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Advanced users and the adoption of high speed broadband: Results of a living lab study in the Netherlands☆

Bert M. Sadowski

Department of Industrial Engineering and Innovation Sciences, Eindhoven University of Technology, IPO 2.20, 5612AZ Eindhoven, The Netherlands

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ABSTRACT

In linking the literature on the adoption of Information and Communication Technology (ICT) with the lead user theory, the paper presents the results of a living lab study on the adoption of high speed broadband and advanced ICT services in the Netherlands. The paper proposes that advanced users are able to shape ICT technologies based on their status, their needs and their ability to propose new solutions. In order to examine the role of advanced users, we use data from an on-line survey conducted in a living lab called "Kenniswijk" (Knowledge District) in the Netherlands carried out among 2994 residential users in July 2009. In a first step, the paper examines the leading-edge status of advanced users. Afterwards it studies the extent to which the choice of these users to adopt high speed broadband is related to their decision to adopt advanced ICT services. Finally, the paper utilizes an experimental choice design in order to examine the role of advanced users in defining new product and service characteristics of advanced ICT services. Our research shows that an advanced group of users expected to benefit from using a variety of advanced ICT services in areas such as e-surveillance and local television. In addition, they can contribute to the product and service generation phase within a living lab environment.
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1. Introduction

Over the past years, the economic literature on information and communication technology (ICT) adoption and research within the lead user tradition has addressed different aspects of user involvement in markets affected by ICT. The economic literature on ICT adoption has been rooted in early studies on the demand for ICT services linking the start-up problem of these services to the creation of a critical mass of users (Artle and Averous, 1973; Rohlfs, 1974; Taylor, 1994). Cost-sharing arrangements aimed at accounting for large fixed costs of the underlying network and the formation of joint user expectations have been critical to create a critical mass of users necessary to overcome the start-up problem of network technologies such as telephony (Rohlfs, 1974), cable television or electronic banking (Shapiro and Varian, 1999; Shy, 2001). Different cost-sharing arrangements have been aimed at identifying an early group of advanced users based on individual characteristics such as level of ICT usage or income (Artle and Averous, 1973; Rohlfs, 1974) but also depending on their joint characteristics related, in particular, to the interrelatedness of their decisions (Katz and Shapiro, 1985, 1994). The formation of joint expectations of users has been critical to the adoption of compatible technologies, with critical mass being a determined percentage of users willing to adopt compatible technologies as a result of these expectations (Artle and Averous, 1973; Rohlfs, 1974; Shy, 2001). This literature has recently addressed the shift in technology from lower speed to higher speed[1] broadband networks allowing for a greater variety of advanced ICT services and more options for user involvement (Bar and Riis, 2000). As this literature has extensively contributed to a better understanding of the interrelatedness of joint decisions in the adoption of ICT services, the living lab approach has been considered as a novel method on user involvement to address the complexities of these technologies and potential contributions of users to innovation (Ballon et al., 2005; Følstad, 2008).

Within the growing body of literature on lead users (Bogers et al., 2010; Greer and Lei, 2012; Lüthje and Herstatt, 2004; Schreier and Prügl, 2008), the problem of user involvement in innovation has been central. Research has recently focused on identifying consumers' leading-edge status and linking it to the adoption of new technologies

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E-mail address: b.m.sadowski@tue.nl.

[1] For simplicity reasons, we use "speed" and "bandwidth" interchangeably. To be precise, we are actually talking about "bandwidth" defined in megabits per second (Mbit/s). Bandwidth can be considered as consisting of three elements: bits transferred, time and the combination of time and bits (called the sustained rate). The sustained rate is important for real-time communication e.g. Voice-over-IP telephony or real-time video applications (OECD, 2008).

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(Schreier and Prügl, 2008). Based on the lead-user theory originally developed by von Hippel (1986) to characterize the type of user attractive for user innovation (Baldwin et al., 2006; Franke et al., 2006), industry studies have produced supporting empirical evidence on consumers acting as innovators (Bogers et al., 2010) in consumer goods industries like extreme sports (Franke and Shah, 2003), outdoor sports (Lüthje, 2004) or mountain biking (Lüthje et al., 2005). Lead user theory has generated new insights with respect to incentives of consumers as innovators (E. von Hippel and von Krogh, 2003) and the role of communities of users (Eric von Hippel, 2007) in participating, in particular, in open source software projects (Franke and von Hippel, 2003; Hertel et al., 2003; Sadowski et al., 2008). In this tradition, research has shown that compatibility decisions are important for innovation in ICT industries (Magnusson, 2009) with the living lab approach as an important concept to examine these decisions (Følstad, 2008)

From the methodological point of view, we used the "users as innovators" approach (Bogers et al., 2010) to examine the interaction between the advanced group of residential users and the internet service provider (ISP) at the product and service generation stage of ICT innovation process. To study the involvement of advanced users at this stage, an experimental design using a web-based conjoint analysis was applied to evaluate the different service concepts suggested by the ISP (Feurstein et al., 2008). There have been a variety of attempts to identify lead users in a Living lab environment by using different user-centered approaches (e.g. Coorevits et al., 2013). Commonly, these studies have characterized the demonstration of new needs as a first and important characteristic of a lead user. We follow these approaches by first identifying the leading-edge status of advanced users. In contrast to these studies, we link this status to the level of digital skills of advanced users. Furthermore, we address the extent to which decisions of this group of users to adopt high speed broadband and advanced ICT services are interrelated. Thirdly, the different service and product concepts proposed by the ISP are evaluated by the advanced group of residential users. Based on these characteristics, the paper develops a different definition of advanced users by contrasting it to the group of ordinary users (Magnusson, 2009). Based on the empirical testing of different hypotheses, the paper extends the definition of the advanced user category by including the level of digital skills and the link to the local community. By using this definition, the paper demonstrates the inter-relatedness of decisions with respect to the adoption of high speed broadband *and* the use of advanced ICT services can be (better) explained by the different expectations of advanced users. Furthermore, by categorizing advanced users in this way, new product and service characteristics of advanced ICT services can be (better) identified.

