This is the published version of a paper published in *Journal of Business Research*.

Citation for the original published paper (version of record):

A service ecosystem perspective on the diffusion of sustainability-oriented user innovations
*Journal of Business Research*, 1-9
https://doi.org/10.1016/j.jbusres.2020.01.011

Access to the published version may require subscription.

N.B. When citing this work, cite the original published paper.

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A service ecosystem perspective on the diffusion of sustainability-oriented user innovations

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ARTICLE INFO

Keywords:
User innovation
Diffusion
Service ecosystem
Innovation ecosystem
Sustainability

ABSTRACT

This article conceptualizes the diffusion of user innovations from a service ecosystem perspective. With the focus on sustainable innovations, the service ecosystem is evaluated, along with other systemic innovation concepts, as a possible theoretical basis for explaining the first adoption and diffusion of user innovations. It is proposed that an ecosystem perspective contributes three assumptions that help to better understand the (non)diffusion of sustainability-oriented user innovations: (1) innovation diffusion is a multi-level and -actor phenomenon; (2) an actor-to-actor orientation integrates user innovators into the ecosystem; (3) the service perspective defines innovation diffusion as an evolving co-created process. The assumptions are translated into policy implications and future research requirements for moving towards an innovation infrastructure that considers the role and contribution of users in sustainable innovation.

1. Introduction

Innovation has been long thought of as a producer-centered process based on the assumption that profit-seeking incentives are the main driver of innovation. A producer (e.g., a firm) invests in innovation activities with the expectation of generating profits from sales. It comes naturally that the same producer takes the initiative in diffusing its innovations into different market segments, where consumers will, hopefully, adopt these innovations. However, this producer innovation model has been increasingly questioned due to research findings showing that users are also a major source of innovation when they innovate for-use rather than for-sale (Baldwin & von Hippel, 2011). With user innovation, we refer to an activity conducted by users (e.g., individual consumers, end-users, and citizens) who spend their unpaid discretionary time developing innovative solutions to address their personal needs (Gambardella, Raasch, & von Hippel, 2016). These users are also willing to share or give away their innovation as a free good for others to use, typically in the form of a set of instructions specifying how to reproduce the novel solution (von Hippel, 2016).

While the user innovation paradigm presents a successful departure from the conventional producer-centric model of innovation, it suffers from problems regarding diffusion. Studies show that user innovations with the potential to enhance social welfare do not diffuse (de Jong, Gillert, & Stock, 2018; de Jong, von Hippel, Gault, Kuusisto, & Raasch, 2015). National surveys suggest that non-diffusion applies to approximately 80–90% of user innovations within developed economies (de Jong, 2016). This lack-of-diffusion phenomenon is also evident in the sustainable innovation field. While studies provide numerous examples of novel sustainability-oriented innovations stemming from end-users, they also point out that users often end up innovating in isolation because they lack the tools, skills, and resources needed to share their solutions beyond a small local community (e.g., Nielsen, Reisch, & Thøgersen, 2016).

The term sustainability-oriented innovations refers to solutions that ensure “a social structure can be maintained profitably and indefinitely, without degrading the systems on which it depends” (Newton, 2003, p. 5). Many sustainability-oriented innovation initiatives are currently directed towards achieving the 17 sustainable development goals (SDGs) defined in the United Nations (UN) Agenda 2030 action plan (United Nations, 2015). To reach these goals, however, it is not sufficient to rely solely on producers; a radical rethinking is required regarding who innovates and for what purpose, as well as how innovation practice is supported by policymaking (Behnam, Cagliano, & Grijalvo, 2018; von Weizsäcker & Wijkman, 2018). In line with this argument, we propose that the roles and contributions of users need to be considered in driving sustainable innovation. This does not mean that all user innovations are socially important or contribute to a more sustainable future, but that sustainability-oriented user innovations should be identified and supported.

The user’s role in sustainable innovation activities is often defined...
as passive or even completely neglected (Nielsen et al., 2016). This position is problematic for two reasons. First, top-down producer-driven innovations often fail to break unsustainable consumer patterns because the provided alternatives are too distant from what consumers actually need to change their behavior (e.g., Block et al., 2016; Scheurenbrand, Parsons, Cappellini, & Patterson, 2018). User innovations can help to bridge this distance because their solutions are directly built on problems related to their everyday practices and needs (Kristensson, Gustafsson, & Archer, 2004; Trischler, Pervan, Kelly, & Scott, 2018). Second, sustainable innovations compete, in many cases, against incumbent regimes (e.g., fossil fuel-based technologies), which means diffusion depends on users not only being adopters but also playing a part in adaptation, reconfiguration, and intermediation (Hysalo, Juntunen, & Martiskainen, 2018). Exploring the roles of users in innovation and diffusion is, therefore, a key research priority, especially in the field of sustainable innovation (Nielsen et al., 2016), and new perspectives on this matter are called for by de Jong et al. (2018).

