Research Policy 52 (2023) 104840

Contents lists available at ScienceDirect

Research Policy

journal homepage: www.elsevier.com/locate/respol

Heroes of diffusion: Making user innovations widely available

Jeroen P.J. de Jong *, Coen Rigtering, Lara Spaans

Utrecht University, Kriekenpitplein 21-22, 3584 EC Utrecht, the Netherlands

ARTICLE INFO

Keywords:
User innovation
Diffusion failure
Nurse innovation
Makerspaces

ABSTRACT

User innovations are often valuable to other people, but fail to diffuse because users lack incentives to do a dissemination effort. Past research recognized that users sometimes spur diffusion themselves, and that producers may search for and commercialize user innovations. In this study we identify a third type of actor who fills the void between initial solution and broad dissemination - without being a potential user or commercial diffuser himself. We document a case study at an academic hospital where workers created and institutionalized a system to support and disseminate user innovations developed by nurses. They proactively created a network with makerspace facilities, without being asked or instructed to do so. These workers fulfilled a disseminator role: they continued to develop user innovations to make adoption easy, explored commercial pathways, mobilized peer demand, and created favorable project conditions. Interestingly, the diffusion system was institutionalized by job crafting, securing budgets, embedding diffusion activities in the organization chart, and developing strategic relationships. Disseminators were motivated by self-actualization, enjoyment, reputation advancement, and altruism towards the nursing community; they strived to become 'heroes of diffusion'. We conclude that a disseminator role in-between user innovators, and peer adopters and commercial producers, represents an alternative mechanism for user innovations to spread widely, and opens opportunities for new research.

1. Introduction

User innovations are goods, services or processes developed by individuals or firms to satisfy their own needs (von Hippel, 2005). User innovations complement so-called producer innovations: new products that require adoption by others for the innovator to benefit (von Hippel, 2005). Users innovators are found in any part of the economy, including households and businesses (de Jong, 2016). Many of their innovations are valuable to other users facing similar needs or problems. User innovations can spread commercially (e.g., a producer adopts the innovation to sell it as a commercial product) or directly to peers (the innovation is freely shared with adopters who replicate the innovation for themselves) (de Jong et al., 2015).

Unfortunately, generally valuable user innovations often fail to diffuse (de Jong et al., 2015). This diffusion problem is caused by lacking incentives: after satisfying their personal needs, users do not benefit from value that adopters obtain (von Hippel, 2017). This keeps users from communicating about their innovations (de Jong et al., 2015) and from continued development efforts that would make adoption easy (von Hippel, 2017). Diffusion becomes even more problematic with regulation: while users are autonomous to innovate for themselves, turning innovations into products that can be sold comes with many additional requirements, e.g., related to safety and liability (Torrance and von Hippel, 2015). This creates a gap between initial solutions - good enough for users themselves - and improved versions that can be easily adopted. Diffusion failure has been demonstrated in samples of physicians (von Hippel et al., 2017), consumers (de Jong et al., 2015), home-inventors (de Jong et al., 2018), and employees (Hartmann and Hartmann, 2023), and is a market failure exclusively associated with user innovation – it does not exist for producer innovations where commercial firms benefit from selling their products.

Past research identified various factors that diminish the diffusion problem. Users sometimes start ventures to commercialize their innovations (Shah and Tripsas, 2007). Producers may actively search for user innovations that meet a general demand that they can profitably serve (von Hippel, 2005, 2017). In specific circumstances, users voluntarily reveal their innovations to peers, for example to reciprocate help received from collaborators (Ogawa and Pongtanalert, 2013); when they expect indirect benefits such as future favors (de Jong and Flowers, 2018), or when they wish to advance a common cause (Jeppesen, 2021). These alleviating factors are uncommon, and continued work on diffusion is called for (de Jong et al., 2021).

* Corresponding author.
E-mail address: j.p.j.dejong@uu.nl (J.P.J. de Jong).

https://doi.org/10.1016/j.respol.2023.104840
Received 17 May 2022; Received in revised form 27 May 2023; Accepted 12 June 2023
Available online 17 June 2023

Researchers so far only considered that user innovators spur diffusion themselves, or that producer firms search for user innovations to commercialize. The contribution of this paper is that we take a new perspective: *other* people may take charge of the diffusion effort without being motivated by personal need or commercial incentives. This idea is inspired by Stock et al. (2016) who studied the influence of personality traits on the ideation, development, and diffusion of user innovations. Stock and colleagues found that single actors usually lack all traits associated with these three steps, and speculated that other people than user innovators may conduct the diffusion task. Hence, in this paper we focus on people who are not user innovators themselves, nor commercial producers, but still strive to make user innovations widely available.

As the idea of a third actor is new to user innovation research, our approach is inductive. We describe a case study at an academic hospital where individuals developed a system to support and diffuse user innovations by nurses. At first sight, our research context seemed like a regular makerspace, offering physical equipment and technical assistance (Rieken et al., 2019). Previous scholars have repeatedly suggested makerspaces to support user innovation (de Jong et al., 2015; von Hippel, 2017), but unfortunately, diffusion in such makerspaces often fails (Svensson and Hartmann, 2018), or only happens when user-developers are commercially oriented (Halbinger, 2018). Interestingly, in our case study environment much better diffusion outcomes were achieved.

We explored *how* and *why* individuals in our case study developed systems that effectively bridge the gap between the initial development of user innovations, and broader diffusion. We found a group of workers who proactively built a system to diffuse nurse innovations beyond their hospital's borders. Their system originated from an initial user innovation project, but over time its pioneers started to also support and spread other user innovation projects, conducting pre-commercial and peer diffusion activities in which nurse innovators themselves were not interested. Interestingly, to secure ongoing diffusion efforts, they also institutionalized the favorable environment they had created; by crafting their jobs, obtaining permanent budgets, and embedding their facilities in the organizational chart.

We observed that broad diffusion of multiple user innovations can be achieved by a specific type of individual who pick up a disseminator role; filling the void between user-innovator problem solving and broad diffusion by producers who are initially not interested, or capable, to do this job. Disseminators do not seek personal use benefits or commercial advantages, but are driven by self-actualization, enjoyment, reputation advancement, and altruism towards a user group – essentially, their motivation is to become 'heroes of diffusion'. They prioritize impact to users over value creation to their organization, and they are concerned with spreading many innovations, instead of developing a single project. The disseminator role is context-specific; without affinity to a user group the same individuals would not engage in diffusion. Rather than an innate trait, the disseminator role can emerge and vanish over time. In our propositions for continued research, we suggest that the presence of disseminators is a main reason why some makerspaces are effective in accomplishing diffusion, and that disseminators' proactive and early involvement helps to create better systems to make user innovations widely available. In our Discussion section we elaborate why the disseminator role was not identified before, and the new research opportunities it helps to create.

2. Theory

2.1. User innovation and diffusion failure

For societal welfare it is important that user innovations—to the extent that they have general value—become available to other users (von Hippel, 2005; de Jong et al., 2015). This avoids that other users have to replicate the development effort, provided that they would be capable of replication in the first place. User innovations may diffuse commercially, for example when users themselves start ventures (Shah and Tripsas, 2007), or when producer firms adopt user innovations to commercialize (Baldwin et al., 2006). User innovations can also disseminate directly to peers, such as has been observed in hobbyist communities (Franke and Shah, 2003).

Unfortunately, diffusion of user innovations often fails due to lacking incentives. Users are motivated to solve a personal or internal problem, and benefits that others would obtain from adoption are an externality to them. This leads to a diffusion shortfall: "*Investment in diffusion by* [*user*] *innovators can increase social welfare because it is often the case that even relatively small investments can greatly reduce search and adoption costs for* [*others*]. (…) *The problem is that innovators have to bear the costs of investments in diffusion, while adopters get all of the benefits and do not share those costs. There is no market link that would enable a more appropriate allocation*" (von Hippel, 2017: p.65–66). Evidence for diffusion failure has been reported in multiple contexts, including user innovations developed by physicians (von Hippel et al., 2017), citizens (de Jong et al., 2015) and employees in organizations (e.g., Hartmann and Hartmann, 2023).

The user innovation literature identified three specific causes of diffusion failure. First, users do not actively inform other people about their innovations. They may passively disclose their innovations by using them in public (Shah and Tripsas, 2007; von Hippel, 2005), but lack incentives to share details about their designs (von Hippel, 2017). Second, users do not continue to develop their innovations up to a point where adoption becomes easy. Their innovations generally enable novel functions to address their unique problems, but are often poorly designed (von Hippel, 1994; Riggs and von Hippel, 1994). From an adopter point of view, user innovations are often 'amateurish' prototypes that provide an immediate solution to a problem. These solution-prototypes are sufficient for users themselves, but broad adoption would require improved and more reliable versions of the solution—preferably a full-fledged product that adopters can plug-and-play. Lack of continued development leaves particularly unskilled adopters deprived (von Hippel, 2017). Third, broad diffusion requires that regulatory requirements must be met. Individual users are free to personally use their solutions, and also autonomous to disclose innovations, as long as they do this for free. However, if user innovators would build copies for other users, or sell their innovations as products, regulation comes into play (Torrance and von Hippel, 2015) – e.g., related to safety, liability, and sustainability.

Fig. 1 summarizes why diffusion of user innovations falls short. The diffusion gap implies that initial prototypes that solve the user's problem, are often not enough developed for producer firms to commercialize, or for other users (peers) to easily replicate. The problem becomes more severe in heavily regulated environments.

2.2. Alleviating factors

Studies so far identified five factors that diminish diffusion failure: commercial motivation, active search by producers, community involvement, indirect benefits, and common cause motivation.

2.2.1. Commercial motivation

After satisfying their personal needs, some users develop commercial intentions which triggers a continued diffusion effort (de Jong et al., 2015, 2018). Typically, user innovators only become commercially motivated after interactions with their environment. People in their surroundings may ask for copies of their solution, and this makes the user aware of a business opportunity – they become user entrepreneurs (Shah and Tripsas, 2007).

