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# Interdependent technology attributes and the diffusion of consumer electronics

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A B S T R A C T

In many studies on innovation diffusion, five attributes of innovations by Rogers [Rogers, E.M., 2003. Diffusion of Innovations. Free Press, New York] are used to explain the adoption of innovations. These five attributes (relative advantage, compatibility, complexity, trialability and observability) are related to each other. This paper develops a theoretical framework on how these attributes are interrelated. We show empirically that modelling the theoretical interdependencies leads to better results in predicting the adoption of consumer electronics. Further, we show that our framework is not only valid on a product-domain level, but also for separate clusters within the product domain.



## 1. Introduction

In subsequent editions of his book “Diffusion of Innovations” Everett M. Rogers (1962, 1983, 1995, 2003) was the first to extensively describe the diffusion process of innovations. According to Rogers (2003), the rate of adoption is explained by: (1) the perceived attributes of the innovation, (2) the type of innovation-decision, (3) communication channels, (4) the nature of the social system, and (5) the extent of change agents’ promotion efforts. Rogers and Shoemaker (1971) identified five relevant attributes of innovations that would promote diffusion: relative advantage, compatibility, complexity, trialability and observability (Rogers, 2003, p. 15–16). In a wide series of studies (Ostlund, 1974; Labay and Kinnear, 1981; Carayannis and Turner, 2006; Yakel and Kim, 2005; Hashem and Tann, 2007), these concepts are claimed to have a strong explanatory power in describing the likelihood of adopting innovations – here referred to as innovativeness. Based on a series of studies in the 1960’s, the innovation attributes are claimed to explain 49–87% of the rate of adoption of an innovation (Rogers and Shoemaker, 1971; Rogers, 1983, 1995, 2003). It should be noted, however, that these studies were all on the domain of agricultural innovations, and thus one could argue whether these findings can be generalized to other domains.

Rogers (2003) did acknowledge that these innovation attributes are conceptually interrelated and therefore not completely independent. Therefore, in any attempt to explain the diffusion of innovations, it makes sense to take the relations between these concepts into account. The first contribution of this paper is therefore a proposed theoretical construction of the relationships among the innovation attributes. Consequently, this construction will be empirically tested in the domain of consumer electronics, these are electronic products intended for everyday use by consumers.

Many studies on the adoption of innovations investigate the adoption of a single product (e.g. Eastin, 2002; Aoki and Downes, 2003; Lal, 2005; Yang, 2005). In order to make a more general statement, this study views innovation at a more

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aggregated level. Therefore, we will look at the domain of consumer electronics in general, instead of looking at single product. However, it can be questioned whether products in the same domain should be characterized on the basis of similar attributes (Lyytinen and Damsgaard, 2001). Global or domain-specific constructs can be poor predictors of concrete consumer purchase behavior (Goldsmith et al., 1995); therefore, we will also look at the relationships at a more concrete level within the product domain. One way of looking at the influence of the different characteristics within a product domain is to use the concept of technology clusters (Rogers, 2003; Vishwanath and Chen, 2006; Van Rijnsoever and Castaldi, 2009). Innovations are often not perceived singularly by individuals, but as part of a larger bundle of interrelated ideas (Rogers, 2003); the adoption of one innovation may stimulate the adoption of others. A technology cluster can be considered to be an intermediate level of analysis between a product domain and the specific product (Van Rijnsoever and Castaldi, 2009). Our second contribution is that we, besides addressing the general framework, look whether the importance of the relations among the characteristics differ per technology cluster. This will test to what extent the proposed relationships among the innovation characteristics are valid on the domain specific level, or whether there are differences between technology clusters.

The results of this study will be particularly useful for producers and marketers of innovations (in particular consumer electronics), as this provides more accurate insights into the innovation attributes and their relationships per technology cluster. This will enable them to better develop specific aspects of an innovation, which will lead to a better positioning in the market.

In the next section we will present the proposed theoretical relationships among the innovation attributes. These relationships will be tested per cluster on the domain of consumer electronics with a structural equation model approach.

## 2. Theory

### 2.1. Domain specific innovativeness and cluster specific innovativeness

The dependent variable in the model by Rogers (2003) is rate of adoption. He defines this as: "*the relative speed with which an innovation is adopted by members of a social system*". Usually, it is measured as the number of individuals who adopt the innovation in a specific time period. Our main dependent variable will be the actualized innovativeness of an individual; this is the concrete ownership of products by the consumer in the domain of consumer electronics. The difference between the rate of adoption and actualized innovativeness is that the former is measured on a population level, while the latter is measured on an individual level. Further, rate of adoption implies a change of over time, while actualized innovativeness is measured at only on point in time. Since the perceived attributes are measured on the individual level at one point in time, actualized innovativeness is the appropriate dependent variable.

