Adoption of behaviour: predicting success for major innovations

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Abstract

Purpose – The goal of this article is to show that memetics is particularly useful to predict the adoption of major innovations.

Design/methodology/approach – Describes how TNO Telecom, an applied research institute in The Netherlands, adopted the theory of memetics to develop an instrument that predicts the adoption of major innovations. Explains and defines relevant aspects of this focus.

Findings – Initial results are encouraging and suggest that the approach may provide qualitatively better results than the existing methods when applied to major innovations.

Originality/value – Describes for the first time how the theory of memetics can be used to gain a real insight into the market adoption of major innovations as well as to focus and optimise product development.

Keywords Product innovation, Forecasting, Behaviour, The Netherlands

Paper type Case study

Introduction

Predicting whether an innovation will be adopted in a market has always formed a major scientific challenge. Generations of scientists have pursued this challenge, by studying the subject from different disciplinary angles and for different kinds of innovations. Sociologists and psychologists have tried to pinpoint the unique characteristics of the first groups of consumers that adopt an innovation (the innovators and the early adopters). After studying these characteristics, they tried to predict the likelihood that an innovation would be adopted by these types of people, leading to a critical mass of users in the market. An overview of the results of this line of research is provided by Robertson (1971), Engel *et al.* (1990), Foxall and Goldsmith (1994) and Rogers (2003). Macro economists have studied the specific conditions on the supply and the demand side of the market that foster innovation (Shumpeter, 1942; Galbraith, 1956; Schmookler 1967; Mansfield, 1968; Kamien and Schwartz, 1975). Consumer researchers have focused on measuring potential consumers' reactions to, or perceptions of, product concepts and thereby estimated future demand for the final product (Greenhalgh, 1985; Moore, 1982; Page and Rosenbaum, 1992). As well as these approaches, diverse methods of using expert opinions have been applied (Armstrong, 2001a; Rowe and Wright, 2001). For example, the Delphi technique can lead to a consensus between a range of experts on the likely success of an innovation. Furthermore, several methods of data-analysis and curve fitting have been applied to predict the adoption of innovations (Armstrong, 2001a). Finally, econometric models have been developed to predict the sales and market shares of product variants (Lilien *et al.*, 1992; Leeflang and Naert, 1978; Allen and Fildes, 2001). Although widely

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different in scientific approach and orientation, these studies have clearly indicated that there are a number of difficulties in predicting whether an innovation will be adopted in a market. We will focus on one of these difficulties, namely: how can we validly predict the adoption of major innovations that change the patterns of product usage. Prevailing methods of market analysis, data analysis and expert analysis fall short in this case.

This article introduces a new approach, based on memetics, to predict the adoption of major innovations. Relevant aspects of this focus will be explained and defined.

Memetics

Memetics is a theory that proposes a mechanism for the evolution of ideas and their associated behaviours. Memetics postulates that ideas and their associated behaviours survive in a population by being copied between people. The theory describes the conditions under which this copying of behaviour is likely (see also the section, "Description of memetics"). This article considers adoption and use of an innovation as a type of behaviour that can be copied. Insights from the theory of memetics are applied to indicate how likely certain types of people are to copy certain types of product-related behaviour.

Major innovations

Although innovation is sometimes defined, rather broadly, as a new product, service, process, or type of organization (Trott, 2002; Tidd *et al.*, 2001), this article will focus on product innovations. Various typologies have been proposed to distinguish the degree of newness of product innovations (Veryzer, 1998; Garcia and Calantone, 2002). We will focus on major product innovations because for these innovations new approaches are required to predict adoption. Major product innovations comprise a completely new set of attributes and form a new product category, as opposed to minor innovations comprising small-scale alterations to existing products. Major innovations induce behavioural changes on behalf of the users (demand side of the market). As well as this, the production and marketing of new product categories typically requires new market actors, and thereby induces new patterns of interaction in the market (supply side of the market). The focus in this article will be on the demand side of the market since it describes an approach to predict the adoption of human behaviour.

Adoption of an innovation

The adoption of innovations in many cases just seems to refer to the act of buying an innovation (Tornatzky and Klein, 1982). Following Tauber (1977) and Tornatzky and Klein (1982), adoption in this article refers to buying and using a product innovation. Buying and using a product innovation are important since both behaviours are inextricably linked and can be copied by potential consumers.

Relevance of predicting the adoption of major innovations

Methods to predict the rate of adoption of major innovations have a large practical relevance. Major innovations have been the source of new markets and industries (Christensen, 1997; Olleros, 1986; Abernathy and Clark, 1985; Henderson and Clark, 1990; Tushman and Rosenkopf, 1992). For some companies, the introduction of major innovations has been a keystone of their long-term viability. The history of the

American company Ratheon, for example, is intimately connected with the radar, a major product innovation. Similar examples of companies that are closely related with one or more major innovations are: Xerox (photocopying machines) and The Bell company (e.g., the fax and the transistor). Yet, for many other companies, the introduction of major innovations has caused their demise (Olleros, 1986; Pech, 2003). When a high level of investment is combined with a high level of risk, it is clear that the ability to predict the adoption of major innovations is of crucial importance.

Goal of the article

The goal of this article is to show that memetics is particularly useful to predict the adoption of major innovations. The following section, "Current approaches," describes why these predictions are difficult to make for major innovations. It will also show what types of questions have to be addressed by any new approaches. The next section, "Description of memetics," will introduce the scientific field of memetics and will show that this field offers a new perspective on the topic. This is followed by "Instrument development," describing an instrument based on memetics to predict the adoption of major innovations. Preliminary results of this method will be described. Finally, conclusions are stated and discussion issues are addressed.