2.2.2. Active search by producers

Producers that are active in the same product domain have an interest to search for and commercialize user innovations (von Hippel, 2017). They may apply methods to identify user innovations, like

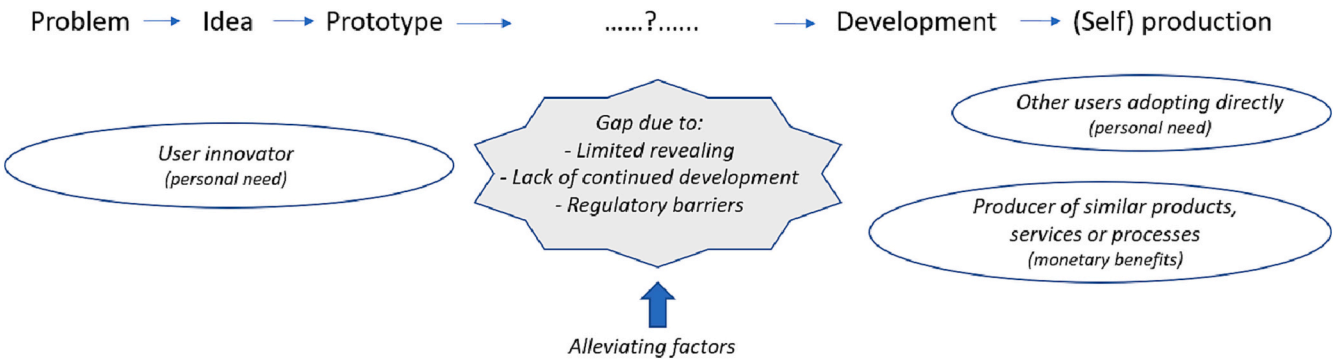


Fig. 1. Gap between initial prototyping and diffusion of user innovations.

crowdsourcing (Füller et al., 2017), lead user studies (Hienerth and Lettl, 2017) or firm-hosted user platforms (Ma et al., 2019). To the extent that user innovations are congruent with the firm's core competences, continued development and tackling regulatory barriers becomes less complicated. A problem that frustrates producer adoption, however, is that the initial expected market demand of user innovations is often small and uncertain, while at the same time regulatory barriers can be high (von Hippel, 2017).

2.2.3. Community involvement

User innovations are sometimes developed with the help of other users, active in a community of people facing similar problems or challenges. For example, user innovators in sports communities are often revealed for free, to reciprocate help received from community members (Franke and Shah, 2003). Community involvement increases the odds that user innovations are communicated, and that collective processes emerge to improve prototypes, so that adoption becomes easier (von Hippel, 2007).

2.2.4. Indirect benefits

Diffusion may also occur when user innovators anticipate indirect benefits. This has been documented especially for user innovations developed by firms who tend to selectively share user innovations (Henkel et al., 2014). They may do so to influence technology standards (Henkel et al., 2014), or for expected return favors from their network ties (de Jong and Flowers, 2018). In contrast, individual consumers sometimes openly reveal user innovations: due to altruism or for a sense of accomplishment (von Hippel, 2017), or in the hope that producer firms will develop a better and cheaper version of their solution (Harhoff et al., 2003). Indirect benefits are associated only with free or selective revealing, not with deeper investments into continued development or overcoming regulatory barriers—so its impact on broad diffusion is limited unless a knowledgeable adopter takes this responsibility.

2.2.5. Common cause motivation

Jeppesen (2021) recently introduced the idea of 'social movement innovation' in which individuals develop innovations not only to use themselves, but also to address a public cause (e.g., reduce meat consumption, save energy). These individuals are highly motivated to spur diffusion by free revealing.

The aforementioned factors are uncommon, and it has been recommended to keep investigating factors that alleviate the diffusion shortfall (de Jong et al., 2021).

2.3. Makerspaces as a potential intervention

User innovation scholars have suggested makerspaces as a policy intervention to facilitate the development and diffusion of user innovations (e.g., de Jong et al., 2015; von Hippel, 2017). As we explain next, evidence for their effectiveness to improve diffusion has been modest.

Makerspaces are physical workshops that offer shared access to fabrication tools. They can be funded by memberships, subscriptions, or donations (Halbinger, 2018), or initiated by corporate organizations to leverage employee innovation (Rieken et al., 2019). Makerspaces may facilitate hobby-related innovations (Beltagui et al., 2021), commercial innovations (Rieken et al., 2019), user innovation (Svensson and Hartmann, 2018), or a mix of these.

Makerspaces usually provide a positive environment to develop user innovations. Their facilities lower the threshold for solution-prototyping, by providing physical tools (e.g., laser cutters, 3D printers) and technical assistance (Beltagui et al., 2021; Rieken et al., 2019). Makerspaces can also facilitate collaboration and knowledge sharing, but these benefits are only reaped when the makerspace's culture is altruistic and dedicated to revealing knowledge (Beltagui et al., 2021; Gantert et al., 2022). In a study of makerspaces at Swedish hospitals, Svensson and Hartmann (2018) found many developed user innovations, mostly initiated by physicians. The potential returns of these innovations, if they would spread broadly, were estimated to be over ten times the required investment.

Unfortunately, evidence for broad diffusion of user innovations developed in makerspaces is not encouraging. In Svensson and Hartmann's (2018) study the potential returns were barely realized, as the user innovations did not spread. They identified as main problem that user innovators did not want to personally pursue diffusion activities, while commercial firms did not (yet) see enough market demand. This is in line with the diffusion gap we visualized in Fig. 1. Likewise, Halbinger (2018) surveyed participants of subscription-based makerspaces. She also found a positive impact on the development of innovations, but diffusion rates were more modest. Eighteen percent of all makerspace innovations in her study had diffused commercially. As such, this was considered a positive outcome: broad surveys of consumer innovation showed commercial diffusion rates of 6 % or less (e.g., de Jong et al., 2015). Yet, Halbinger found that diffusion-oriented participants had commercial intentions already when they joined the makerspace, which is in line with the first alleviating factor we discussed above. No evidence was presented for a positive impact on peer diffusion.

In all, the evidence suggests that in the absence of commercial motivation, creating systems to diffuse user innovations is challenging. Offering makerspace facilities in itself does not seem to do the job. In the next sections we report a case study in which involved individuals proactively built a makerspace environment dedicated to user innovation, where good diffusion outcomes were achieved.

3. Methods

Our case study was at a large academic hospital in the Netherlands. We detected a group of workers involved in a makerspace focused on nurse innovation. They have proactively developed an environment with positive diffusion outcomes, while none of the aforementioned

alleviating factors applied (Section 2.2). We studied how involved individuals developed the diffusion system, their critical activities, and their motivation.

3.1. Empirical context

The case of nurse innovations was a suitable empirical setting for our research purposes. First, innovations developed by nurses are typically user innovations to improve the effectiveness, efficiency or safety of work processes (Hughes, 2006; Blakeney et al., 2009; Glasgow et al., 2018). Next, nurse innovations diffuse slowly or not at all (Nelson, 2020). After solving a personal problem at work, nurses lack incentives to communicate their innovations (Gomez-Marquez and Young, 2016; Nelson, 2020; O'Harra et al., 2022). Moreover, diffusion requires more than a prototype to solve a nurse's immediate problem. Continued effort is needed to design a solution suitable for adoption. The diffusion problem of nurse innovations is amplified by regulatory barriers. All healthcare innovations have to comply with medical regulations, but this is a lengthy and expensive process (Svensson and Hartmann, 2018). Lack of compliance with medical regulation also frustrates diffusion to peers.

The group of workers we identified was associated with a makerspace for nurse innovations. When we started our data collection (Fall of 2020), the makerspace was a temporary facility, offering access to physical tools, technical assistance, and an expert network – seemingly the usual corporate makerspace environment for employee innovation (Rieken et al., 2019). Nurses initiated innovations by reporting a problem and an initial prototype or solution idea, then a multidisciplinary team from the network provided assistance to solve the problem. What made this makerspace environment exceptional was that many innovations diffused to others, thanks to specific diffusion efforts (presented hereafter).

3.2. Interviewees

Our interest was to explore the diffusion behaviors of the people involved in nurse innovation projects. For this purpose, we first made an inventory of individuals affiliated with the makerspace who actively contributed to diffusion. One author of this paper spent several months at the makerspace. She got access to its project database, that she enriched based on regular talks with and observations of people contributing to innovation projects, and by studying secondary sources (e.g., the hospital's internal magazine and social media). This resulted in an overview of who had contributed to each nurse innovation, how, and what kind of diffusion effort had been done.

Altogether 26 out of 45 nurse innovation projects had been completed halfway through 2021: a solution was put into use by the initiating nurse. Appendix A provides examples. In 24 out of these 26 projects some diffusion effort had been done, e.g., by showing prototypes to producers, or by direct sharing with (previously uninvolved) nurses, departments and/or hospitals. At the time of our data collection 12 projects had reached some kind of diffusion (8 nurse innovations were directly adopted by other nurses, and 4 nurse innovations were in the process of being commercialized by producers).

From our database we identified thirteen individuals who actively diffused nurse innovations. Table 1 shows that most were primarily affiliated with other hospital departments, or even external organizations. Many had secured permission from their management to spend part of their job on nurse innovation, on top of informal contributions done in slack time.

As we explain later, the makerspace with its diffusion activities had emerged as a *consequence* of our interviewees' behaviors. In particular interviewees #1, #2 (but also #3 to #5) had pioneered the favorable diffusion environment.

Table 1
Interviewees.

Interviewee	Job title	Main affiliation	Work time[a]	Former nurse
#1	Senior researcher & coordinator	Makerspace	90 %	Yes
#2	Manager	Makerspace	50 %	Yes
#3	Design lecturer & coach	Polytechnic institute^	20 %	No
#4	Senior design lecturer	Polytechnic institute^	10 %	No
#5	Senior business developer	Technology transfer office	20 %	No
#6	Entrepreneur	Medical device business^	0 %	Yes
#7	Nursing advisor	Children's intensive care department	0 %	Yes
#8	Operations advisor	Medical instruments department	50 %	No
#9	Design lecturer & coach	Polytechnic institute^	20 %	No
#10	Nurse quality coordinator	Home ventilation department	0 %	Yes
#11	Medical device engineer	Medical instruments department	10 %	No
#12	Junior business developer	Technology transfer office	20 %	No
#13	Electrical engineer	Makerspace	20 %	No

[a] Official working time at the makerspace; slack time not included, ^ main affiliation external to the hospital.

3.3. Assessment of diffusion potential

Before interviewing we checked whether the completed nurse innovations had potential to diffuse. Past user innovation studies showed that solutions may just be irrelevant to others. In that case lack of diffusion only indicates that adopter interest is missing (de Jong et al., 2015).

