion of innovations among consumers in Latin America, particularly in Brazil, where such studies are still scarce (Hegedus, 2006).

## DIFFUSION OF INNOVATIONS

The application of the diffusion of innovations theory to the field of consumer behavior began in the 1960s with studies utilizing concepts of the general theory of diffusion in consumer research (Arndt, 1967; Frank, Massy, and Morrison, 1964; Robertson, 1967).

One of the most common goals of employing diffusion of innovations theory in marketing is to create knowledge that can accelerate the rate of diffusion of a new product, thereby reducing the time from release to the time the product reaches the point of critical mass, when the rate of adoption becomes self-sustaining (Rogers, 2003).

McDonald, Corkindale, and Sharp (2003) emphasize that knowledge of the diffusion process has the potential to improve the efficiency of efforts related to launching a new product due to several factors:

- identification of early adopters in the target market;
- indications of the nature and size of the potential market;
- study of how to raise the degree of "innovativeness" of a population; and
- indication of time to adoption for various population groups.

One definition of diffusion of innovations, specifically in relation to technology, states that "diffusion is commonly used to describe the process by which individuals and firms in a society/economy adopt a new technology, or replace an older technology with a newer one" (Hall, 2004, p.2).

Rogers (2003) described the different stages of adoption of products, with adoption understood as the first purchase of a product (including goods or services) or the first use of an innovation and proposed a more generic definition, applied to various fields of knowledge, in which diffusion was "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" (Rogers, 2003, p. 5).

#### ATTRIBUTES OF INNOVATIONS

Rogers (2003) reviewed several studies on innovation adoption and conjectured that five characteristics of an innovation could affect its rate of diffusion: relative advantage, compatibility, complexity, observability and triability. These constructs were supposed to be the main factors that influence a faster or slower adoption of an innovation. Note that they are subjective and relate to individual perceptions of innovation, that influence the consumer's choice regarding whether or not to adopt the innovation.

Rogers (2003) defined the concepts thus:

- *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 understand and 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 that looked at over 75 articles, Tormatzky and Klein (1982) identified ten characteristics often exploited in studies on diffusion of innovations, that included the five attributes proposed by Rogers, in addition to cost, communicability, divisibility, profitability and social approval. Tormatzky and Klein acknowledge, 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 variables. However, social approval — called "image" by Moore and Benbasat (1991) — proved to be relevant to the adoption decision. Rogers (2003) included this concept of the search for social prestige, status or enhanced image in a social system, as part of the concept of relative advantage. However, 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 considered, measured and analyzed separately.

#### Degree of Knowledge

Other authors have also brought contributions to the study of diffusion of innovations, either by addressing the subject directly or by indirectly addressing related issues. If the five attributes proposed by Rogers (2003) can exert direct influence on the rate of adoption, other aspects not directly related to the characteristics of innovation can also affect the perception of potential adopters, and, thereby, the rate of adoption of an innovation.

The decision to adopt a new technology requires knowledge that it exists, an understanding of the concept, and information as to the technology's suitability to the contextual circumstances of the potential adopter (Rogers, 2003; Hall, 2004). The potential adopter's degree of knowledge of the new idea can be influenced by factors related to the offerer, such as efforts on the part of the agents of change (Hall, 2004; Gatignon and Robertson, 1985).

The influence can also be exerted by 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 concept of the innovation (Hirschman, 1980; Rogers, 2003).

### **Perceived Risk**

Perceived risk is also a factor that may influence the adoption decision of consumers. In the case of innovations related to consumer goods, the purchase of new products tends to represent a situation never before experienced by the consumer; therefore perceived risks may affect his (her) decision as to whether to adopt the innovative product.

One of the first models proposed defines perceived risk as being composed of two components: the importance of negative consequences that the decision could entail, and the probability that some (or all) of these consequences will actually occur (Cunningham, 1967).