The present article responds to this research priority by investigating the diffusion of user innovations, or the lack of thereof, from a service ecosystem perspective. The service ecosystem is a key concept of service-dominant (S-D) logic and is defined as “a relatively self-contained, self-adjusting system of resource-integrating actors connected by shared institutional arrangements and mutual value creation through service exchange” (Vargo & Lusch, 2016, p. 10–11). In this article, we evaluate the service ecosystem, along with other systemic approaches to innovation, and as a result, develop a theoretical basis for designing an innovation infrastructure that helps to overcome the first adoption and diffusion problem of sustainability-oriented user innovations. Three assumptions underpin our proposed theoretical basis: (1) innovation diffusion is a multi-level and -actor phenomenon; (2) an actor-to-actor orientation can help to integrate user innovators into the ecosystem; and (3) the service perspective defines innovation diffusion as an evolving process that relies on ecosystem actors’ resource integration and value co-creation activities. The article thereby contributes a more expansive and inclusive theoretical departure, which, as highlighted by Nielsen et al. (2016), is lacking yet urgently needed to better inform the role of users within the sustainable innovation field.

The remainder of this article is structured as follows. Next, we review user innovation and diffusion research to explore the non-diffusion phenomenon more deeply. We then integrate the service ecosystem concept, along with other systemic perspectives on innovation, and evaluate its potential in better explaining the diffusion of sustainability-oriented user innovations. We discuss our evaluation with links to two illustrative user innovations that aim to contribute to Sweden’s current efforts to address the SDGs as defined in Agenda 2030. We conclude the article by outlining the requirements for moving towards an innovation infrastructure that considers not only producers but also users as having the potential to make relevant contributions to sustainable innovation activities.

2. The (non)diffusion of user innovation

Recent studies indicate that user innovations often do not diffuse despite having general use value (i.e., useful to others in the social system; Svensson & Hartmann, 2018; von Hippel, 2016; von Hippel, de Jong, & Flowers, 2012). The lack of diffusion is linked to the motivation driving the user to innovate: users primarily innovate to address a personal need and, hence, gain benefits from using rather than selling their innovations. Conversely, firms are highly motivated to commercialize their solutions and profit from their innovation-related investments. This incentive is further leveraged by intellectual property rights (IPRs), which give firms a temporary monopoly on their innovation. However, only a few users protect their innovations via IPRs, and most do not make any effort to or invest resources in making their solution available to others (de Jong et al., 2018; von Hippel, 2016). When user innovations diffuse, they do so via peer-to-peer transfers, spillover to producers, or entrepreneurial pathways (de Jong et al., 2018; Gambardella et al., 2016). Thereby, a necessary step in the diffusion process is first adoption, which refers to the act of other people start using a user innovation (de Jong et al., 2018).

2.1. Peer-to-peer diffusion

Peer-to-peer diffusion requires first adopters to have the capability to produce copies of a user innovation for themselves since there is no producer mediating the process of production and consumption. First adoption is, therefore, typically limited to a set of instructions or a ‘recipe’ specifying how to reproduce the solution for self-provision purposes (Baldwin & von Hippel, 2011). One illustrative example of peer-to-peer diffusion is the ‘Patient Innovation’ platform, where patients and caregivers around the world connect to share solutions they have developed themselves (DeMonaco, Oliveira, Torrrance, von Hippel, & von Hippel, 2019).

Despite digitalization, public ‘makerspaces,’ and 3-D printing making it increasingly simple for non-innovating peers to adopt user innovations without producer intermediation, many designs remain underdeveloped because users often do not develop their innovations beyond a barely functioning prototype (Svensson & Hartmann, 2018). In addition, since limited efforts are put into making user innovations accessible to others (e.g., by translating instructions into different languages or simplifying a software code), peer-to-peer diffusion often remains limited to a small user base (Gambardella et al., 2016) or a local niche (Hossain, 2016). Understanding the mechanisms might inhibit or support first adoption, and the diffusion of socially valuable user innovations is, therefore, important to innovation policymaking.

2.2. Customer co-creation

Unlike peer-to-peer diffusion, customer co-creation refers to the transfer of user innovations to firms for commercialization (Fuchs & Schreier, 2011; Gemser & Perks, 2015; Mahr, Lievens, & Blazevic, 2014). Studies in this domain show that the commercialization of user-generated designs can have a number of benefits for the focal firm, such as solutions that are more novel and better aligned with user needs (Kristensson et al., 2004; Poetz & Schreier, 2012; Trischler et al., 2018), higher sales revenues (Nishikawa, Schreier, Fuchs, & Ogawa, 2017), and the firm being perceived as more innovative (Schreier, Fuchs, & Dahl, 2012). This stream of literature is also in line with the open innovation paradigm, specifically the ‘outside-in’ process, where new ideas and offerings are co-developed with actors outside the focal organization’s boundaries (West, Salter, Vanhaverbeke, & Chesbrough, 2014; Chesbrough, Lettl, & Ritter, 2018).

With the aim of leveraging their innovation efforts, many firms have begun to actively involve their users in the innovation process through, for example, innovation toolkits, innovation contests, or lead-user workshops (Boudreau & Lakhani, 2013; Nishikawa et al., 2017; Russo-Spena & Mele, 2012). While these developments may seem promising for supporting the diffusion of valuable user innovations, these depend on the firm making its innovation process available to users, as well as users taking the initiative to share their innovations. This might not always be the case as sustainable innovation studies in healthcare, transportation, and energy suggest that organizations, especially those in the public sector, lack the structural conditions and resources required to move towards an innovation model that integrates user innovation activities (Snyder & Engström, 2016; Trischler, Dietrich, & Rundel-Thiele, 2019).