We asked two coders to rate the developed solutions on relative advantage and ease-of-use. These are important indicators of expected demand (Rogers, 2003). The coders were not involved in the makerspace: the manager at the hospital's intensive care department, and a business developer at the hospital's technology transfer office. We showed them a photo of each nurse innovation and a full description: what the innovation did, and the problem it solved. Each solution was rated on relative advantage ('*To nurses, will this innovation offer a clear, unambiguous advantage over previous tools, methods or devices?*') and ease-of-use ('*To nurses, will this innovation be easy to understand and use?*') with answers 'to none or few' (score 1), 'to some' (2), and 'to many' (3). We assessed interrater reliability with two-way mixed average-measure ICC-values (McGraw and Wong, 1996). The ICCs were 0.72 (relative advantage) and 0.61 (ease-of-use) indicating good absolute agreement (Cicchetti, 1994). If coders disagreed we conservatively estimated diffusion potential with their lowest score. Relative advantage was expected for many (58 %), some (34 %) or no/few (8 %) other nurses. Ease-of-use was expected for many (69 %) or some (31 %). Hence, the nurse innovations were deemed moderately or highly valuable to other users. Lack of broad dissemination would resemble with the diffusion failure encountered in previous studies (e.g., Svensson and Hartmann, 2018).

3.4. Procedure and analysis

We conducted in-depth interviews with the thirteen subjects to learn about their diffusion behaviors and motivations. The average interview time was 75 min, with a range from 60 to 90 min. We processed all notes and audio recordings into full interview transcripts. We first elaborated on the interviewee's formal work tasks, and how they had become involved in the makerspace's activities. Next, our embedded researcher

had identified two types of diffusion behavior: (i) to spread specific user innovations, and (ii) to create a favorable environment for diffusion. We structured the main part of the interview accordingly. First, we asked for behaviors and activities to stimulate the diffusion of individual user innovation projects. To assist the subjects' recalling of the innovations we showed a list of the 26 developed solutions. Next, we asked to report behaviors to improve the general environment to build a system for diffusing nurse innovations, and how this had evolved over time. Finally, interviewees elaborated on their motivations to contribute to the diffusion of nurse innovations.

We started our analysis with open coding; summarizing the interview transcripts into basic blocks of data, and identifying initial categories (Strauss and Corbin, 1998). We regularly discussed and modified these until saturation was reached. In the next step, we condensed the categories to obtain key diffusion behaviors and motivations with axial coding. Our coding scheme (developed based on procedures recommended by Gioia et al., 2013) is shown in Appendix B.

We continuously went back and forth between the data and the literature. Alternating between qualitative data and literature is typical for grounded theory approaches (Strauss and Corbin, 1998). For example, initially, we considered diffusion motivations from the user innovation literature (e.g., to commercialize, for enjoyment, or to learn – see von Hippel, 2017) but soon learned that many interviewees were driven by other factors (like self-actualization and reputation enhancement) and found Battistella and Nonino's (2013) broader overview of motives to contribute to innovation challenges more useful. Hence, the interviews put us on track of new literature relevant to interpreting diffusion behaviors.

Another example of alternation between data and literature, is that we had expected to observe known diffusion-related roles like the innovation champion (Howell and Higgins, 1990) and promotor (Hölzle et al., 2010). However, these roles did not adequately describe the behaviors we observed. Some interviewees invested a lot in creating a favorable diffusion environment, and in developing general facilities to secure dissemination of user innovations. To our knowledge this kind of behavior has not been described in the earlier (role) literature. It made us conclude that a particular disseminator role is important to spread user innovations, that individuals may deploy without personally needing user innovations, nor by being commercially incentivized.

4. Findings

We first explain how the makerspace with its diffusion facilities emerged, based on proactive behaviors of our interviewees. Next, we discuss critical behaviors to diffuse nurse innovation projects, and how the favorable diffusion environment was institutionalized. We then discuss what motivated all diffusion behaviors, and what the differences were between the thirteen interviewees.

Table 2
Three phases of diffusion system emergence.

Phase	Period	Description
1. User innovation project	2013–2015	Develop own nurse innovation project Rely on informal support and resources
2. Hybrid portfolio	2015–2020	Support and diffuse others' nurse innovations Develop diffusion activities; create temporary makerspace Add ad-hoc formal support and resources
3. Institutionalized department	2021-today	Develop and diffuse many nurse innovations Embed makerspace and diffusion activities; adapt to organizational setting Secure permanent support and resources

4.1. Emergence

The makerspace with its diffusion activities emerged in three phases (Table 2, marked by increased scope and formalization).

4.1.1. Phase 1: user innovation project

In April 2013, while working with prematurely born babies, a nurse of the children's intensive care department (interviewee #1) observed insufficient compliance with hand hygiene protocols, which is crucial to reduce the spreading of pathogens and bloodstream infections in prematurely born babies. Realizing that work pressure derails behavioral change, he initiated a technical solution. The incubator traffic light forces nurses to meet hygiene standards (Appendix A). The nurse innovator then realized that additional expertise and resources were needed for a prototype that could meet regulatory standards. Hence, he sought help. At the local polytechnic institute a design lecturer (#4) was interested to contribute in his spare time and to also send engineering students as interns to develop specific parts. Additionally, lab facilities were informally obtained at the hospital's medical instruments department (by interviewee #8). In this phase all support and resources were informal: "*Our very first project was put together with duct tape. We used leftover budgets kindly offered by some of our sympathizers*" (#1). In this initial phase, the emerging team worked under the radar.

4.1.2. Phase 2: hybrid organization with a portfolio of projects

In 2015, the nurse innovator (#1) realized that his informal network and resources could be helpful to other nurses. Given his strong desire to positively impact the nursing community, he and the design lecturer (#4) started to help other nurses. They deployed their network and slack time to assist in nurse innovations, and put effort into diffusing completed prototypes for general benefit: "*Innovation is something that most nurses do unconsciously and on the side. They do not know much about the innovation process, and dissemination is notoriously difficult given the regulations and required level of technical expertise. My aim is to develop the profession by ensuring that nurse innovations become available to other nurses*" (#1).

Over time multiple nurse innovation projects were adopted. With the number of projects increasing, more people were sought to help. Some of these were motivated to continue their contributions, also to diffuse initial prototypes. For example, ongoing support was provided by another design lecturer from the polytechnic institute (#3), a former nurse who had become a line manager (#2), and an employee from the technology transfer office (#5). They all sympathized with nurse innovation, and subsequently liked to help this group of workers – which the hospital did not consider a valuable source of innovation. This group initially worked on slack time, and sometimes also violated their department's policies and principles. For example, technology transfer offices usually prioritize license fees, and would not freely reveal innovations: "*We have done many projects on which we did not make a single dime. Our projects have high societal value which we should get to users*" (#5).

In this phase, members of the emerging network started to ask their managers for permission to spend part of their job on nurse innovation. They sometimes also applied for grants to diminish their regular tasks in favor of nurse innovation. Next, in 2018 they persuaded the hospital's board to temporarily fund makerspace facilities: as the number of projects had grown to a size were a dedicated lab was helpful. They were able to accomplish this after demonstrating a range of nurse innovations that were clearly advancing the nursing profession (examples in Appendix A). Crucially, our interviewees did not merely replicate the usual makerspace model with physical equipment and technical assistance. Instead, they carefully asked themselves what kind of processes would be optimal for dissemination: "*We checked other makerspaces, including some American ones, but their model was not good for us. Their focus was too much on developing solutions with nurses, but broad dissemination was not on their radar*" (#2).

4.1.3. Phase 3: institutionalized department

Continuous outreach and showcasing successes played a major role in both obtaining permanent budgets and eventually permission to become a regular hospital department. With the help of an operations advisor (#8), the makerspace's manager (#2) and coordinator (#1) developed a plan that was approved by the hospital's board: "*As of 2021, our space has become a formal department within the hospital, responsible for nurse innovation and dissemination. This is a rare accomplishment. It never happened in our history that two former nurses founded a separate department*" (#2). This step necessitated formalizing the makerspace and its diffusion activities, and align all procedures with those of the hospital: "*I helped us become embedded in the hospital's financial systems. To become a department we had to develop not only a business case but also a management accounting system*" (#8). At the time of our research the makerspace received an annual and fixed budget, but was also supposed to strive for revenues from license fees when user innovations would be commercialized by producers.

4.2. Diffusion activities

We identified four key diffusion behaviors deployed by interviewees: i. continued development, ii. explore commercialization, iii. mobilize peer demand, and iv. improve project conditions. Collectively these behaviors helped to bridge the gap between initial prototyping and broad diffusion (Fig. 1).

4.2.1. Continued development

In a typical process, nurses develop a solution-prototype with the help of design students from the local polytechnic institute, using the makerspace's physical equipment. For subsequent diffusion, interviewees ensure that these prototypes were developed further. Quality, robustness, and ease of use were improved by involving more professional helpers – such as the hospital's medical device department: "*I check whether a design can actually be produced and how we can reduce production costs. Students usually prototype with 3D printers, but this technology does not meet clinical and safety requirements*" (#11). For example, the infusion lines flower (Appendix A) was initially reusable, but to meet hygiene requirements it was redesigned as a disposable. Interviewees optimized designs by reducing the number of components, using different materials, and properly documenting design files: "*I feel guilty when there is no proper version of a solution. I always try to have it completely finished. Without a proper design we cannot expect anyone to work with our Nutri press*" (#9).

4.2.2. Explore commercialization

Interviewees bridged the gap to commercial production. Especially innovations that have to comply with high medical regulation standards were in need of commercial partners because of the required development costs. Interviewees contacted, involved, and negotiated with producer firms and entrepreneurs. For example: "*We work with platforms on which you can post a prototype as a challenge; entrepreneurs and producers can then contact us*" (#2). Sometimes businesses were approached directly: "*We have a national committee for children with tracheostomy tubes in which producers participate, so I contacted them about our project*" (#7). Also, time was invested in market research to explore and demonstrate broader demand. This was usually done with the help of design students, and lowered producers' adoption barriers: "*We* [*check*] *if there is already something available on the market. Maybe the producer already knows it is a niche product* (…) *we do extensive market research*" (#3).