As mentioned in the introduction, we will look at two distinct levels of aggregation for innovativeness. The first level is domain specific innovativeness, which views the total number of products researched in the product domain (Goldsmith et al., 1995). The second level is that of the technology clusters that can be distinguished within the domain; this variable will be called cluster specific innovativeness.

According to Rogers (2003, p. 14, 249), a technology cluster is defined as one or more separable but related elements of a technology through which people link a certain technology. It is not clear which elements of a technology are considered to be related. Clusters can be formed based on different related elements of a technology. The clusters can be based on a shared infrastructure (LaRose and Atkin, 1992; LaRose and Hoag, 1996), brand, name, package (Warlop et al., 2005) or being a part of the same product category (Nedungadi et al., 2001). Clusters might also be determined more broadly like having a fit with the lifestyle of the adopter (Ettema, 1984), or because of some emotional attachment (Kwortnik and Ross, 2007). Through a series of interviews Van Rijnsoever and Castaldi (2009) identified four clusters among 16 consumer electronics. These technologies were found to be related on the basis of functional properties. In this paper, we will research the same set of technologies and therefore we will use these groups as technology clusters within the product domain.

### 2.2. Technology clusters and innovation attributes

Rogers (2003) uses clustering as part of compatibility, but the other attributes can have different effects in different clusters. Following Rosch and Mervis (1976), Ozanne et al. (1992) suggested that: "*to respond to the overwhelming amount and variety of information in their environment, people group objects and events into categories on the basis of perceived similarities and resemblances*". This implies that observability could play an important role if the resemblances in visual patterns are likewise for products. However, Rosa and Porac (2002) noted that product categories can be particularly flexible and categorizations on the basis of observability seem to be less persistent with new market introductions than categorizations on the basis of relative advantage or experiences – trialability. But the importance of the attributes seems to differ per category. For example, Kim and Morris (2007) already concluded that consumers show a different response to trialability for the extent to which they are experienced as hedonic or functional innovations.

Yeh and Barsalou's (2006) work on concept properties confirms that people tend to rely on different ways of processing a certain concept or in this case a new product. According to Van Rijnsoever and Castaldi (2009), these different ways of processing can be made specific to concepts within the consumer electronics domain:

- *Taxonomic concepts:* Neighbouring concepts in a taxonomy that contains the target concept (e.g. MP3-player and PDA for the concept of a mobile phone, all can share functional properties).
- *Entity properties:* Properties that describe the target object's surface properties and components (e.g. small, ring tone, buttons for a mobile phone, design for an iPod).
- *Situational properties:* Properties that describe a physical setting or event in which the target object occurs (e.g. conversing, hearing a ring tone and beeps for the mobile phone, the computer in an office, or being connected to another item).
- *Introspective properties:* Properties that describe an agent's subjective perspective on the target object (e.g. annoying, convenient for the mobile phone).

These property typologies make clear that Rogers' attributes are not unbiased, because compatibility can be considered to be both an entity property (e.g. in terms of its interface and controls) and a situational property (in terms of its match with surroundings and visual notification properties). The same problem arises for the attribute relative advantage; the functional advantage is an introspective property, but the advantage of gaining status with a product is obviously more related to situational properties.

These problems require us first to redefine the innovation attributes by Rogers (2003). Compatibility and relative advantage will in this study each is split up into two different concepts (they are also treated separately by Rogers (2003). Complexity is the only variable that is negatively related to rate of adoption. In technology acceptance models (Davis, 1989; Venkatesh and Davis, 2000), the opposite of complexity is often applied, which is ease of use. To ease the interpretation of the results, we follow Davis (1989) and substitute complexity with its opposite, which will be named simplicity. Finally, the attributes trialability and observability will be combined to a single variable, since they both help to familiarize the consumer with the innovation. This leads to the six following definitions of attributes of innovations.

#### 2.2.1. Functional advantage (FA)

The functional advantage of an innovation can either be considered to be the relative functional performance of this innovation compared to the product(s) it substitutes, or the benefit the user experiences by making use of the product. An innovation that enables a user to perform a single or multiple tasks which is/are beneficial will thus be perceived to represent greater functional advantage than if these functions could else not have been performed, or with less incurred benefit.

#### 2.2.2. Status advantage (SA)

The status advantage of an innovation is related to the associated status people assign to the person who possesses and masters a certain product. This means that the ownership and usage of innovative products that people tend to find impressive, imposes a higher status upon this person relative to persons that do not use or own this product (Rogers, 2003, p. 230).

