

The Changing Roles of Innovation Actors and Organizational Antecedents in the Digital Age

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Abstract. Despite being acknowledged for playing a pivotal role in facilitating innovations in the digital age, there is a lack of research on the multifaceted role of digital innovation actors. This paper provides a systematic, multi-disciplinary literature review on innovation actors in a digital and non-digital context. Based on a search of 149 high-quality journals and conference proceedings, we identified 110 articles as relevant and categorized as well as synthesized the knowledge on innovation actors' role and organizational antecedents in a digital and non-digital context. We find an increasing focus on innovation actors' role in user communities in a digital context. Moreover, literature on organizational antecedents puts a stronger emphasis on allocating resources to innovation actors outside the organization. By analyzing extant research we provide a comprehensive summary on current knowledge and outline opportunities for future research on digital innovation actors.

Keywords: Digital Innovation Actors, Organizational Antecedents, Literature Review, Digital Innovation, Digital Age

1 Introduction

Digital technology has given rise to a radically new type of innovation [1]. These digital innovations have been conceptualized as “carrying out new combinations of digital and physical components to produce novel products” [2, p.725]. The transformation in the nature of innovations' outcome has not only manifested itself in more heterogeneous knowledge [3], and an increased importance of network effects [1] but has also given rise to a more distributed agency [4]. Consequently, a new set of digital innovation actors with distinct proficiencies has emerged [1].

The innovation management literature has acknowledged the importance of innovation actors early on by pointing out their key role in innovation development: “A new idea either finds a champion or dies” [5, p.84] and “successful innovation [...] require a special combination of entrepreneurial, managerial and technical roles” [6, p.59]. Innovation actors are defined as stakeholders who promote an innovation vigorously through the various stages of the development process against resistance and by taking risks [5–8]. Existing reviews in innovation management [e.g., 7, 9]

have considered the concept of innovation actors through the perspective of their particular subdiscipline, without considering the new materiality of digital innovation.

In a digital context, a number of studies with various research foci have explored digital innovation actors' roles and organizational antecedents [e.g., 10, 11]. However, literature reviews that synthesize the current state of knowledge on digital innovation actors are very scarce so far [12]. Thus, existing reviews focus on digital innovation, but neglect to consider literature on innovation actors [e.g., 13, 14]. Moreover, no comprehensive literature reviews exist that explore fundamental differences in innovation actors' roles and organizational antecedents in a digital and non-digital context. Changes in innovation actors' roles and organizational antecedents that are caused by the distinct materiality of digital technology are unclear so far [1, 3]. With the rising importance of digital technology and the increasing prevalence of digital innovation such research is important. Organizations can only identify innovation actors and promote them by creating fitting organizational conditions, if innovation actors' roles in a digital and non-digital context are sufficiently clear [15].

Literature acknowledges this gap and called for future research to explore innovation actors' roles in a digital context by acknowledging "the complexity of how their actions interact with, and can be shaped by, a wider change process" [12, p.108]. Therefore, we explore the following two research questions:

RQ1: What are distinct roles of innovation actors in a digital and non-digital context?

RQ2: Which organizational characteristics promote or hinder innovation actors in a digital and non-digital context?

In a nutshell, this research article provides a comprehensive literature review on innovation actors' roles and organizational antecedents in a digital and non-digital context. By presenting an in-depth analysis of four subdisciplines and synthesizing findings from an individual and organizational perspective, this literature review offers the opportunity to build a thorough understanding of innovation actors. Based on differences in digital and non-digital innovation literature, we also identify gaps in existing research and provide practical implications.

The paper is structured as follows. While the next section outlines the methodology, section 3 describes the findings of our content-based analysis. Next, we discuss our results with implications for theory and practice and identify avenues for future research. Finally, we delineate our study's limitations.

2 Methodology

With respect to the methodology, a narrative literature review [16] was performed following a systematic and transparent methodology based on Paré et al. [17]. For the purpose of assuring the findings' quality, our search process comprised six steps adopted from Rowe [18]: selecting research questions, choosing sources, creating a search string, applying methodological and practical screening criteria, categorizing and reviewing literature's findings as well as synthesizing the results.