Current approaches

Many methods are suggested to predict the adoption of innovations (Armstrong, 2001a). Taschner (1999), in a simple categorization, distinguishes three categories of methods: consumer, expert, and data analysis. Each category includes a range of different methods. Expert analysis, for example, includes methods like Delphi approaches and expert interviews. Table I describes and compares these categories. The first row lists some of the methods in each category. The second row summarizes the type of conclusions that can be expected when applying each category. The next rows describe the source of the data, what data are required, the assumptions and requirements for valid conclusions, and the kind of situations in which the category of methods cannot be applied, respectively.

Table I shows that consumer analysis techniques gather data about (potential) consumers and therefore focus on conclusions with regard to the demand-side of the market. On the other hand, methods of expert and data analysis can be applied to analyse data from the supply *and* the demand side of the market. The fifth row in Table I summarizes the assumptions and requirements for valid conclusions for each category of methods. This row implies that the three approaches do not deliver valid results for major innovations. The distinction between minor and major is important here. A minor innovation has a combination of attributes that is similar to the attributes of products that are already on the market. The set of competitive products as well the majority of the market actors involved in production and marketing of these products remain essentially the same. The basic attributes and the working of these products are known by most potential consumers. Although the minor innovation may contain some new features that distinguish it from similar products in the market, its adoption will not require major behavioural changes on the behalf of its users. The usage situations are mostly known for these products. So, relatively valid consumer evaluations regarding their future adoption behaviour, or relatively valid expert opinions regarding the market developments are possible prior to the introduction of a

Table I. Characteristics of three categories of methods to predict the adoption of innovations

Categories → Characteristics ↓ of category	Consumer analysis	Expert analysis	Data analysis
Examples of techniques in each category	Consumer survey, concept test, conjoint measurement, focus group, consumer interviews, test markets, simulations with consumers, experiments	Delphi technique, focus group, electronic group discussion techniques, expert interviews, expert surveys	Trend extrapolation, curve fitting analogy marketing models econometric models
Type of conclusions possible on the basis of techniques	Problems of consumers with current products, analysis of required versus actual characteristics of products, description of user segments for a product category, description of potential consumers for a product category, preferences for specific product, actual behaviour of consumers in usage situations, effect of marketing-mix changes on consumers'preferences	Technological developments in the industry, comparison of price/performance-ratios of alternative products, assessment of the effect of long-term trends in the market on the actors in the market, prediction of future demand of consumers	Extrapolation of long-term trends in the industry, long-term developments in diffusion of a product category, analysis of short-term sales of product variants when marketing-mix of another product changes, effects of these changes upon the entire market and the market shares of product variants of various companies
Data source	Consumer evaluations and opinions	Expert evaluations and opinions	Long-term data about past (weekly) sales of existing products in a category
Type of data requested from source	Future behaviour of consumers	Future developments on the demand and supply side of the market, future behaviour of consumers	Data about prices, specific actions, type and intensity of distribution and communication for all products variants in a category

(*continued*)

Table I.

Categories → Characteristics ↓ of category	Consumer analysis	Expert analysis	Data analysis
Assumptions and requirements for valid conclusions about market adoption	Consumers understand the product, its main attributes, its consequences in use and are aware of alternative products. Consumer researchers can validly deduce future consumer adoption behaviour if evaluations, attitudes and intentions are strongly related to this future adoption behaviour	Experts understand the market and its main actors on the supply and demand sides. Experts know the (future) competitive products. Experts understand how long-term trends will impact on the industry. Experts understand how changes in market patterns will affect adoption and usage behaviour	The product category and marketing approaches for this category will essentially remain the same. Similar numbers and types of products will remain in the product category
Situation in which techniques cannot be applied to predict market adoption	When an innovation requires significant behavioural changes and when consumers cannot understand the product or its likely impact on their daily lives. This is because it comprises a new set of attributes, or when evaluation requires a long term learning process	When the industry changes radically, i.e. when new product categories emerge, and when usage patterns in the market change radically	When sales of an innovation cannot be derived from past data of prevailing products, i.e. when new product categories emerge, and when usage patterns in the market change radically

minor innovation in the market. Moreover, since the product category to which the minor innovation belongs remains essentially the same, data about the diffusion of the product category can still be extrapolated.

In practice, a major innovation comprises a new combination of attributes, and requires considerable changes in behaviour. As a result, it is more difficult for potential consumers to infer the benefits of this product (consumers can not evaluate the benefits of products that they will use as part of a completely different behavioural pattern). That means that they have more difficulties in validly indicating whether this product will fulfil their needs and wants. The difficulties in consumer research for major innovations have been recognized by many authors (Hills, 1981; Von Hippel, 1986; Moriarty and Kosnik, 1989; Ortt, 1998; Shanklin and Ryans, 1987; Taschner, 1999; Tauber, 1974; Tauber, 1977).

Similarly, the validity of experts' opinions with regard to market developments becomes much more questionable since major innovations cause a discontinuous shift in relevant market actors on both the demand and the supply side of the market. Experts tend to be prone to bias and inconsistency, both of which damage forecasting accuracy (Harvey, 2001; Hogarth, 1987), they tend to place too much trust in their own predictions (Brenner *et al.*, 1996; Arkes, 2001) and they have a bad record in predicting the adoption of major innovations (Schnaars, 1989; Wheeler and Shelley, 1987).