#### 2.2.3. Infrastructural compatibility (IC)

The infrastructural compatibility of an innovation is its compatibility with other products in terms of its connectivity or shared infrastructure. This increases the functionality of the innovation or the set of connected products as a whole. Thus, if an innovation could easily be connected to another product with which it can interact to perform certain tasks it is considered to have greater infrastructural compatibility than a product which lacks those connectivity features.

#### 2.2.4. Lifestyle compatibility (LC)

The lifestyle compatibility of an innovation is its perceived compatibility in terms of its situational properties. This may be the match with the surrounding interior of the room it is placed in, or the match with the owner's preferences for appearance and interface features. The latter relates to the consumers' profile, like a business man preferring clear communicational and organizational product features, or a sportsman having preferences for features related to effective outdoor usage (Lüthje, 2004). A better situational fit, to either the surroundings or the consumers' profile would thus imply greater lifestyle compatibility.

#### 2.2.5. Simplicity (SI)

The simplicity of an innovation (as opposed to its complexity) is defined here as the extend to which the user is able to understand the way the product works and its perceived ease of use. Consequently, if a consumer can easily make use of the product to perform a certain task, because he/she is capable to do so, or because he/she understands how to, it is perceived to have greater simplicity.

#### 2.2.6. Trialability & observability (T&O)

The trialability & observability of an innovation is an indicator for the extend to which a consumer is able to witness and experience features of a product he/she is rather unfamiliar with. If a potential buyer is able to try out the product, or observe the product. It enables the consumer to make a judgment of its trialability & observability and draw inferences on the basis of this. Highly visible and trialable products are thus judged to have greater trialability & observability.

### 2.3. Relationships among innovation attributes

Next, we will describe which of our concepts are related to each other and how. As point of departure we will follow Rogers (2003), and all the research that has supported his claims. We state that all the innovation attributes defined in the previous section have a positive influence on actualized innovativeness. Second, we hypothesize that there are no differences between the domain specific level and the clusters specific level, nor are there any differences between the clusters. The relationships we formulate are thus general ones. Our empirical tests will show to what extent these claims hold.

Our explanatory mechanisms are formulated from a perspective on how the attributes are related to each other in a temporal order. However, since this causal order is not tested, the hypotheses are formulated in a non-causal manner. The causal mechanisms are thus only implied as likely explanations.

#### 2.3.1. Trialability & observability and simplicity

Observing and trying out a product leads to a better understanding of the different functions it can perform. This makes it possible for a consumer to create some sort of mental map of its handling and to get an idea about the underlying mechanisms that make the product perform its tasks. The trialability & observability would thus positively affect the perceived simplicity, since having observed and tried out a product makes it appear more understandable and thus less complex.

- *H1: Perceived trialability & observability is positively related to perceived simplicity*.

#### 2.3.2. Simplicity and infrastructural compatibility

Simple products have an easier-to-understand-interface and less customizations and deviations from standards. They tend to have less diversity in types of in- and output channels through which they communicate, and thus a smaller variety in possible infrastructural gateways. These gateways require less knowledge to interconnect the products, which in turn can make people perceive them as being more compatible with other products.

- *H2: Perceived simplicity is positively related to perceived infrastructural compatibility*.

#### 2.3.3. Simplicity and lifestyle compatibility

Consumers shape constructs of the meaning of technology differently (Lyytinen and Damsgaard, 2001). If a product is positively judged in terms of simplicity, this means that the consumer can easily understand the way the product is supposed to be used. Therefore, it enables a consumer to place the product in the right context (Rogers, 2003). If more people are able to understand the product, then they are more able to judge whether it fits with their lifestyle. Complex products are understood by less people and therefore have a smaller chance of being perceived to be compatible with lifestyle. Moreover, it is less likely that a consumer will ignore the product because he/she thinks it is meant to serve other people with different lifestyles (like a complex PDA would be put aside as being designed for a businessman's lifestyle). Greater simplicity would therefore positively influence the perceived suitability with this person's lifestyle.

- *H3: Perceived simplicity is positively related to perceived lifestyle compatibility.*

#### 2.3.4. Infrastructural compatibility and lifestyle compatibility

Ownership of technologies can serve to enhance social identity (Bandura, 1977; Leung, 1998; Aversi et al., 1999). This means that the technologies, the functions they perform and the infrastructural connections between the technologies are also a part of that lifestyle (for example the connection between internet and a computer, or between a DVD-player and a TV). If the ability to connect two technologies to each other is indeed perceived to be a part of the lifestyle, then it follows that there is positive connection between infrastructural compatibility and lifestyle compatibility. If it fits with lifestyle then it also fits with infrastructure, but if it fits with the infrastructure, it does not need to fit with lifestyle.