4.2.3. Mobilize peer demand

Interviewees made sure to communicate innovations to other nurses, and facilitate initial adoption. This triggered demand from peers both within and beyond hospital borders. Demonstrations and workshops were organized, and innovations were showcased in external communications. Additionally, free copies were shared in 'pilots' that were actually meant as a fait accompli: "*We distributed copies of our ampule opener, disguised as a pilot. At some point nurse managers came in and asked us more copies*" (#10). Next, interviewees helped adopting nurses to re-invent prototypes to better meet their personal requirements: "*I thought let's get creative with a do-it-yourself package; I went to another hospital with pictures and drawings to do it yourself*" (#12). Interviewees also freely disclosed designs: "*If there is demand but it is too small for commercialization, we just share the CAD or design files with other hospitals to produce themselves*" (#3). These activities generated traction, and helped to signal broader demand to producer firms. Moreover, interviewees sometimes stretched the rules of their own departments to facilitate sharing with peers. For example, the hospital's medical instruments department was not supposed to produce many copies of an innovation, but nevertheless: "*We are able to produce a lot in-house* (…) *we do not want to* (…) *but we do produce an X number if there is sufficient demand for a nurse innovation*" (#11).

4.2.4. Improve project conditions

Finally, interviewees improved the general conditions to disseminate individual nurse innovation projects. They asked managers at various departments to fund future versions of a prototype, or to facilitate initial adoption. Interviewees also applied for one-time subsidies to enable continued development, market research, and demonstration projects, e.g., "*We made a request at* [*charity for child care research*] *to fund a better diaper puncher*" (#7). They reached out to external experts to support continued development and or diffusion: "*I recently asked an acquaintance to complete a design. I know I cannot do it as well as she can*" (#9). Later on, the makerspace formulated as a policy that nurses, when initiating projects, had to bring a manager or influential colleague committed to promoting the innovation within and beyond hospital borders: "*We now prefer not to be a problem-solver only. We rather spend our time on projects that are useful to many others, instead of fixing the problems that* [*individual*] *colleagues throw over the fence*" (#2).

4.3. Institutionalization

Some interviewees went beyond disseminating individual projects: they put lots of effort into institutionalizing the favorable diffusion environment that they had helped to create. Securing makerspace facilities (a permanent location within the hospital with physical tools) was only part of their effort. They also ensured permanent resources, and developed relationships, structures and processes, to institutionalize the diffusion system. Institution building was done proactively, mainly by the interviewees who had been involved as of phase 1. Institutionalization was accomplished by: i. job crafting, ii. securing budgets, iii. embedding diffusion activities in the hospital's organization chart, and iv. building strategic relationships.

4.3.1. Job crafting

Job crafting is the proactive modification of work tasks and relational boundaries to improve the fit between the characteristics of a job and one's personal needs, abilities, and preferences (Wrzesniewski and Dutton, 2001). This is what we observed in our case study: interviewees secured permanent time spending on diffusion by earmarking part of their official work time. Almost all interviewees had started contributing from slack, such as in phase 1: "*We call it the cowboy period. We were not immediately asked what we were spending time on, so we could just develop things*" (#1). Interviewees also invested leisure time and create additional slack by efficiently planning their regular tasks. Subsequently, in phase 2 interviewees arranged formal but temporary exemptions from their regular job: "*At some point that became too complex. So I made work of grants and budgets to compensate our time*" (#4). In phase 3, time spending on nurse innovation and diffusion became embedded; jobs were crafted to dedicate part of the work time on nurse innovation. At the time we collected data most interviewees had secured 20 % of their

work time, with some exceptions (50 % to 90 % of work time, see Table 1). Most interviewees still added a significant amount of slack time on top.

4.3.2. Secure budgets

Nurse innovation and diffusion requires raw materials, tools, and other resources to communicate about innovations and to organize events. In phase 1 interviewees had done this without official funds. For out-of-pocket expenses they persuaded department managers to donate from their schooling or quality control budgets. In phase 2 temporary funding was secured to work on a portfolio of nurse innovations: "*For two years we received subsidy from* [*internal subsidy program of the hospital*]*, mostly because of our likeability. I also knew people from* [*Dutch Organization for Health Care Research*] *who enabled me to reduce my regular tasks*" (#1). In phase 3 the makerspace started to receive permanent funding for its physical facilities and coordination tasks. Importantly, its pioneers had persuaded the hospital's board that the makerspace did not have to break-even; as many nurse innovations cannot serve profitable markets. At the time of our data collection, only part of the budget was obtained from commercial fees: "*Some projects can only be given away for free, but others can give us some revenue. However, we do not need to break-even with all investments, that is impossible. Most innovations' market size is just too small.*" (#5).

4.3.3. Embed in the organization

Activities to diffuse nurse innovations were initially not formalized. In phase 2 a temporary organization was created, with supportive infrastructure (makerspace facilities). At the time, the makerspace was officially part of the children's intensive care department. An initial webpage was launched, and social media channels opened for communication purposes. In phase 3 the makerspace became an official department with permanent housing. In this phase job routines were standardized, and internal procedures aligned with the hospital's standards. Also, procedures were developed for basic work processes: "*I help to standardize the innovation and diffusion processes. One of my contributions is that we no longer enthusiastically start projects right away, but first do market research and look for comparable solutions. Instead of developing first and then see if there is broad interest, we now prefer to work on things that can be applied beyond the initiating nurse*" (#6).

4.3.4. Build strategic relationships

As of phase 2, the makerspace's pioneers intensively networked to expand their diffusion system. Initially this came down to broadcasting successes: "*We always did a lot with social media to showcase our projects and to ensure that people knew about us. It is important to reach out to new people who may support us, or work with us to bring our prototypes to the market*" (#3). Over time, the focus of their networking changed. Relationships were initiated with decision-makers and influencers for long-term support, e.g., the hospital board, department managers, and external contacts like professional nurse organizations, and decision-makers at other hospitals: "*I give many presentations about our work, last year it was over fifty. The board recently asked us to present what we were developing. I also broadcast our work to the ministry of health and to other hospitals to inspire them about what we are doing*" (#1). In the phase 3, some of these relationships were formalized. Examples include agreements with the polytechnic institute that initially brought students as ad-hoc interns, but now allowed some of its staff members to contribute parttime. Moreover, to help broadcast the makerspace's activities, relationships with other hospital departments were formalized: "*We learned how to feed the hospital's general communication department with examples and press releases, and we will also linked to HRM. They now use our projects and involved nurses in their hiring process, communicating that nurses innovate at our hospital*" (#2).

4.4. Motives

Looking at the motives of our interviewees, the main motivations identified in the user innovation literature—personal use benefits and commercial benefits (von Hippel, 2005; de Jong et al., 2015)—did not explain their diffusion efforts. Although the makerspace had emerged from a user innovation (see Section 4.1), as of phase 2 interviewees had no intention to personally use the innovations that were supported. We identified four motives that explained our interviewees' behaviors: a. self-actualization, b. enjoyment, c. reputation, and d. altruism towards a user group.

4.4.1. Self-actualization

Self-actualization is the complete realization of one's potential and abilities (Maslow, 1943). Individuals may be even motivated 'beyond' self-actualization by being meaningful to others (Greene and Burke, 2007). This highly applied to our interviewees who were eager to diffuse nurse innovations for the sense of accomplishment that comes from solving real-life problems. Broad adoption contributed to their sense of making impact with high societal relevance: "*I usually work with scientists; develop their research instruments. It takes years to see impact, if at all. Nurse innovations get immediately applied in practice, I help to fix real problems. This is much more in line with who I am*" (#11). Working on broad diffusion felt rewarding; our interviewees thought that they put their capabilities into good use: "*I used to be an entrepreneur, but the commercial part started getting to me. I much rather make a difference to people. In the end I do not mind giving away knowledge, I prefer making impact*" (#3).

4.4.2. Enjoyment

Another widely shared motive was sheer fun: "*I really like to work with young people who think differently and who we can complement with new ideas, being critical. The fun part is reaching out to other people. They do not realize yet, but our great innovations will make their lives better and easier*" (#1). Interviewees also appreciated the high autonomy when moving into unknown territory when trying to spread innovations. Finally, they enjoyed working with like-minded others: "*I like being part of a group of enthusiastic people who try to change how things are done. I cannot imagine a better thing than that. And I even get paid for it*" (#4).

4.4.3. Advance reputation

Some interviewees were eager to build diffusion structures for ego-related reasons. They aimed to be known as nurse innovation experts: "*I am proud of the diffusion of our innovations, I want to become the expert of nurse technology in the Netherlands*" (#1). Developing an expert reputation increases their sense of self-worth. It gave them a feeling of high professionalism and being well-regarded and appreciated. In terms of Maslow's (1943) needs hierarchy, diffusion helped them to accomplish self-esteem, by building a reputation: "*I used to work as a manager with 250 subordinates. I stepped down to work parttime here, combining it with managing another department. But this is the one I get out of bed for every morning. It gives me the chance to become what I want to be known for*" (#2).

4.4.4. Altruism towards user group

Some were also highly committed and strongly empathized with nurses in general. They would not do the effort if innovations were meant for another groups of users – like physicians. Interviewees wanted to empower nurses and advance professional standards: "*We can truly help to improve the nursing profession. I am convinced that nurses bring lots of innovation potential and the profession deserves much better*" (#2). For this purpose it made a lot of sense to spread solution-prototypes, and even more to create an environment in favor of diffusion. Interviewees in this category felt emotionally connected to the nursing profession, which partially explained their diffusion behaviors: "*In healthcare, innovation is the domain of physicians. Nurses are not supposed to innovate. I used to be a nurse myself, I wanted to do things completely different. I am*

convinced that nurses can take charge and initiate innovations themselves, and deserve help to get it done. Yes, I have much more sympathy for nurses than for physicians" (#1).

4.5. Differences between interviewees

Interviewees contributed to diffusion in various degrees. Some perfectly matched with all of the aforementioned behaviors and motives, while others did so only partially (Table 3).

Interviewees #1 and #2 clearly possessed all behaviors and motives. Both were deeply motivated to make a difference to the nursing profession and develop a reputation as central diffusion node. Interestingly, they both were former nurses themselves, but had moved into different positions already before they started to invest in nurse innovation and diffusion. They had crafted their jobs to spend considerable time on nurse innovation; at the time of our data collection this was 90 % and 50 %, respectively. Their primary concern was now to institutionalize the diffusion environment, but they still also contributed to the diffusion of individual projects. Combining their motives, they strived to become 'heroes of diffusion'. A hero is "*a person that you admire because of a particular quality or skill that they have*" (Oxford learner's dictionaries, 2023). What made them potentially most heroic was their focus on impacting the nursing profession based on altruism, and obtaining expert status.