Finally, data analysis is also not recommended for major innovations (Armstrong, 2001b). A major innovation in many cases causes a new product category. The invention of video communication in 1930, and its subsequent development into the product television, created an entirely new product category, for example. Along with an entirely new combination of core attributes, new suppliers, new producers and new competitors of the product may emerge in the market, causing a shift in the relevant market structure. Because of this shift, past data regarding the diffusion of predecessors of the innovation can no longer be extrapolated to indicate the future adoption of such a major innovation.

So, current approaches to predict the adoption of innovations, i.e. consumer analysis, expert analysis and data analysis, seem inapplicable in case of major innovations.

What type of approaches are required for major product innovations?

Several adaptations of the current research methods have been proposed to help improve this situation. One of these adaptations concerns the selection of experts and consumers on the basis of their expertise and experience. It has been shown that consumers with high levels of expertise and experience are more able to understand early concepts of major innovations (Loosschilder and Ortt, 1994). A second adaptation concerns checking the consistency of experts' opinions or consumers' evaluations. It has been shown that higher levels of expertise and experience are related to more consistent evaluations (Ortt, 1998). A third approach, based on the structuring of judgmental techniques, attempts to formalize the steps taken when posing questions, collecting opinions and analysing the responses, in order to reduce bias and inconsistency (Stewart, 2001). A fourth adaptation attempts to increase the validity of consumer evaluations by checking whether consumers actually understand the concept of the major innovation before they start evaluating it. More adaptations are possible in consumer, expert and data analysis but all of them somehow assume that

adoption can be predicted either by human opinion about the future or by the analysis of past data.

This assumption of predictability of adoption seems highly unlikely if one looks at the pattern of diffusion of major innovations. Major innovations change existing markets and create new markets. A closer look at this market creation shows a trial-and-error process. Even the most successful major innovations, like television, fax, telephone, laser, CTI scans and so on were confronted with dubious results after their first introduction into the market (Lynn *et al.*, 1996; Ortt, 1998). During the process of creating a new market, we think that approaches should focus on the following issues:

(1) Create alternative product variants or designs for the major innovation.

(2) Distinguish alternative customer groups.

(3) Carefully match the product variants with the characteristics of the customer groups.

(4) Select the (logical order of) segments or niches that may establish a critical mass of users.

Especially during the erratic pattern of diffusion just after the market introduction of a major innovation, prevailing methods of consumer, expert and data analysis are not applicable. Clearly, something new is needed in this case.

Description of memetics

Memetics is a theory that proposes a mechanism for the evolution of ideas and their associated behaviours and material artefacts. For example, the use of children's nursery rhymes can be seen to evolve over time. Each new generation of parents introduces their children to the nursery rhymes from their own youth. The least popular or least memorable rhymes are discarded or forgotten and their place is taken by new rhymes. Small changes in some rhymes, for example an alteration in a couple of words or an adaptation of the tune, may be adopted by subsequent generations. Some nursery rhymes remain in use for hundreds of years, whilst many others fail to be adopted by more than one generation. Long-lived nursery rhymes often have particular mechanisms which aid their chances of survival. A rhyme may be sung with an easily remembered tune and may be accompanied by a group dance on the school playground. Another may contain a message which increases the chance that parents will want to sing it to their children, such as an encouragement to the children that they go quietly to sleep. There are many other commonly used examples used to describe memetics, such as ideologies, languages and clothing styles. The theory took shape in the 1970s when Cloak (1973, 1975) proposed two forms of culture: the instructions in our minds he termed "i-culture" and the material expression of these instructions (including behaviours) he termed "m-culture". The proposal was that m-culture functions to maintain and propagate i-culture within a population. It does this, according to Cloak, through a process of natural selection of the cultural elements most suited to the human environment. The evolutionary geneticist, Dawkins, coined the term "meme", pronounced to rhyme with "beam", as a unit of cultural inheritance (Dawkins, 1976). Memes evolve in much the same way as genes. Genes are carried by biological organisms, and affect the physical and behavioural characteristics of those organisms. These characteristics determine the likelihood that each organism will

survive and reproduce in a particular environment. And this in turn determines which genes are passed on to the next generation. Genes that have survived for many generations have proven themselves to be highly capable of getting themselves passed on in this way. Memetics proposes an analogous (although not identical) mechanism for memes. Memes, in the form of ideas, or their associated behaviours and material artefacts, are held by people. For example, some parents know and remember the song, "Rock-a-bye baby" (the idea, or i-culture). They may sing it to their children (the behaviour). They may own a book with the words and music in written form (the material artefact, which together with the behaviour are the m-culture). The characteristics of this meme (how easy it is to remember, how appealing it is for parents to sing, how much children like to hear it, etc.) determine the likelihood that it will survive and be passed on to subsequent generations. Memes that are better suited to a particular environmental niche (for example, rhymes with catchy tunes and pacifying lyrics) will out compete other memes and be expressed more often and by more people. Memes that have survived for many generations have proven themselves to be highly capable of getting themselves passed on in this way. It is important to note that memes, unlike genes, are not only passed on from parents to children. They can be passed on within a generation, such as children learning a dance from each other, and can even be passed from younger to older generations, such as when a teenager shows her grandfather how to use an internet browser. This opens the possibility for memes to spread rapidly through an entire population in a fraction of a biological generation. In this way i-culture can be seen as analogous to the information coded by genes and m-culture can be compared to the biological phenotype, or physical expression of those genes (see Table II).