Decades later, Mitchell (1999), when compiling several academic works related to the construct, found that more recent studies confirmed a significant association between uncertainty and consequences. Therefore, the two basic components would not, in fact, be distinct. This finding would confirm the pioneering vision of Bauer (1960), for whom — given that consumers' cognitive ability is limited — it would be inconceivable that consumers could consider more than a scant few consequences of their actions, since it is 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 fully trusted. When dealing with completely new purchases, consumers' ability to accurately assess risk is virtually nil (Mitchell, 1999). Thus, instead of considering perceived risk as a combination of probability and consequence of loss, Stone and Winter (1987) preferred to define risk as merely a subjective expectation of loss: the more the consumer is sure of the loss, the greater the risk he (she) perceives.

Perceived risk can be expressed in several ways. Jacoby and Kaplan (1972) proposed a five dimensions model, (physical, psychological, social, financial, and performance risks). An sixth dimension — the risk of lost time — was proposed contemporaneously by Roselius (1971). This multidimensional model for perceived risk will be assumed throughout this study.

### **Perceived Resources**

Another important factor influencing the adoption of an innovation, especially in the case of a consumption innovation, is the the potential adopter's financial capacity to make the purchase. 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 (her) available financial resources (Dupagne and Driscoll, 2009).

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

### INFLUENCE ON THE ADOPTION OF DIGITAL TV

One of the most important factors for the low adoption of digital TV in Australia, during the first year of its launch, was the small perceived relative advantage, due to the high price of converters and TV sets (an economic factor). Another factor was the scant available new digital programming, especially sports and drama, which would best exploit the big screen format compared to the established analog TV base (a non-economic factor not specifically linked to HD) (Weerakkody, 2003).

The most obvious characteristic of HDTV (picture quality) is reflected by its observable features, related to the factors observability and triability (Baaren, Wijngaert, and Huizer, 2008). Therefore, change agents exhibit the device displaying HD content to communicate better the advantages of HD and to demonstrate the sharpness of image and sound quality (Baaren *et al.*, 2008). For this reason, the two factors will, in this study, be considered jointly.

Five years after the launch of digital TV in Australia, the most common reasons for take-up cited by adopters (better image quality) and for non-take-up by non-adopters (unappealing cost/benefit) were related to relative advantage (Weerakkody, 2007). Baaren *et al.* (2008) cited the subscription price (an economic factor) in the case of HDTV availability.

Rhodes (2004) reviewed several studies conducted in the U.S. during the early years of digital broadcasts in the country and found that respondents did not perceive digital TV as being better than the analog TV they already had. In a study conducted by Chan-Olmsted and Chang (2006), respondents also failed to see digital TV as substantially better than their analog TV. In the Netherlands, however, lack of content was identified as a major barrier to the adoption of HDTV in the country (Baaren *et al.*, 2008).

The lack of understanding the concept (how to use it and how it works) was mentioned in several studies reviewed by Rhodes (2004) as a main barrier to the adoption of digital TV in U.S. Besides the low degree of understanding, in many cases the core ideas had been misunderstood, or their names were not recognized—often a vendors fault when, by ignorance, misinformed customers.

Evidence of poor knowledge and misunderstanding about digital TV 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 digital TV were some of the best predictors of intention to adopt digital converters in the United States (Chan-Olmsted and Chang, 2006). Also in the Netherlands, knowledge and understanding of digital TV were predictors of the perceived usefulness of HDTV (Baaren *et al.*, 2008).

In a study conducted in Australia, 25% of respondents reported knowing little about digital TV, 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 concepts (Weerakkody, 2003).

Digital TV does seem to be a complex concept, with benefits that remain unclear to many (Chan-Olmsted and Chang, 2006): Weerakkody (2003), for example, discussed the Australian consumer's confusion regarding the implementation of digital TV in the country; Dupagne and Driscoll (2009) also observed that complexity can be a powerful deterrent acting against the adoption of communication technologies such as digital TV and HDTV.

In the case of digital TV, it seems that 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 is considering as presenting this dual scope of meaning.

