Design Science

Community interaction in open business models: how IoT companies can handle community-generated innovation

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Abstract

We investigate how four internet of things (IoT) companies perceive the large quantity of community-generated content as a significant source of innovation. We study the extent to which these companies are willing to align their internal organisation to cope with the external community dynamics and define beneficial modes of collaboration for all involved stakeholders. Four IoT companies adopting open-source hardware principles were selected as case studies. The data collection was based on 18 interviews highlighting both the perspectives of the companies and their corresponding communities and the opinions of key experts in the domain. In our findings, we illustrate the different manifestations of open business models and the companies' concrete approaches to working with external stakeholders. It is shown that companies with a business history more clearly claim sovereignty over their strategic decisions in a community-infused model, while, on the other hand, the community-based companies pursue a community-led strategy.

Keywords: internet of things, open-source hardware, open innovation, open business model, open product development

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1. Introduction

The interaction of firms with communities has taken on a central role in innovation management in recent decades as part of open innovation approaches. In many areas, companies' potential and current customers and stakeholders are organised in communities – often online. Interacting with these communities gives companies the opportunity to obtain important information, such as feedback on their products, ideas for new products or tips for solving technical challenges. However, companies' interactions with external communities are characterised by differences and trade-offs. The voluntary, open organisational structure of communities is fundamentally different from hierarchical company structures, which are bound by contracts and pursue economic goals. These differences give rise to challenges at the interface between organisations and communities in many areas, such as managing and protecting intellectual property (Dahlander & Gann 2010), motivating community members and effectively communicating with the community.

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A company that interacts intensively with a community on product development but has no internal structure to react to the community's needs and suggestions would be unable to generate much value from such interactions and at the same time would alienate the members of the community.

Here, business models describe how companies arrange their resources to create and capture value. They are therefore a suitable perspective for understanding whether companies accord interaction with communities a central role internally. Research suggests that companies need to achieve a fit between their open innovation activities and their business model to sustain valuable interaction with communities (Panduwawala et al. 2009; Hienerth & Lettl 2011; Saebi & Foss 2015; Najar 2020).

There is a growing body of research on open business models and ample research on specific open innovation methods – i.e., communities, competitions or customer integration – as well as on the management of these methods. At the same time, however, there is still a lack of research on how organisations integrate open innovation into their business models in the long term and across the various forms of communication. Hence, our research question is: How do companies manage the integration of open innovation with open-source hardware communities in their business models?

Companies in the internet of things (IoT) industry offer a good context for examining the management of open innovation for two reasons. First, they operate in an environment of high competition and intensive innovation. Many companies use open innovation approaches to achieve high innovation speeds and to make their products attractive to the market. Second, IoT innovation can be understood as digital innovation (Nambisan et al. 2017). In the context of digitisation, innovation can no longer be explained as an intra-organisational phenomenon but must be seen as an interaction of a company with external stakeholders. As a result, innovation usually takes place in the form of distributed activities (Ibid.)

Drawing on the work of Saebi & Foss (2015), who specified the conditions under which business models are beneficial to the success of open innovation strategies, this article contributes to the research field through the construction of an analytical framework that shows the connection between the characteristics of a business model and the degree of openness in the business model. Our results provide a better picture of what an explicitly open business model looks like in practice and how interlocked community and business processes are in companies. Using the specific example of four open-source-hardware-based IoT companies, we discuss how co-creation, collaborative capability and the organisation of knowledge flows manifest themselves in exchanges between companies and communities. In addition, by comparing the companies studied, we reveal differences between companies that build up communities or tap into existing ones and other companies that emerge as a business idea from an existing community dynamic.

The remainder of this article is presented in four parts. In the first part, we discuss the literature on open innovation and business models. The second part presents the chosen methodology and our sample of companies. In the third part, we show the results of the research and discuss their significance. The last part gives the summary and conclusions.

2. Literature review

Open innovation and open business model research sheds light on how companies open up their innovation processes to external stakeholders and specifically on the prerequisites, processes and consequences associated with this. The concepts have been introduced by Chesbrough (2003*a*, 2006) and received a lot of attention from both academics and practitioners (Chesbrough 2003*a*,*b*; West & Bogers 2014; Saebi & Foss 2015; Bogers *et al.* 2017; Gassmann, Frankenberger, & Choudury 2020). The popularity of the concepts, however, has led to a situation where they have often not been differentiated from each other clearly enough (Vanhaverbeke & Chesbrough 2014). Open innovation is possible in closed business models, so the concepts are not interchangeable but can be combined. Making the difference between them allows to study a broader range of phenomena. Therefore, we introduce each concept separately before discussing strategies for combining open innovation and open business models.

2.1 Open innovation

Chesbrough defines open innovation as 'the use of purposive inflows and outflows of knowledge to accelerate internal innovation and expand the markets for external use of innovation, respectively' (Chesbrough 2006, p. 1). When discussing innovation, some authors have used the terms information and knowledge synonymously. In the context of open innovation, Chesbrough (2006) explicitly speaks of 'knowledge flows' while Nambisan, Siegel, & Kenney (2018) refer to the same phenomenon as 'information flows'. The distinction between the terms is important because, as argued by Nonaka & Von Krogh (2009), knowledge entails the potential to perform skillful action while information is a mere precursor to knowledge that must be gathered and processed by decision makers to better understand their environment and make better decisions (ibid.). In this article, we use the authors' respective terms but agree with Nonaka & Von Krogh (2009) that information precedes knowledge and, strictly speaking, knowledge cannot be transferred directly.

Chesbrough (2006) idea contradicts the previously established paradigm that innovation works best in internal processes that are largely sealed off from the outside (Chesbrough 2003*b*; Bessant & Tidd 2015). To keep pace with the technical, social and cultural complexity of their environment and to assert themselves in an increasingly competitive innovation environment, companies are often forced to open up their operational innovation processes to the outside world (Gassmann & Enkel 2006; Laursen & Salter 2006; Neyer, Bullinger, & Moeslein 2009). A clearer conceptualisation of the idea of openness is provided by Dahlander & Gann (2010), who use a two-dimensional matrix to differentiate between monetary versus nonmonetary and inbound versus outbound types of open innovation.

Two main processes support open innovation: On the one hand, there are 'inbound open innovation' processes, which refer to the internalisation of external knowledge from customers, suppliers or partners and the active transfer of technologies from other companies and universities. Processes of externalising and exploiting knowledge to bring innovations onto the market more quickly are, on the other hand, summarised under the term 'outbound-open innovation'

(Chesbrough 2006). Innovation networks, which connect outside-in and inside-out processes – for example, to form alliances – are sometimes referred to as a third 'coupled process' (Gassmann & Enkel 2004; Conboy & Morgan 2010). Many research projects on open innovation utilise this process perspective (Herstad *et al.* 2008; Ebersberger *et al.* 2012; Spithoven *et al.* 2013; Lahi & Elenurm 2015). The kind of information that users contribute to companies in open innovation processes is described by Hurmelinna-Laukkanen, Nätti, & Pikkarainen (2021) as a wide range including innovative solutions, domain knowledge, user needs and ideas, and feedback on company products.

Laursen & Salter (2006) have questioned the effectiveness of external innovation search in open innovation. Using a representative study of companies in the UK, they show that external search for innovations takes money and effort. Both companies that undertake very little and very intense external innovation search exhibit a weak innovative performance. In contrast, companies that employ external search to a moderate breadth and depth perform significantly better (ibid.). This idea that open innovation can be differentiated according to the breadth and depth of the efforts has been adopted by a large number of studies (e.g., Spithoven *et al.* 2013; Radicic & Pugh 2017). The breadth refers to the number of external partners or knowledge sources and results from the totality of all external knowledge sources that a company considers in the search for ideas and knowledge. By contrast, the depth reflects the intensity of use of external search for knowledge sources for innovations. The degree of openness is inferred based on these two indices (Laursen & Salter 2006).