Organisms reproduce, whereby their genetic material is replicated, occasionally with mutations giving rise to novel adaptations. During the "struggle for survival" (Darwin, 1859) the organisms most suited to their environment will generally prosper better and bear more offspring. In much the same way as Rogers' theory of the diffusion of innovations (Rogers, 2003), memetics takes an "idea-eye-view" of the world and postulates that behaviours and ideas compete for attention and expression by their human carriers and replicate themselves through imitation or copying behaviour (Dawkins, 1976; Blackmore, 1999). This implies that for a meme to be suitable for a particular group of people, it must combine well with the other memes already resident in their minds (c.f. Blackmore, 1999).

Memetics applied to the adoption of innovations

Memetics has the potential to provide an insight into which behaviours or ideas become successful. A plain, non-memetic, viewpoint may hold that the behaviours most likely to become widespread will simply be those offering the most benefit to people. In contrast, a memetic viewpoint would propose that the behaviours which will

	Replicator	Physical form
Genetics	Gene	Physical characteristics and instinctive behavioural characteristics of organism
Memetics	Meme, ideas, i-culture	Copied behaviours, material artefacts, m-culture

Table II.
Comparison of two forms of replicator: genes and memes

be expressed the most will be those which are best suited to being copied. The theory proposes that for a behaviour to be successful it must achieve three things:

There must be many copies made of it (fecundity). For example, imagine a new type of dance which is intended for any type of situation; at parties, in the disco, etc. Such a dance may spread more rapidly through a population than a new dance which is only intended for infrequent occasions; such as weddings or royal coronations.

The copies must be quite accurate (fidelity). If the dance steps are altered too much each time a new person copies them, then the original dance will not survive long. On the other hand if the fidelity is 100 per cent, then the dance cannot adapt, for example to changing social styles, and will eventually become old-fashioned and obsolete.

The copies should be long-lived (longevity). If each person that learns the new dance remembers it and performs it over a long period, then many others will come into contact with it. If the dance conforms to prevalent social attitudes, for example of individuality and personal expression, then it is more likely to remain a stable part of one's behavioural habits.

We believe that the behavioural component of the use of products and services could also be analysed in this manner. If we are to do this, we will need to assess the capacity a behaviour has to get itself copied in a particular population. As such, this approach is different to all the existing methods for assessing the adoption of innovations. Existing methods make use of one of three sources: the opinions of people about the future behaviour of themselves; the opinions of people about the future behaviour of others; or they make use of data obtained from existing products. The more radical an innovation, the less human experience or past data can be validly applied. In these cases, this new approach may offer an advantage.

Existing research applying memetics to innovations

Despite the commercial investments made in understanding customer behaviour, for example through market research, usability studies and market forecasting, little work has been published in which the new perspective offered by memetics is applied to product-related behaviours.

More than twenty years ago, developments in the field of cultural evolutionary theory led researchers to adapt mathematical models from population genetics and apply them to cultural traits (e.g. Feldman and Cavalli-Sforza, 1976). Although most traits studied were "vertically transmitted", i.e. passed from parents to children, such as religion or the use of salt, some were "horizontally transmitted", i.e. within peer groups and were unrelated to reproductive or biological fitness, such as a preference for a particular soft drink (Cavalli-Sforza and Feldman, 1981; Boyd and Richerson, 1985).

We have only been able to identify two studies since then linking memetics to products or innovation processes. Pech (2003) claims that management strategies can be seen as memes which can be copied between or within organizations. Some such memes may be highly stable, resisting challenge from other memes, even when this is not in the best interests of the company. For example, the belief that a proven and successful technology will remain successful may become so powerful that the threat posed by a new technology may be ignored.

More directly relevant to the products themselves, is the work of Marsden (2002) who has developed a method he calls "meme mapping." This method appears to have

much in common with another method, known as "laddering" (Reynolds and Gutman, 1988). When applied to the brand image of a commercial product, Marsden starts with the central value of the product (his example is the value of healthy living). Consumers are then questioned in order to distil out the component values and their relative positive or negative connotation. In this way he produces a hierarchical analysis (the meme map) of the values embodied within a product brand.

Controversies surrounding memetics

The theory of memetics, sometimes referred to as an emerging science, is not without its controversies. Although this is not the place for a rigorous discussion of all the detailed issues surrounding memetics, if we are to propose a new method based on the theory then it is essential to believe that any serious reservations others have concerning the theory do not undermine the relevance or validity of our method. Therefore, a few of the most important controversies and those most relevant to this paper are briefly described below.

What exactly is a meme? An idea can be very narrow (e.g. relating to a single word) or very broad (e.g. an entire language). How necessary is it to have a strict definition? On the one side of this debate are those who believe that such a vaguely defined term is meaningless (e.g. Plotkin, 2000; Williams, 2002). They argue that such diverse things as ideas, behaviour, artefacts, mental states, information and culturally transmitted instructions cannot all be described by the single term, meme. On the other side of the debate are those who believe that the theory in its current state already offers a useful perspective and that a tight definition will come as a matter of course. In much the same way as the Darwinian theory of evolution through natural selection (the non-random selection of random mutations) had to wait for Mendel to show that it was particulate and for Watson and Crick to identify the specific molecules involved. Some authors (e.g. Auger, 2002) believe that recent advances in neurology already allow us to describe a meme as a neuronal state and a specific configuration of neurotransmitters.