It also appears that consumers consider it risky to invest money in the purchase of digital TV services (Chan-Olmsted and Chang, 2006), which is consistent with studies that



Mitchell (1999) cites, showing that more expensive products are perceived as riskier than more affordable or more convenient products.

The factors highlighted here are included in 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) mention that the degree of knowledge is positively related to the diffusion rate, while Ostlund (1974), Peters and Venkatesan (1973), Labay and Kinnear (1981) and Fliegel and Kivlin (1966) found cases where the perceived risk is negatively related. Lin (1998), Dupagne (1999), Chan-Olmsted and Chang (2006) and Dupagne and Driscoll (2009), on the other hand, all report on studies that indicate that perceived resources relate positively to the intention to adopt innovations.

### **INFLUENCE OF DEMOGRAPHIC VARIABLES**

One of the first studies (2004) conducted in Brazil on the estimated demand for digital TV examined socioeconomic factors that could affect the service diffusion (Menezes *et al.*, 2005). Unlike other social classes, higher income consumers (Brazilian social classes A and B) showed the same expected rates of adoption, regardless of the price level assigned to the converter or digital television sets with built-in converter, a result that suggests these consumers would not be affected by price.

In another study on diffusion curves of various innovative and durable goods, including TVs, conducted in Brazil, price drop did not emerge as a factor encouraging the spread of these innovations, indicating that price may not be a particularly influential variable in the diffusion process (Hegedus, 2006).

However, the influence of price on the diffusion process, should be considered with caution, since opinion leaders have, in general, higher socioeconomic status than other consumers (Rogers, 2003). 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) emphasizes the important role played by higher-income classes in the process of diffusion of durable innovations in Brazil, pointing that the behavior of these classes may serve as a bellwether of behavior of other income strata, affecting also the intensity of diffusion. Another conclusion of his study is that the higher purchasing power, the faster the adoption of goods. It is therefore possible that the diffusion of digital TV commences with the upper classes, and not based on an initial popularization of the price of the converter, in order to make the technology accessible to low income classes.

Studies in other countries also suggest a positive link between income and innovativeness (Martinez *et al.*, 1998; Labay and Kinnear, 1981; Dickerson and Gentry, 1983; Mahajan, Muller and Srivastava, 1990; Lin, 1998; Li, 2004) for various categories of products (Gatignon and Robertson, 1985). In relation to digital TV, in studies conducted in the United States, Dupagne (1999) presented empirical evidence of relationships between income, knowledge, interest and intention to adopt converters for high-definition broadcasts, while Chan-Olmsted and Chang (2006) found that income can be a good predictor of purchase of TV sets with built-in digital converter.

McDonald *et al.* (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 TV sets with integrated converters and/or digital TV ready.

The diffusion theory (Rogers (2003) also points in this direction. Although Rogers (2003) cautions that economic factors do not provide a full explanation of innovative

behavior, he admits that wealth and innovativeness are strongly related. Indeed, several socio-economic characteristics assigned to 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). Furthermore, the wealthy can absorb losses, due to product failures, that correspond to a smaller portion of their disposable income, meaning they tend to perceive less financial risk (Dickerson and Gentry, 1983).

Although Rogers (2003) suggests there is no influence of age differences between early and late adopters, other empirical studies posit a negative link between age and innovativeness (Danko and Maclachlan, 1983; Lin, 1998; Labay and Kinnear, 1981; Reagan, 1987; Li, 2004). This negative relationship was also found in studies involving HDTV (Dupagne, 1999) and Digital TV (Atkin *et al.*, 2003).

## METHOD

In order to evaluate which factors were most influential in the adoption process of digital TV, a survey was conducted among subscribers of pay TV in Brazil who did not yet have any digital or HD services enabled. The variables included in the data collection instrument were selected based on the literature and on in-depth interviews carried out with a small sample of pay TV and free-t-air consumers.