2.3. User entrepreneurs

Finally, users might bring their innovations to the market by becoming entrepreneurs. Before commercialization, these user entrepreneurs typically operate under the radar of incumbent firms to
gain sufficient experience and attract an initial customer base (Haeffliger, Jäger, & Von Krogh, 2010). Thus, these users innovate solutions based on their personal needs and, while using and sharing their innovation with a community of fellow users, recognize the potential for commercialization (Shah & Tripsas, 2007). User entrepreneurs might also include institutional entrepreneurs referring to marginalized consumers who seek social justice or equality without an underlying profit motive (Maguire, Hardy, & Lawrence, 2004). In fact, these entrepreneurs can play a key role in mobilizing consumers with similar needs to collectively change markets (Scarbrough & Fischer, 2012).

Examples of user entrepreneurship include extreme sports (Lüthje, Herstatt, & von Hippel, 2005), juvenile products (Shah & Tripsas, 2007), video gaming (Haeffliger et al., 2010), and renewable energy technologies (Hyysalo et al., 2018), among others. Collectively these studies show that user entrepreneurs rely heavily on a community of fellow users as a knowledge pool for skills development, feedback and (financial) support, experimentation with different commercialization paths, and first adoption. However, it also needs to be noted that diffusion via users becoming entrepreneurs only applies to a fraction of innovations because users often lack the necessary time and resources or interest in becoming entrepreneurs (de Jong et al., 2015; Hamdi-Kidar & Vellera, 2018). Six national user innovation surveys confirm this by finding that less than 10% of user innovators are interested in becoming entrepreneurs or selling their innovations to producers (von Hippel, 2016).

Despite the availability of different diffusion pathways, only 10–20% of innovations developed by users are adopted by others (de Jong, 2016; de Jong et al., 2015, 2018). One reason for the non-diffusion phenomenon is conventional innovation policies and practices built on an assumption that individual firms spread isolated offerings to aggregate markets and, thus, inappropriately considering the roles and motivations of other actors within the social system (Kivimaa, Boon, Hyysalo, & Klerks, 2019; Muller & Peres, 2018). The implication is that policymakers underestimate the importance of users as sources of innovation and, hence, underinvest in initiatives supporting user innovation activities (Bradonjic, Franke, & Lüthje, 2019). The result is an innovation infrastructure that hinders the diffusion of sustainability-oriented user innovations because users rely on an ecosystem of actors, including so-called ‘sponsors’ (Bogers, Sim, & West, 2019), ‘keystones’ (Iansiti & Levien, 2004), or ‘transition intermediaries’ (Kivimaa et al., 2019), to scale beyond a local niche. Therefore, with the aim of developing an alternative approach to conceptualizing the diffusion of user innovations, next, we will evaluate the potential of the service ecosystem, along with other systemic innovation perspectives.

3. Innovation from a service ecosystem perspective

The service ecosystem has become a key concept in S-D logic, where it provides the unit of analysis for value co-creation activities among actors integrating resources and exchanging services within dynamic networks, which are facilitated by institutional arrangements (Vargo & Lusch, 2017). In contrast to networks, systems are assumed to be nested within or part of a larger system, and these systems influence each other (Kast & Rosenzweig, 1972). Furthermore, a service ecosystem has the ability to self-adjust to changes resulting from, for example, resources integrated from nested subsystems or overlapping systems, which means that actors, with each instance of value co-creation, influence how service ecosystems evolve (Wieland, Polese, Vargo, & Lusch, 2012). In turn, institutional arrangements refer to interrelated sets of institutions, and when combined, they constitute a relatively coherent assemblage that facilitates the coordination of activity in value co-creating service ecosystems. Specifically, they provide “the building blocks for increasingly complex and interrelated resource-integration and service-exchange activities in nested and overlapping ecosystems organized around shared purposes” (Vargo & Lusch, 2016, p.18).

Applying the systemic lens to innovation is not new. Innovation clusters (Audretsch & Feldman, 1996; Baptist & Swann, 1998; Cooke, 2001), innovation networks (Freeman, 1991; Häkansson, Havila, & Pedersen, 1999; Powell, Koput, & Smith-Doeer, 1996), innovation systems (Cooke, Gomez Uranga, & Etxebarria, 1997; Edquist, 2013), the multi-level perspective on transitions (Geels & Schot, 2007), and the triple helix model (Etkzowitz & Zhou, 2017; Leydesdorff & Etkzowitz, 1998) all emphasize the networked and systemic nature of innovation. Of these concepts, the triple helix model depicts an innovation infrastructure as overlapping institutional spheres between academia, state, and industry and proposes hybrid organizations emerging as a result (Etkzowitz & Leydesdorff, 2000). The model also considers the dynamic and complex nature of innovation processes, including sub-dynamics, such as market forces, political power, institutional control, and social movements (Etkzowitz & Leydesdorff, 2000). More recently, the triple helix model has been extended to the quadruple helix to more directly consider the ‘public’ (i.e., media-based and culture-based public) and the civil society (Carayannis & Campbell, 2009), in which the knowledge economy and knowledge society coevolve (Dubina, Carayannis, & Campbell, 2012).