Of central importance for the triumph of open innovation in practice is the development of Web 2.0 and its 'social software' applications, such as forums, chats and social networks (Bächle 2008). It allows companies to interact with numerous sources and enables an unprecedented level of richness in the information gathered (Enkel, Gassmann, & Chesbrough 2009, p. 314). Habicht, Möslein & Reichwald (2011, p. 45) identify five primary tool types that support and advance the approach of open innovation: innovation competitions, innovation marketplaces, innovation communities, innovation toolkits and special innovation technologies.

Saebi & Foss (2015) have identified knowledge flows, collaborative capability and the level of co-creation as three strategic dimensions in a company that are interdependent with the company's open innovation strategy. They illustrate that openness can be achieved on a continuum of levels rather than as a dichotomous decision either to be open or closed (Figure 1).

In their conceptual article, Saebi & Foss (2015) describe the levels of value co-creation using examples. In this regard, they understand an efficiency-driven company that only incorporates existing information with little room for co-creation as exhibiting a low level of value co-creation. On the other hand, a company that becomes an open innovation platform by connecting with individuals, communities and other organisations to co-create innovations would have the highest level of value co-creation. The authors draw on the work of Gassmann & Enkel (2004) on knowledge flows in open innovation and distinguish between unilateral, dyadic and multilateral flows.

Since communities outside the organisation can be an important source of information for organisations (Dahlander & Wallin 2006), the interest in this source of innovation from practitioners and researchers is increasing (Martinez 2015). West & Lakhani (2008) define open innovation communities as a 'voluntary
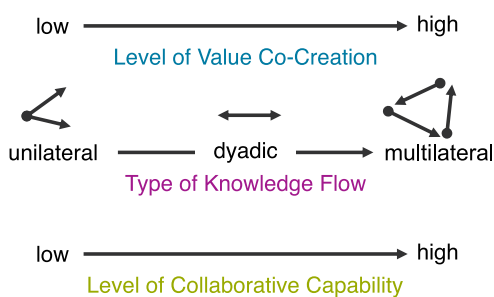
Figure 1. Continuum of openness (based on Saebi & Foss 2015).

association of actors, typically lacking in a priori common organizational affiliation […] but united by a shared instrumental goal – in this case, creating, adapting, adopting, or disseminating innovations' and clarify that the communities can consist of both individuals and organisational members. Crowdsourcing communities and contests also fall into this category – in the latter case, companies seek to motivate volunteer problem solvers, mostly monetarily, to complete a defined task (Martinez 2015). A distinct subset of research on open innovation communities focuses on open-source collaborative innovation (Von Krogh *et al.* 2012; Liu, Hull, & Hung 2017). Community volunteers in this case are mostly unpaid and have a range of motivations for contributing, such as self-interest in the product, learning or reputation (Von Krogh *et al.* 2012). Stam (2009) studied the financial and innovative performance of software firms with an open business model and Dutch open-source communities. He showed that firms that actively communicate in communities themselves achieve better results than inactive free riders. On this basis, Stam points out that these companies incur significant costs by designing and managing the interaction with the communities.

When dealing with external knowledge, companies need to build and use several capabilities – for absorbing, transforming and connecting knowledge (Lichtenthaler & Lichtenthaler 2009). To maintain competitive advantage, they need dynamic capabilities to help adjust the value base in a company, seize opportunities and counter threats. Against this background, Lichtenthaler & Lichtenthaler (2009) argue that open systems of information sharing intensify the demands on management. What matters is that management creatively brings together and coordinates distributed capabilities and resources and reshapes organisational structures. Saebi & Foss (2015) have built on the research into capabilities and coined the term *collaborative capability* to describe the types of governance mechanisms that a company develops to organise open innovation. They posit that new governance approaches, like a complementary internal network of employees, will be needed to support high degrees of openness.

Empirically, the first decade of research on open innovation primarily involved conducting case study-based analyses of large companies. Chesbrough (2003*a*) presented extensive studies for IBM and Intel. These and other case studies offered detailed but very individual descriptions of how companies develop external sources of innovation and benefit from them (Chesbrough 2003*b*; Dodgson, Gann, & Salter 2006). Subsequently, research began to increasingly investigate open innovation using cross-sectional analyses (Dahlander & Gann 2010; Vrande, Vanhaverbeke, & Gassmann 2010; Huizingh 2011; Schroll & Mild 2012; Spithoven

et al. 2013; Bogers *et al.* 2012, 2017). However, despite important progress, several questions remain unanswered to date. West & Bogers (2014) have summarised the literature on open innovation and find that the identification of evidence about 'the development and application of competencies for integrating innovation from external sources' is lacking. They suggest linking open innovation more closely with management research and economics to better understand the boundaries of open innovation and the moderating influences on it. They also state that a stronger focus on practicable business models is necessary. We address these topics in the article.
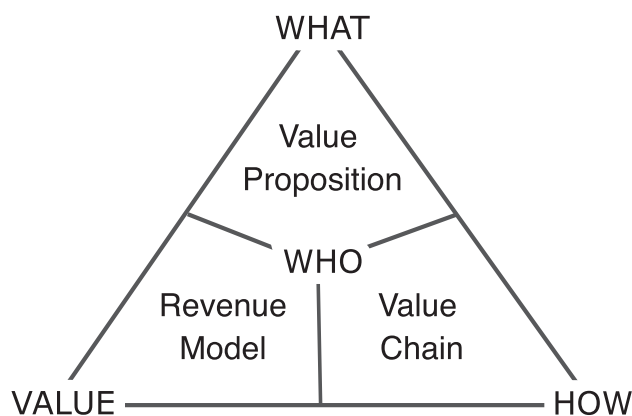
2.2 Open business models

The term business model was introduced in the late 1950s, but it took until the 1990s for the construct to become a focal point in business research and practice (Timmers 1998; Amit & Zott 2001; Osterwalder, Pigneur, & Tucci 2005; Chesbrough 2007; Bucherer, Eisert, & Gassmann 2012; Saebi & Foss 2015; Gassmann *et al.* 2020). But despite high levels of interest and attention, the phenomenon still represents 'a slippery construct to study' (Casadesus-Masanell & Zhu 2013, p. 480; Spieth, Schneckenberg, & Ricart 2014, p. 238). One reason for this is that it has been used to describe different things, 'such as parts of a business model (e.g. auction model), types of business models (e.g. direct-to-customer model), concrete real world instances of business models (e.g. the Dell model) or concepts (elements and relationships of a model)' (Osterwalder *et al.* 2005, p. 8). We refer to the term in the latter, conceptual sense as 'the logic of the firm' (Cantrell & Linder 2000).

In this regard, a business model can be described as 'the design or architecture of the value creation, delivery and capture mechanism' (Teece 2010, p. 191). In a similar form, Yunus, Moingeon, & Lehmann-Ortega (2010, p. 312) see business models 'a consistent and integrated picture of a company and the way it generates revenues and profit'. To Chesbrough 'a business model performs two important functions: value creation and value capture' (Chesbrough 2007, p. 12). It does so by linking 'ideas and technologies to valuable economic outcomes' (Vanhaverbeke & Chesbrough 2014, p. 52).

