PLATE
Product Lifetimes And The Environment

A double diffusion of innovations: the case of electric automobility product service system

Catulli M., Cook M. and Potter S.

Department of Engineering and Innovation, Open University, Walton Hall, Milton Keynes UK, MK7 6AA

Keywords

Diffusion of Innovation
Electric Vehicles
Practice Theory
Product Service Systems

Abstract

This paper explores the double diffusion of an electric vehicle Product Service System (PSS). The research is based on a case study of a use orientated PSS run by UK-based e-car club.

The double diffusion involves consumers being confronted with electric vehicles (EV) - a technical innovation, accessed through a car club - a PSS sociotechnical innovation. The paper explores the intertwining of these two innovations.

Using Practice Theory, the paper concentrates on meanings that users associate, or find lacking, in performing automobility through an EV car club. For an EV mobility PSS to diffuse, it is necessary to disassociate it from meanings of poor availability, range anxiety and concern about location of charging facilities and associate it with positive meanings of freedom, thrift, altruism and environmental protection. The offer of additional service through links with mobile phone apps could facilitate diffusion. These meanings appear to have stronger resonance among certain segments of car users than others, which suggest that insights offered by Practice Theory need to be complemented by other research perspectives to explore characteristics of individual users.

Introduction

This paper reports results from an ongoing study into an electric automobility Product Service System (PSS). A PSS is a system of products, services, supporting networks and infrastructure designed to be more resource efficient than traditional business models (Mont, 2002). PSS are often classified (Hockerts 1999, Cook et al. 2006) into three categories:

- **Product orientated**, where service is added to basic products.

- **Use orientated,** when customers access products owned by suppliers, such as e-car club.

- **Result orientated,** when consumers acquire results, such as when "thermal comfort" is supplied to customers.

Sustainability is a major challenge to product design and PSS diffusion could improve resource efficiency (Cook, 2014). But PSS suffer from poor uptake (Vezzoli et al., 2015), especially in consumer markets (Catulli, 2012).

Car clubs are organizations which provide members with access to a fleet of shared cars (Shahen & Cohen, 2007) for local trips (Bardhi & Eckhardt, 2012). Examples, such as Zipcar, using conventionally-powered cars, are established in many places (Catulli et al., 2016). However all car clubs together have only 0.4% niche market share of automobility in the EU, high rates of failure and customers' defection (Le Vine et al., 2009). With car ownership is associated with meanings of freedom and independence (Choo & Mokhtarian, 2004), the lack of control allegedly associated with PSS (cf. Tukker's, 2015) may apply to e-car club. Such PSS may also suffer from poor on demand availability (Catulli, 2012).

EVs also present challenges. Although EV uptake rates are now increasing, initially they were lower than expected (Walsh et al., 2014). EVs remain expensive to buy, involve range anxiety (Lane & Potter, 2006) with concerns about recharging (Shepherd et al., 2012). Combining automobility PSS with EVs thus involves social and cultural dynamics shaping diffusion processes of two different innovations. With this automobility PSS, consumers are confronted with a double diffusion of innovations:

1) Electric vehicles (EV) – a technical innovation
2) PSS – a sociotechnical innovation

The paper therefore explores the intertwined diffusions of these two innovations.

Research perspective and methods

Following Mylan (2015), the research adopts Practice Theory (PT) to investigate diffusion of an EV automobility PSS. PT is a cultural theory which analyses social practices to explain how human subjects make and transform the

world in which they live through their daily routines (Feldman & Orlikowski, 2011). A social practice is a "routinized type of behaviour which consists of several elements, interconnected to one another: forms of bodily activities, forms of mental activities, "things" and their use, a background knowledge in the form of understanding, know how, states of emotions and motivational knowledge" (Reckwitz, 2002:249), i.e. 'materials', 'competences' and 'practices' (Shove et al., 2012). Importantly, PT focuses on mundane practices, of what people do and feel in their daily routines (Warde, 2005). PT seeks to go beyond consumers' purchasing decisions to explore how consumers integrate materials they use in their routines, as this integration plays a profound role in sustainable consumption (Shove & Walker, 2010). PT's focus on mundane activities can complement the understanding of acquisition offered by other consumer studies approaches.

Mylan (2015) suggests that obduracy of current consumption practices may impede diffusion of PSS. Traditional automobility is obdurate for two reasons:

1) Automobility is tightly linked to conventionally-powered cars
2) Automobility is tightly linked to activities such as shopping and commuting to working.

These two linkages re-enforce the obduracy of traditional mobility

The case study for this paper is the UK-based e-carclub (e-carclub.co.uk, 2015). This car club, which rents out EVs, was established by the National Energy Foundation and Sustainable Venture (e-carclub.co.uk, 2015) and is now owned by Europcar. The methods used to gather data included participant observation and 15 interviews of current, dormant and lapsed e-carclub members.