Interviewees #3 to #5 had all contributed to nurse innovation and diffusion as of phase 1, or early phase 2 at the latest. They had crafted their jobs to spend around 20 % of their work time, and were still expanding this. Unlike #1 and #2, they did not aim so much for expert recognition, and were not as deeply committed to advancing the nursing profession in particular. Rather, they indicated that the diffusion of nurse innovations enriched their jobs, such that they were eager to craft their jobs to contribute to the makerspace even more - but not with the intention to contribute fulltime.

Interviewees #6 to #13 contributed regularly to the diffusion of individual projects, but only incidentally to institutionalizing the diffusion system. They had deep sympathy for nurses and found diffusion important, but in parallel with other activities. Their motivation was primarily self-actualization and enjoyment.

In overview, our interviewees were concerned with diffusion to various degrees. Interviewees #1 and #2 clearly had all characteristics, and interviewees #3 to #5 partially. In the next section we develop propositions about the disseminator role that we identified from our case study.

5. Propositions

Our case study shows that the diffusion gap (Fig. 1) can be diminished by individuals who take charge of a disseminator role. This role implies wide spreading of user innovations in a particular domain, by (1) engaging in diffusion activities, for example by continued development of prototypes, exploring commercial pathways, and facilitating free revealing, and (2) creating and institutionalizing favorable diffusion environments. Moreover, individuals who pick up a disseminator role are (3) motivated by self-actualization, enjoyment, and – most distinctively –reputation enhancement and altruism. Accomplishing this would make them 'heroes of diffusion'. The disseminator role is context-specific; if strong affinity with a user group would be absent, the same individuals would refrain from the effort. Based on our case study findings, and review of the literature, we offer eight propositions about the disseminator role, its emergence, and role in designing more effective makerspaces.

Table 3
Presence of diffusion behaviors and motivations across interviewees.

Behavior/motivation	#1,#2	#3-#5	#6-#13
Diffusion of nurse innovation projects	Continuously	Continuously	Regularly
Institutionalizing the diffusion system	Continuously	Regularly	Barely/ not
Motivation: self-actualization, enjoyment	Highly	Highly	Partially
Motivation: reputation, altruism	Highly	Barely/not	Barely/ not

Notes: # indicates interviewees 1 to 13.

5.1. Dissemination of user innovations

A key question is whether the disseminator role generalizes beyond our case study. Future research should provide a final answer, but with our current knowledge we propose it will – as similar behaviors and motives can be observed in parallel user innovation contexts where diffusion system were effectively organized, e.g., communities of practitioners and online knowledge-sharing platforms.

Communities of practitioners (CoP) are groups of individuals with a common passion, interest, or set of problems. CoPs regularly emerge bottom-up, for example as hobbyist user groups, tech clubs or online circles (Wenger et al., 2002), and have also been associated with diffusion of user innovations (e.g., Hienerth et al., 2014). Usually few pioneers do substantial effort to build the CoP, develop its infrastructure, and lower participation barriers (Wenger et al., 2002; Corso et al., 2008). Pioneers of CoPs are often driven by altruism towards their community, enjoyment, self-actualization, and they appreciate a heroic reputation amongst their peers (Costanza-Chock, 2020). Hence, they resemble with the disseminator role we encountered in our case study.

Another context where we see resemblance is amongst individuals who start and develop online knowledge-sharing platforms (OKSPs). OKSPs are web environments facilitating an accumulated knowledge base, where people share content (Baruch et al., 2016; Mancilla-Amaya et al., 2010), and which can include user innovations (e.g., de Jong and Lindsen, 2021). The substantial effort required to develop OKSPs' infrastructure and diffusion activities is usually done by few enthusiasts. A specific example is Patient-innovation.com. What started as an online platform for knowledge sharing, is nowadays a hybrid environment where patients and caregivers can improve, share and commercialize user innovations to better cope with diseases. From personal communication with its founders we learned that Patient-innovation.com was started for similar motives (altruism, enjoyment, reputation enhancement, and self-actualization) as our disseminator role.

Perhaps surprisingly, the CoP and OKSP literature did not yet zoom in on the behaviors and motives of their pioneering enthusiasts. We suspect that when user innovation-related CoPs and OKSPs emerge without commercial motivation (some of these platforms are firm-hosted, which is a different matter), their pioneers may well resemble with the disseminators from our case study. We propose:

P1. Diffusion failure of user innovations can be diminished by individuals who pick up a disseminator role: by proactively developing diffusion activities, creating and institutionalizing favorable diffusion environments; and motivated by self-actualization, enjoyment, reputation enhancement, and altruism towards a specific user group.

Next, we propose that the disseminator role represents a previously undetected factor that can alleviate diffusion failure. Most important is that while researchers so far assumed that user innovators spur diffusion themselves, in our study, different actors fill the void between initial prototyping and broad diffusion.

Looking at the five existing alleviating factors (commercial motivation, active search by producers, community involvement, indirect benefits, and common cause motivation, see Section 2.2), individuals in our case study were not commercially motivated. Second, they did not represent producer firms searching for user innovations. (Their employer (hospital) could be regarded as a producer, but recall that our interviewees were never instructed to diffuse nurse innovations – their

primary motivation was to advance the nursing profession in a broad sense, not to pursue the hospital's immediate interests.) Third, the makerspace environment was not a user community as described in previous studies (Franke and Shah, 2003; Ogawa and Pongtanalert, 2013). Rather, external help was provided by people who sympathized with nurses, but who were not users themselves. Fourth, disseminators did not aim to reciprocate those who had helped them. Altruism and reputations benefits were of primary importance to them, while for user innovators such benefits are 'only' a side issue, if important at all. Fifth, disseminators did not seek to advance a broad societal challenge or common cause for which they developed innovations themselves (as described by Jeppesen, 2021). Rather, they diffused other users' innovations with a particular user group in mind.

In all, the disseminator role is sufficiently distinct to be regarded as a separate factor, especially because it is different actors than user innovators pick up this role:

P2. The disseminator role is an alternative factor that alleviates diffusion failure of user innovations. Disseminators are not commercially driven or producer representatives, nor are they user innovators who may diffuse to reciprocate collaborators, pursue indirect benefits, or advance a common cause.

Our following proposition is that classical roles in innovation management do not adequately explain the disseminator role we identified. Important known roles are the innovation champion (Howell and Higgins, 1990), intrapreneur (Pinchot, 1985), promotor (Hölzle et al., 2010) and change agent (Rogers, 2003). As we explain next, these roles differ from the disseminator role on some important aspects.

Champions actively pursue new product ideas, evolve them into innovations, and bring them to market (Schon, 1963). Champions are associated with pursuing opportunity to create value for the organization (e.g., Howell and Higgins, 1990), and take charge of the full innovation process (Hölzle et al., 2010; Drechsler et al., 2021). In contrast, disseminators in our case study created value for a particular user group, only addressed the gap between initial prototyping and broad diffusion, and delegated commercialization to others. Unlike disseminators, champions have not been reported to create and institutionalize environments in which multiple innovations can be diffused.

Intrapreneurs are "*dreamers who do; those who take hands-on responsibility for creating innovation of any kind within an organization; they may be the creators or inventors but are always the dreamers who figure out how to turn an idea into a profitable reality*" (Pinchot, 1985: p: ix). Hence, intrapreneurs are commercially oriented and act in the interest of their organization (e.g., Gawke et al., 2019). Like champions, they are associated with single projects (opportunities that are developed), do not build systems for diffusion, and take the lead in all phases of the innovation process.

Promotors are individuals, usually managers, who voluntarily support innovation projects in organizations (Hölzle et al., 2010). They may do so with expertise, power, advice or access to relationships (Gemünden et al., 2007). Like disseminators, promotors are active in few phases of the innovation process (Goduscheit, 2014). However, promotors have not been associated with building and institutionalizing diffusion systems. They prioritize their organization's interests, rather than a group of users that transcends organizational boundaries. Our interviewees mentioned that they regularly mobilized helpers (e.g., managers, physicians) to support individual nurse innovations, but these 'promoters' were helping out reactively, and did not develop the diffusion system, not did they disseminate a portfolio of user innovations.

Change agents "*influence clients' adoption decisions in a direction deemed desirable by a change agency*" (Rogers, 2003: p.27) and "*…provide a communication link between a resource system with some kind of expertise and a client system. One main role of the change agent is to facilitate the flow of innovations from a change agency to an audience of clients*" (p. 368). Like disseminators, change agents can be motivated by intrinsic factors like impact, meaningfulness and altruism (Specht et al., 2018). Change agents may spread innovations in the broadest sense: novel product or applications, but also new ideas or practices. Unlike disseminators, change agents have not been reported to build and institutionalize diffusion systems. They represent a change agency that is usually an organization benefiting from realizing change (Rogers, 2003), and that generally fits a producer innovation perspective. Disseminators would accept that some user innovations fail to diffuse, as long as their overall effort would have a positive impact to the user group. Change agents on the other hand would not: their role is to accomplish diffusion at the project level, in the interest of their organization.

In summary, existing roles in innovation management do not (sufficiently) explain the behaviors and motives we encountered in our case study. Most salient differences are that disseminators (1) prioritize impact to users over value creation to the organization, (2) are concerned with spreading many innovations, instead of developing a single project, (3) create and institutionalize systems for diffusion. We propose:

P3. The behaviors and motives of disseminators differ from existing innovation management roles (champion, intrapreneur, promotor, change agent), as disseminators diffuse multiple user innovations, create and institutionalize diffusion systems, and prioritize impact to a user group over their organization's interest.

5.2. Emergence of the disseminator role

In our case study, many interviewees had experience working with nurses, and with user innovation processes in particular. Five interviewees were former nurses themselves, of which three (#1, #7, #10) had initially become involved for a user innovation, and two (#2, #6) had started to contribute to the diffusion system without initially being user innovators themselves. Another six interviewees (#3, #4, #5, #8, #9, #11) had abundant experience with innovation in healthcare. All interviewees deeply empathized with nurses, and were well aware of nurses' innovation challenges. Only two (#12, #13) had little domain-relevant experience. These interviewees had joined the makerspace later, when resources had become available that facilitated permanent hiring.