### Questionnaire Design

The questionnaire design involved several different stages, starting with a series of in-depth interviews to explore consumers' perceptions and adoption intent regarding digital TV and HDTV. During this initial phase, investigations were carried out to identify potential innovation attributes that could show significant connection with a consumer's intention of buying digital converters/sets or subscribing to HD pay TV services. Fifteen interviews were conducted with consumers of both genders, aged 25 to 65, belonging to high-income social classes. Content analysis showed that knowledge about the technology, the diverse attributes of innovations (relative advantage, complexity, observability, triability, perceived risk and perceived resources) and demographic variables could have effects upon the adoption intention of digital TV or HD pay TV.

The initial version of the questionnaire included demographic and filter items (such as whether the participant was already a HD pay TV subscriber), several items meant to measure usage patterns of pay TV content, the perception of the consumer regarding the different attributes evaluated, and an item to measure the consumer's intention to adopt HD pay TV services.

Scales already developed and tested were employed to measure perceptions in relation to attributes of innovations, as suggested by Bearden and Netemeyer (1998): innovations in information technology in organizations (Moore and Benbasat, 1991), communication technologies (Dupagne and Driscoll, 2009) or, specifically, for digital TV (Chan-Olmsted and Chang, 2006).

The first two studies sought to develop scales that could be broadly replicated, working with various items for each construct. The study of Chan-Olmsted and Chang (2006), which included other variables beyond the perception of attributes, focused on developing a model that might predict intent to adopt digital TV — a similar objective to the focus of this study. A scale to perceived risk had already been developed and tested in Brazil (Barreto and Hor-Meyll, 2006), measuring the dimensions of financial, performance, time, and total perceived risk in four-point Likert scales. One question (*How likely are you to order HD pay TV service in the next six months?*) measured the adoption intention on a 5-point scale, ranging from 1 (*definitely will not order*) to 5 (*definitely will order*).

The structure of the instrument and the phrasing of each item were subject to three different pre-tests, on samples of 20, 40 and 87 participants respectively. After each pre-test, some items in the questionnaire were refined, re-evaluated or even eliminated to improve the scales' reliability. The final version contained 39 items, including demographic measures and filter questions.

### **Sample**

This study focused on the perceptions of pay TV subscribers who were not subscribers of any digital/HD service. The sample included only pay TV subscribers in which, in Brazil, the presence of members of the highest income classes (A and B) would be more likely. The 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, snowball sampling was chosen to obtain a reasonable number of valid questionnaires that would ensure the reliability of the analysis. This technique is recommended to sample a specialized population (in this case, pay TV subscribers without HDTV service) (Aaker, Kumar and Day, 2004).

Several criteria to minimize survey and non-response errors were considered (Dillman and Bowker, 2001).

### **Data Collection**

The questionnaire was posted on a website, to where respondents were directed via an email that presented the survey and contained instructions and recommendations for filling out the form, along with a note of appreciation for participation. The email also asked the respondent to forward it to other people they acquainted, who had the desired sample characteristics.

The use of snowball sampling does not allow to know how many people were invited to participate; neither is it possible to determine the response rate. However, 690 questionnaires were started, 519 (75%) were completed and 348 (50,4%) were considered valid for analysis (filled out by pay TV subscribers who were not subscribers of HD TV services).

## **DATA ANALYSIS AND DISCUSSIONS**

### **Sample Characteristics**

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

### **Modeling Procedure**

Given the presence of missing data and due to the fact that many of the measured variables showed skewed or otherwise badly shaped distributions, data mining procedures (Witten *et al.*, 2011; Linoff and Berry, 2004) were employed to identify which attributes were most important in predicting the adoption intention. Among many different available data mining modeling procedures, decision trees were chosen, due to their ability to clearly explain which variables were utilized in the model and their order of importance in predicting the target. Decision tree models are resilient to missing values, have no restricting data assumptions, and welcome categorical data as well as numeric variables was also a desired



feature (Witten *et al.*, 2011). Nonetheless, during early modeling stages, neural networks and logistic regressions were also tested, but proved less accurate in out-of-sample analysis, probably due to 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 variable measured through a five point scale in the research instrument and assigning the answer values 1 and 2 (for the affirmative *I will NOT subscribe to a HD pay TV service*) to one class and the other answer values (3, 4 and 5), which indicated some degree of desire to subscribe to digital TV services, to the other class. The new binary variable “adoption intention” had now two values: zero (consumers that showed no intention to adopt HD pay TV, corresponding to 64.6% of the sample) and one (consumers who did express desire to subscribe to the service, representing 35.4% of the sample).