Findings
Competences, materials and meanings
Competences (the skills and know-how of the practitioners) and materials (physical objects such as tools, hardware and infrastructure) are drawn from the framework used by Shove et al. (2012) to shape the meanings of the focal practice (using the e-carclub for automobility). Meanings, which are the symbols, norms and collective conventions imbued in practices, are important because of their role in motivating consumers to perform practices (cf. Reckwitz, 2002), and so shape PSS diffusion (Mylan, 2015). Therefore, in the following narrative we focus on these meanings and how they interplay with the other elements, as revealed in the responses to interviews and observations made in this research.

Car-based mobility is a practice which drivers perform to meet obligations towards members of their families. For example, drivers use their own cars to take children to school and parents to health care visits.

"….my niece (…) is 17 and she's just about to get her driver's license and in her family there's three kids and two parents but her father doesn't drive and so her mother has to do all the driving. (…) her mother's reasoning is, (…) there would be another adult to take responsibility for driving the other kids around, like to brownies and choir (…), so at the moment it's always Karen and if Kathy had a car then she could also take on some of that responsibility and ease the burden on Karen".

Some participants feel that they need vehicle ownership to meet these obligations reliably. This is particularly true in emergencies. Automobility through e-carclub on the other hand is associated with inflexibility. Mike for example explains that e-carclub would not give enough flexibility in his mobility:

"…if one of them (his children or their friends) says, oh I need to be in school early (…), oh suddenly we've got to jump in the car…"

Participants who have families thus seem not to think the PSS empowers them to fulfil those obligations. They want their own car outside their door. The PSS is seen as unable to support this flexibility. In this respect, automobility with e-carclub is associated with lack of empowerment, as EVs are not always accessible on demand to meet obligations. But another group of e-carclub users thinks differently. For younger people and students, the PSS enables them to drive new cars that they cannot afford to buy. For example, they may not own a car because they mostly travel by bicycle and public transport. For them, unlike in the case of people with families, the PSS may be associated with meanings of empowerment, including to assist relatives in their travel. Guy for example explains that

"….when my mum and dad came for the weekend and I wanted to take them to Stowe (…) there was no public transport so the e-car was ideal".

So the meanings associated with the practice are shaped by practitioners' characteristics and circumstances. Certain mobility segments find positive value in e-car club, whereas others do not and that value can be transient or vary with particular situations.

Although many users of e-carclub find it offers less empowerment and flexibility than owning a car, there are some compensating advantages. It is associated with freedom from responsibilities, e.g. parking, maintenance and taxes, but is also associated with range anxiety and fear of liability for damage incurred during use. Freedom is thus limited by obligation towards the PSS provider. As Mike explains, he does not feel as free in using a PSS EV, as with his own car:

"….we used to throw all stuff in there, wetsuits and things and occasionally we'd even put a boat on the roof and things like that, we had a roof rack, so we usually use our car as a workhorse and (…), messing up your own car

PLATE 2017 Conference Proceedings | 77

is fine but if you're messing (a rented car), is (…) someone going over the car with a magnifying glass and saying, oh you've scuffed this or that? If it's not my car, I can't sort of treat it in the cavalier fashion".

Another beneficial meaning for users of the EV PSS is that it is strongly associated with environmental protection and also with thriftiness; it is seen as a "hip", "clever" mobility practice. It is also associated with novelty and modernity – partly because it is an EV, but also because of the practice of booking the service using apps. As Caroline explains:

"This looks brilliant, you know, I get my membership, I get my PIN number, I swipe, (…), you know, obviously it's fairly automatic in that there's not that many people around, (…), it's kind of manpower efficient, but (…), what if something goes wrong?"

The last point suggests desire for quality assurance, which could reduce meanings of loss of empowerment.

Finally, for some participants, the focal practice is associated with meanings of health because car ownership encourages them to use their car every day, rather than only occasionally if they use e-carclub. As Jaspreet says:

"…if I do use it on a day to day basis I become lazy, so actually (…) being able to rent a car is much better because it still kind of encourages you to walk around, be fit, but only take a car when you really, really need it".

In short, meanings of environmental protection, novelty and thrift encourage automobility using e-carclub. However, traditional mobility using owned cars is made obdurate by the belief by most participants that owned cars are more reliable for the fulfilment of obligations towards others. Table 1 summarizes the meanings.

Access as part of PSS
Accessing products through a PSS differentiates from traditional product purchase for consumption because of different relationships that consumers have with materials, meanings and competences required.