Domain-specific experience certainly contributed to our interviewees' motivation and competences to undertake diffusion activities. They recognized that nurse innovation and diffusion facilities in healthcare did not exist, and required proactive effort. Their experience was important in facilitating their contributions to the emerging diffusion system. Hence, although the disseminator role is not exclusively deployed by former user innovators, domain-specific work experience and user innovation experience seem likely antecedents. We propose:

P4. The more individuals are experienced in a particular user domain, and/or have experience with user innovation processes, the more likely they will deploy a disseminator role.

Next, individuals in our case study developed their disseminator role gradually. Recall that in phase 1 two interviewees (#1, #4) developed a user innovation project. Almost from the beginning onwards they had in mind that other nurses should be able to benefit as well. Later they were eager to deploy their informal network to help other nurses solving their problems, again with broad diffusion in the back of their minds.

The pioneers of our makerspace were motivated by self-actualization and enjoyment, and some of them also by altruism and reputation benefits (Table 3). Initially no interviewee envisioned creating a new department. Rather, their activities expanded based on the nurse innovation problems that they encountered, which over time made them realize that they needed their own facilities. When proposing the makerspace plan to their hospital's board, they deliberately deviated from the classical makerspace model that revolves around prototyping equipment and technical assistance (see Makernurse.com, 2023; Marshall and McGrew, 2017). Instead, they prioritized diffusion as part of its objectives and processes. We suspect that when the hospital had

top-down instructed some employees to start a makerspace with diffusion activities, it would have been less successful (see propositions P7 and P8 hereafter).

In all, we propose that the disseminator role emerges over time, and is associated with diffusion activities that are increasingly focused on creating and institutionalizing diffusion systems:

P5. Over time, individuals develop their disseminator role gradually, with an initial focus on the diffusion of individual user innovations, to a later focus on creating and then institutionalizing diffusion systems.

Finally, we can anticipate that the disseminator role more likely emerges in specific circumstances. A first requirement seems the presence of a regular stream of user innovations, from which other users can benefit – such as with nurses (Marshall and McGrew, 2017), patients (Oliveira et al., 2014, 2017), and physicians (von Hippel et al., 2017), but also outside the healthcare domain, like in 3D printing (de Jong and Lindsen, 2021). Second, we observed that the disseminator role becomes more important if the diffusion gap (Fig. 1) exceeds a particular threshold. When potential adopters lack skills to replicate innovations (von Hippel, 2017) and regulation is more severe (Torrance and von Hippel, 2015), the gap in Fig. 1 widens. Third, producers in the same domain may not at all search for user innovations. When producers do not deploy methods like crowdsourcing and firm-hosted user platforms, more user innovations remain undetected (von Hippel, 2017). In all these situations the space for disseminators increases:

P6. The disseminator role is more likely picked up by individuals in contexts (a) where many user innovations are present, (b) when the diffusion gap is more severe (e.g., unskilled peer users, heavy regulation), and (c) where producer firms searching for user innovations are absent.

5.3. Disseminator's contribution to more effective makerspaces

In our theory section we explained that effective diffusion of user innovations developed in makerspaces is not self-evident. The differences we observed between our case study and regular healthcare makerspaces enable us to propose that the involvement of disseminators helps to create makerspaces where the diffusion shortfall is minimized.

Most healthcare makerspaces are modeled after the world's first medical makerspace at the University of Texas Medical Branch (UTMB) (see Makernurse.com, 2023; Marshall and McGrew, 2017). The focus is usually on offering physical equipment and support services. In our case study these necessities were present too, but of top that, spreading innovation was in the makerspace's DNA. Individuals with disseminator characteristics developed their makerspace bottom-up, and gradually. They thoroughly embedded diffusion in its culture and processes. As of phase 3, they even started to restrict the intake of new nurse innovation projects based on diffusion potential, implying that nurse innovators no longer received a uniform treatment.

To better secure that user innovations in makerspace environments spread, we propose it is important that individuals with disseminator characteristics take charge early, and avoid copy-pasting blueprints. When forming new organizational entities, behaviors and motivations of the individuals involved in early phases are paramount to imprint appropriate goals and methods (Kozlowski and Klein, 2000). Once established, behavioral and motivational patterns are often difficult to change (Archer, 1995). Reliance on a blueprint usually implies that structures and processes are imposed. In contrast, our makerspace emerged proactively, based on disseminators' motives. Makerspace facilities were only put into place *after* an initial diffusion network had been developed; the lab facilities complemented the emerging diffusion system rather than dictating it. We propose:

P7. Makerspaces more effectively stimulate diffusion of user innovations, when they are set up by people with disseminator characteristics who take charge early on.

Next, we observed that disseminators in our case study managed to avoid restrictive revenue targets from commercial diffusion. They initially faced their board's logic that innovations should generate income from sales or license fees (a typical producer innovation perspective). This was not a good match with user innovations that often spread more effectively when freely revealed to peers, or where the numbers of adopters is too small to justify commercial investment. It was agreed that both diffusion pathways would remain eligible. The makerspace would attempt to generate license fees and donations from commercial organizations whenever reasonable, but free revealing activities remained possible, to help advance the nursing profession. In all, the diffusion system we observed enables us to propose:

P8. Makerspaces to support user innovation will reach better diffusion rates if (a) both peer and commercial diffusion are deemed eligible pathways, and (b) there is no requirement to break-even, but part of the activities is financed with a lumpsum budget; provided the makerspace is developed by people with disseminator characteristics.

6. Discussion

We documented a group of workers at an academic hospital who proactively built a system to diffuse user innovations. Out of an initial user innovation project, they pulled together knowledge, networks and resources in what became a makerspace for nurse innovations. Interestingly, they did not restrict themselves to develop user innovations, but instead bridged the gap towards broad diffusion (to peers and/or commercially) by engaging in specific diffusion activities, and by institutionalizing the diffusion environment they had created.

6.1. Implications for research

So far, in the user innovation literature there has been no attention for individuals who are primarily concerned with diffusion, unless they have a strong commercial motivation. Previous studies focused on how and when user innovations emerge, and identified roles were related to the front end of the innovation process. Hence, there have been descriptions of the user innovator who develops solutions to personal needs (von Hippel, 2005), and the lead user who is ahead of a trend and expects high benefits from a solution to his needs (von Hippel, 1986). More recently, attention has shifted to the consumer innovator who is driven by both personal needs and hedonic motives (Raasch and von Hippel, 2013) and the embedded lead user who is simultaneously employed at a company *and* a lead user of the products that his/her company sells (Schweisfurth and Raasch, 2015). However, individuals who are primarily driving diffusion have been understudied, with the exception of the user entrepreneur – who develops commercial interests on top of satisfying a personal need (Shah and Tripsas, 2007). Our study confirms Stock et al.'s (2016) proposition that the dissemination role can be picked up by third actors who are not users or producer innovators themselves.

We suggest that it is not surprising for the disseminator role to be identified only now. First, the diffusion problem of user innovations was identified only recently (de Jong et al., 2015; von Hippel et al., 2017; Stock et al., 2016). In the early days of user innovation studies, researchers mainly focused on empirical contexts where users *did* diffuse their innovations, as for example in communities of hobbyists (Franke and Shah, 2003) and open-source (von Hippel, 2005). More recently, however, it has become evident that these situations are exceptions, and that the bulk of user innovations does not diffuse to the extent they should from a social welfare perspective. Second, producer innovation was, and still is, the dominant perspective in innovation management. If we would look at our case study from a producer innovation point of view, the disseminator role is easily overlooked. Involved individuals would at first sight seem to just do their jobs as makerspace employees, or members of its support network, acting in the interest of their

organization. After deeper exploration, it became evident that the makerspace facilities were actually a *consequence* of disseminators' behavior and motivation, and that contributions from the support network were done by employees who were stretching their formal responsibilities, and in their slack time. Also, the pioneers of the makerspace had never been asked to build a diffusion system, and actually deployed activities primarily for nurses, while not prioritizing their organization's direct interests – this they regarded more as a boundary condition to secure support from some involved stakeholders.

Recognizing that a disseminator role exists provides opportunities to study a range of new topics: how the gap between initial user prototyping and broad diffusion can be further delineated (we suggest that Fig. 1 provides a start), the nature and uniqueness of the disseminator role, its antecedents and processes of emergence, and implications for the design of interventions like makerspaces. Our propositions in Section 5 are meant to provide initial directions and inspire continued work, but are certainly not exhaustive.

To mention only the most salient opportunities for continued research, we recommend to explore if disseminator characteristics are found with the pioneers of communities of practitioners, and online knowledge-sharing platforms. When such systems are started bottom-up (so not by profit-seeking producers), we suspect they will. Next, it may be studied how the disseminator role exactly differs from existing roles in innovation management, like the promotor (Hölzle et al., 2010) and change agent (Rogers, 2003). Third, we would prioritize investigating whether domain-specific knowledge, in particular work experience and former user innovation experience, is essential to become an effective disseminator. This is an important question, as it would provide guidance to policy makers and managers who are willing to support disseminators to reap broader benefits of user innovation.

Although it was not our primary focus, our study also has implications for researching makerspaces to support innovation processes. In the public domain, little evidence exists on the effectiveness of makerspaces (Paskaleva and Cooper, 2021). In this vein, Beltagui et al. (2021) recently concluded a study of UK makerspace participants. They found that diffusion was frustrated because makerspace innovations were quickly and informally developed based on bricolage, but not yet designed in a form that other people can adopt. Beltagui and colleagues suggested that for subsequent diffusion, the makerspace approach needs modification: by creating different processes and resources. Our study suggests that it makes a difference who initiates such makerspaces, when these individuals become involved, and with what kind of motivation they do so.

6.2. Implications for practice

Our study sheds new light on how policy makers and innovation managers can address diffusion failure of user innovations.

To policy makers, our study suggests that launching makerspaces based on the usual blueprint will probably not reach (desired) broad dissemination. This requires that the 'right' people drive implementation. If policy makers simply subsidize labs with physical equipment, technical assistance, and a community moderator, we expect an environment with many hobbyist-like projects, but low societal impact. Diffusion outcomes are expected to improve when makerspaces are organized bottom-up by individuals with disseminator characteristics; who are deeply committed to a specific user group. Hence, we would advise against hiring makerspace managers who are seeking a career move in a domain they barely know. To avoid top-down implementation of makerspace blueprints, policy budgets probably have to be handed out based on dissemination milestones.