Various frameworks have been established to describe and analyse the heterogeneous elements of a business model and their complex interrelationships (Osterwalder *et al.* 2005; Maurya 2012; Gassmann *et al.* 2020). Gassmann *et al.* (2020) put the customer at the heart of their framework and condense the business model into three main elements: the value proposition, operational model and profit mechanism. The value proposition describes what the company offers to target customers and how this meets the customer's needs or benefits them. The profit mechanism explains how a company captures value. It includes aspects such as the cost structure and revenue mechanisms. The value chain is defined as the specific combination of activities, processes, resources and capabilities via which the company creates value (Gassmann *et al.* 2020, pp. 6–7).

Companies design their business models by combining these elements in a wide variety of ways. In principle, each business model is unique, as it reflects the strategic decisions of the respective company (Saebi & Foss 2015, p. 204). However, Gassmann *et al.* (2020) state that, in practice, 55 more or less generally applicable patterns can be identified and used to describe most business models (Figure 2).

Figure 2. Elements of a business model (Gassmann *et al.* 2020, p. 7).

Like a company's products and services, business models are subject to continuous innovation. Some authors have even argued that they have become the new basis of competition (Zott, Amit, & Massa 2011; Spieth *et al.* 2014; Najar 2020). The process of searching 'for new business logics of the firm and new ways to create and capture value for its stakeholders' (Casadesus-Masanell & Zhu 2013, p. 464) is referred to in the literature as business model innovation. Research around business model innovation focuses on the factors driving, facilitating and hindering business model innovation; it also explores the circumstances that can give rise to sustained competitive advantage (Foss & Saebi 2017, p. 201).

The idea that both innovation processes and business models can benefit from expanding the traditional boundaries of the firm was first introduced by Chesbrough (2003*a*, 2006). While he initially used the term open business model to describe value creation in the context of open innovation (Chesbrough 2007), Vanhaverbeke & Chesbrough (2014) later argued that open innovation and open business models are not necessarily linked phenomena. It is possible to pursue some open innovation strategies while maintaining a closed business model.

Assuming that there can be open innovation without an open business model, Najar (2020, p. 2) states that the open business model 'is the match between the adoption of an open innovation strategy and its effects on the business model'. Saebi & Foss (2015. p. 204) elaborate that 'since a company can adopt different (open) innovation strategies for its different business units, it becomes imperative for the company to match its different innovation practices with the right type of business model'. Combining Gassmann's business model framework and Saebi and Foss' idea of openness, this means the three dimensions of the setting of openness can operate at very different levels.

Therefore, in this article, we understand an open business model as a business model that is making internal knowledge available to others while also making use of external knowledge at the core of its value creation.

3. Methods

3.1 Research setting

The IoT is an evolving technology area that offers companies new opportunities to develop products, services and business models.

Companies are employing a fast-growing number of ever-smaller, more cost-efficient and more sophisticated sensors and devices on the IoT to make more areas of wider industries accessible for digitisation. This is evident through the continuous development of a business area with double-digit growth rates and global technology spending of over 100 billion USD (Columbus 2018). The EU has recognised the importance of IoT and has allocated 95.5 million EUR of research funding for IoT development for the period of 2021–2027 (European Union 2022). Accordingly, research on IoT applications and fundamentals has increased (Dachyar, Zagloel, & Saragih 2019). The intense competition in the early phase of the IoT's development results in high investments and uncertain market success for the companies involved. These challenges have been associated with rising costs and shorter development cycles.

In the IoT market, there have been a remarkable multitude of successful open-source hardware projects in which private individuals and companies were able to quickly prototype applications and test offerings with low development costs and at high speed. Well-known and successful examples include Arduino, WeIO, Particle and the Raspberry Pi Foundation. The fact that these companies are cooperating at the open-source level and competing at the market level ignited our interest in exploring how such companies handle community-generated innovation in their business models.

3.2 Research approach

The topic of how IoT companies explore open-source hardware for open innovation through collaborative product development online communities is a relatively new. An exploratory study that asks open questions to examine, gain insights and develop a hypothesis is needed to investigate such a phenomenon.

Since each community around different IoT solutions and companies is unique, we selected a multiple case study research approach that allowed us to look at the specific roles, processes and structures that IoT manufacturers use to interface with diverse customers and manage their needs as well as their feedback. Although case study research has been criticised as being time-consuming and expensive to conduct but unable to produce generalisable results, Saunders, Lewis, & Thornhill (2016) have highlighted its significance in the business and management field. Likewise, Baxter & Jack (2008) have described the results of such studies as often stronger and more reliable than those achieved with other study types and as enabling a wider exploration of research questions.

Because we wished to investigate the exchanges at the interface between the IoT companies and their corresponding community members, we recruited interviewees from both companies and communities. We designed two sets of problem-oriented semi-structured interviews in which guidelines served to elicit freely told narratives. The interview guide structured the conversation and provided thematic orientation but was not intended to be followed too strictly. This guaranteed that interviewers adopted a controlled and comparable approach to the subject – they

guided participants on what to talk about, while still enabling reciprocity between the interviewer and participant (Gill *et al.* 2008; Galetta 2012). We determined our interview structure before the interview based on previous knowledge from literature reviews or practical experiences as advised by various authors (Mason 2004; Rubin & Rubin 2005; Kallio *et al.* 2016). The interview guide was structured according to the main categories that we identified from literature; it was presented in the conceptual framework, which we tested in prior expert interviews.

Recruitment channels and methods to reach out to the interviewees included networks and connections, direct emailing and LinkedIn. We ensured balance between the two groups in terms of interviewees' number, position and level of involvement to ensure complementary and diverse input. The interviewees from the community that were not directly recruited by the research team were mostly suggested by company members. Expert interviews were then conducted to further discuss the company and community members' observations and insights. All interviews were carried out between November 2018 and Mar 2019 (Table 1).

The data from all interviews conducted were processed using qualitative content analysis (Mayring 2015). Adopting a deductive category application approach (Mayring & Brunner 2006), we identified the continuum of openness and the elements of a business model as units of analysis. The main categories were defined based on theory and correspond to the elements in Figure 3. They served as the basis for the first coding guide. The transcribed interviews were then analysed