Meanings that support EV PSS	Meanings averse to EV PSS
Environmental protection	Obligations (to family and friends)
Modernity	Liability for damage
Trendy	Lack of availability (including emergencies)
"Hip"	Lack of control
Thrift	Lack of empowerment
Empowerment (if ownership not affordable)	Lack of flexibility
Freedom (from maintenance, road tax, etc.)	Range anxiety
Control granted by apps for younger drivers	Concerns with recharging
	Lack of independence

Table 1. Meanings associated with EV PSS.

Access, seen as a transaction "that can be market mediated but where no transfer of ownership takes place"(Bardhi and Eckhardt, 2012:1), is a defining element – and a sub-practice in itself. Drivers learn access processes, including booking of the EV through apps on mobile phones. They also need to learn to plug in and unplug EVs as e-carclub drivers are responsible for leaving EVs charged for next users. Learning the practice of access produces anxiety. As Donna explains,

"I was absolutely terrified so my partner just jumped in it, drove it no problem, it took me a while to build up the confidence and I had to go out with him first and drive it on my own somewhere quiet (…), to get the hang of it and then I watched YouTube videos, I mean the instructions were clear but I felt I had to kind of watch YouTube videos first".

Remembering passwords and login names also seems to be a problem for some participants, used as they are to jumping in the car parked on their drive. E-carclub mobility also involves travelling to where EVs are parked, which may involve additional forms of mobility. Practitioners however resist this. They seem strongly against combining different modes of transport, including walking. Felicity for example would need to carry heavy loads to the EV,

"…it would be a real hassle even just walking to the bus stop with this bag of books"

In short, access, as alternative to purchasing products, is key to PSS and it is an integral part of the focal practice. Because of this, PT's lack of focus on consumers' ways to acquire products can be problematic in understanding PSS consumption. Data shows that participants use materials and competences associated with other practices to access EVs. Here we see that materials such as mobile phones and apps, together with competences to use them, migrate into the mobility practice from communication practices (Cf. Shove et al., 2012).

Jaspreet explains, for example, that using mobile phone and apps became an integral part of managing access to EVs, making PSS seem more acceptable,

"Yeah, like booking it from an app, that's definitely a really good idea because a lot of students are lazy so (it) is easy to just quickly go on your phone and just know that you can book it from there, that's definitely good. A lot of students have smart phones or iPhones or like Samsung so if you can just, (…) download the app and every time you need a car, (…), because if you are a member of course you can take the car any time you want, so just being able to directly book it from your phone, then being able to collect it is very easy".

This seems to make younger people, who are more familiar with apps, receptive to practicing automobility through e-car club. To be practical the system needs to be

booked via mobile phone apps. Comparing participants' responses it appears that younger ones, such as students, are far readier to adopt access practices if these are supported by ICT.

In summary, access is an integral part of PSS consumption. Whilst PT usefully describes the interplay of meanings, competences and materials involved in practices associated with PSS, a lack of focus on acquisition may limit its ability to contrast access with traditional acquisition. Furthermore, types of consumers differ in their interaction with access. Access seems to be problematic for many practitioners, who do not trust it to provide the necessary reliability and availability of materials. In some cases participants mentioned difficulties in performing access activities. However, access has potential with younger, trend-conscious practitioners. These seem to have the competences required for access and associate it with positive meanings. This highlights the need to research differences between practitioners, for which PT may need to be complemented by other approaches (cf. Shove et al., 2012).

Discussion and conclusions

This research used Mylan's (2015) framework to explore this double diffusion process of two innovations. The findings have shown the presence of tight links of conventional mobility practices to meanings of freedom, independence, access on demand and empowerment. This makes use of owned cars obdurate, impeding PSS diffusion. The double diffusion involved in an e-car club PSS is also associated with a number of negative meanings for EVs, such as range anxiety and concern about location and use of charging facilities. For an EV mobility PSS to diffuse, it is necessary to disassociate it from these meanings and associate it with positive meanings of freedom, thrift, altruism and environmental protection. The offer of additional service through links with mobile phone apps could facilitate diffusion. These meanings appear to have stronger resonance among certain segments of car users than others, suggesting a weakness in PT's implied homogeneity of users. In a nutshell, the issues shaping PSS go beyond lack of control.

Further research is needed to explore different aspects of PSS consumption, in particular access and its similarities and differences from traditional acquisition, and the role of consumers' diverse identities and their relationship with access in shaping PSS diffusion. This may be enabled by complementary consumer studies perspectives that focus on these aspects of consumer behaviour.

Acknowledgments

References

Bardhi, F., & Eckhardt, G. M. (2012). Access-Based Consumption: The Case of Car Sharing. *Journal of Consumer Research, 39*(4), 1-18.

