

Exploring open innovation in the digital age: A maturity model and future research directions

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1. Introduction

Technology has never been more influential than it is today. In 2011, the top five publicly traded companies by market capitalization were one financial company (ICBC), three natural resource companies (ExxonMobil, PetroChina, Petrobras), and one tech company (Apple) (Financial Times, 2011). Just over 6 years later, in 2017, the top five publicly traded companies by market capitalization were Apple, Alphabet, Microsoft, Amazon.com, and Facebook (Financial Times, 2017), that all of which are tech companies. Moreover, all five companies have in common that they anticipate changes, adjust business models, and align complementarities to sustain viability (Teece, 2017). Like Amazon.com, which started as a bookstore, expanded into a marketplace and became a cloud company (Amazon Web Services) (Galloway, 2017). This shows that companies need to transform themselves at one time or another to embrace long-term competitive advantage (Brennan and Dooley, 2005; Schmitt et al., 2018). Strategic renewal is a key consideration in understanding firm's long-term survival and prosperity, and how firms alter their path dependence by transforming their strategic intent and capabilities (Flier et al., 2003; Kuratko et al., 2015; Schmitt et al., 2018). Successful strategic renewal requires companies to overcome the inertial forces anchored in the

company's established strategy and to bridge the gap between existing core competencies and the emerging foundations of competitive advantage (Floyd and Lane, 2000; Sagmeister, 2019) such as digitalization, artificial intelligence, and blockchain (Gartner, 2019).

Strategic renewal can be influenced by opening of internal R&D activities to acquire external knowledge or capabilities by partnering with and learning from external partners (Dushnitsky and Lenox, 2005; Basu et al., 2015). One of the erosion factors that has augmented firms' ability to 'leverage increasingly distributed knowledge sources [is] the rise of the Internet (and the related rise of social media)', which has brought the knowledge access and sharing capabilities of previously firm-specific internal ICT [information and communication technologies] networks to the World Wide Web' (Chesbrough and Bogers, 2014, p. 16). This shift has implications for open innovation, ranging from how individuals share knowledge within and outside the organization (Dodgson, et al., 2006; Salter et al., 2014; Dahlander et al., 2016) to how organizations manage knowledge flows in innovation ecosystems and platforms (Rohrbeck et al., 2009; Nambisan and Baron, 2013; Gawer and Cusumano, 2014). More generally, in the face of such erosion factors, a dynamic capability perspective entails that organizations should not only focus on external knowledge per se but also realize that open innovation is as much about 'leveraging and

成功的战略更新需要公司克服固定在公司既定战略中的惯性力量, 并弥合现有核心能力与新兴竞争优势基础之间的差距

战略更新可以通过开放内部研发活动来影响, 通过与外部合作伙伴合作并向外部合作伙伴学习来获取外部知识或能力

网络的兴起

这种转变对开放式创新产生了影响, 从个人如何在组织内外分享知识到组织如何管理创新生态系统和平台中的知识流动

科技公司共同点: 即他们预测变化调整商业模式并协调互补性以维持生存能力

公司需在一个时间转变自己或者拥有长期竞争优势

战略更新是理解企业长期生存和繁荣以及企业如何通过改变战略意图和能力来改变路径依赖的关键考虑因素

enhancing internal capabilities as well' (Bogers et al., 2019, p. 84).

The digital age provides new enabling factors for generating, sharing, retrieving, and storing data, information or knowledge that could dramatically impact how organizations manage their boundaries (Whelan et al., 2010; Dougherty and Dunne, 2012; Fitzgerald et al., 2013). In many cases, managers need to let go of the traditional logic of managing knowledge for innovation that may reside inside or outside the organization, but instead need to find new ways of managing the entire ecosystem where complementary partners are co-innovating new solutions that they can only establish together (cf. van der Borgh et al., 2012; Chesbrough et al., 2014; Rayna and Striukova, 2015).

However, the knowledge management literature (e.g. Nonaka and Takeuchi, 1995) instructs us that the impact of digital technology likely will vary between the explicit and tacit forms of knowledge. Explicit knowledge lends itself well to digitalization, and will likely travel widely, both within and especially across organizational boundaries. However, the more experiential knowledge that only arises from sustained personal interaction will likely not benefit nearly as much from digitalization.