First, we selected a research question (see section 1). In a second step, we chose the sources for our literature search by opting for leading journals in four

subdisciplines, information systems, organization and human resources, business administration as well as technology, innovation and entrepreneurship to account for the interdisciplinary nature of the research theme. A meta-ranking (Journal Quality List [19]), which incorporates 12 different journal rankings (e.g., Financial Times 50 Ranking 2016 or German VHB-JOURQUAL3), was used to evaluate the publication outlets. The 149 selected publication outlets were classified as leading journals in the majority of these rankings and include among other outlets the AIS Senior Scholars' Basket of 8. When considering, for instance, the German VHB-JOURQUAL3 we included all journals, ranked in the categories A+, A or B. The literature search was restricted to the time frame 1995 to 2018, because the year 1995 marks the beginning of the Internet commercialization, characterized by the elimination of the last restrictions on its commercial use [20]. This acknowledges innovation actors' high importance for digital innovation development [21] and enables us to draw a comparison between a digital and non-digital context.

In a third step, we created and utilized an extensive search string within the selected journals including five keywords: innovation, championing, level of analysis, characteristics and context. As depicted in Table 1 each keyword was covered by a variety of search terms, including synonyms as well as corresponding adjectives and verbs. To cover innovation actors comprehensively as well as systematically and to limit prepossessions on the research topic, we chose a broad range of synonymous and overlapping search terms to characterize innovation actors who promote innovation. We consolidated activities, such as brokering and promoting to cover innovation actors' roles in both a non-digital (e.g., innovation champions [8]) and digital context (e.g., lead users [10]). Moreover, we consider innovation actors both from an individual and organizational perspective.

Table 1. Search string

<i>Keyword</i>	<i>Search terms</i>
Innovation	("innovat*")
Championing	("champion*" OR "promot*" OR "boundary spann*" OR "broke*" OR "recombin*" OR "cataly*" OR "sponsor*" OR "corporate entrepreneur*" OR "blog*" OR "challeng*" OR "use*" OR "develop*" OR "influenc*")
Level of Analysis	("individ*" OR "personal*" OR "user*" OR "human" OR "employee") OR ("organi?ation*" OR "network*")
Characteristics	("characteristic*" OR "behav*" OR "attribute*" OR "trait*" OR "propert*" OR "qualit*" OR "capabilit*" OR "structure*" OR "culture*" OR "factor*" OR "requirement*" OR "variable*" OR "element*" OR "competence*" OR "nature*" OR "personalit*")
Context	"digital"

At least one search term related to each keyword had to appear either in the title, the abstract or the subject terms in order to be considered relevant for our literature review. Accordingly, a complete search string was generated. Next, a literature search was executed by using this search string and a meta-search engine, based on 202 different databases, such as EBSCO Business Source Complete, and containing all relevant 149 publication outlets. We ran our search both with and without the search

term “digital” to cover both a digital and non-digital context. In the search, 1178 research articles were identified as potentially relevant.

In a fourth step, we screened the potentially relevant research articles grounded on five methodological and practical criteria. The examined articles had to (1) include a research methodology, (2) address aspects of the innovation process, (3) analyze an actor championing innovation, (4) adopt an individual or organizational perspective, and (5) not focus on the macro level. First these filtering criteria were applied to the title, abstract and keywords resulting in a reduction of the relevant research articles to 270. Second, the full text was screened, which led us to 85 relevant research articles. Following Webster and Watson [22], we then performed a backward (i.e., reviewing older literature quoted in the relevant papers) and a forward search (i.e., reviewing sources that quoted the article) to include all literature sources on innovation actors, which resulted in 25 additional research articles. Overall, the final sample consisted of 110 relevant papers.

Fifth, we categorized and reviewed literature’s findings. We covered innovation actors both from an individual and organizational perspectives by categorizing the content of the research articles into (1) (digital) innovation actors’ roles and (2) six dimensions of organizational antecedents. The different roles of innovation actors were derived in an iterative and inductive process. To analyze literature on organizational antecedents systematically, we adopted a categorization from prior research [23–25] that has found these six organizational characteristics¹, structure [24], human resource (HR) practices [25], culture & climate [24], resource allocation [24], knowledge management [24], and strategy [24], to influence organizational innovativeness. Finally, we synthesized literature’s findings, as elaborated in the following section (step 6).

3 Analysis

In the following, we first analyze innovation actors’ roles (individual perspective). Next, we outline our findings on organizational antecedents, characteristics that facilitate or hinder innovation actors’ innovativeness (organizational perspective). Figure 1 illustrates our theoretical framework based on our categorization schema.