Rose (1998) suggests that much of the controversy has originated through carelessness in distinguishing between the ideas residing in minds and the physical or behavioural expression of those ideas. Cloak's definition of replicating and competing ideas (i-culture) and that being expressed (m-culture) seems clear enough to be used in our case. For example, the idea of sending messages to a friend using a mobile phone has become propagated with the help of the copyable behaviour of actually sending a text message. People see others sending and receiving messages and hear about text messaging from friends or through the media. This has been enough to stimulate many people to adopt the idea that text messaging is a good thing to do.

A second controversy surrounds the explanatory power of memetics (e.g. Williams, R., 2002). Some authors believe it to be, at best, an intriguing perspective on the world, unable to provide insight into why one meme becomes widespread whilst another dies out? Rose (1998) suggests that other theories, in particular socio-biology (the use of biological theories, including population genetics, to explain social phenomena such as altruism, kinship, etc.), are sufficient to understand human cultural evolution and that, therefore, memetics is unnecessary. Other authors see the application of "universal Darwinism" to fields other than biology as providing a rich and powerful insight (e.g.

Dennett, 1995). The instrument we propose in this paper, based on memetics, goes some way in testing precisely this explanatory power.

Another issue relevant to this paper is the question regarding how we choose new memes to adopt. If our minds are composed of memes, who is it then who does the choosing (c.f. Rose, 1998)? Some (e.g. Rose, 1998; Williams, R., 2002) ask if memetics requires the existence of a mind which is distinct from one's memes. Others (e.g. Blackmore, 1999; Lynch, 1996) suggest that we have a complex of memes of which our minds are composed, which is capable of providing a coherent self image and at the same time selecting new memes. In terms of our needs for this paper, the instrument which we propose includes an assumption that the personality traits of a person play an important role in their (conscious or sub-conscious) processes of selecting new memes. This will be described further in the next section. Whether those personality traits are formed by existing memes or in other ways (such as being genetically programmed) is then, for our current purposes, less relevant.

The following paragraph describes how the theory of memetics has been used as the basis for a new type of instrument for assessing the likely adoption of new behaviours. Specifically, behaviours relating to the use of new products or services.

Instrument development

As stated in the introduction, the very "newness" of major innovations brings the validity of the current approaches into question. The end-user, for instance, cannot say he is going to use something he cannot yet imagine. Considering this from a memetics point of view, we may be able to bypass opinions about what will happen in the market and simply address the question of whether or not a new behaviour is suited to being adopted (copied) by a certain type of person. We take this "type of person" to be reflected in the basic personality traits and therefore that one's make up in terms of those traits will determine (consciously or subconsciously) which new ideas or behaviours one is likely to adopt. If we succeed in decomposing innovative concepts into a number of behavioural elements (memes) it should be possible to estimate the probability that a person with certain personality traits will copy these behavioural elements and, as a consequence, will adopt the new product.

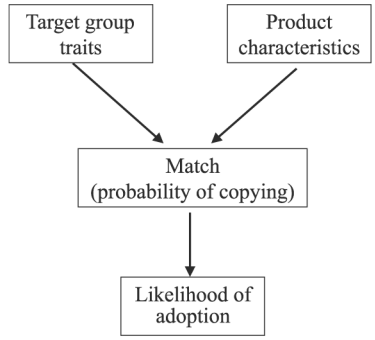
Based on these principles an instrument was developed which is described below. Basically it analyses the match between a number of product characteristics and a number of target group characteristics. This instrument, called SUMI (Service-User Matching Instrument), calculates the likelihood that a target group with certain characteristics will copy the behaviour associated with certain product characteristics (see Figure 1).

The process of developing the instrument was started with a literature search looking for product characteristics that can be related to copying behaviour and also for personality traits that might influence the copying behaviour of an individual. This resulted in two "long lists" of characteristics. Both lists were reduced in size during a number of discussion sessions with experts. To determine the match between product characteristics and personality traits an "expert model" was developed in which for each characteristic – trait combination the likelihood of copying is estimated on a generic level. The process was completed with the development of a software application into which specific information about product and target group must be fed. The application then calculates the likelihood that a specific target group will

adopt a specific new product. The phases of the development process are now described in more detail.

Product characteristics

Several authors described sets of product characteristics which are important for the adoption of a product (including Tholke *et al.*, 1997; Heylighen, 2001; Rogers, 2003). From these sets of characteristics the ones which possibly related to copying behaviour, in a positive or negative sense were selected. For instance the characteristic "complexity" (Rogers, 2003) is supposed to have a negative impact on the possibility that behaviour is copied, while "tryability" (Rogers, 2003) has a positive effect. This resulted in a list of 26 product characteristics affecting copying behaviour. These characteristics can be clustered into Dawkins' (1976) categories: fidelity, fecundity and longevity (see "Description of memetics") whereby the most successful behaviours are those that make many accurate and long-lived copies of themselves (Blackmore, 2000). Some characteristics fit into more than one cluster. The characteristic "visibility", for instance, affects fecundity (more visibility leads to more copies) as well as fidelity



Note: Target groups are described in terms of their personality characteristics. Products are described in terms of the behaviour related to their use

Figure 1.
Basic model of the SUMI instrument

Fecundity	Product combines well with existing behaviour: the extent to which the behaviour is reinforced because it is part of (or complementary to) other behaviour
	Inherent sociability: the extent to which the behaviour is social or forms part of a social event, etc.
Fidelity	Ease of use: the extent to which the product is easy or difficult to operate
	Visibility: the extent to which the behaviour can be perceived in full detail, etc.
Longevity	Stability: the extent to which the behaviour remains constant over time
	Long-term effect on the individual: the long-term positive effects the behaviour has for individuals (money, time, status, appreciation), etc.