A concept that also seems closely related to the service ecosystem is the innovation ecosystem. The ecosystem concept has been introduced to the management literature as an “economic community supported by a foundation of interacting organizations – the organisms of the business world” (Moore, 1996, p. 26). The ‘eco’ prefix and, thus, biological analogy, suggests that like individual species in a biological ecosystem, members of an innovation ecosystem, despite being largely autonomous, depend on one another for their effectiveness and survival (Iansiti & Levien, 2004). More specifically, and unlike other systemic conceptualizations, organizations in an ecosystem are not seen as formally connected to each other (e.g., via contractual arrangements) or fully hierarchically controlled (e.g., supply networks), yet they still share strong interdependency in terms of whether value is created or a market can emerge (Adner; 2006; Iansiti & Levien, 2004). Moreover, in contrast with network approaches, which focus on patterns of connectivity and define the network according to actor ties, the innovation ecosystem sets the boundaries around the set of actors that need to interact for a value proposition to materialize (Adner, 2017). Hence, the innovation ecosystem covers both vertical and horizontal relationships between actors for the purpose of joint value creation (Autio & Thomas, 2014).

The innovation ecosystem concept has also faced criticism, particularly for its original focus on market-driven systems and commercialization, thus leading to policies emphasizing for-profit firms over market forces (Oh, Phillips, Park, & Lee, 2016; Ritaia & Almanpououlou, 2017). This is problematic since the ongoing underestimation of users as a source of innovation results in a lack of support for them (Bradonjic et al., 2019). Therefore, recent developments have moved beyond this narrow conceptualization to consider the roles of different actors, such as research institutions, non-governmental organizations (NGOs), and individuals. For example, Bogers et al. (2019, p.2) define an innovation ecosystem as “an interdependent network of self-interested actors jointly creating value.” The same authors propose that while actors are interdependent and, therefore, work towards advancing the success of the overall ecosystem (i.e., the joint creation of value that could not be achieved by a single actor), pursuing their personal interests is still a priority (i.e., individual determination of value). In turn, the way value is co-created and determined by the individual actors depends on the respective actors’ role (e.g., sponsor, keystone, hub, member, follower, or niche player), the nature of the interdependence between actors (i.e., cooperative, competitive, or coopetitive), and the form of governance (e.g., self-regulation, contracts, or standards; Adner, 2017; Jacobides, Cennamo, & Gaver, 2018; Bogers et al., 2019).

We propose that the service ecosystem, complemented by the innovation ecosystem concept, can contribute a theoretical basis for investigating the user innovation phenomenon, in general, and the diffusion of sustainability-oriented user innovations in particular. Three
arguments underpin our proposition. First, the service ecosystem considers individual actors’ activities on the micro-level to be nested in and influenced by activities on the meso- and macro-level (Lasch & Vargo, 2014; Vargo, Wieland, & Akaka, 2015). In innovation ecosystem research, this multi-level orientation is described by means of the system structure or architecture, including modularity (Jacobides et al., 2018), embeddedness (Venkatraman & Lee, 2004), and network governance (Tiwana, Konsynski, & Bush, 2010). For example, radical innovations and the shaping of new markets depend on cooperating members’ adoption and processing times within the ecosystem, which, in turn, are affected by the members’ form of governance or government interventions (Adner, 2006; Jacobides et al., 2018). In a similar vein, Auto and Thomas (2014, p. 206) suggest that the innovation ecosystem is “one of the few constructs that explicitly covers conceptually both upstream (production side) and downstream (user side) activities.” Therefore, both ecosystem concepts move beyond the firm-consumer dyad or value chain and, as such, help in conceptualizing user innovations as a multi-level phenomenon.

Second, the service ecosystem does not pre-assign specific roles to the system’s actors but defines all actors as resource-integrating ‘enterprises’ with the common purpose of value co-creation (Vargo & Lusch, 2016). This generalization encourages moving beyond thinking of consumers as mere adopters and toward playing roles in innovation and diffusion. However, innovation ecosystem studies emphasize that actors’ roles cannot be kept completely general; instead, actors have defined positions and activity flows among them based on their specific interests. For example, a sponsor or keystone integrates resources with the aim of improving the ecosystem as a whole by connecting new actors for joint value creation or by supporting the creation of new niches (Gawer & Cusumano, 2014; Iansiti & Levien, 2004). Niche players, in turn, apply and utilize resources in cooperation with other ecosystem actors to innovate and diffuse new value propositions (Iansiti & Levien, 2004). Further, members of an ecosystem need to arrange themselves around constraints and dependencies, which are typically governed by the sponsoring actor (Jacobides et al., 2018; Nambisan & Baron, 2013). This means a defined set of actor roles is required to ensure the coordination of joint value creation among interdependent but largely autonomous actors across the systems levels. We propose that the actor-to-actor orientation, along with the consideration of defined roles, can provide a starting point for integrating users into innovation ecosystems.