- *H4: Perceived lifestyle compatibility is positively related to perceived infrastructural compatibility*.

#### 2.3.5. Lifestyle compatibility and status advantage

Again, the ownership of technologies can serve to enhance social identity (Bandura, 1977; Leung, 1998; Aversi et al., 1999). If a consumer has more products that fit a certain lifestyle, this lifestyle becomes more prominently visible to others. If, for example, a consumer is a business man, products that better fit the business man lifestyle will make him appear more like a business man. This can increase the perceived status in the eyes of others. More generally, "adoption of new products is often motivated by social benefits" and acts as a symbol of group affiliation (Arkesteijn and Oerlemans, 2005). Thus, a motivation for an individual to adopt an innovation is the desire to gain social status (Rogers, 2003). Furthermore, people that are relevant in judging a consumers' status tend to be likeminded on features that determine status. This is because status is determined within different but specific social groups with shared characteristics like the work or hobby they exercise and the associated lifestyle. The social process that determines the extent to which an innovation fits someone's lifestyle thus also affects this person's status.

- *H5: Perceived lifestyle compatibility is positively related to perceived status advantage.*

#### *2.3.6. Lifestyle compatibility and functional advantage*

If a product matches a consumers' lifestyle, this means that a greater fit will be perceived, this is a positive impulse leading him or her to judge a product more positively. Additionally, if a producer has a target group in mind, corresponding to a certain lifestyle, he or she will have an incentive to make the product extra beneficial for this targeted group of consumers. This in turn leads to the effect that products belonging to certain lifestyles have a greater perceived functional performance for people with this lifestyle.

- *H6: Perceived lifestyle compatibility is positively related to perceived functional advantage.*

#### *2.3.7. Infrastructural compatibility and status advantage*

If a consumer places higher value on functional compatible products, he/she will probably only do so if he/she knows the ways in which to take advantage of this and thus how to implement the infrastructural features. If one has more functional compatible products, a knowledge base is built around this cluster based on shared infrastructure (Van Rijnsoever and Castaldi, 2009). This can lead others to assign a higher status to this person, based on this knowledge base. The consumer might be perceived to be an opinion leader on the subject (Rogers and Cartano, 1962; Flynn et al., 1996). Furthermore, people are more likely to perceive products to be compatible if they actually own these products (then they know for sure that it is compatible). This means that the consumer is likely to own more products, which is associated with a high-status (Rogers, 2003). Consequently, if a consumer has more compatible products other people will award him/her with a higher status.

- *H7: Perceived infrastructural compatibility is positively related to perceived status advantage.*

#### *2.3.8. Infrastructural compatibility and perceived functional advantage*

If products are mutually more compatible due to shared infrastructures, the consumer can take benefit of a larger variety of functionalities of each of these products. For instance, a digital camera which supports USB can be connected to a computer through an USB cable, making it possible to see, store and manipulate photos, which otherwise would have only been possible by printing the photos at a photo shop. The consumer is thus able to take advantage of such functions thanks to the exploitation of infrastructural compatibility. Greater compatibility thus means more functional advantage for the consumer.

- *H8: Perceived infrastructural compatibility is positively related to perceived functional advantage.*

#### *2.3.9. Status advantage and functional advantage*

People are rather high-status than low-status (Cancian, 1967; Homans, 1974). As mentioned earlier, technology ownership can enhance status. Thus, if a product leads to a higher social status being assigned to the consumer, it hereby makes this consumer appreciate this product more, experiencing it as being more beneficial to him or her. The product is thus perceived by the owner as performing an additional function.

- *H9: Perceived status advantage is positively related to perceived functional advantage.*

Taking all these hypotheses on the relations between the different concepts together, a representation of the resulting conceptual model can be drawn, depicted in Fig. 1.

## 3. Methods

### *3.1. Sample and data collection*

To answer our research question we combined the results of the qualitative study by Van Rijnsoever and Castaldi (2009) with a quantitative study. The study by Van Rijnsoever and Castaldi (2009) led to the identification of four clusters among 16 consumer electronics products (see Table 1): a television cluster, a computer cluster, a gadget cluster and a music cluster.