Table III.
Examples of product characteristics in the three categories

(better visibility leads to better copies). Table III shows a number of examples of product characteristics.

Target group traits

The Jungian approach to personality psychology embodied by the Myers-Briggs Type Indicator (Myers, 1962, Hirsh and Kummerow, 1990) has evolved into a new approach focussed on traits rather than types. The standard personality model in this trait theory consists of five personality dimensions, known as the big five (Ewen, 1998; Norman 1963; Tupes and Christal, 1961). Many researchers agree on the basic influence of these dimensions, although there are a number of different labels in use, including a version based on the acronym, OCEAN, which stands for Openness, Conscientiousness, Extraversion, Agreeableness, and Neuroticism (Digman, 1997). A number of similar approaches have been combined to produce the Abridged Big Five Dimensional Circumplex (Hofstee *et al.*, 1992; Johnson and Ostendorf, 1993). Some dispute the accuracy of these models which use such a broad-brush approach to something clearly so complex as human personality (e.g. Paunonen, 2001). However, for our purposes these approaches, although not perfect, do appear applicable, having stood up to rigorous testing over a number of decades. SUMI is based on a combination of seven pairs of these traits (Table IV).

Match between traits and characteristics

The match between personality traits and product characteristics is determined by the influence of the behaviour associated with a certain product characteristic on the likelihood that the person will copy that behaviour. Table V gives some examples of

Table IV.
Personality traits used by SUMI and other authors

SUMI	Big Five dimensions (e.g. Hofstee *et al.*, 1992)	Myers-Briggs Type Indicator (Myers, 1962)
Innovative – Conservative	Openness (O)	
Organised – Spontaneous	Conscientiousness (C)	Judging – Perceiving
Introvert – Extrovert	Extroversion (E)	Introvert – Extravert
Altruistic – Egoistic	Agreeableness (A)	
Conformist – Non-conformist	Neuroticism (N)	
Rational – Emotional		Thinking – Feeling
Driven stoical		
		Sensing intuition

Table V.
Examples of how the personality traits match with product characteristics to influence the likelihood that the behaviour will be copied

Personality trait		Product characteristic		Influence on likelihood of copying
Openness	Innovative	Distinctiveness	High	High
Extroversion	Extrovert	Inherent sociability	High	High
Conscientiousness	Spontaneous	Ease of use	Low	Low
Conscientiousness	Organised	Visibility	Low	High
Openness	Conservative	Stability	Low	Low
Agreeableness	Egoistic	Effect on individual	Positive	High

the proposed influence of product features on the chance that a person with a particular personality trait will copy the behaviour associated with that feature. For example the first row in the table means that if the product related behaviour is highly "distinct from existing behaviour", the likelihood that an "innovative" person (who is more than average open to new experiences) will copy that behaviour is higher than for a person who is average with respect to new experiences.

The heart of the SUMI instrument is an "expert model" in which generic estimations are made of all possible combinations of which Table V gives examples, i.e. the effect that a certain product characteristic has on the chance that an individual possessing certain traits will copy the behaviour associated with the product. For each of the possible combinations of characteristics and traits (26×14) experts were asked the following question: "What is in general the effect of characteristic *x*, on the chance that a person with trait *y*, will copy the behaviour associated with the use of the product". This expert model is generic and can be applied to a broad range of combinations of products and target groups. To apply the instrument to a specific product – target group combination, the characteristics of both product and target group have to be assessed by people with sufficient knowledge of these characteristics. The characteristics are scored on Likert type scales. Based on these scores the expert model calculates a total "match score" for the product – target group combination, which is a measure for the expected adoption of the product by this target group. The instrument also generates match scores for every individual product characteristic (see Figure 2).

Figure 2 can be understood best by starting with characteristic 1 (first bar). The match score for this characteristic is about 3, the "target group sensitivity" is 5 (dotted line), so the match is reasonable but not perfect. So in Figure 2 the dotted line represents the target group. It is a measure of the "sensitivity" of the target group for each product characteristic. The bars are the match scores for the product characteristic – target group combinations. The distance between the top of a bar and the target group sensitivity line represents the possibility for improvement of the product. This kind of output can be used for detailed analysis of the product – target group combination. It is important to focus on the product characteristics where target