Table 1. Interviews and dates

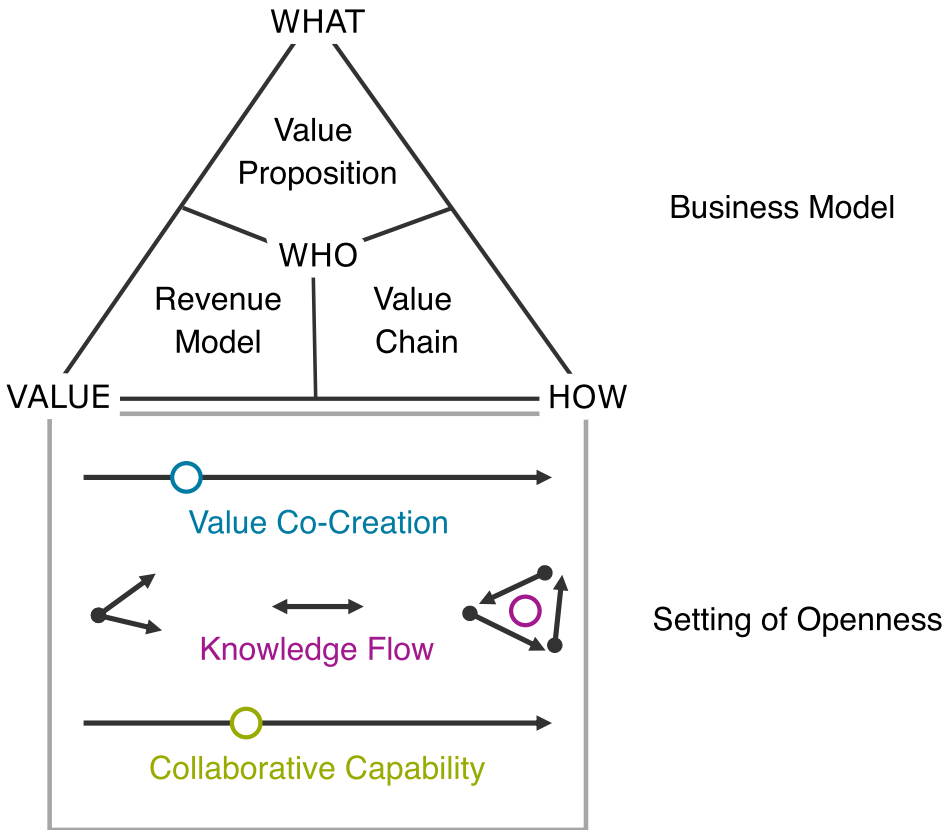| Company	Role	Interview
Case A	Co-founder	1
Case A	User	2
Case A	User	3
Case A	User	4
Case A	CTO	5
Case B	Product manager	6
Case B	User	7
Case B	User	8
Case C	Founder	9
Case C	Co-founder	10
Case C	User	11
Case C	User	12
Case D	User	13
Case D	Co-founder	14
Expert	Business strategy consultant	15
Expert	Professor	16
Expert	Think tank director	17
Expert	Digital product developer	18

Figure 3. Open business models.

in two cycles. First, the coders identified relevant text passages and then rewrote them 'in a concise, descriptive form (paraphrasing) limited only to the content' (Mayring 2015, p. 71) to assign them to the main categories (subsumption). Paraphrases that could not be assigned to any of the categories but were considered relevant because of their content were selected and reduced to a new level of abstraction for the creation of a new category. In the subsequent second cycle, coders undertook another final material pass. To avoid coding errors and establish reliability in both cycles, the coding process was performed by two independent coders. Disputed cases were discussed until a unanimous agreement was reached. This was possible because the material to be coded was extensive enough to allow all texts to be coded.

3.3 Case description

In case study research, case selection is limited by the accessibility of cases due to constraints such as cost and time (Rowley 2002). Therefore, we restricted our sample to IoT four companies. The cases are nonrepresentative samples and intended to illustrate this specific approach of company community

interactions in open-source hardware product development. Although the companies vary in terms of their size, age, core product/service, business strategy and community size, the research team established a general set of criteria to provide a basis for comparison. These included the following requirements: (i) the companies must be a part of the IoT hardware market; (ii) they must apply open innovation beyond mere product development in the sense of the front end of innovation and (iii) they must engage in open-source collaborative innovation. This means that the intellectual foundations of companies' open-source hardware products must be at least partially accessible to other stakeholders, users and competitors.

Case A is an IoT hardware development, device management and IoT hardware provider to private companies and the public sector. It started as an online shop and built a community to further develop certain products based on an open-source kit. The company sells hardware and services for the management of IoT devices. It aims to develop an advanced product to attract a wider range of potential customers – which confirms that it has adopted a product-driven approach, where product development has preceded the search for corresponding customers – Case A, company interview. The company interviewee claimed that they make strong use of customer-driven innovation that gives them better products faster. Users of their products contribute during the whole product life cycle.

Case B provides both a cloud solution to manage IoT devices and connected products; it also sells IoT hardware for development and for industrial applications. The community dynamics are comparable and dependent on the nature of the product and its level of appeal to the members. Both Cases A and B are private companies aiming to generate profit by involving their community members in further co-innovating, designing and developing their offerings, i.e., innovating openly.

Case C offers a device that fits smartphones with a wide range of sensors for scientific and educational applications. The company describes itself as an organisation whose goal is to develop open-source software and hardware as a community. The community was founded to host conferences and meetups on the topic of open-source software and hardware and is still following that mission. When business ideas arise, members with specific expertise can develop them into products and even business cases.

Case D has developed a soft- and hardware prototyping platform centred around a microcontroller kit that is mainly used for prototyping and educational applications. The company started as a project that aimed to make a university-developed piece of hardware available to the public. The project steadily grew into a large community. Disputes between different branches of the community and commercial providers of the hardware led to the founding of two companies, which later merged into one joint venture. Within Case D, the customers are perceived as users who benefit and contribute to the mission of the companies rather than profit generators.

Cases C and D exhibit a much more central role of education, community work and outreach in their history and public communication. For them, value creation is a secondary goal, if at all (Table 2).

Table 2. Case study description

Case	Founding year	Product/service	Sales model	Company size	Community size
A	2016	IoT hardware based on open-source kit	B2B	50–100	∼5000
B	2015	Cloud solution managing IoT devices	B2B	50–100	∼10,000
C	2009	IoT-sensing device	B2C/B2B	50–100	∼25,000
D	2005	Hardware/software platform around a microcontroller	B2C/B2B	100–200	∼100,000

4. Findings

Our four case studies allow us to illustrate the different manifestations of open business models and the companies' concrete approaches to working with external stakeholders.

4.1 Business models: value proposition, revenue model and value chain

Open business practices were present in all three parts of the business model – the value proposition, the revenue model and the value chain – albeit in different forms. All the companies have in common that they use open innovation approaches in the value chain, as described by Chesbrough (2007). In addition, all companies consciously use the intensive exchange about their products and prototypes in their respective communities to obtain important information about customers' needs and to identify solutions to newly arising problems.

Company D has an additional open element of the value chain. As part of their product line, the company sells sets of electronic parts that customers can then combine and assemble themselves for various purposes. In this instance, we could reasonably describe what happens in later phases of the value chain as co-creation – as would apply to companies that ship partially assembled products and leave the final assembly to the customers.

As far as the revenue model is concerned, open elements are particularly noticeable in company B. This company actively involves customers in pricing decisions and gives away expensive rewards like invitations to trade shows with airline tickets to particularly active developers.

As part of the value proposition, the community of active product users is important for all companies studied. The fact that even complicated and detailed technical questions can be quickly clarified with other developers in forums is a valuable offering for customers. In addition, company B also stated that they discuss and compare their product roadmap with the community (Table 3).

4.2 Knowledge flows

Cases A and B both use a portfolio of channels to interact with their external users. The most important one for Case A is a company-run forum. Both companies

Table 3. Open elements in business models

Value chain	Value proposition	Revenue model
(i) Open innovation development	(i) Community support	(i) Involvement in pricing decisions
(ii) Self-service	(ii) Product roadmap coordination	(ii) Valuable rewards assembly

share different resources on appropriate channels – such as GitHub – to make it available to the public as well as engaging in general communication on social media, providing tutorials to educate users and offering other information on hackster.io. They also host and attend in-person meetings (meetups) with engaged people from the community. The interviewees reported that no formalised criteria are used to filter the outward knowledge flow; the inward knowledge flow is filtered through the individual judgement of the companies' technical staff and not by predetermined criteria.

Trained technical staff in Case A perform daily scans of the company forum as part of their daily activities. This includes joining and initiating discussions as well as responding to relevant inquiries and redirecting questions to previously given answers. Internally, daily and weekly company operations meetings are held to discuss notable forum activities.