The quantitative study consisted of a survey that was conducted among consumers in the Netherlands. Quota for age and sex were used in order to make the survey as representative for the Dutch population as possible. The response, after using multiple imputation to deal with missing values (Donders et al., 2006), was a dataset containing 339 usable cases. Although the age and

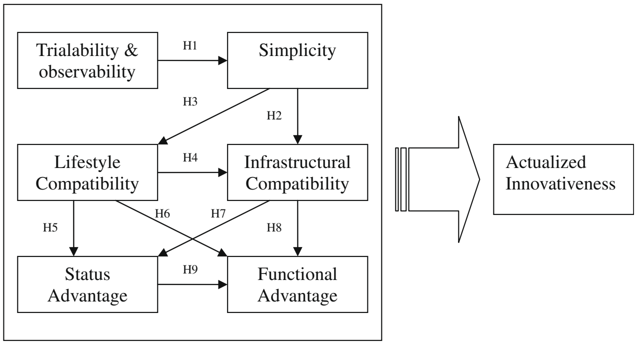


**Fig. 1.** The proposed relationships between the innovation attributes and the dependent variable.

**Table 1**
Four technology clusters in the consumer electronics product domain.

| Cluster | Technologies |
|---|---|
| Television | TV, HDTV, FPTV, DVD-player, Dolby surround |
| Computer | Desktop, Laptop, Broadband Internet, Webcam, Game console, PDA |
| Gadget | Mobile Phone, Mobile Phone with Camera, Digital Camera, PDA |
| Music | MP3-player, iPod |

**Table 2**
The operationalization of the variables.

| Variable | Measurement |
|---|---|
| Actualized innovativeness | *The number of products the respondent owns from a particular cluster of technologies* |
| Functional advantage | *What grade would you give to the product if you would grade them by their functionality?* (10-point scale from 1 to 10) |
| Status advantage | *In what way could a person distinguish himself or herself with the product?* (5-point scale from very negative to very positive) |
| Infrastructural compatibility | *How well does the product connect with other products you already own?* (5-point scale from very bad to very well) |
| Lifestyle compatibility | *How well does the product match with your lifestyle? (*5-point scale from very bad to very well) |
| Simplicity | *To what extend do you perceive the product as being easy to use? (*5-point scale from very difficult to very easy) |
| Triability & observability | *To what extend did you have the opportunity to use or watch the product being used before you considered buying it?* (5-point scale from very bad to very well) |

gender distribution were in line with Dutch population statistics, the sample size is too low for being a real representation of the population. The results are thus mainly indicative; caution should be exercised when attempting to generalize.

The questionnaire inquired, among other things, about rating the technology attributes described above, for each of 15 products.[1] Also information was gathered to determine if the respondents actually knew the product, and whether the product was actually owned.

The respondents had to rate each product separately for all the six attributes. They only had to answer the question if they really knew what the product was. The exact operationalization is provided in Table 2.

To come to a domain specific measure for each of the attributes we summed the indicators for all attributes of the products together after performing a homogeneity analysis. All Cronbachs Alpha values were larger than 0.8, making this addition reliable. We also added the values of the attributes for the products within the clusters together. We did not perform homogeneity analyses here, because the number of indicators per concept is too small, which biases the outcome of the analyses. We do acknowledge that per attribute, different clusters might be formed. We have chosen to follow technology clusters specified in Table 1.

## 4. Analysis

All our analyses were done with the LISREL 8.80 program (Jöreskog and Sorböm, 2006), using maximum likelihood estimation. The use of the LISREL program has as major advantage over ordinary regression techniques in that it allows us to

[1] We excluded the ordinary television, because it is owned by 98 % of the population (CBS, 2007), therefore it would have too little added value as a part of innovativeness.

model all paths in one model at once. Further, it specifies model performance indicators that indicate how well the specified model fits the empirical data. All variables in the models were treated as single indicator variables with no measurement error. As a starting point we fitted a model with the domain specific attributes (all 15 technologies combined) predicting innovativeness, but without any relationships among the independent variables. Next, the conceptual model is fitted on a domain specific level to see whether this would be a significant improvement. Then we fitted two models for each of the four technology clusters. One model without the relationships among the attributes specified and one with these relationships. Comparing the two models was done with a Chi-square test. This allows us to check whether there is a significant model improvement by adding the relationships among the independents. If there are major improvements possible, these will be mentioned in the text. Finally, we looked at the extent to which these cluster models differed from our theoretical model.

## 5. Results

This section will report our empirical findings. The results will be presented in five tables. In each table the dependent variables are displayed in columns and the independent variables are displayed in rows. The cells represent the standardized estimates of each path and their p-value. For each dependent variable we also report the R-square value as a measure for the explained variance. The first column and top row represent the abbreviation of the variable name. The second column shows the results of the model without relationships among the independent variables, the next six columns give the results of the relationships among the independent variables in the model with the relationships among the independent variables specified. The results in the last column represent the prediction for the actualized innovativeness of the individual. For each model we report the Goodness of Fit Index (GFI) and the Root Mean Squared Error of Approximation (RMSEA) as model performance indicators. The explanations and implications of the results will be reported in the discussion section.