Digital technologies have a far-reaching impact on how individual and organizations innovate together. Moreover, notions as alliances, innovation ecosystems, and the triple helix gain new importance in the digital age (cf. Etzkowitz and Leydesdorff, 2000; Adner and Kapoor, 2010; Faems et al., 2010). The increased opportunities of identifying the solution to an innovation problem through distant search has given rise to new innovation processes and business models, such as crowdsourcing and innovation intermediaries, cutting across various levels of analysis in the face of open innovation (Vanhaverbeke et al., 2014; West and Bogers, 2014, 2017; West et al., 2014; Bogers et al., 2017, 2018). This is causing important challenges for established firms and startups alike as well as for governments and other organizations (cf. Eftekhari and Bogers, 2015; Schmidhuber et al., 2019). As Lifshitz-Assaf's (2018) research on crowdsourcing at NASA shows, the receipt of a digitally provided solution does not necessarily translate into a smooth integration into the organization's business processes. And Chesbrough's (2020) most recent book argues that innovation scholars need to push through the initial generation phase of a new technology, to also incorporate aspects of diffusion and absorption, in order to realize meaningful economic and social benefit from new digital technologies.

2. Maturity model of open innovation in digital times

One of the most important question for academics as well as for practitioners remains: how much digitalization in open innovation do we need? Or more precise: is there a difference in the maturity of company's open innovation approach that demands different emphasis of digitalization? Based on our experience with company's open innovation approaches of the last 20 years we created the following maturity framework (Figure 1, see also Enkel, 2018).

Business strategy and the opening degree need to connect and be enabled by the corporate culture. Empirical studies show that not every company needs the same degree of openness, depending for example on innovation speed, corporate strategy, market positioning, or technology need (Enkel et al., 2009). Additionally, corporate culture does not always support the degree of openness needed to achieve a desired strategy (Enkel et al., 2011). A corporate culture, which enables the company purposeful inflow and outflow of knowledge, has to be established systematically and over time. A quick test for the establish cultural background: while the employees at the beginning of the opening up of the innovation process sense external knowledge as threat for the own reputation of an expert—the so-called not-invented-here syndrome (Katz and Allen, 1982) takes effect—, and rely on their own internal resources (e.g. Wernerfelt, 1984), management has to react to the need to open up in order to increase innovation speed or enable new learnings (Chesbrough, 2003; Dahlander and Gann, 2010; Gassmann and Enkel, 2004; Huizingh, 2011; Laursen and Salter, 2006) e.g. by appointing an open innovation officer, or similar function, in order to minimize organizational barriers and to incentivize the employees for desired open innovation behavior. By experiencing positive results with first achievements in the integration of external knowledge, mostly customer and supplier, using a more open approach in innovation management, the culture will be slowly changing to more openness (e.g. Enkel et al., 2009; Rohrbeck et al., 2009). A sense of urgency by management and employees will support a more rapid change.

Thus, a 'traditionalist' becomes a 'modernist' and the opening of the innovation process will be seen as a chance instead of threat (e.g. Dodgson et al., 2006). In the initial stages of open innovation, the company focus stronger on the outside-in process for example by collecting ideas from customers and suppliers, while the inside-out portion of open innovation remains unused (Enkel et al., 2009). The focus of external knowledge lays on the integration

并非每家公司都需要相同程度的开放

企业文化并不总是支持实现预期战略所需的开放程度

通过使用更开放的创新管理方法,在整合外部知识(主要是客户和供应商)方面取得积极成果,企业文化将慢慢向更开放的方向转变

在许多情况下,管理者需要放弃管理知识创新的传统逻辑。这些创新可能存在于组织内部或外部,而是需要找到管理整个生态系统的新方法。在这个生态系统中,互补的合作伙伴正在共同创新新的解决方案。而这些解决方案只能由他们共同建立。