'So we have a rule that every technical employee that we have daily checks the forum to see what's happening and to see where they can potentially either learn from the forum or gives a contribution to the forum' – Case A, company interview.

Case B reported experimenting with different levels of engagement: 'I was actually able to sit down for an hour with all the people who were part of the Alpha trial period and really get their full perception of the product to understand how they were using it' – Case B, company interview. The people concerned with external information in Case B seek to balance feedback based on whether it is relevant for external developers or customers.

Company C is also using multiple channels for external communication, such as general mailing lists, more specific GitHub for development, issue tracking and reports. For chat, the company uses gitter.im. The company explicitly uses the channels preferred by the users and is 'also on social media. It depends on the user. So, we […] open up in many ways that people can do what is convenient for them' – Case C, company interview. This means that besides online communication also physical formats such as meetups and conferences are employed.

The interviews show that the company seeks multilayered communication with their communities: 'We look for people who have abilities to learn something and share it with the community […] this is very much like the scientific community […] we are meeting online, or in events and conferences, sometimes we have workshops together' – Case C, company interview.

Company D also makes use of several channels such as a forum, an educational platform, their website and social media like Instagram. The company follows its community in 'different ways. First of all, we tried to give the community the tools they need by setting up online services so that they will be able to exchange information with us' – Case D company interview (Table 4).

Table 4. Interaction with external users

Theme	Case A	Case B	Case C	Case D
Focal point of communication	Company forum	Company forum	Where the people are	Follows community
Main direction of communication	Dyadic communication with users	Dyadic communication with users	Multilateral communication between user and company	Multilateral communication between user and company

4.3 Level of co-creation

Saebi & Foss (2015) describe a link between the locus of co-creation and the level of value co-creation. As the level of value co-creation increases, the locus shifts to outside of the company. At low levels of co-creation, it remains an internal activity within the company; at moderate levels, it becomes a collaborative activity at the border of the company. Finally, at high levels of co-creation, it becomes an activity mainly outside the company. For this reason, we have summarised statements in this code category that describe the value that companies assign to contributions by external stakeholders in their business model.

Interviewees in Case A describe their company as a project driven by a focus on customer-driven innovation. The users' contribution is made throughout the whole product life cycle.

Projects initiated by customers within the community often help the company to develop new products or significantly improve existing products and 'that influences your whole strategy making in the company' – Case A, company interview.

Interviewees from Case B report interest in a broad dialogue with external stakeholders that range from general interactions to discussions of all parts of the business model ('… to get raw feedback on things across the board from our pricing model to the functionality of our platform to really know more qualitative information about how these customers see our product fitting into their product roadmap' – Case B, company interview). The interview emphasises the importance and influence on the business model – 'It fundamentally impacts our business model because the way we see the strategic value of the developer community and open innovation' – Case B, company interview. Interviewees also describe the external developers in quite emotional terms as the core of the company: 'I think of our developer community as really the lifeblood of our company in the sense that they give us a direct understanding of how our products are landing in the market, customer satisfaction, the ability to get raw feedback' – Case B, company interview. Yet another statement emphasises the external contribution: '(external feedback) … sometimes even goes all the way up to our C level suite' – Case B, company interview.

The answers of the respondents from Case C indicate that the business and revenue model plays a secondary role – 'So, basically I don't believe so much in the profit idea' – and a central role of community interaction – 'the goal is to bring people together' Case C, company interview. Revenue generation in this case seems

Table 5. Level of co-creation and focal value

Theme	Case A	Case B	Case C	Case D
Level of co-creation	Customer-driven innovation	Fundamental impact on business model	Collaborative open business model	Collaborative open business model
Focal value	Business value	Business value	Purpose-driven innovation	Purpose-driven innovation

more as a means to an end: 'We believe for us the company is the best means to achieve our goal and of course we need money to do that". And so that's why we set up the company. But the driving part is not actually the profit […] it's all about open education' – Case C, company interview.

An interviewee explained that the most important people for the company are not necessarily members of the company: 'There is a core team of about 8 people who […] actually really drive things and take responsibility […] and not everyone in this team might always be a member of the company […] especially the genius-kind of people don't always want to be associated with a company' – Case C, company interview.

The answers of representatives from Case D regarding the level of co-creation point in the same direction. In their statements, the interviewees evaluate the revenue model 'actually the drive to do what we do is not because we want to make a profit' – Case D, company interview – and also emphasise a nonmarket relationship with the community 'First of all I would say we don't speak of customers but we're calling it users' – Case D, company interview. This disregard for revenue versus the higher goal can be traced back to the beginning of the company: 'We did not want to make a company. So, the company was something that emerged later … the community ended up becoming a company' – Case D, company interview.

Unlike in Cases A and B, in Case D, the strategy is not only influenced by the users – 'our strategy is defined by the response we measure up on people and our products' – Case D, company interview (Table 5).

4.4 Collaborative capability

We have summarised the second-order codes for structures, processes and roles that contribute to the collaborative capability of the firms. The structures in Case A that deal with the processing of external information are daily and weekly meetings, meetups and a daily check of the company forum by all technical employees. Employees have a high degree of freedom in how they conduct this investigation: 'everybody is independent and self-managing their timing and how they act through the forum' – Case A, company interview. One employee noted that it would be interesting to rank external contributions according to importance but that this does not currently happen.

Case B has several roles, including a product team, engineering team and organisational staff. There is a customer support team that operates at the interface with the external community. Other structures include regular feedback sessions and 'ask engineering processes'. The company has formed a customer council that is involved in the design, testing and pricing processes. They prioritise the external

stakeholders differently: 'We've created what's called a council of some of our most highly influential and largest customers so that we can regularly communicate with them and understand where they're struggling and what's nice about that is, you know, the developer community is really strong, we're getting feedback on prototyping and so on' – Case B, company interview.

Case B users confirmed this perspective and added that there were elements of a very intense relationship. 'We have been with [Case B] since the beginning, over time and based on our contribution we became like partners, we get early prototypes shipped to us all over the world, we have a biweekly meeting with the engineers, we even get flight tickets and conference invitations to represent the company […] we are a family!' (Case B, user interview).

One Case B employee noted a clear difference between the internal structures and the external, free communication but did not identify a related conflict: 'So I would say to an extent you should embrace the chaos […] that is what helps you learn things that you didn't know before' – Case B, company interview.

At the level of co-creation, an employee of Case C attributed a much more active and technically skilled role to the external party (here: developers). The company has 'a lot of mailing lists […] but the most effective way is […] that we educate the user to submit an issue or a bug report […] going directly to a developer' – Case C, company interview 9. In this way, suggestions for improvement and questions find their way directly to the internal developer. Case C also emphasises the importance of end-user assistance from the community: 'We rely a lot on the effort of the community' – Case C, company interview.

The interviews give the impression that important decisions or directions for the company should rather be given by the community than by the company: Several quotes from the interviews point towards a relationship where the community seems to be more important; 'we want the community to rule naturally' – Case C, company interview.

Nevertheless, one approach to communicating with users entails 'that people can do what is convenient for them' – Case C, company interview – but the external contributions are prioritised when 'they're directly related to the business then it's classified as a higher priority' – Case C, company interview.

In Case D, community users can be mentors, project leaders, senior developers, freelancers and customers as developers/users. Company activities include the organisation of coding contests and incubators for new businesses. In the company, there are roles for community managers, forum moderators and customer support officers.

One Case D employee particularly emphasised the dynamics of controlling the interface with the community: 'We go with the public […] we are adjusting to their new coming communication techniques all the time' – Case D, company interview. Although Case D has considerable experience in community management, many processes are not strictly defined 'after 13 years of existence we are starting to discuss which would be their right workflow […] this year is the first year that we have a fixed agenda' – Case D, company interview.