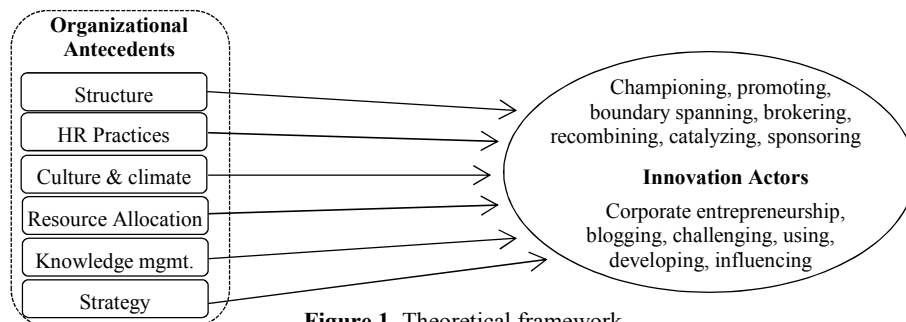


Figure 1. Theoretical framework

¹ A table depicting the definitions of the different categories can be accessed here: <https://bit.ly/2ToX7cS>

3.1 Roles of Innovation Actors

Innovation Actors in a non-digital context. Our analysis showed that we can distinguish between a number of innovation actors in a digital and non-digital context. The innovation champion constitutes one of the earliest identified innovation actors [5], who promotes an innovation vigorously through the various stages of the development process against potential resistance by taking risks [e.g., 6, 8]. Innovation champions have been described as motivating their innovation team [e.g., 26], inspiring others with their vision [e.g., 15], transferring information and knowledge [e.g., 27], connecting with others and building networks [e.g., 26], bringing different actors in the organization together [e.g., 28] and gaining management support [e.g., 8]. Besides the innovation champion, further types of innovation actors² have been identified as summarized in the following table.

Table 2. Roles of Innovation Actors in non-digital and digital context

<i>Roles of Innovation Actors</i>	<i>Exemplary Sources</i>
Innovation champion – Innovation actor who promotes an innovation vigorously through the various stages of the development process against potential resistance by taking risks. [6, 27] (Synonym: <i>process promoter</i>)	<i>Non-digital:</i> [8, 28] <i>Digital:</i> [29]
Corporate entrepreneur – Innovation actor who creates a new venture or initiates renewal or innovation within an existing organization by combining four competencies: inventing, brokering, championing and sponsoring. [30]	<i>Non-digital:</i> [31, 32] <i>Digital:</i> [33, 34]
Sponsor – Innovation actor who holds a managerial position and uses his or her formal power to support an innovation by supplying or obtaining resources, lending legitimacy or giving advice. [6, 27] (Synonym: <i>power promoter</i>)	<i>Non-digital:</i> [30, 35] <i>Digital:</i> [11, 36]
Boundary spanner – Innovation actor who is responsible for the interaction of an organizational unit or organization with its environment. [27, 37] (Synonym: <i>relationship promoter</i>)	<i>Non-digital:</i> [35, 37] <i>Digital:</i> [38]
Knowledge broker – Innovation actor who facilitates information flows by transferring knowledge important in the innovation process between otherwise unconnected actors. [39]	<i>Non-digital:</i> [39, 40] <i>Digital:</i> [41]
Lead user – Innovation actors on the user side who detects problems, generates ideas for improvements to existing products and subsequently carries out modifications to generate an innovative product. [10, 42]	<i>Non-digital:</i> - <i>Digital:</i> [43, 44]

Innovation Actors in a digital context. The roles of innovation actors described above are also mentioned in a digital context. At the same time, digital technology gives rise and puts special emphasis on two roles, lead users and sponsors. Lead users have been shown to drive innovations from a user perspective in a digital context [e.g., 10, 43]. They communicate and collaborate with other (lead) users in user communities via digital platforms or technologies and apply their own knowledge and

² Even though roles of innovation actors have been characterized extensively in the literature, we only focus on the most frequently mentioned activities characterizing innovation actors. Therefore, the cited references only represent a selection of the research articles that we considered in the analysis overall.

knowledge exchanged with other users to advance products and drive innovation [e.g., 42]. A purely user-specific role of innovation actors has only been enabled by the distinct characteristics of digital technology. Moreover, literature in a digital context puts a stronger emphasis on the role of sponsors. Especially the new organizational role of the chief digital officer, one type of sponsor, has gained considerable significance, as these innovation actors in management positions drive an organization's digital transformation and champion digital innovation [e.g., 11].

3.2 Organizational Antecedents

We now analyze how idiosyncratic characteristics of an organization influence and shape innovativeness of digital and non-digital innovation actors following the framework depicted in Figure 1. All findings are summarized in Table 3³.

Structure. As an organizational antecedent to innovation actors' effectiveness in a non-digital context organizational structure has been widely studied. A high degree of centralization in decision-making and a high degree of formalization of behavior through rules and procedures have been found to form barriers for non-digital innovation actors' emergence and effectiveness [e.g., 37, 45]. In contrast, a low degree of vertical differentiation, i.e. the existence of few hierarchical levels, and structuring an organization into teams and based on projects, an aspect of horizontal differentiation, enhances non-digital innovation actors' activities [e.g., 30].