通过远程搜索来确定创新问题的解决方案的机会越来越多,从而产生了新的创新过程和商业模式。

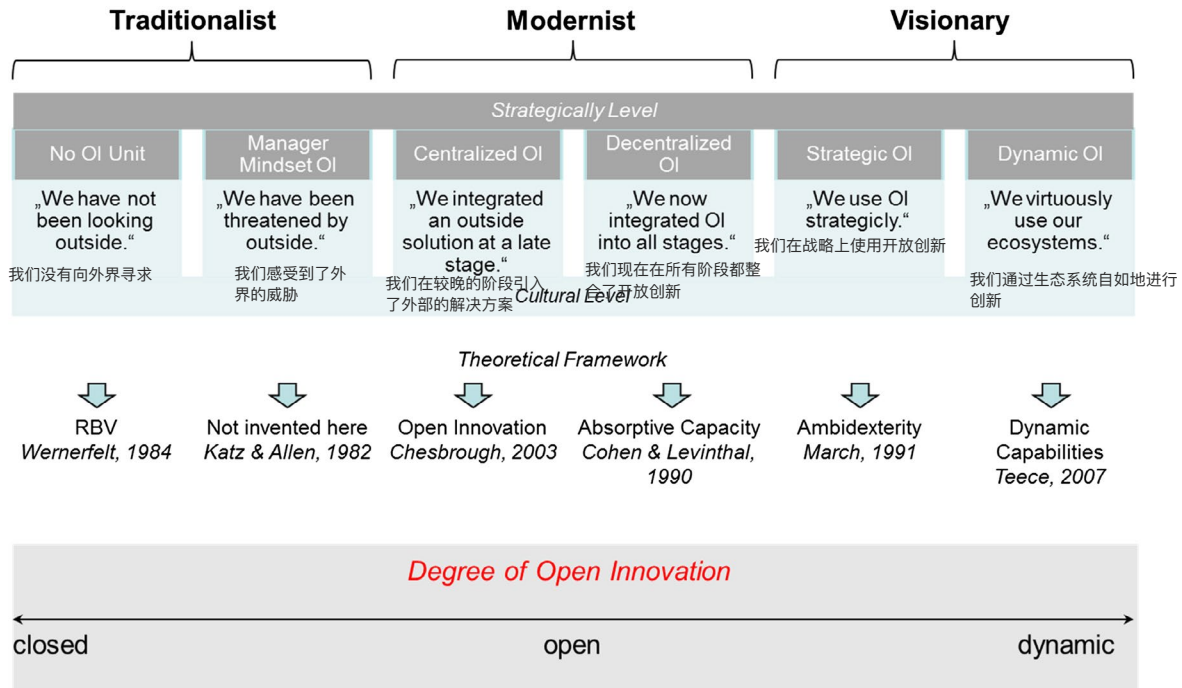


Figure 1. Maturity framework of open innovation. [Colour figure can be viewed at wileyonlinelibrary.com]

与组织当前业务模式不一致的机会和投入现在可能被允许在公司外部测试新的替代业务模式。这是一种由内而外的适应

外部知识的重点在于整合自身价值链中熟悉的合作伙伴，如客户，供应商和研究机构或咨询公司

of familiar partners of the own value chain like customers, suppliers and research organizations or consultancies. In order to broaden the experience with open innovation throughout the company, the lonely manager from the traditionalist is now supported by a centralized team of open innovation officers, able to support a wider range of different activities with different players. Again, over time beside the usual suspects, new partners with valuable knowledge or capabilities inside and outside the industry will be acquired (Gassmann and Enkel, 2010; Enkel et al., 2018), and long-term collaborations with different partners in diverse stages of the innovation process will be coordinated. Now the company could use a portfolio of different activities, both in the integration of external knowledge (outside-in process) and the collaboration with partners (co-creation) (West and Bogers, 2014). The business culture has opened enough that every employee not only sees the potentials of open innovation for his innovation activities, but also can sophisticatedly choose and execute the correct activities. At this point the company changes from a central open innovation department, which serves with coordinating and supporting functions, to a decentralized team within the different business units in order to specifically support product or service needs (e.g. Dingler and Enkel, 2016). Opportunities and inputs that do not align with the current business model of the organization might

now be allowed to test new alternative business models outside the firm, an Inside-out adaptation.