The activities of Case D show a strong commitment towards education and outreach. 'We give free workshops at schools and conferences—you know, different kinds of places. We are very active' – Case D, company interview (Table 6).

Table 6. Communication governance and community relation

Theme	Case A	Case B	Case C	Case D
Communication governance	Structured, individual autonomy	Structured, individual autonomy	Emergent, empowering users	Emergent, empowering users
Community relation	Intense but company focused	Intense but company focused	Community-led	Community-led

5. Discussion

Our case study illustrates how four companies integrate their external stakeholders in their core business functions. The depth of the involvement of external stakeholders we have observed is greater than what has been described in the literature to date. In Case A, for example, the external stakeholders directly and permanently influence central functions such as the pricing model and product strategy. They therefore represent examples of pronounced co-creation in open business models. Although open-source hardware is linked to challenges such as high marginal costs and reproduction requirements, we have discussed several companies for whom openness is a central contribution to the success of their business model. The companies, however, differ in their approaches to organising open value creation and private value capture in one business model.

In the literature, open platform business models have been mainly examined as companies that provide and manage a business platform for others (Parker, Van Alstyne, & Jiang 2017). In these examples, however, the company still has complete control over the core of the business model. Regarding their internal functions, platform companies often employ strong secrecy and operate in a proprietary manner and with complete autonomy (De Reuver, Sørensen, & Basole 2018). To use a sporting analogy, the companies provide the field on which the sport is played, and the rules and the actual athletes are essential to the success of the whole game. But at the same time, the athletes have no access to the design of the conditions and are often very powerless. Curchod *et al.* (2019) have described this relationship for the company eBay.

In clear contrast to this model, all of the companies we examined exhibit a very strong interaction with a community that has grown over a long period and with which there is also an intense social relationship. The companies are interested in having key business decisions initiated or evaluated by external partners. Thus, the Saebi & Foss (2015) model lacks a crucial dimension of openness, which can be described as the level of *shared governance*. Because even if external stakeholders sometimes contribute more to a company's value than its internal functions, as Parker *et al.* (2017) describe, external stakeholders do not necessarily influence the business organisation.

A remarkable observation is how little motivational aspects played a role in the respondents' answers. All four companies engage in some open-source development, but they all have their own economic interest and thus do not fall into the

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field of collective action. They seem to belong to the middle ground described by von Hippel and von Krogh between purely private innovation and classic collective action (Hippel & Krogh 2006). According to the interviewees, the private benefits they gain from their investment of time and expertise also seem to fall partly into the learning and enjoyment category. For the many professional users who are active in the communities, the benefits are more likely to involve solving their own problems, engaging in technical learning and having the opportunity to co-design products in such a way that they can be used.

5.1. Business models: elements influenced by open innovation strategies

When we started the project, it was not clear to us whether different constellations of open business model elements may require or condition specific configurations of the strategic dimensions. In fact, we found slightly different constellations in each of the four companies we studied, but all of them were characterised by a distinctively high degree of openness. This corroborates Saebi & Foss's (2015) thesis that the use of open innovation strategies will be reflected in the business model dimensions – at least for our sample.

One further result that will be of particular interest to practitioners is the fact that open innovation strategies do not only affect the value chain area of the business model as well-described in the literature. We also observed the alignment of the product roadmap in the area of value creation and the alignment of pricing decisions in the revenue model part of the business model.

5.2. Knowledge flows: lateral and dyadic

Knowledge flows are often discussed as a question of direction – unilateral, dyadic, and so forth We find that, in practice, the direction does not matter as much as the locus of communication. All the companies we examined manage a portfolio of digital channels such as forums and real-life channels such as meetups as part of their inbound and outbound knowledge flows with the outside world. They use the affordances of different platforms and channels, for example, to conduct technical discussions in GitHub and to engage in more social exchange via Twitter or similar.

5.3. Value creation: open source instead of contracts

The cases we examined are in line with a collaborative business model proposed by Saebi and Foss. Yet, we find no support in our data for Saebi and Foss's idea that collaboration with external knowledge providers in a cooperative business model must be governed by contracts. There is a clear need for contracts in the case of proprietary products. In our case, however, the collaborations result in freely available goods, and a negotiation over private returns is replaced by a common interest in the jointly developed goods.

Likewise, no interviewee mentioned motivational aspects. Yet, in research, motivating external users to contribute is considered a substantial problem (Dahlander & Piezunka 2014). This leads us to conclude that the small sample we selected solved the motivation problem well. Several interviewees agreed on the high importance of emotional ties between companies and the community. The

interviewees mentioned terms like 'family' and 'lifeblood' where '… the company [is] being part of the community and feeling like a family member in that community' – expert interview. The business model literature naturally has a strong focus on monetary value creation. Research on emotional topics (e.g., emotional labor) has attracted less attention in economics. But nonmonetary motivation and social connection as a motive have been studied by several publications on user innovators. A deeper consideration of emotional ties could lead to a more differentiated understanding of value for different stakeholders in the business model literature.

5.4. Collaborative capability: appropriating value instead of external searching

Dahlander & Wallin (2006) have examined how companies coordinate cooperation with communities that lie outside their control. In their study of open-source software, they posit a sponsorship mechanism as a method of managing external communities. In contrast, our results suggest that the companies surveyed organise the tasks of interfacing with their communities within existing roles rather than creating completely new teams or roles. Our interview partners describe processes that provide the product team, engineering or even the management with important information from the community, but there are no teams or people who are dedicated to community interaction.

Here, one can see both a static and a dynamic approach. Cases A and B report a balance of structured methods for company-managed community curation and management and high degrees of individual autonomy in community interaction with regard to identifying and passing information to internal company functions.

On the other hand, Cases C and D have adopted a much more self-orchestrated and self-managed form of community interaction in which the company becomes an enabler of the activities within the community. These two fundamentally different orientations towards interaction could still be a late echo of the organisations' different origins, since Cases A and B were market-oriented commercial enterprises from the beginning, while C and D started in community activities and later chose to organise as a company.

5.5. Community-infused and community-led open business models

The results of our interviews show that the companies fall into two general categories. On the one hand, the companies with a business history more clearly claim sovereignty over their strategic decisions in a community-infused model, while, on the other hand, the community-based companies seem to pursue a community-led strategy.

The comparison shows that the two different types of companies operate on a very different basis, although they are present in the same market and produce similar products. They might not, however, have decided on one of the business models themselves but rather fallen into the respective model because of their business- or community-driven past.

Theme	Community-infused business model	Community-led business model
Main direction of communication	Dyadic communication with users	Multilateral communication between company and users
Focal point of communication	Company forum	Where the people are
Level of value co-creation	Customer-driven innovation	Collaborative open business model
Focal value	Business value	Purpose-driven innovation
Communication governance	Structured	Emergent
Community relation	Community-infused	Community-led

6. Future research and limitations

The small number of companies in our sample and the special focus on the IoT market bring limitations. To expand the results, research that includes more companies is needed. It is not clear whether the market dynamics around the IoT environment create special conditions that favour the combination of open innovation and open business models described here. Further studies in other markets should therefore follow. Due to the recruitment of interviewees through recommendations and networks, no representativeness of the interviewees can be expected and a bias is possible in the form that rather committed and active community members appeared in the interviews. It is not the goal of this article to represent all good and not so good community experiences, so this bias would not be problematic. However, future research on how the interaction affects different members is desirable.