Table 3 represents the results of the domain-specific model.

The model without relationships among the independent variables has a GFI 0.50 and a RMSEA 0.476, this is a very poor fit, the chi-square 1125.51 with 15 degrees of freedom. The GFI of the model with relationships among the independents is 0.99, indicating a near perfect fit. The RMSEA is 0.060, which is also very good. The chi-square of the model is 13.14 with 6 degrees of freedom. This is a highly significant improvement over the previous model.

The table shows that all relations as proposed by the hypotheses in our conceptual model are confirmed. Notable are the high R-squared values for some of the attributes (up to 60%), the attributes are heavily dependent on each other. The results of the last column show that the attributes Status Advantage and Lifestyle compatibility are not significant predictors for domain specific innovativeness. There is a significant negative relation between concept Trialability & Observervability and Domain Specific Innovativeness.

Table 4 represents the results for the TV cluster. The GFI of the first model is 0.52, the RMSEA 0.462, both indicate a poor fit. The chi-square is 1062.43 with 15 degrees of freedom.

The GFI of the second model is 0.99 and the RMSEA is 0.034, again a near perfect fit. The chi-square is 8.20 with 6 degrees of freedom. This is again a significant improvement over the model without the relationships among the independents specified.

All relations proposed for the TV cluster are significant within a 99.9% interval except for H8, which is not significant. H8 is the relation between the concepts of Infrastructural Compatibility and Functional advantage. The last column shows that the concepts of Status Advantage, Infrastructural Compatibility, Simplicity and Trialability & Observability are not significant in predicting Innovativeness in the TV cluster.

Table 5 presents the results for the computer cluster. The GFI of the first model is 0.51, the RMSEA is 0.471, again a very poor fit. The Chi-square is 1105.07 with 15 degrees of freedom. In the second model the GFI has improved to 0.99 and the RMSEA is 0.059, again an excellent fit. Also the chi-square is 12.84 with 6 degrees of freedom, which is a significant improvement over the model in the second column.

**Table 3**
The results of the model using the all technologies model.

| | Dominnov | FA | SA | IC | LC | SI | T&O | Dominnov |
|---|---|---|---|---|---|---|---|---|
| FA | 0.43*** | | | | | | | 0.40*** |
| SA | −0.10* | 0.13** | | | | | | −0.09 |
| IC | −0.01 | 0.11* | 0.30*** | | | | | −0.01 |
| LC | 0.23*** | 0.62*** | 0.21** | 0.49*** | | | | 0.21** |
| SI | 0.24*** | | | 0.31*** | 0.61*** | | | 0.22*** |
| T&O | −0.11** | | | | | 0.33*** | | −0.10* |
| $R^2$ | 0.32 | 0.60 | 0.23 | 0.53 | 0.39 | 0.11 | | 0.43 |

FA: functional advantage; SA: status advantage; IC: infrastructural compatibility; LC: lifestyle compatibility; SI: simplicity; T&O: trialability & observability; Dominnov: Domain Specific Innovativeness.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

**Table 4**
The results of the model for the TV cluster.

| | TVinnov | FA | SA | IC | LC | SI | T&O | TVinnov |
|---|---|---|---|---|---|---|---|---|
| FA | 0.37*** | | | | | | | 0.35*** |
| SA | −0.12** | 0.25*** | | | | | | −0.12 |
| IC | 0.02 | 0.07 | 0.27*** | | | | | 0.02 |
| LC | 0.35*** | 0.59*** | 0.43*** | 0.43*** | | | | 0.34*** |
| SI | 0.00 | | | 0.25*** | 0.46*** | | | 0.00 |
| T&O | −0.04 | | | | | 0.41*** | | −0.04 |
| $R^2$ | 0.27 | 0.66 | 0.37 | 0.33 | 0.22 | 0.17 | | 0.34 |

FA: functional advantage; SA: status advantage; IC: infrastructural compatibility; LC: lifestyle compatibility; SI: simplicity; T&O: trialability & observability; Tvclus: innovativeness in the TV cluster.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

**Table 5**
The results of the model for the computer cluster.

| | Compinnov | FA | SA | IC | LC | SI | T&O | Compinnov |
|---|---|---|---|---|---|---|---|---|
| FA | 0.51*** | | | | | | | 1.00*** |
| SA | −0.02 | 0.13** | | | | | | −0.03 |
| IC | −0.16*** | 0.17** | 0.31*** | | | | | −0.31* |
| LC | 0.21*** | 0.54*** | 0.15* | 0.55*** | | | | 0.40** |
| SI | 0.29*** | | | 0.26*** | 0.66*** | | | 0.55*** |
| T&O | −0.12** | | | | | 0.26*** | | −0.24** |
| R2 | 0.43 | 0.55 | 0.19 | 0.56 | 0.45 | 0.06 | | 0.49 |