Third, the service ecosystem has a service orientation, which means goods and services are not seen as alternative forms of products but as resources (i.e., operand and operant) that, in constellation rather than in isolation, support the adopter/user in integrating and operating their resources for the purpose of value creation (Ordanini & Parasuraman, 2011). Innovation, from this perspective, is less concerned about new features and focuses more on changes in value creation through resource integration (e.g., commercial offerings or resources already in possession; Edvardsson, Kleinaltenkamp, Tronvoll, McHugh, & Windahl, 2014; Koskela-Huotari, Edvardsson, Jonas, Sörhammar, & Witell, 2016), new practices (i.e., diverse kinds of activities; Schau, Muniz, & Arnould, 2009; Scheurenbrand et al., 2018), and a redefinition of consumer and producer roles (e.g., new ways of using; Michel, Brown, & Gallan, 2008). Similarly, the innovation ecosystem literature focuses on the structure and activities required for a value proposition to materialize (Adner, 2017; Auto & Thomas, 2014). Importantly, this focus concerns not only joint value creation but also value realization where a beneficiary actor deploys resources to achieve a personal goal (Chesbrough et al., 2018). Both ecosystem perspectives, as such, are in line with the for-use focus of user innovations.

The next section builds on the propositions described above and evaluates the applicability of the service ecosystem to provide an alternative theoretical basis for investigating the diffusion of sustainability-oriented user innovations.
However, the innovation might not have been diffused if it were not supported by sponsoring keystone actors, which in this case involved the Scout Association and a Swedish business cluster within the forest bio-economy called ‘Paper Province.’ Adam states following regarding his experience with Green Leaf,

I cannot do it myself; I am not a businessman. I can build a minimum version, a skeleton of the game […], but then I want this to be given to someone who can make this into a 2-3-year project and do the funding for it.

The Scout Association agreed to diffuse the platform through its worldwide network of more than 32 million registered scouts. In turn, Paper Province supported the development of the platform through a small-scale funding scheme reserved for sustainability-oriented user innovation ideas. However, it is not primarily the monetary reward that motivated Adam to take his idea further, but the recognition that his idea is socially valuable: “You get encouragement. It is very helpful to hear someone say, ‘Hey, this is a very good idea. I believe in your idea; go for it!’”

On the macro level, the allocation of innovation-related resources by policymakers was important for the integration of user innovation activities into the bio-economy cluster, Paper Province. The Swedish Innovation Agency, Vinnova, granted Paper Province SEK 130 million over a 10-year period to drive sustainability-oriented research and development within the region. In spring 2019, the focus was set on four Agenda 2030 goals, including SDG 12 (i.e., responsible consumption and production). Since changing consumption practices requires a deep understanding of its context (Scheurenbrand et al., 2018), Paper Province applied a bottom-up approach to address this goal. This included two initiatives aimed at supporting user innovations (i.e., an ‘idea platform’ linked with a support scheme for selected user innovations, and an incubator to help start-ups within the region). Green Leaf is one of 81 user innovations submitted over a one-year period to Paper Province’s funding scheme, which explicitly excludes research projects or firm-driven ideas.

4.2. Defining actor roles in user innovation diffusion

User innovation research has widely evidenced the importance and capabilities of users driving innovation (Bradonjic et al., 2019; von Hippel, 2016). Likewise, studies in market system dynamics and transformative service research provide examples of consumers collectively attempting to change markets (Giesler & Fischer, 2017; Scarabotto & Fischer, 2012; Skålén, Aal, & Edvardsson, 2015). Both streams of research point out that users often need to compete against incumbent regimes or contest dominant structures, and the same is true for sustainability-oriented user innovations (Nielsen et al., 2016; Hyyssalo et al., 2018). Thus, a rethinking of the users’ role is required, along with an examination of the roles other actors can play in the ecosystem to foster the diffusion of sustainability-oriented user innovations.

As we have described above, the service ecosystem does not distinguish between producers and consumers; instead, it has an actor-to-actor orientation. Vargo et al. (2015, p. 63) highlight that “the study of innovation, in general, has been developed from a view of value creation that separates firms as producers (e.g., innovators) and customers as consumers (e.g., adopters) of market offerings.” The actor-to-actor orientation thus removes presumed labels and opens new possibilities for defining who innovates and diffuses based on what purpose. We propose that the actor-to-actor orientation, as well as insights concerning the set of actor roles required for an ecosystem to function, can provide guidance on how users can become an integrated part of an innovation ecosystem.

Within an innovation ecosystem, user innovations can be viewed as niches that contribute radical new solutions and add diversity to the innovation ecosystem. As a niche player, users are dependent on collaboration with other actors (Geels & Schot, 2007; Iansiti & Levien, 2004). A collaborative environment can be facilitated through online knowledges platforms (Baruch, May, & Yu, 2016; Hyyssalo et al., 2018), innovation toolkits (Thomke & von Hippel, 2002), or design competitions (Hienerth, Lettl, & Keinz, 2014). In turn, a keystone or hub, for example, in the form of an innovation cluster, government agency, or sponsoring firm, can support users or other actors to further develop and scale their innovations. Beyond that, government interventions may be required to increase the probability of users taking the step from innovation to diffusion by, for example, introducing policies that reduce the costs of sharing or launching open collaborative innovation projects (Strandburg, 2009; Svensson & Hartmann, 2018). One such an intervention may be public procurements that are inclusive of users. While public procurement for innovation has been discussed as a policy instrument effective for mitigating sustainability challenges, it still primarily focuses on producers and suppliers (Edquist & Zabala-Iturriagagoitia, 2012). Thus, and as highlighted by the quadruple helix model (Carayannis & Campbell, 2009), the government can take a central role not only as a customer of innovations but also in creating an innovation environment that acknowledges the ‘public’ as a contributing actor in the innovation ecosystem.