The analysis is based on a large-scale survey among 2994 residential users of a cooperative ISP and was combined with an experimental choice design to examine different advanced ICT service options. The study was undertaken in July 2009 in the Living Lab called Kenniswijk (Knowledge District) in Eindhoven, the Netherlands. The "Kenniswijk" program starting in 2003 by the Dutch Ministry of Economic Affairs was aimed at experimenting with and learning from the application of new ICT technologies (Kenniswijk, 2005). The unique and very detailed dataset was provided by a cooperative ISP which was set-up and partly financed by the Kenniswijk subsidy in 2006. The objective of the program was to propel the Eindhoven region two years ahead of the rest of the Netherlands in terms of ICT diffusion (Kenniswijk, 2005).

In the first part, the paper briefly describes the economic discussion on ICT adoption and lead user theory (Section 2). Then, it looks at the characteristics of the group of advanced residential users with respect to their leading-edge status (Section 3). Afterwards, the paper examines the inter-related decisions of advanced users with respect to their choice of high-speed broadband and the adoption of a set of advanced ICT services (Section 4). Lastly, it uses an experimental choice design to determine important product and service characteristics of this set of advanced ICT services (Section 5). The paper closes with a discussion of the results and conclusions for future research.

2. Theoretical framework and hypothesis

2.1. The nature of fiber-based broadband networks and ICT services

Characterized by rapid technological change, the info-communication industry consisting of different layers of interacting players such as telecommunication operators, Internet service providers (ISPs) and residential users (Fransman, 2010; Krafft, 2004) has moved towards broadband technologies over the past twenty years (Bar and Riis, 2000; Fransman, 2010; Gaffard and Krafft, 2000; Krafft, 2010). Broadband includes a wide variety of technologies ranging from current (e.g. Digital Subscriber Lines (DSL) and cable modem technologies) to new broadband (e.g. fiber-based) technologies providing access to end consumers while carrying the promise of advanced ICT services in areas such as e-government, e-health and e-security (ITU, 2011). In the layered model of the info-communication industry (Fransman, 2010; Krafft, 2010), telecommunication operators (like KPN or British Telecom) provide broadband access to ISPs (like XS4All in the Netherlands or TalkTalk in the United Kingdom) in charge of delivering ICT services to residential users at the upper layer (see Fig. 1). With telecommunication operators involved at the lower layer and ISPs operating at the upper layer in a complementary fashion, broadband can be considered as an innovation in which compatibility decisions on the side of suppliers and on the side of users are important (Krafft, 2010). Complementary activities between telecommunication operators and ISPs operating at these layers involve network capacity planning, quality of service, Internet connectivity, billing or marketing activities. For example, network capacity planning activities are important at both layers as they determine whether or not sufficient capacity will be available for ISPs to provide high definition television (HDTV) with a satisfactory quality. Similarly, marketing activities by ISPs are trying to assess the demand for different sets of ICT services by residential users which might require a higher speed of broadband access provided by telecommunication operators. Technological change has affected companies operating at these layers in the industry in different ways, first, by providing increasingly higher bandwidth at the lower layer and, second, by generating a greater variety of ICT services at the upper layer.

At the lower (access) layer, new fiber-based broadband networks allow – in contrast to other current broadband technologies –high (nearly) unlimited bandwidth which makes these networks the "most future proof" technology in the fixed broadband network (ITU, 2011; OECD, 2008). Even if current broadband (in particular DSL) technologies still dominate the access layer in broadband networks in most OECD countries (OECD, 2013), a gradual shift towards fiber-based networks is currently underway and stimulated by governments in most OECD countries (OECD, 2011). With increasing bandwidth, consumers are increasingly using ICT services which provide more high-bandwidth contents and a greater variety of contents (Hitt and Tambe, 2007). In order to get more bandwidth and advanced ICT services, users have the option to stay at current broadband networks (and wait for upgrading in terms of bandwidth and ICT services) or to migrate to fiber-based broadband networks (Krafft and Salies, 2008; Sunada et al., 2011). If users migrate to fiber-based broadband networks, they expect that these networks provide advanced ICT services which are linked to existing basic ICT services (telephony, internet access or television) (Sunada et al., 2011). In other words, migration towards fiber-based broadband networks takes place as a process of adoption in which users not only opt for high(er) bandwidth but develop expectations about the availability of advanced ICT services.

The start-up problem for fiber-based broadband networks is related to the high initial capital investment costs at the access layer in conjunction with the (current) limited availability of bandwidth intensive (advanced) ICT services at the upper layer. The largest share of capital investment in fiber-based broadband networks is sunk with a long period of physical (at least 30 years) and economic depreciation (about 15 years) (OECD, 2008). As some advanced ICT services do not require

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