The different interviewees responded to the topic in very different levels of detail, although we had a dedicated questionnaire block on the topic. This may be because interview partners who are employed as product managers in the company may not have a pronounced strategic perspective on the company as a whole.

The interviews emphasised a dynamic and emergent development of their interaction with external stakeholders. This dynamic can only be extensively investigated by longitudinal studies.

At the same time, our study shows that in this market, in which ecosystems and the cooperation between companies, stakeholders and sometimes also competitors play a major role, there can be very intensive uses of open resources. For practitioners in other markets in which product ecosystems are highly important, such as the newly emerging electric car industry, the option of open-source hardware should be given more attention.

Several interviewees reported that interactions with the community are 'not controllable' or that 'you should embrace the chaos'. This distinction between the clear structure on the corporate side and the free, open structures outside the company seems to represent a tension. How companies are dealing with this tension should be investigated in more research.

References

Amit, R. & **Zott, C.** 2001 Value creation in e-business. *Strategic Management Journal* **22** (6–7), 493–520.

Bächle, M. 2008 Ökonomische Perspektiven des web 2.0–open innovation, social commerce und enterprise 2.0. *Wirtschaftsinformatik* **50** (2), 129–132.

Baxter, P. & **Jack, S.** 2008 Qualitative case study methodology: study design and implementation for novice researchers. *The Qualitative Report* **13** (4), 544–559.

Bessant, J. & **Tidd, J.** 2015 *Innovation and Entrepreneurship*. John Wiley & Sons.

Bogers, M., **Zobel, A. K.**, **Afuah, A.**, **Almirall, E.**, **Brunswicker, S.**, **Dahlander, L.**, **Frederiksen, L.**, **Gawer, A.**, **Gruber, M.**, **Haefliger, S.**, **Hagedoorn, J.**, **Hilgers, D.**, **Laursen, K.**, **Magnusson, M. G.**, **Majchrzak, A.**, **McCarthy, I. P.**, **Moeslein, K. M.**, **Nambisan, S.**, **Piller, F. T.**, **Radziwon, A.**, **Rossi-Lamastra, C.**, **Sims, J.** & **Ter Wal A. L. J.** 2017 The open innovation research landscape: established perspectives and emerging themes across different levels of analysis. *Industry and Innovation* **24** (1), 8–40.

Bucherer, E., **Eisert, U.** & **Gassmann, O.** 2012 Towards systematic business model innovation: lessons from product innovation management. *Creativity and Innovation Management* **21** (2), 183–198.

Cantrell, L. J. & **Linder, J.** 2000 Changing business models: surveying the landscape. *Accenture Institute for Strategic Change* **15**, 142–149.

Casadesus-Masanell, R. & **Zhu, F.** 2013 Business model innovation and competitive imitation: the case of sponsor-based business models. *Strategic Management Journal* **34** (4), 464–482.

Chesbrough, H. W. 2003a *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Harvard Business Press.

Chesbrough, H. W. 2003b The era of open innovation. *MIT Sloan Management Review* **44** (3), 35–41.

Chesbrough, H. 2006 *Open Innovation: A New Paradigm for Understanding Industrial Innovation*. Oxford University Press, pp. 1–12.

Chesbrough, H. W. 2007 Business model innovation: it's not just about technology anymore. *Strategy & Leadership* **35** (6), 12–17.

Chesbrough, H. W. 2007 Why companies should have open business models. *MIT Sloan Management Review* **48** (2), 22.

Columbus, L. 2018 *Roundup of Internet of Things Forecasts and Market Estimates*, Forbes, online document https://www.forbes.com/sites/louiscolumbus/2018/12/13/2018-roundup-of-internet-of-things-forecasts-and-market-estimates/.

Conboy, K. & **Morgan, L.** 2010 Combining open innovation and agile approaches: implications for IS project managers, *ECIS 2010 Proceedings*. **21** http://aisel.aisnet.org/ecis2010/21/ (accessed 30.08.2022).

Curchod, C., **Patriotta, G.**, **Cohen, L.** & **Neysen, N.** 2019 Working for an algorithm: power asymmetries and agency in online work settings. *Administrative Science Quarterly*, **65** (3), 644–676. https://doi.org/10.1177/0001839219867024

Dachyar, M., **Zagloel, T. Y. M.** & **Saragih, L. R.** 2019 Knowledge growth and development: internet of things (IoT) research, 2006–2018. *Heliyon* **5** (8), e02264; doi:10.1016/j.heliyon.2019.e02264.

Dahlander, L. & **Gann, D. M.** 2010 How open is innovation? *Research Policy* **39** (6), 699–709; doi:10.1016/j.respol.2010.01.013.

Dahlander, L. & **Piezunka, H.** 2014 Open to suggestions: how organizations elicit suggestions through proactive and reactive attention. *Research Policy* **43** (5), 812–827; doi: 10.1016/j.respol.2013.06.006.

Dahlander, L. & **Wallin, M. W.** 2006 A man on the inside: unlocking communities as complementary assets. *Research Policy* **35** (8), 1243–1259.

De Reuver, M., **Sørensen, C.** & **Basole, R. C.** 2018 The digital platform: a research agenda. *Journal of Information Technology* **33** (2), 124–135.

Dodgson, M., **Gann, D.** & **Salter, A.** 2006 The role of technology in the shift towards open innovation: the case of Procter & Gamble. *R&D Management* **36**, 333–346.

Ebersberger, B., **Bloch, C.**, **Herstad, S. J.** & **Van De Velde, E. L. S.** 2012 Open innovation practices and their effect on innovation performance. *International Journal of Innovation and Technology Management* **9** (06), 1250040.

Enkel, E., **Gassmann, O.** & **Chesbrough, H. W.** 2009 Open R&D and open innovation: exploring the phenomenon. *R&D Management* **39** (4), 311–316; doi:10.1111/j.1467-9310.2009.00570.x.

European_Union. 2022 Research & Innovation in Internet of Things, online document https://digital-strategy.ec.europa.eu/en/policies/internet-things-policy (accessed 30.08.2022).

Foss, N. J. & **Saebi, T.** 2017 Fifteen years of research on business model innovation: how far have we come, and where should we go? *Journal of Management* **43** (1), 200–227.

Galletta, A. (2013). Mastering the semi-structured interview and beyond: From research design to analysis and publication. New York University Press.

Gassmann, O. & **Enkel, E.** 2006 Open innovation. *Zeitschrift Führung+ Organisation* **75** (3), 132–138.

Gassmann, O. & **Enkel, E.** 2004 Towards a theory of open innovation: three core process archetypes. In *Proceedings of the R&D Management Conference*, Lisbon, Portugal, July 6–9, pp. 1–18.

Gassmann, O., **Frankenberger, K.** & **Choudury, M.** 2020 *Geschäftsmodelle Entwickeln: 55 Innovative Konzepte Mit Dem St. Galler Business Model Navigator*. Carl Hanser Verlag GmbH Co KG.

Gill, P., **Stewart, K.**, **Treasure, E.** & **Chadwick, B.** 2008 Methods of data collection in qualitative research: interviews and focus groups. *British Dental Journal* **204** (6), 291–295.

Habicht, H., **Möslein, K. M.** & **Reichwald, R.** 2011 Open innovation: Grundlagen, Werkzeuge, Kompetenzentwicklung. *Information Management und Consulting* **26** (1), 44–51.

Herstad, S. J., **Bloch, C.**, **Ebersberger, B.** & **van de Velde, E.** 2008 Open innovation and globalisation: theory, evidence and implications. *Vision: EraNet* **19** (9), 1–96.