One example that illustrates the potential effect of facilitating an environment supportive of user innovations is the introduction of makerspaces in Swedish hospitals (Svensson & Hartmann, 2018). Based on the request from the Ministry of Enterprise and Innovation, the Swedish Innovation Agency VINNOVA invested a total of MSEK 78.2 in the development and operation of makerspaces in Swedish hospitals. The funding ran for three years from April 2010 to April 2013 and involved the setting up of makerspaces at six hospitals, the employment of assistance staff, and the provision of prototyping equipment. In an evaluation of this policy initiative, Svensson and Hartmann (2018) find that with annual operating costs of approx. 9 MSEK the makerspaces resulted in 56 user innovations out of 754 suggested solutions within one year. The productivity gain of these 56 innovations is estimated to 1.138 MSEK per year if they were diffused through the Swedish public healthcare system. Yet the authors also find that the innovations were only developed to a functioning minimum, which means that despite they allowed the respective innovator to solve a particular problem, they were not developed well enough to be recognizably valuable to others. While this example illustrates that users, if enabled, can meaningfully contribute to addressing sustainability challenges (in this case SDG 3 – Good health and well-being), a question that arises is how the underdevelopment and subsequent under-diffusion of their innovations can be overcome.

One actor that can play an important role in supporting the development and diffusion of sustainability-oriented user innovations is a so-called boundary organization (Nielsen et al., 2016) or transition intermediary (Kivimaa et al., 2019). This actor is a ‘facilitator of innovation’ who engages in network and system-building activities in situations “where direct interaction is difficult due to high transaction costs (e.g. locating a suitable partner to collaborate with, disincentives to collaborate) or communication problems resulting from differences in culture, interests, and capacity to absorb or exchange knowledge” (Kivimaa et al., 2016, p. 1063, 2019). In addition, such an actor can, in form of a competence center, support users in obtaining funding and managing IPRs, and in so doing, give them more confidence to engage in innovation activities (Meyer et al., 2019), and prevent the unfair exploration of new ideas and knowledge (Päälijäho & Kuusisto, 2011). Moreover, a transition intermediary can act as a funnel for user innovation activities since not all users may engage in activities that are beneficial in addressing sustainability goals or are socially valuable (Nielsen et al., 2016). The importance of such a role is illustrated by outlaw innovation studies providing insights into cases where users individually or collaboratively attack software systems, develop products beyond its intended use, or illegally share digital content (Flowers, 2008; Mollick, 2005).
4.3. User innovation diffusion through value co-creation

The service ecosystem is built on the fundamental premise of S-D logic by asserting that value is not created via exchange, but during use (Vargo & Lusch, 2008). The latter is also central to user innovation since users innovate for-use rather than for-sale (Baldwin & von Hippel, 2011). Users do fundamentally the same as producers, namely integrating resources from various sources to benefit their own and other actors’ lives (Vargo & Lusch, 2016). In fact, it may be well argued that firms also innovate for-use since the purpose of their innovations is to (better) support customers’ value creation activities (Patricio, Gustafsson, & Fisk, 2018). Importantly, however, the for-use focus of innovation suggests that its diffusion cannot be limited to isolated market offerings disseminated to the social system. Instead, innovation diffusion may be better described as a value proposition that continuously evolves through resource integration activities between various actors within the ecosystem.

We illustrate the evolving nature of an innovation by means of the example of Go Climate Neutral, which started as a user initiative before recently turning to a defined business model due to its strong growth rate. The information presented here originates from an in-depth interview with a volunteer who helped in the design of the Go Climate Neutral platform. During a hiking trip in the Alps, a young couple experienced first-hand the significant demise of glacier ice. This experience motivated the couple, who graduated with degrees in information technology and business economics and are employed full-time, to live a climate neutral life by reducing their personal footprint and offsetting for things they cannot reduce. However, the couple was frustrated by the lack of transparency about the many existing climate projects. Consequently, the couple started a list of UN-certified and transparent climate offset projects. After they shared their initiative with their community, the couple receives support from two agile software developers, a user experience (UX) designer and a political scientist, to transform their idea into a fully integrated subscription platform called Go Climate Neutral. In their spare time, the team analyzed climate offset policies, developed a business plan, designed the platform interface, and disseminated their idea on social media.

Launched in 2017, Go Climate Neutral enables people to estimate their individual carbon footprint and offset their surplus to various climate projects. Linked to the platform is a blog where members can post and discuss ways to reduce their personal footprint and help slow down climate change in a meaningful way (e.g., alternatives to flying on unavoidable long-distance travels). In the first months, and mostly through peer-to-peer diffusion, the platform reached 300 subscribers and increased to more than 2700 subscribers after one year. A key reason for this strong increase was a respected agile team mentor and strong climate advocate who contributed to the platform design and shared the idea within his social network of 25,000 Twitter followers and 9600 YouTube subscribers.