FA: functional advantage; SA: status advantage; IC: infrastructural compatibility; LC: lifestyle compatibility; SI: simplicity; T&O: trialability & observability; Compinnov: innovativeness in the computer cluster.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

All relations proposed by the hypotheses for the computer cluster are significant. The last column shows that Status Advantage does not predict ownership of technologies within the computer cluster. The concepts of Infrastructural Compatibility and Trialability & Observability show a significant negative relationship to the prediction of ownership of technologies within the computer cluster.

Table 6 gives the results for the gadget cluster. The GFI of the first model is 0.59 and the RMSEA is 0.397, a very poor fit. The chi-square is 789.29 with 15 degrees of freedom. The model with the relationships among the independent variables has a GFI of 0.96, which indicates a good fit, but has an RMSEA of 0.150, which is relatively poor. The chi-square of the model is 49.99 with 6 degrees of freedom, a significant improvement.

All relations as proposed by the hypotheses are significant except for H9 which is the relation between Status Advantage en Functional Advantage. The concept SI has little explained variance. The last column shows that the concepts of Status Advantage, Infrastructural Compatibility and Trialability & Observability are not significant as predictors for the ownership of technologies within the gadget cluster. The modification indices suggest adding a path, between Simplicity, and Functional Advantage. This would improve the GFI to 0.99 and the RMSEA to 0.079.

Finally, Table 7 represents the results for the music cluster. The GFI of the model without the interrelated independent variables is 0.57, the RMSEA 0.412. The chi-square is 849.57 with 15 degrees of freedom. The model with the interrelations

**Table 6**
The results of the model for the gadget cluster.

| | Gadinnov | FA | SA | IC | LC | SI | T&O | Gadinnov |
|---|---|---|---|---|---|---|---|---|
| FA | 0.34*** | | | | | | | 0.36*** |
| SA | −0.04 | 0.00 | | | | | | −0.04 |
| IC | 0.13** | 0.15** | 0.21** | | | | | 0.13 |
| LC | 0.17*** | 0.55*** | 0.21** | 0.47*** | | | | 0.17* |
| SI | 0.29*** | | | 0.28*** | 0.55*** | | | 0.30*** |
| T&O | −0.09 | | | | | 0.23*** | | −0.10 |
| R2 | 0.25 | 0.43 | 0.14 | 0.44 | 0.31 | 0.05 | | 0.41 |

FA: functional advantage; SA: status advantage; IC: infrastructural compatibility; LC: lifestyle compatibility; SI: simplicity; T&O: trialability & observability; Gadinnov: innovativeness in the gadget cluster.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

**Table 7**
The results of the model for the music cluster.

| | Musinnov | FA | SA | IC | LC | SI | T&O | Musinnov |
|---|---|---|---|---|---|---|---|---|
| FA | 0.48*** | | | | | | | 0.29*** |
| SA | −0.11** | 0.20*** | | | | | | −0.06* |
| IC | 0.07 | 0.14** | 0.30*** | | | | | 0.04 |
| LC | 0.24*** | 0.53*** | 0.20*** | 0.26*** | | | | 0.14*** |
| SI | 0.30*** | | | 0.34*** | 0.58*** | | | 0.18*** |
| T&O | −0.10** | | | | | 0.30*** | | −0.06* |
| R2 | 0.41 | 0.50 | 0.19 | 0.29 | 0.35 | 0.09 | | 0.55 |

FA: functional advantage; SA: status advantage; IC: infrastructural compatibility; LC: lifestyle compatibility; SI: simplicity; T&O: trialability & observability; Musinnov: innovativeness in the music cluster.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

**Table 8**
A summary of the results.

| | Domain specific innovativeness | TV cluster | Computer cluster | Gadget cluster | Music cluster |
|---|---|---|---|---|---|
| H1 | Sig. | Sig. | Sig. | Sig. | Sig. |
| H2 | Sig. | Sig. | Sig. | Sig. | Sig. |
| H3 | Sig. | Sig. | Sig. | Sig. | Sig. |
| H4 | Sig. | Sig. | Sig. | Sig. | Sig. |
| H5 | Sig. | Sig. | Sig. | Sig. | Sig. |
| H6 | Sig. | Sig. | Sig. | Sig. | Sig. |
| H7 | Sig. | Sig. | Sig. | Sig. | Sig. |
| H8 | Sig. | N.s. | Sig. | Sig. | Sig. |
| H9 | Sig. | Sig. | Sig. | N.s. | Sig. |

Sig.: Hypotheses is significant and confirmed for the specific model; N.s.: Hypotheses not significant for the specific model.

added had a GFI of 0.98 and a RMSEA of 0.093, a reasonable fit. The modification indices do not show any major possible improvements. The chi-square is 22.92 with 6 degrees of freedom.