Catulli, M. (2012). What Uncertainty? Further Insights on why consumers might be distrustful of product service systems. *Journal of Manufacturing Technology Management, 23*(6), 780-793.

Catulli, M., Cook, M., & Potter, S. (2016). PSS Users and Harley Davidson Riders; The importance of consumer identity in the diffusion of sustainable consumption solutions. *Journal of Industrial Ecology*. doi: 10.1111/jiec.12518

Choo, S., & Mokhtarian, P. L. (2004). What type of vehicle do people drive? The role of attitude and lifestyle in influencing vehicle type choice. *Transportation Research Part A, 38*, 201–222. doi: 10.1016/j.tra.2003.10.005

Cook, M. (2014). Fluid transitions to more sustainable product service systems. *Environmental Innovation and Societal Transitions, 12*, 1-13. doi: 10.1016/j.eist.2014.04.003

Cook, M. B., Bhamra, T. A., & Lemon, M. (2006). The transfer and application of Product Service Systems: from academic to UK manufacturing firms. *Journal of Cleaner Production, 14*, 1455-1465.

e-carclub.co.uk. (2015) Retrieved 1/01/2017, 2017, from https://ecarclub.co.uk/

Egbue, O., & Long, S. (2012). Barriers to widespread adoption of electric vehicles:Analysis of consumer attitudes and perceptions. *Energy Policy, 48*, 717–729. doi: http://dx.doi.org/10.1016/j.enpol.2012.06.009

Feldman, M. S., & Orlikowski, W. J. (2011). Theorizing Practice and Practicing Theory. *Organization Science, 22*(5), 1240-1253.

Hockerts, K. (1999). Innovation of Eco-Efficient Services. In M. Charter & M. j. Polonsky (Eds.), *Greener Marketing*. Sheffield: Greenleaf Publishing Ltd.

Lane, B., & Potter, S. (2006). The adoption of cleaner vehicles in the UK: exploring the consumer attitude-action gap. *Journal of Cleaner Production, 15*, 1085-1092. doi: 10.1016/j.jclepro.2006.05.026

Le Vine, S., Lee-Gosselin, M. E. H., & Polak, J. W. (2009). *An analysis of car club participation and its environmental effects*. Paper presented at the UTSG, London.

Mont, O. K. (2002). Clarifying the concept of Product Service System *Journal of Cleaner Production, 10*, 237-245.

Mylan, J. (2015). Understanding the Diffusion of Sustainable Product-Service Systems: Insight from the Sociology of Consumption and Practice Theory. *Journal of Cleaner Production, 97*, 13-20. doi: 10.1016/j.jclepro.2014.01.065

Reckwitz, A. (2002). Toward a Theory of Social Practices. *European Journal of Social Theory, 5*(3), 243-263.

Rexfelt, O., & Hiort af Ornäs, V. (2009). Consumer Acceptance of Product Service Systems - designing for relative advantage and uncertainty reductions. *Journal of Manufacturing Technology Management, 20*(5), 674-699.

Schrader, U. (1999). Consumer acceptance of eco-efficient services. A German perspective. *Greener Management International, 25*, 105-122.

Shahen, S., & Cohen, A. (2007). Growth in Worldwide Carsharing: An International Comparison. *Transportation Research Record: Journal of the Transportation Research Board, 1992*, 81-89. doi: DOI: 10.3141/1992-10

Shepherd, S., Bonsall, P., & Harrison, G. (2012). Factors affecting future demand for electric vehicles:Amodel based study. *Transport Policy, 20*, 62–74. doi: 10.1016/j.tranpol.2011.12.006

Shove, E., Pantzar, M., & Watson, M. (2012). The Dynamics of Social Practice: Everyday life and how it changes

Tukker, A. (2015). Product services for a resource-efficient and circular economy – a review. *Journal of Cleaner Production, 97*, 76-91. doi: http://dx.doi.org/10.1016/j.jclepro.2013.11.049

Vezzoli, C., Ceschin, F., Diehl, J. C., & Kohtala, C. (2015). Why have 'Sustainable Product-Service Systems' not been widely implemented? Meeting new design challenges to achieve societal sustainability. *Journal of Cleaner Production, 35*, 288-290.

Walsh, S., Copsey, S., Smyth, A., Catulli, M., & Southern, R. (2014). *Plugging the gap? - Addressing resistance to the adoption of electric vehicles thrugh a university based e-car club: a United Kingdom case study approach* Paper presented at the ETC 2014.

Warde, A. (2005). Consumption and Theories of Practice. *Journal of Consumer Culture, 5*(2), 131-153. doi: 10.1177/1469540505053090

PLATE 2017 Conference Proceedings | 79