For innovation managers, our study suggests specific strategies to support the diffusion of user innovations that originate within organizations. Diffusion of user innovations can be beneficial for organizations' own workers who may face problems at work that are similar to those described in our case study of nurses at the hospital. User innovations at the shopfloor must first be detected, and probably require further improvements before dissemination can occur. This phenomenon is not self-evident for similar reasons as we discussed in our Theory section (Fig. 1). To develop a sound infrastructure that supports internal diffusion, we suggest that workers with disseminator characteristics may play a positive role. Instead of immediately spending budgets to copy-paste existing idea management systems, we have higher expectations from a gradual process of infrastructure emergence driven by individuals, who are motivated to help other employees. We recommend to back up disseminators, and our case study reveals how this may be effectively done. At the level of individual projects, managers can be important promotors by securing resources, expertise, or referrals (Hölzle et al., 2010). With regard to the creation of a favorable diffusion environment, it is important to carefully consider disseminators' proposals for new facilities (e.g., in our case study these were proposed makerspace facilities to support nurse innovators, but also collaboration agreements between the hospital and a local polytechnic to involve engineering students in the user prototyping process). Likewise, we recommend to seriously consider disseminators' requests to modify existing innovation and diffusion practices (e.g., in our case study interviewees lobbied at the hospital's technology transfer department to also support free revealing and open standards, beyond technology licensing for royalties).

6.3. Limitations and suggestions

Our study has some limitations that bring additional opportunities for future research. First, our case study provides only initial evidence and a proof of existence of the disseminator role. Replication is important: for nurse innovations at hospitals, but also in other contexts. As mentioned, we suggest investigating the pioneers of communities of practitioners and online knowledge sharing platforms are larger scale, to see if their behaviors and motives correspond with the disseminator role.

Also, we recommend continued work to identify factors that make disseminators arise, or that may suppress their motivation and behaviors. A noteworthy study was recently published by Hartmann and Hartmann (2023) at Danish police and military organizations. They found many user innovations that their developers kept hidden, due to heavy internal regulation and lack of organizational interest. No signs of disseminator activity were detected. We speculate that the policy and military culture is so much focused on obeying rules, that potential disseminators may be permanently discouraged. The Danish research suggests that more antecedents exist.

In general, we expect that our findings with regard to the characteristics of the disseminator role will be refined, based on research in other contexts. For example, none of the involved nurse innovators in our study were interested in commercialization, or required compensation for the benefits that adopters would obtain – they were happy to have their innovations freely revealed, as long as it would not take too much of their own time. However, in different circumstances disseminators may have to negotiate with user innovators about the conditions to spread their initial solutions. When users suspect that (at some point) producer firms will make money off of their innovations, fairness perceptions can keep them from sharing knowledge (Franke et al., 2013). Thus, lowering the barriers for user involvement can be another critical behavior practiced by user disseminators – their diffusion behaviors may differ depending on the type of innovation and specific circumstances.

CRediT authorship contribution statement

Jeroen P.J. de Jong: Conceptualization, Methodology, Investigation, Writing – original draft, Supervision. **Coen Rigtering:** Formal analysis, Investigation, Writing – review & editing. **Lara Spaans:** Formal analysis, Investigation, Data curation, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix A. Example of nurse innovations

Ampule opener

Tool to avoid the risk of cutting while breaking glass ampules.

Nutri press

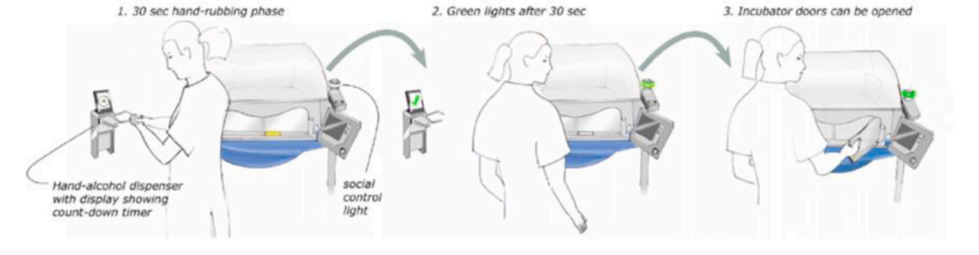
Device to assist tube-feeding. Diminishes physical strain required to feed comatose patients.

Infusion lines flower

Organizes infusion lines at intensive care beds. Prevents safety hazards when infusion lines mix up.

Diaper puncher

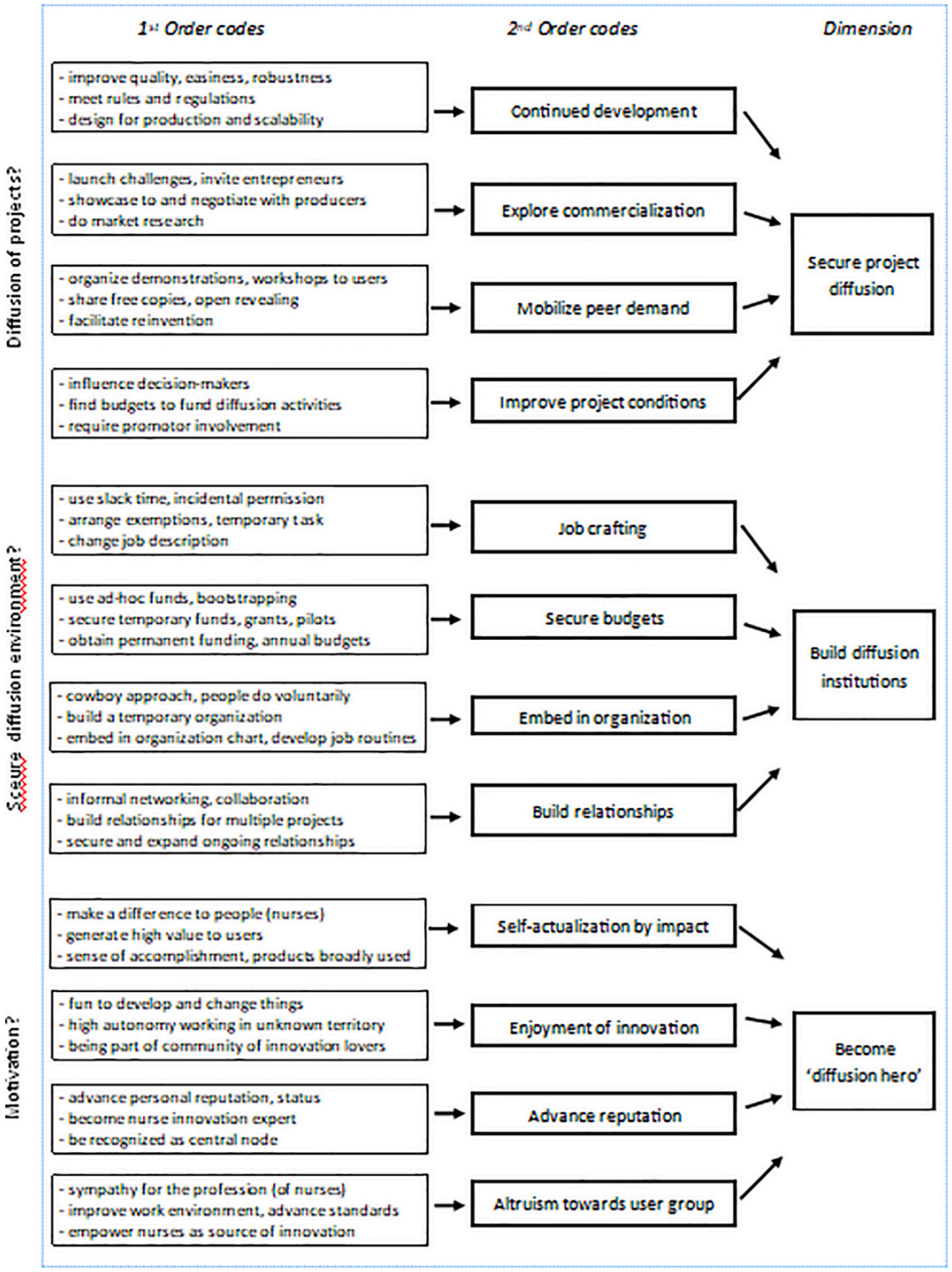
Enables diaper preparation. After hypospadias surgery, babies need modified diapers (saves manually cutting holes).



Incubator traffic light

Increases compliance with hand hygiene protocols. Includes a touchless alcohol-based hand rub dispenser, combined with an integrated color display and incubator door sensor.

Appendix B. Coding scheme



References

Archer, M.S., 1995. Realist Social Theory: The Morphogenetic Approach. Cambridge University Press, Cambridge.

Baldwin, C., Hienerth, C., Von Hippel, E., 2006. How user innovations become commercial products: a theoretical investigation and case study. Res. Policy 35 (9), 1291–1313.

Baruch, A., May, A., Yu, D., 2016. The motivations, enablers and barriers for voluntary participation in an online crowdsourcing platform. Comput. Hum. Behav. 64, 923–931.

Battistella, C., Nonino, F., 2013. Exploring the impact of motivations on the attraction of innovation roles in open innovation web-based platforms. Prod. Plan. Control 24 (2–3), 226–245.

Beltagui, A., Sesis, A., Stylos, N., 2021. A bricolage perspective on democratising innovation: the case of 3D printing in makerspaces. Technol. Forecast. Soc. Chang. 163, 120453.