All relations as proposed by the hypotheses are significant. The concept SI has little explained variance. The last column shows that only the concept Infrastructural Compatibility is not tested significant as a predictor of ownership of technologies within the music cluster. The concepts of Status Advantage and Trialability & Observability show the same significant negative relation to the prediction of ownership of technologies within the music cluster.

As mentioned earlier, the sample cannot be seen as a real representation, of the Dutch population, therefore the results are mainly indicative. Given this limitation, the implications of the results will be discussed in the next paragraph. The following table provides a summary of the results discussed above (see Table 8).

## 6. Discussion

The results have shown convincingly that a model that does not take the interdependencies among the technology attributes into account has an extremely poor fit with the empirical data. For any model that predicts the diffusion of innovations with these attributes to make sense, it is required to take the relationships among the attributes into account. Not only does this yield a significantly better fit with the data, it also leads to higher amounts of explained variance for predicting innovativeness. The path-analytical model has not only demonstrated that the attributes are interrelated, but also how they are related, and therefore how different attributes explain the same variance of the dependent variable. It is true that all technological attributes are positively related to innovativeness.[2] The large correlations among the attributes themselves however, imply that some relationships are explained by others. This leads to negative correlations when predicting the main dependent variable. Fortunately, none of the hypothesized relationships had the wrong direction. This reinforces the surmise that the attributes are not directly affecting the main dependent variable, but instead do so indirectly because of their highly interlinked nature. Taking into account the relationships among the independents had an improvement in explained variance as result and a better model fit for all clusters. In future research it is thus important to model the interdependencies among the attributes.

The framework we have provided here is formulated at a domain specific level and can easily be extended to a cluster-specific level. Only in two instances were hypotheses rejected.

We have not attempted to model on a product-specific level, because the LISREL procedure is not adequate for predicting dummy variables. Based on the cluster results, we expect the results on a product-specific level to be roughly the same,

[2] When a correlation matrix is fitted, this would indeed be the result.

although they may vary per specific product. To what extend these relationships are valid outside the domain of consumer electronics, is something that has to be investigated in future research.

A theoretical implication is that the five attributes of innovations by Rogers (2003) do not fit with the consumer electronics domain. Status Advantage and Functional Advantage are two distinct concepts that have to be treated separately. The same applies for Lifestyle Compatibility and Infrastructural Compatibility. Trialability and Observability in this study fulfill the same function; they familiarize the consumer with the innovation. Whether this is valid has to be determined by future studies in the product domain that treats the concepts separately.

Another theoretical result of this study is that it provides evidence against the claim made by Rogers (2003) that 49%–87% of the adoption of an innovation can be explained by these attributes. In only two of our models we found a number that high (the computer cluster and the music cluster). A likely explanation for the difference found is that the percentages Rogers provides are based on rather old studies (the 1960's) based on agricultural innovations, a domain that is unrelated to consumer electronics. These findings show that such claims cannot be easily generalized to other product domains. The implication is that the influence of the other variables mentioned by Rogers (e.g. adopter characteristics, type of innovation-decision, exposure to communication channels or change agents and the social system) is probably much larger than earlier assumed. These variables are also likely to be interrelated with each other and with the technology attributes. Future research could focus on this issue.

The fact that perceived attributes of consumer electronics are interrelated also has implications for marketers. An increase in one attribute often leads to an increase in the other attributes. The only really independent attribute is Trialability & Observability. An increase in this attribute indirectly leads to an increase in all the other ones. Therefore, a first step to enlarge the chances of adoption of consumer electronics is to familiarize consumers with the new product, by making it visible and to allow them to experiment with it. However, the amount of explained variance by Trialability & Observability on Simplicity is rather low. Therefore additional effort has to be invested in increasing the Simplicity. Keeping the product simple increases the perceived compatibilities which in turn positively affect the relative advantages. An increased simplicity will lead to a larger perceived lifestyle compatibility, which in turn will, via infrastructural compatibility and status advantage, leads to an increased functional advantage and lead to a higher likelihood of adoption. The bottom-line for product developers and marketers thus becomes: make sure that people perceive the product as easy to use.

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