The example illustrates how a user innovation initiative continuously evolves through resource integration and value co-creation activities between multiple actors. Users often do not have the capabilities, resources, or motivation to fully develop their solutions ‘in-house’ or invest in innovation diffusion (de Jong et al., 2015). However, both the Green Leaf and Go Climate Neutral examples show that user innovators use their personal network to gain access to the required resources for scaling their solution. In fact, both cases did not invest in the diffusion process per se but relied on the support of organizations, interest groups, or influencers. This illustrative insight aligns with research on grassroots innovation, showing the reliance on networks for scaling innovations beyond a niche (Hossain, 2016; Oremzeder & Rohracher, 2013), as well as the central role of transition intermediaries (Kivimaa et al., 2019) or influencers (Watts & Dodds, 2007) in the diffusion process. The latter, as highlighted in the Go Climate Neutral example, is especially important for diffusion via social media because the network position and social influence of the content sharer determine the magnitude of innovation diffusion in an increasingly hyper-networked society (Susralla, Oh, & Tan, 2012).

5. Discussion and implications

Although the importance of user innovations in enhancing social welfare and addressing current sustainability challenges has been extensively evidenced (e.g., Gambardella et al., 2016; Nielsen et al., 2016; Svensson & Hartmann, 2018), decision-makers continue to under-estimate the impact users can make (Bradonjic et al., 2019). The consequences are innovation policies, regulations, and a funding structure that hinder rather than support the diffusion of sustainability-oriented user innovation activities. Against this backdrop, the present article investigated the (non)diffusion of user innovations from a service ecosystem perspective. Through the integration of diffusion, innovation ecosystem, and user innovation research, viewed in light of two sustainability-oriented user innovations examples, we propose that the service ecosystem may provide an alternative to the conventional producer-centric model of innovation. Specifically, we propose that the service ecosystem, in combination with insights from innovation ecosystem research, can provide a theoretical basis that guides the design of an innovation infrastructure inclusive of users. We base this conclusion on the following:

1. Rather than a firm-driven linear process, the activities underpinning innovation and diffusion are conceptualized as a multi-actor and multi-level phenomenon, thus providing a basis for understanding how individual users and their innovation activities are affected by the actors and structure of the ecosystem.

2. Unlike the conventional innovation model, no presumed distinction is made between producers and consumers, but an actor-to-actor orientation is taken as a starting point for defining the user’s role within the ecosystem.

3. The for-use focus of both user innovations and the service ecosystem concept implies that diffusion is not about distributing isolated market offerings but is, instead, an ongoing process that relies on ecosystem actors integrating resources into a constantly evolving value proposition.

We conclude the article by elaborating on these assumptions and discuss the implications for moving towards an innovation infrastructure that is inclusive of user innovators and can help to overcome the non-diffusion of sustainability-oriented user innovations.

Diffusion, when conceptualized from an ecosystem perspective, does not solely take place at the micro-level, where an innovation is produced and distributed by one party and consumed by another. Instead, we propose that diffusion takes place across systems levels and involves multiple actors who create value jointly. This proposition has several implications for an innovation infrastructure that aims to overcome the first adoption and diffusion problem of sustainability-oriented user innovations. Firstly, innovation policies should not solely focus on profit incentives driving first adoption and diffusion but also non-monetary drivers, such as altruism (Baruch et al., 2016), fun and enjoyment of innovation challenges (Frey, Lüthje, & Haag, 2011), reputation gains, engagement and community identity (Füller, Matzler, & Hoppe, 2008), or reduced development costs and learning (Baldwin & von Hippel, 2011). In fact, not only are these drivers central to users taking a step towards sharing their innovations; they can also increase the chance of adoption by others in the social system (e.g., Venkatesh, Thong, & Xu, 2012; Wunderlich, Veit, & Sarker, 2019).

Secondly, it needs to become easier for users to conduct and scale sustainable innovations. Directly related to enabling sustainability-oriented user innovations are education initiatives, supportive intermediaries, micro-loans, and open data access (Hossain, 2016; Nielsen et al., 2016; Seyfang, 2007). For example, open education courses that increase technical literacy and knowledge in design thinking, rapid
prototyping, and idea management, or recognition rewards to acknowledge valuable user contributions can help to counteract the current under-diffusion problem of socially valuable user innovations (Nielsen et al., 2016). In addition, government authorities should design innovation policies and provide funding schemes that incentivize not only producers but also users to develop and share their innovations (Bradonjic et al., 2019).

Thirdly, user innovations need to be more effectively integrated into innovation ecosystems by providing advice to firms and communities on how they can benefit from user-driven initiatives. In this regard, Nielsen et al. (2016) and Gambardella et al. (2016) propose policy actions that instigate collaboration between users and firms by facilitating firms’ investment in activities that are synergistic with user innovation. Possible examples are living labs, legal opportunities to modify existing products or services, and more flexible funding schemes. Moreover, investment in makerspaces, along with pathways for self-production (Svensson & Hartmann, 2018) or the provision of free and easy-to-use platforms, can support user communities in sharing design information (von Hippel, 2016).