Blakeney, B., Carleton, P., McCarthy, C., Coakley, E., 2009. Unlocking the power of innovation. Online J. Issues Nurs. 14 (2).
Cicchetti, D.V., 1994. Guidelines, criteria, and rules of thumb for evaluating normed and standardized assessment instruments in psychology. Psychol. Assess. 6 (4), 284–290.
Corso, M., Martini, A., Balocco, R., 2008. Organising for continuous innovation: the community of practice approach. Int. J. Technol. Manag. 44 (3–4), 441–460.
Costanza-Chock, S., 2020. Design Justice: Community-led Practices to Build the Worlds We Need. MIT Press.
de Jong, J.P.J., 2016. The empirical scope of user innovation. In: Harhoff, D., Lakhani, K. (Eds.), Revolutionizing Innovation: Users, Communities and Open Innovation. MIT Press, Cambridge, MA, pp. 67–87.
de Jong, J.P.J., Flowers, S., 2018. Free in, free out? Outbound transfer of user innovations in small UK firms. Ind. Mark. Manag. 73, 21–30.
de Jong, J.P.J., Lindsen, I., 2021. Enhancing diffusion of consumer innovations on knowledge sharing platforms. Asian J. Technol. Innov. 1–19.
de Jong, J.P.J., von Hippel, E., Gault, F., Kuusisto, J., Raasch, C., 2015. Market failure in the diffusion of consumer-developed innovations: patterns in Finland. Res. Policy 44 (10), 1856–1865.
de Jong, J.P.J., Gillert, N.L., Stock, R.M., 2018. First adoption of consumer innovations: exploring market failure and alleviating factors. Res. Policy 47 (2), 487–497.
de Jong, J.P.J., Ben-Menahem, S.M., Franke, N., Füller, J., von Krogh, G., 2021. Treading new ground in household sector innovation research: scope, emergence, business implications, and diffusion. Res. Policy 50 (8), 104270.
Drechsler, K., Reibenspiess, V., Eckhardt, A., Wagner, H.T., 2021. Innovation champions' activities and influences in organizations: a literature review. Int. J. Innov. Manag. 25 (06), 2150066.
Franke, N., Shah, S.K., 2003. How communities support innovative activities: an exploration of assistance and sharing among end-users. Res. Policy 32 (1), 157–178.
Franke, N., Keinz, P., Klausberger, K., 2013. "Does this sound like a fair deal?": antecedents and consequences of fairness expectations in the individual's decision to participate in firm innovation. Organ. Sci. 24 (5), 1495–1516.
Füller, J., Hutter, K., Hautz, J., Matzler, K., 2017. The role of professionalism in innovation contest communities. Long Range Plan. 50 (2), 243–259.
Gantert, T.M., Fredrich, V., Bouncken, R.B., Kraus, S., 2022. The moral foundations of makerspaces as unconventional sources of innovation: a study of narratives and performance. J. Bus. Res. 139, 1564–1574.
Gawke, J.C., Gorgievski, M.J., Bakker, A.B., 2019. Measuring intrapreneurship at the individual level: development and validation of the Employee Intrapreneurship Scale (EIS). Eur. Manag. J. 37 (6), 806–817.
Gemünden, H.G., Salomo, S., Hölzle, K., 2007. Role models for radical innovations in times of open innovation. Creat. Innov. Manag. 16 (4), 408–421.
Gioia, D.A., Corley, K.G., Hamilton, A.L., 2013. Seeking qualitative rigor in inductive research: notes on the Gioia methodology. Organ. Res. Methods 16 (1), 15–31.
Glasgow, M.E.S., Colbert, A., Viator, J., Cavanagh, S., 2018. The nurse-engineer: a new role to improve nurse technology interface and patient care device innovations. J. Nurs. Scholarsh. 50 (6), 601–611.
Goduscheit, R.C., 2014. Innovation promoters - a multiple case study. Ind. Mark. Manag. 43 (3), 525–534.
Gomez-Marquez, J., Young, A., 2016. A History of Nurse Making and Stealth Innovation. MIT Institute for Medical Engineering & Science. Available at SSRN: https://ssrn.com/abstract=2778663. Available at SSRN:
Greene, L., Burke, G., 2007. Beyond self-actualization. J. Health Hum. Serv. Adm. 30 (2), 116–128.
Halbinger, M.A., 2018. The role of makerspaces in supporting consumer innovation and diffusion: an empirical analysis. Res. Policy 47 (10), 2028–2036.
Harhoff, D., Henkel, J., von Hippel, E., 2003. Profiting from voluntary information spillovers: how users benefit by freely revealing their innovations. Res. Policy 32 (10), 1753–1769.
Hartmann, M.R., Hartmann, R.K., 2023. Hiding practices in employee-user innovation. Res. Policy 52 (4), 104728.
Henkel, J., Schöberl, S., Alexy, O., 2014. The emergence of openness: how and why firms adopt selective revealing in open innovation. Res. Policy 43, 879–890.
Hienerth, C., Lettl, C., 2017. Perspective: understanding the nature and measurement of the lead user construct. J. Prod. Innov. Manag. 34 (1), 3–12.
Hienerth, C., von Hippel, E., Jensen, M.B., 2014. User community vs. producer innovation development efficiency: a first empirical study. Res. Policy 43 (1), 190–201.
Hölzle, K., Mansfeld, M.N., Gemünden, H.G., 2010. Personal characteristics of innovators—an empirical study of roles in innovation management. Int. J. Innov. Manag. 14 (6), 1129–1147.
Howell, J.M., Higgins, C.A., 1990. Champions of technological innovation. Adm. Sci. Q. 35 (2), 317–341.
Hughes, F., 2006. Nurses at the forefront of innovation. Int. Nurs. Rev. 53 (2), 94–101.
Jeppesen, L.B., 2021. Social movements and free innovation. Res. Policy 50, 104288.
Kozlowski, S.W.J., Klein, K.J., 2000. A multilevel approach to theory and research in organizations: contextual, temporal, and emergent processes. In: Klein, K.J., Kozlowski, S.W.J. (Eds.), Multilevel Theory, Research and Methods in Organizations: Foundations, Extensions, and New Directions. Jossey-Bass, San Francisco, CA, pp. 3–90.
Ma, J., Lu, Y., Gupta, S., 2019. User innovation evaluation: empirical evidence from an online game community. Decis. Support. Syst. 117, 113–123.
Makernurse.com, 2023. Makerhealth spaces. Accessed on January 5 at. http://makernurse.com/makerhealth-spaces.
Mancilla-Amaya, L., Sanin, C., Szczerbicki, E., 2010. Smart knowledge-sharing platform for e-decisional community. Cybernetics Syst. Int. J. 41 (1), 17–30.
Marshall, D.R., McGrew, D.A., 2017. Creativity and innovation in health care: opening a hospital makerspace. Nurse Leader 15 (1), 56–58.
Maslow, A.H., 1943. A theory of human motivation. Psychol. Rev. 50 (4), 370–396.
McGraw, K.O., Wong, S.P., 1996. Forming inferences about some intraclass correlation coefficients. Psychol. Methods 1 (1), 30–46.
Nelson, R., 2020. Nursing innovation. Am. J. Nurs. 120 (3), 18–19.
Ogawa, S., Pongtanalert, K., 2013. Exploring characteristics and motives of consumer innovators: community innovators vs. independent innovators. Res. Technol. Manag. 56 (3), 41–48.
O'Harra, Ackerman, M.H., Raderstorf, T., Kilbridge, J.F., Melnyk, B.M., 2022. Building and sustaining a culture of innovation in nursing academics, research, policy, and practice: outcomes of the National Innovation Summit. J. Prof. Nurs. 43, 5–11.
Oliveira, P., Zejnilovic, L., Canhão, H., von Hippel, E., 2014. Patient innovation under rare diseases and chronic needs. Orphanet J. Rare Riseases 9 (1), 1.
Oliveira, P., Zejnilovic, L., Canhao, H., 2017. Challenges and opportunities in developing and sharing solutions by patients and caregivers: the story of a knowledge commons for the patient innovation project. In: Governing Medical Knowledge Commons, 301.
Oxford Learner"s Dictionaries, 2023. Hero. Retrieved January 5 8 at. https://www.oxfordlearnersdictionaries.com/definition/english/hero?q=hero.
Paskaleva, D.K., Cooper, D.I., 2021. Are living labs effective? Exploring the evidence. Technovation 106, 102311.
Pinchot, G., 1985. Intrapreneuring: Why You Don't Have to Leave the Corporation to Become an Entrepreneur. Perennial Library, New York, YN.
Raasch, C., von Hippel, E., 2013. Innovation process benefits: the journey as reward. MIT Sloan Manag. Rev. 55 (1), 33–39.
Rieken, F., Boehm, T., Heinzen, M., Meboldt, M., 2019. Corporate makerspaces as innovation driver in companies: a literature review-based framework. J. Manuf. Technol. Manag. 31 (1), 91–123.
Riggs, W., von Hippel, E., 1994. Incentives to innovate and the sources of innovation: the case of scientific instruments. Res. Policy 23 (4), 459–469.
Rogers, E.M., 2003. Diffusion of Innovations. Free Press, New York.
Schon, D.A., 1963. Champions for radical new inventions. Harv. Bus. Rev. 41, 77–86.
Schweisfurth, T.G., Raasch, C., 2015. Embedded lead users - the benefits of employing users for corporate innovation. Res. Policy 44 (1), 168–180.
Shah, S.K., Tripsas, M., 2007. The accidental entrepreneur: the emergent and collective process of user entrepreneurship. Strateg. Entrep. J. 1 (1–2), 123–140.
Specht, J., Kuonath, A., Pachler, D., Weisweiler, S., Frey, D., 2018. How change agents' motivation facilitates organizational change: pathways through meaning and organizational identification. J. Chang. Manag. 18 (3), 198–217.
Stock, R.M., von Hippel, E., Gillert, N.L., 2016. Impacts of personality traits on consumer innovation success. Res. Policy 45 (4), 757–769.
Strauss, A., Corbin, J., 1998. Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory. Sage, Thousand Oaks.
Svensson, P.O., Hartmann, R.K., 2018. Policies to promote user innovation: makerspaces and clinician innovation in Swedish hospitals. Res. Policy 47 (1), 277–288.
Torrance, A.W., von Hippel, E., 2015. The right to innovate. Detroit College Law Michigan State Univ. Law Rev. 2, 793–829.
von Hippel, E., 1986. Lead users: a source of novel product concepts. Manag. Sci. 32 (7), 791–805.
von Hippel, E., 1994. "Sticky information" and the locus of problem solving: implications for innovation. Manag. Sci. 40 (4), 429–439.
von Hippel, E., 2005. Democratizing Innovation. MIT Press, Cambridge, MA.
von Hippel, E., 2007. Horizontal innovation networks—by and for users. Ind. Corp. Chang. 16 (2), 293–315.
von Hippel, E., 2017. Free Innovation. MIT Press, Cambridge, MA.
von Hippel, E., DeMonaco, H., de Jong, J.P.J., 2017. Market failure in the diffusion of clinician-developed innovations: the case of off-label drug discoveries. Sci. Public Policy 44 (1), 121–131.
Wenger, E., McDermott, R., Snyder, W., 2002. Cultivating Communities of Practice: Guide to Managing Knowledge. Harvard Business School Press.
Wrzesniewski, A., Dutton, J.E., 2001. Crafting a job: Revisioning employees as active crafters of their work. Acad. Manag. Rev. 26 (2), 179–201.