Decision tree modeling used as inputs all the variables measured in the questionnaire (innovation attributes and demographic information). To ensure the stability of results and the generalization of the final model, ten-fold cross-validation was employed (Witten *et al.*, 2011). After parameter optimization and testing different tree architectures, a final decision tree model was obtained, providing a satisfactory prediction of the binary adoption intention target. 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 digital/HD TV services. The final model accuracy (22% total misclassification rate for out-of-sample observations) is shown by the confusion matrix (Table 1).

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

**Table 1. Confusion Matrix**

The lift chart (Figure 1) indicates that, if consumers in the sample were ordered in a descending order by the adoption probability predicted by the model, the decision tree would be able to identify 2.4 times more adopters of HD pay TV services than would a random sample of 10% of consumers. This result emphasizes the good fit of the model to the sample.

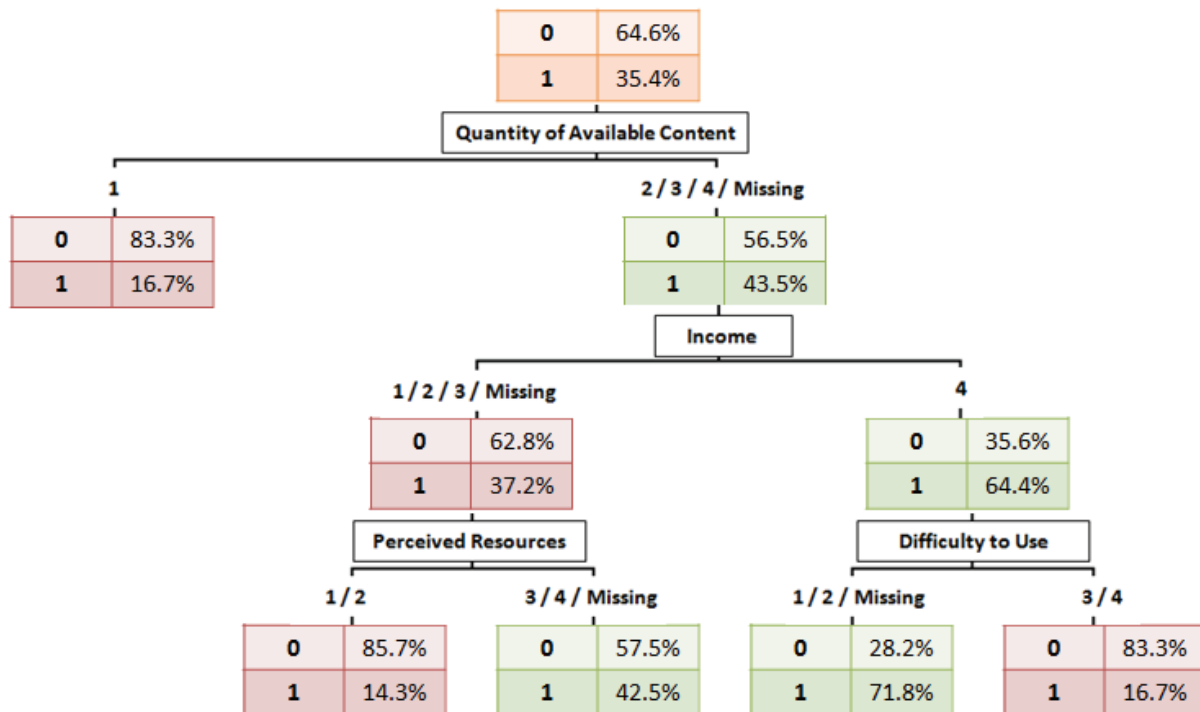


**Figure 1. Lift chart for the Final Decision Tree Model**

Since the results represent an increase in accuracy of nearly one fourth compared with what would be expected by chance (given that the target variable had a 64.6%/35.4% split, the accuracy expected by chance — classifying everyone in the most common class — would be 64.6%), the final model can be considered to have good performance (Hair *et al.*, 2009).