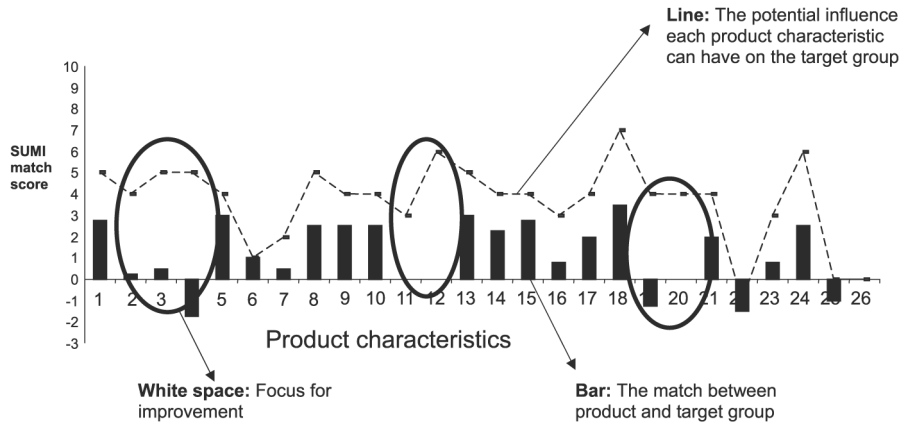


Figure 2.
Example of the output generated by a SUMI analysis

group sensitivity is high and the match is low (circled areas). These characteristics represent the best possibilities for improvement.

The process of using SUMI

The process of a SUMI analysis is illustrated using the adoption of SMS by trendy adolescents.

(1) By means of a series of interviews, as much information as possible is gathered about the service and about the envisaged target group. The people to talk with at this stage are, for instance, product developers, product managers, marketing directors and marketers. During these interviews the emphasis is on factual information (e.g. the market segmentation methods which are used, target group descriptions, etc.). The SUMI variables are not directly mentioned at this stage.

(2) During the next phase the researchers translate this information into the characteristics and traits used by the SUMI instrument and quantify it. Typically, one or two variants of a product are analysed for three or four target groups. SMS gets high scores on, for example: visibility, reach, inherent sociability, combines with other behaviour and frequency. It scores low on: financial attractiveness and ease of use. A few traits of the target group, trendy adolescents, are: innovative, spontaneous, egoistic and emotional.

(3) In the next phase the product and target group scores are fed into the instrument and the results are calculated and analysed.

(4) The process is concluded with a workshop with stakeholders in where the results are presented and discussed. Discussion is specifically focussed on those product characteristics that are important to the target group(s) and on how to improve the product offering when results exhibit a poor match for those characteristics.

Case study

The following example is an illustration of applying SUMI in the telecommunications sector. It was in an assignment for a European mobile telecommunications operator, who was considering the introduction of a number of mobile services. Ten mobile services were analysed for their likely adoption by one broad target group, self-employed entrepreneurs working from home or from a small office. Five of the services had already been launched and the operator wanted to decide which of the other five to introduce. The mobile telecom services were:

- Text messaging (SMS (Short Message Service).
- SMS group.
- SMS info.
- Voicemail.
- Voicemail call back.
- Voicemail direct.
- Voicemail group.
- Fax mail.

- Internet-connectivity via WAP.
- Internet-connectivity via GPRS.

During a number of workshops with marketing and product experts information about the target group and about the services was collected. Based upon this information the SUMI experts determined the input scores for the product characteristics and the target group traits. The results were calculated and analysed. During a final workshop with the most important stakeholders the results were presented and discussed.

In Table VI the total SUMI scores for the ten services are summarised and compared to the market penetration in The Netherlands where the ten services were already on the market. The match scores, which provide a relative indication of likely adoption, vary between 1 and 52. It is clear that the two highest SUMI scores match precisely with the two services that did in fact achieve the highest penetration. For the moderately successful and failed services there is also agreement between SUMI scores and market adoption, although the exact match is less clear. Only one service, which scored "5" in the SUMI analysis, performed clearly better in the Dutch market than the SUMI score would have predicted.

Managerial applicability

The results of a SUMI analysis can be used in a number of ways:

- *The overall match score compared to other products from previous analyses.* This overall match score is an indication of the probability of adoption by the target group. Managerially it can be used to decide whether or not to launch the product.
- *A comparison of a number of variants of the same product.* Especially in the early stages of development a lot of decisions have to be made about which product variant to offer to which market segment. SUMI can assist in this decision making process, by showing which variants show the highest potential for the chosen target groups.
- *Identifying the strong points of a product for a certain target group.* From the detailed results, like Figure 2, it is possible to asses the elements that are important for the target group and that have a high match (high bar and high

SUMI scores for the ten services	Market adoption by target group in The Netherlands
1	Failure
9	
14	
17	
5	Moderate
16	
22	
23	
50	Success
52	

Note: Services are displayed anonymously. The target group was self-employed entrepreneurs working from home or from a small office

Table VI.
SUMI scores for the ten analysed services, compared to the penetration level in The Netherlands

target group sensitivity in Figure 2). This can be used, for example, in the design of marketing campaigns.

- *The aspects of a product that can be improved.* From the same results the characteristics that need improvement can be derived (circles in Figure 2). This can be used for changes in the design of the product, making it better suited to being adopted by the target group.
- *A comparison of target groups.* Finally it is possible to analyse a product for a number of different target groups. The results of these analyses can be used to select the launching target group and / or to focus the marketing of the product.

So the SUMI results can be applied in a number of ways. In some cases it can lead to a decision to stop the development of a product and not put it on the market. Other decisions can lead to changes in the product design, or to a shift of focus regarding the target group. The analysis can also result in recommendations for the marketing of a product, for example, by using the advertising message to emphasizing its strong points or to paint the important but weak point in a positive light. Another possible application is to use the instrument to choose (or prioritise) from a range of products, which are in competition for a limited development budget. It is important to note in this respect that SUMI can be applied in very early stages of the development process.