Consequently, there is an increase of independent open innovation activities throughout the business units, but subsequently, their focus is rather on incremental innovations in customer-orientated business units without the long-term vision and the financial support of the top management granted by a centralized unit (Bogers et al., 2019). The proportion of radical versus incremental innovation differs strongly corresponding to the strategic orientation of the company (a technological leader has to integrate the newest technologies in his products, which are often radical innovations, while a fast follower rather focusses on cost-efficient incremental innovation) and the industry (e.g. more incremental innovation consumer goods industry, because of their low product development cost and faster product life cycles, while IT companies have to keep pace with newest technologies and quickly changing customer, which will be addressed by means of radical innovations) (e.g. Enkel et al., 2017). If the long-term strategy of the company aims to establish ambidexterity with exploration of new opportunities as well as incremental customer focused innovation, the open innovation approach again needs to change. Ambidexterity requires a willingness to entertain new kinds of business models, and to manage the internal tensions between the established business

激进创新与渐进式创新的比例与公司的战略取向(技术领先者必须将最新技术整合到他的产品中，这通常是激进创新，而快速跟随者则更注重成本效益的渐进式创新)和行业(例如，消费品行业的渐进式创新更多，因为它们的产品开发成本低，产品生命周期快)有很大的不同

而IT公司必须跟上最新技术和快速变化的客户的步伐，这将通过激进的创新来解决

model and nascent alternative models (Eftekhari and Bogers, 2015).

The 'visionaries' are applying open innovation as a strategic instrument to develop for example radical innovation with partners from different industries and to orchestrate networks, which combined in platform-based businesses and ecosystems (Chesbrough et al., 2014), to facilitate the company's new dynamic innovation opportunities. Thus, in the business-to-business area the realization of smart manufacturing (Industry 4.0) will not be successful without a tight networking of other companies of the same and other industries. Also, in the business-to-consumer area, innovations like autonomous driving or smart home will only be possible in close collaboration of ecosystems of partners from diverse sectors. Here, those companies will profit most, which know how to orchestrate their network as a keystone and to adapt itself fast and flexible with the help of new business models to changing environmental conditions by policy, technological development and market needs (Cusumano et al., 2019). Also, the collaboration with other major enterprises, start-ups, crowds, as well as governments, and citizens will become necessary. This takes us well beyond the traditional triple helix model, to a broader conception of the societal context for innovation (Etzkowitz and Leydesdorff, 2000). For this purpose, the company need dynamic capabilities assume the percipience and the adequate reaction to environmental changes, the mobilization of partners in a network and the orchestration of these partners in changing cooperative and competitive activities (Bogers et al., 2019). Besides the dynamic capabilities of opportunity recognition and adoption, **communicative capabilities** are of vital importance. The professional interacting of knowledge needs and the potential, to absorb and assimilate distant knowledge, to establish a trusting relationship, and to be able to reuse anytime the acquired knowledge, boost the efficiency, and the effectiveness of the visionary (Chesbrough, 2020).

At this juncture, it needs to be stressed that the described developmental stages represent in no case a compulsory continuum, because the corporate culture can both delay or prevent the further development or, the strategic positioning of the company can make an intensification of the open innovation activities counterproductive. Thus, a company has to find its own balance of in-house development and collaboration in innovation management. Every phase, traditionalist, modernist, and visionary, need different capabilities, which have to be accordingly to the changes of the outside world. In slow industries, a change from a traditionalist to a modernist might need a long time, in fast industries the fast

development to a visionary stage quickly might be essential for survival.

3. Where open innovation connects with digitalization

This special issue should help to further our understanding about how open innovation is affected by the digital transformation. The digital age provides many opportunities and challenges for knowledge flows across organizational boundaries to support innovation processes (Bogers et al., 2018).

As the *traditionalist* companies should focus on the resource efficient internal management of open innovation approaches, Moellers et al. (2020) investigate knowledge flows across internal units in multi-business firms. They reveal five archetypal forms that differ in the purpose of the open innovation activity, and their underlying managerial processes as well as practices for promoting those. Accordingly, digital technologies can be used and implemented to manage open innovation processes through easier access and sharing the knowledge created and transferred. Urbinati et al. (2020) provide a structured view of how and why digital technologies are used to manage innovation processes. The paper gives answers to the questions how and why certain managerial actions are required for and enabled by digital technologies help firms to develop and nurture open innovation.