Hienerth, C. & **Lettl, C.** 2011 Exploring how peer communities enable lead user innovations to become standard equipment in the industry: community pull effects. *Journal of Product Innovation Management* **28** (s1), 175–195.

Huizingh, E. K. 2011 Open innovation: state of the art and future perspectives. *Technovation* **31** (1), 2–9.

Hurmelinna-Laukkanen, P., **Nätti, S.** & **Pikkarainen, M.** 2021 Orchestrating for lead user involvement in innovation networks. *Technovation* **108**, 102326.

Kallio, H., **Pietilä, A. M.**, **Johnson, M.** & **Kangasniemi, M.** 2016 Systematic methodological review: developing a framework for a qualitative semi-structured interview guide. *Journal of Advanced Nursing* **72** (12), 2954–2965.

Lahi, A. & **Elenurm, T.** 2015 SME open innovation implicating factors in different innovation phases. *The International Journal of Management Science and Information Technology (IJMSIT)* **16**, 29–45.

Laursen, K. & **Salter, A.** 2006 Open for innovation: the role of openness in explaining innovation performance among U.K. manufacturing firms. *Strategic Management Journal* **27** (2), 131–150; doi:10.1002/smj.507.

Lichtenthaler, U. & **Lichtenthaler, E.** 2009 A capability-based framework for open innovation: complementing absorptive capacity. *Journal of Management Studies* **46** (8), 1315–1338.

Liu, M., **Hull, C. E.** & **Hung, Y-T. C.** 2017 Starting open source collaborative innovation: the antecedents of network formation in community source. *Information Systems Journal* **27** (5), 643–670; doi:10.1111/isj.12113.

Martinez, M. G. 2015 Solver engagement in knowledge sharing in crowdsourcing communities: exploring the link to creativity. *Research Policy* **44** (8), 1419–1430; doi: 10.1016/j.respol.2015.05.010.

Mason, J. 2004 The SAGE encyclopedia of social science research methods. In *Semistructured Interview*. Sage.

Maurya, A. 2012 *Lean Running, Iterate from Plan a to a Plan that Works*. In O'Reilly Media.

Mayring, P. 2015 *Qualitative Inhaltsanalyse*. Beltz.

Najar, T. 2020 Antecedents to open business model in the ICT-based sectors. *The Journal of High Technology Management Research* **31** (2), 100388; doi:10.1016/j.hitech.2020.100388.

Nambisan, S., **Lyytinen, K.**, **Majchrzak, A.** & **Song, M.** 2017 Digital innovation management: eeinventing innovation management research in a digital world. *MIS Quarterly* **41** (1), 223–238.

Nambisan, S., **Siegel, D.** & **Kenney, M.** 2018 On open innovation, platforms, and entrepreneurship. *Strategic Entrepreneurship Journal* **12** (3), 354–368; doi:10.1002/sej.1300.

Neyer, A.-K., **Bullinger, A. C.** & **Moeslein, K. M.** 2009 Integrating inside and outside innovators: a sociotechnical systems perspective. *R&D Management* **39** (4), 410–419; doi:10.1111/j.1467-9310.2009.00566.x.

Nonaka, I. & **Von Krogh, G.** 2009 Perspective—tacit knowledge and knowledge conversion: controversy and advancement in organizational knowledge creation theory. *Organization Science* **20** (3), 635–652.

Osterwalder, A., **Pigneur, Y.** & **Tucci, C. L.** 2005 Clarifying business models: origins, present, and future of the concept. *Communications of the Association for Information Systems* **16** (1), 1.

Panduwawala, L., **Venkatesh, S.**, **Parraguez, P.** & **Zhang, X.** 2009 *Connect and Develop: P&G's Big Stake in Open Innovation*. University of Bath.

Parker, G., **Van Alstyne, M.** & **Jiang, X.** 2017 Platform ecosystems: how developers invert the firm. *MIS Quarterly* **41** (1), 255–266; doi:10.25300/MISQ/2017/41.1.13.

Radicic, D. & **Pugh, G.** 2017 Performance effects of external search strategies in European small and medium-sized enterprises. *Journal of Small Business Management* **55** (sup1), 76–114.

Rowley, J. 2002 Using case studies in research. *Management Research News* **25** (1), 16–27.

Rubin, H. J. & **Rubin, I.** 2005 *Qualitative Interviewing: The Art of Hearing Data*. SAGE Publications.

Saebi, T. & **Foss, N. J.** 2015 Business models for open innovation: matching heterogeneous open innovation strategies with business model dimensions. *European Management Journal* **33** (3), 201–213.

Saunders, M. N. K., **Lewis, P.** & **Thornhill, A.** 2016 *Research Methods for Business Students* (7th ed.). Pearson Education.

Schroll, A. & **Mild, A.** 2012 A critical review of empirical research on open innovation adoption. *Journal für Betriebswirtschaft* **62** (2), 85–118.

Spieth, P., **Schneckenberg, D.** & **Ricart, J. E.** 2014 Business model innovation - state of the art and future challenges for the field. *R&D Management* **44** (3), 237–247; doi:10.1111/radm.12071.

Spithoven, A., **Vanhaverbeke, W.**, & **Roijakkers, N.** (2013). Open innovation practices in SMEs and large enterprises. *Small business economics*, **41**, 537–562.

Stam, W. 2009 When does community participation enhance the performance of open source software companies? *Research Policy* **38** (8), 1288–1299; doi:10.1016/j.respol.2009.06.004.

Teece, D. J. 2010 Business models, business strategy and innovation. *Long Range Planning* **43** (2), 172–194.

Timmers, P. 1998 Business models for electronic markets. *Electronic Markets* **8** (2), 3–8; doi:10.1080/10196789800000016.

Vanhaverbeke, W. & **Chesbrough, H.** 2014 A classification of open innovation and open business models. In *New Frontiers in Open Innovation* (*Vol.* **6**). Oxford University Press, pp. 50–68.

Van de Vrande, V., **De Jong, J. P.**, **Vanhaverbeke, W.**, & **De Rochemont, M.** (2009). Open innovation in SMEs: Trends, motives and management challenges. *Technovation*, **29**(6-7), 423–437.

Von Krogh, G., & **Von Hippel, E.** (2006). The promise of research on open source software. *Management science*, **52**(7), 975–983.

Von Krogh, G., **Haefliger, S.**, **Spaeth, S.** & **Wallin, M. W.** 2012. Carrots and rainbows: motivation and social practice in open source software development. *MIS Quarterly* **36**, 649–676.

Vrande, V. V. d., **Vanhaverbeke, W.** & **Gassmann, O.** 2010 Broadening the scope of open innovation: past research, current state and future directions. *International Journal of Technology Management* **52** (3/4), 221; doi:10.1504/IJTM.2010.035974.

West, J. & **Bogers, M.** 2014 Leveraging external sources of innovation: a review of research on open innovation. *Journal of Product Innovation Management* **31** (4), 814–831; doi:10.1111/jpim.12125.

West, J. & **Lakhani, K. R.** 2008 Getting clear about communities in open innovation. *Industry and Innovation* **15** (2), 223–231; doi:10.1080/13662710802033734.

Yunus, M., **Moingeon, B.** & **Lehmann-Ortega, L.** 2010 Building social business models: lessons from the Grameen experience. *Long Range Planning* **43** (2–3), 308–325.

Zott, C., **Amit, R.** & **Massa, L.** 2011 The business model: recent developments and future research. *Journal of Management* **37** (4), 1019–1042.