Discussion

Just after the introduction of a major innovation, in many cases a so-called trial-and-error process occurs in which companies introduce different product forms in different applications and for different target consumer groups. Especially in this phase, a market research instrument is needed by which companies can quickly establish the match between alternative product forms and customer groups. Such an instrument is invaluable since it focuses and shortens this trial-and-error process.

This article shows that current approaches to predict the adoption of innovations, shortly categorized as consumer analysis, expert analysis and data analysis, seem inapplicable in the case of a major product innovation.

A method is needed which does not rely on the opinions of people about the future behaviour of themselves or of others related to the adoption of major innovations, or past data of the adoption of other products in other situations being applied to estimate the future adoption of major innovations.

This paper shows that memetics, a theory of how behaviour is copied and therefore spread throughout a population, appears to lend itself to filling this need. This is the first time, as far as we can tell, that this theory has been applied to predicting the adoption of behaviour relating to innovations. It allows us to assess how well a certain behaviour is suited to people with certain personality traits. It does this without resorting to peoples' judgements about the future and without relying on past data about other (product related) behaviours.

The first attempt to validate an instrument, SUMI, based on this theory, compared adoption predictions for services in one country with market data from the same services in a different (but similar) country. The results are encouraging and suggest that SUMI predictions are reasonably accurate indicators of market potential.

The initial results described in this paper are a first step in the development of a valid and reliable instrument for providing insight into the likely adoption of major

innovations. Ideally, we would already have carried out a series of longitudinal studies across a wide range of sectors and we would have compared the results of SUMI to the predictions made by other methods and instruments as well as to the eventual market data. For such a new instrument this has not yet been possible. The best validation method available at this point is the type of backwards prediction described in this paper.

Actual diffusion requires a focus on more market actors than consumers only. SUMI primarily predicts the acceptance of innovations by looking at the match between (potential) consumers and the characteristics of the innovation. However, more market actors and more market factors have to be taken into consideration to explain whether an innovation will actually be introduced in the market. The acceptance, by 10-20 per cent of the population of people buying and using a car, of electrical vehicles, for example, has been consistently assessed in extensive market research projects in the 1960s, 1980s and 1990s (Ortt, 1998). Yet, the vehicle has only marginally diffused. The reason for this disappointing degree of diffusion is that multiple actors involved in the supply of the product and the complementary services, had convincing reasons to practically block the introduction of the vehicle. SUMI focuses on the consumers only. If a company is willing and capable of introducing an innovation (e.g. infrastructures, service arrangements, outlets and so on are all available) only then can SUMI validly indicate whether this innovation will become a success.

It is important to consider when SUMI can or cannot be applied. Four issues seem worthy of attention: stage of development, level of innovation, product type and industry sector.

SUMI requires input in the form of information about the proposed target group and information relating to the characteristics of the product. This information can be gained early in the development process, long before time and money has been spent developing prototypes or carrying out market trials. In this way, SUMI can have a significant positive effect on the development of major innovations by making the trial and error process quicker, more focussed and therefore cheaper.

In the case described in this paper SUMI was applied to major innovations. There is no reason to believe that SUMI would not be applicable to minor innovations. However, as most existing methods for assessing the likely adoption of products are ideally suited to minor innovations, the added benefit of applying SUMI in these cases appears small.

For SUMI to work, something must be copied by one person from another. For innovations that are invisible to end users, such as cost-efficient chemical processes in the production of materials, the use of SUMI is inappropriate.

Which sectors produce the type of innovation that can be evaluated with SUMI? The case described in this paper comes from the Telecom industry and it appears that SUMI is broadly applicable in this sector. We speculate that SUMI will also be applicable in the closely related industry of consumer electronics, as well as other sectors with a high pace of innovation that directly induces novel consumer behaviour, such as the financial, employment services and fast-moving consumer goods sectors. This is, as yet, speculation and validating case studies in a range of sectors is a priority for further research.

SUMI may be of interest to researchers in the emerging field of memetics. As stated above, some have questioned the explanatory power of the theory and Edmonds (2002) has gone so far as to propose three challenges to memetics if it is to prove itself as a theory worthy of continuing research effort: A conclusive case study, a theory for when it is appropriate and a simulation of the emergence of a memetic process. This paper may have contributed to this debate to a certain degree by offering a practical application of the theory coupled to encouraging early results. This explanatory power has additional relevance to the development of innovations, due to the reduced reliance on opinion and data relating to old or existing products.

Our approach is based on the assumption that for a new idea or behaviour related to a new product to be adopted by consumers, it must match with their personality characteristics. For example, extravert people are more likely than non-extravert people to adopt behaviour that is inherently social. In this way we bypass the discussion about whether an individual is distinct from his or her memes. In whatever way our personalities have developed, with or without the help of our memes, we have more chance of adopting any new behaviour that fits well with our personalities.

This paper describes for the first time how the theory of memetics can be used to gain a real insight into the market adoption of major innovations as well as to focus and optimise product development. But it is just a start. Much further research is needed. In developing SUMI we have selected a range of personality traits and product characteristics. In order to improve SUMI the selection, relative importance and interactions between these variables need to be further researched. As stated above, longitudinal and comparative studies need to be carried out across a range of sectors to clearly assess the validity and reliability of SUMI results. Added to this, the business relevance of improving the process of innovation development as well as the new insights SUMI can provide for marketing communication and target group segmentation have yet to be fully qualified. The results described in this paper would suggest that further investigation of this area is justified.

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