**Importance of Input Variables**

With satisfactory tree accuracy, attention can be devoted to the classification rules it yields and the identification of variables that influence the adoption intention of HD pay TV. In the divide-and-conquer algorithm used by a decision tree (Witten *et al.*, 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 input variables that show any contribution to the division of the target in more homogenous groups appear in the next levels of the tree, 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 in determining the adoption of HD pay TV (Figure 2) is the availability of high definition content perceived by the consumer, particularly the amount of content currently available. The availability of HD content goes along with the consumer's perceived relative advantage, when he (she) mentally compares digital to analog 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.

Looking closely at this split, it is possible to note that if a consumer perceives that almost no content is available in HD format (value 1 for that item), his (her) 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 some amount of HD content is available (answers 2, 3 and 4) or have not answered the item (missing value), his (her) adoption chance increases from 34.4% to 43.4% in the next node.

Income is the next most important variable. Consumers in the highest income category (4) have greater chance (64.4%, compared to 37.2%) of adopting HD pay TV than consumers with lower income (1, 2, 3), or that did not informed about income (missing). This result is in accordance with the influence of income in adoption (Menezes *et al.*, 2005; Rogers, 2003).

When content is deemed available and money is not an issue (following the split with high income), the complexity of the innovation (translated 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%, showing clearly that complexity can be a major barrier to adoption. On the other side, if the innovation is seen as easy to use and friendly, adoption rates rises from 64.4% to 71.8%.

If income is not at the highest measured level (monthly household income of US\$ 6,300, or BR\$ 10,000 or more), consumers will evaluate their perceived resources: if they perceive it as low (available financial means to acquire the service, compared to the intrinsic perceived value of the innovation), chances of adoption will drop from 37.2% to 14.3%. Otherwise, if perceived resources are high (or information is missing), adoption probability rises slightly, from 37.2% to 42.5%, indicating that, even in a situation of low income, consumers perceive value or prioritize the evaluated innovation.

## CONCLUSIONS

This study revealed not only which factors might play a role in consumer decision making regarding HD pay TV, but also their relative importance in the consumer's 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 toward 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 consumer's final decision, clearly leading down the path of non-adoption if those variables exhibit low levels. The availability of HD content is the most important variable in the adoption process, and consumers that do not perceive content as available have very low intention to adopt the technology.

The results may help the planning of governmental agencies, pay TV networks and other players in the digital TV market by highlighting the most important issues against a faster rate of adoption of HD pay TV technology - low availability of content, income of target market, difficulty to use, perceived resources.

Contributions to the diffusion of innovative services knowledge can arise from the evaluation of a comprehensive set of variables that might influence the adoption of a new service and pointing out the most important in characterizing consumer adoption. The data mining approach also constitutes a contribution to the literature, once such methods are scarce in the literature. Finally, given the many studies regarding the diffusion of digital TV around the world (Weerakkody, 2007; Rhodes, 2004; Chan-Olmsted e Chang, 2006; Baaren *et al.*, 2008; Dupagne and Driscoll, 2009), this study constitutes an assessment of the perceptions of Brazilian consumers in regard to the adoption of this particular technology.

## LIMITATIONS AND FUTURE RESEARCH

Besides testing the findings of this work in other settings, particularly other countries with different digital TV policies and in different stages of 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 and emotions) and evaluate their importance and role in defining the adoption of digital TV. Also, larger and more representative samples could be collected to further validate the results here presented.

Some limitations should be considered, as the convenience sample and the web-based data collection procedure that could bias or distort the results, thus limiting their generalization. Although data mining modeling techniques are fairly robust to many data issues, they would benefit from larger data sets that would provide more accurate estimates of splits and more certain classification rules.

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