Consequently, the *modernist* aims to broaden his connections to new collaboration partners. Digital technologies enable collaboration across geographical distances with limited resources. Not only can digital technologies and social networks help to easily identify appropriate knowledge owners and collaboration partners within companies or organizations, but additionally enables to *access and integrate large numbers of diverse and dispersed external unknown individuals*. See for example in this special issue Ruiz et al. (2020) who are investigating how knowledge absorption in the digital age takes place by studying the key role of integration mechanisms in the context of crowdsourcing. However, as Mack and Landau (2020) point out in their paper, the submission quality crowdsourcing contests vary depending on individual-level determinants like their level of domain-relevant skills, creativity-relevant processes, and extrinsic task motivation. Additionally, Hausberg and Spaeth (2020) investigate motivation issue, but they focus in their paper on the motivation of makers in Open Source hardware development. Their findings reveal that enjoyment-based intrinsic motivation but also

数字时代为跨组织边界的知识流动提供了许多机遇和挑战,以支持创新过程

“有远见者”正在将开放式创新作为一种战略工具与来自不同行业的合作伙伴一起开发激进创新并协调网络,将基于平台的业务和生态系统相结合以促进公司新的动态创新机会

沟通能力

expected private benefits through improving own skills are major factors affecting contribution levels.

The *visionary* companies use open innovation more strategically to increase their dynamic capabilities by building up a wide range of partner networks for platform-based businesses and ecosystems in order to stay competitive in the future. Those companies use digital technologies for their open innovation activities not only on firm but on industry level and foster networks and platforms. As most old and new research in open innovation studies the individual and firm level, we need more research studying the effects of open innovation on *industry level*. Olk and West (2020) for example investigate open innovation from the perspective of the pharmaceutical industry and discuss in their paper how industry R&D consortia with complementors as connectors manage open innovation around digital product platforms. They report not only innovation from a company perspective but additionally, how open innovation consortia influence and change the industry landscape.

Investigating the influence of technologies on *digital platforms and ecosystems* and the collaboration of partners within is increasingly important as more and more successful business possess a platform-structure. Digital technologies can not only enable product or service development but also the creation of new business as Bagheri et al. (2020) in this special issue point out. They study the case of Digikala, one of the largest online stores in the Middle East, and how they used the crowd for business model innovation. Hilbolling et al. (2020) investigate how firms can coordinate open innovation as platform strategy for the development of complementary products by independent third-parties with the example of Philips Hue.

From a *research perspective*, only very few papers discuss the *methodological and empirical opportunities* of studying open innovation in the digital age. A lot of studies use data from crowdsourcing activities and digital idea competitions as this data are easier to access and analyses with quantitative research methods. Yet, using the vast opportunities of big data, predictive analytics, or artificial intelligence to come up with new ways of creating ideas and innovation is rarely discussed. Huber et al. (2020) provides an exception by studying open data usage of SMEs and derive main capabilities needed to overcome existing barriers to use this data for innovation.

4. Future research areas

Still, based on the open innovation maturity, we can identify several areas associated with research questions that have yet not been sufficiently addressed and need further research:

1. The nature of collaboration in the digital age
 - How to enable (virtual) collaboration in the digital age, ranging from gatekeepers to ecosystems?
 - What do open business models in the digital age look like, and how do they complement or substitute other business models?
 - What are new mechanisms to source, share, filter, and evaluate external knowledge?
 - How do organizational boundaries (or other boundaries) and the related division of innovative labor shift in the face of digital transformation?
 - How to manage tacit or experiential knowledge in an increasingly digital world?
2. New partners and sources
 - How can digital technologies help to identify new sources of knowledge in an innovation ecosystem?
 - How to use open innovation to leverage 'smart' solutions (such as smart factories or smart cities)?
 - Which influence has big or linked data on open innovation?
 - Who 'owns' the customer (especially the customer's data) in an innovation collaboration? Who has full access to this information?
3. Methodological and empirical opportunities of studying open innovation in the digital age
 - How to analyze open innovation collaboration in terms of their boundaries, leverage, scope, structure, and dynamics? 如何分析
 - What are novel ways of examining the interdependency and co-evolution in the open innovation context (multi-method and big data-driven approaches)?
 - Which actionable research designs could enable both theory building and practical development?
4. Technologies, platforms, and methodologies
 - What is the role of digital technologies and platforms in enabling the connectivity and collaboration between actors (e.g., big data and Industry 4.0)?
 - How does the nature of platform differ from other types of innovation collaboration?
 - Are there new methods and tools necessary to enable or investigate collaboration in the digital age?
 - When should APIs with in a platform be made accessible to all, and when should their use be restricted or even prohibited? 在数字时代启用或研究协作所必需的新方法和工具?
什么时候应该让平台中的api对所有人开放, 什么时候应该限制甚至禁止它们的使用?

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