Moreover, our proposed actor-to-actor orientation challenges the conventional assumption that the firm produces and the consumer receives. This rethinking of the users’ role sets a starting point for designing an innovation infrastructure that gives users access to the resources required to collaboratively develop and share novel solutions. Our perspective is in line with recent developments in the innovation ecosystem literature moving beyond the narrow focus on for-profit firms to consider that “in some ecosystems, some or all of the value is created by individuals who are not employees or otherwise part of an incorporated organization” (Bogers et al., 2019, p. 9).

Within the innovation ecosystem user innovators may be compared with niches that are dependent on other actors, especially on those who play the role of a supporting or enabling function, such as a keystone (Iansiti & Levien, 2004), platform leader (Gawer & Cusumano, 2002), or transition intermediary (Rivinaa et al., 2019). In turn, these supporting actors can benefit from the diversity and radicalness of user innovations, which is a key element of innovation ecosystem health and growth (Auño & Thomas, 2014; Iansiti & Levien, 2004). We argue that this actor interdependency specifically applies to scaling sustainability-oriented user innovations because, within this context, users often end up innovating in isolation or must compete against incumbent regimes (Nielsen et al., 2016). Our actor-to-actor orientation, complemented by insights into actor roles from innovation ecosystem research, sets a starting point for repositioning users from receivers of outputs to active value co-creating actors. Beyond this repositioning, the actor interdependency within the ecosystem can be analyzed to inform the design of interventions aimed at counteracting the non-diffusion of sustainability-oriented user innovations.

Finally, the proposed for-use focus of user innovations implies that innovation diffusion is not the distribution of isolated market offerings but an evolving process relying on ecosystem actors’ resource integration and value co-creation activities. It results in a co-created process of innovation development and diffusion, which might be especially applicable to sustainability-oriented user innovations because, in this context, users often lack the resources to fully develop solutions themselves (Hossain, 2016; Nielsen et al., 2016). Co-creation can also allow user innovators to build internal momentum which is required for niche innovations to compete with existing regimes and transit to mainstream markets (Geels & Schot, 2007). Here, the multi-level and -actor approach of the service ecosystem can set a basis for recognizing the nature of user innovations and designing an infrastructure that supports users to collaboratively develop and share sustainable innovations through the integration of new resources and rebranding of existing resources.

In summary, given the first adoption failure and non-diffusion of user innovations, we propose the service ecosystem as a theoretical alternative to the conventional innovation model because it successfully considers that today’s innovation challenges cannot be tackled by single organizations and requires a systemic multi-actor approach. Our perspective is in line with recent developments in the innovation ecosystem and sustainable innovation literature, both emphasizing the importance of moving beyond a producer-consumer standpoint to re-consider the role of users in innovation and the interdependency between actors affecting the development and diffusion of sustainability-oriented user innovations. This article, as such, offers a more expansive and inclusive basis for designing an innovation infrastructure that is suitable for tackling current sustainability challenges.

We conclude this article with a call for future research. Since this article is conceptual in nature, future research is needed to apply the service ecosystem concept, including its assumptions regarding the diffusion of sustainability-oriented user innovations. Future studies are also required to investigate the effects of new resources, regulations, and actor roles on user innovation activities. For example, one may argue that advancements in information technology, and social media platforms, in particular, increase access to resources and make it easier for users to co-create, share and distribute their innovations. However, what counteracts these developments is that globally, laws governing IPRs and online content copyrights are more strict (von Hippel, 2016). Here, an important aspect is the evaluation of policy interventions aimed at encouraging the collaborative development and sharing of user innovations through, for example, the provision of ‘safe havens’ or easily accessible knowledge protection methods. Directly related to sustainable innovations, more insights are required on how users can be incentivized to co-create innovations beyond their own personal needs and address higher-order social benefits. Such an investigation requires the systematic identification of suitable users, as well as the type of innovation infrastructure, incentives, and resources needed for them to engage in innovation activities. Research on these matters is urgent because, within the current regulatory framework, many socially valuable user innovations remain underdeveloped and do not diffuse (Bradonjic et al., 2019; de Jong et al., 2018; Svensson & Hartmann, 2018).

Finally, future research is needed on the question of whether user innovations do actually meaningfully contribute to sustainable innovations. In an attempt to address this question, Gambardella et al. (2016) find that adopting a mixed user and producer innovation economy yields a superior outcome, from a social welfare viewpoint, than relying solely on producer innovation. However, it also needs to be considered that not all users might be interested in making a positive contribution to social welfare or sustainability goals. Innovations can have both positive and negative effects, and some users might address needs that are in conflict with sustainability goals or have (unintended) negative consequences for the broader society (Nielsen et al., 2016). For example, users may not be concerned with legal liability, corporate reputation, or societal consequences in the same way producers are (DeMonaco et al., 2019; Flowers, 2008). However, studies exploring possible negative effects stemming from user innovation activities are lacking, and we call for future research into this matter. As highlighted by de Jong et al. (2018, p. 496), “[r]esearch into the diffusion of consumer innovations has only just started.” We hope that this article spurs further exploration in this important topic and increases awareness of the roles users can play in the sustainable innovation field.

Acknowledgements

We would like to thank the special issue editorial team and the anonymous reviewers for their valuable comments and feedback on earlier versions of this article. This research was funded by VINNViXT Paper Province 2.0 (Vinnova), Sweden—En storsskalig demonstrator för skogsbaserad bioekonomi, grant #2016-04227.