These findings for the non-digital context are in line with evidence found in a digital context. Thus, Ansari and Munir [43] find that organizations need to move from a structure characterized by hierarchy and control to a structure that enables collaborative and interactive innovation with digital innovation actors in user communities. In addition, digital innovation research also focuses on other aspects of organizational structure. For instance, digital innovation actors in high hierarchical positions can only champion innovation effectively if their role is defined clearly and in alignment with other executive positions [e.g., 11, 36].

HR Practices. With respect to HR practices, research in a digital or non-digital context shows similar findings but addresses distinct types of innovation actors, respectively. When focusing on performance appraisal, sanctions due to failed innovation projects are likely to impede the emergence of non-digital innovation actors. Contrarily, rewards compensating innovation actors for innovation success enhance their emergence in a non-digital context [e.g., 32, 45]. However, non-digital literature disagrees whether performance appraisal should be based on innovation-promoting behavior [30] or innovation accomplishments [45]. Digital innovation research finds that performance appraisal needs to also compensate digital innovation actors in user communities for innovation success monetarily [e.g., 46] or through non-financial measures, such as recognition or rewards [e.g., 10, 44] to enhance

³ In Table 3 different organizational characteristics are considered from the perspective of drivers only. As elaborated, for some of these factors only the counterfactual relations with innovation actors have been explored. In the illustration in Table 3 we inversely code barriers in order to display drivers.

digital actors' activities. Additionally, Tumbas et al. [11] point out the importance of defining key performance indicators for all executives driving digital innovation.

On staffing practices non-digital innovation literature remains largely silent and only proposes hiring employees with distinct personalities [e.g., 30] to spur innovation actor's emergence. In a digital context, hiring employees with high experience inside and outside the organization is found to be positively associated with innovation-promoting behavior [e.g., 41]. When considering a group of digital innovation actors that work together to advance an organization's innovation projects, Van Laere and Aggestam [29] propose that a diverse group of individuals who possess complementary skills, knowledge, and social networks should be hired to enhance digital innovation actors' effectiveness. Additionally, in digital innovation processes that incorporate a user community hiring leaders of the community as gatekeepers between community and organization can enhance innovation promotion within the user community, because these gatekeepers moderate the exchange and simultaneously maintain the boundaries between community and firm [e.g., 44].

Training employees is another aspect of HR practices that has been shown to be positively associated with innovation actors' emergence and effectiveness in both research streams [e.g., 31, 37]. While non-digital literature generally focuses on employees, in a digital context the training of external users is also beneficial for the emergence of digital innovation actors [e.g., 44].

Culture & Climate. Non-digital literature finds that a culture supportive towards innovation [31, 32] is positively associated with innovation actors' activities. Both digital and non-digital innovation research agree that a long-term outcome orientation of the business culture [e.g., 30, 34] as well as culture tolerant of failure [e.g., 10, 31] and risk rewarding [e.g., 32, 47] encourage (digital) innovation actors' emergence and effectiveness. Additionally, in a digital context organization's culture needs to adapt to external users' participative role in the innovation process to encourage the emergence of innovation actors in user communities [e.g., 43]. Going one step further, Parmentier and Mangematin [44] find that organizations need to work towards identity convergence of user community and organization by sharing identifying elements and building common values embedded in products and services.

Resource Allocation. The non-digital literature on resource allocation's influence on innovation actors presents a positive effect of provisioning financial resources and time to pursue innovation [e.g., 32], as well as management legitimization to use existing resources or networks [e.g., 47]. In a digital context, the availability of digital technology can promote, and limitations to technological capabilities can hinder innovation actors' promotion of innovation [e.g., 33, 48]. If no formal allocation of resources towards digital innovation occurs, a lack of internal control benefits digital actors' effectiveness, because it allows the diversion of funds and employees [e.g., 34]. Additionally, literature on digital innovation emphasizes allocating resources to the innovating user community. The provision of tools for innovation-promoting activities as well as support towards the community (e.g., through community events) can enhance digital innovation actors' emergence [e.g., 10, 44].

Table 3. Organizational antecedents of non-digital and digital innovation actors

<i>Category</i>	<i>Non-digital innovation actors</i>	<i>Digital innovation actors</i>
Structure	Low centralization and formalization [e.g., 37, 45]	Structure enabling collaborative and interactive innovation [e.g., 43]
	Low vertical differentiation [e.g., 30]	Definition and alignment of role on executive level [e.g., 11, 36]
	Horizontal differentiation into teams [e.g., 30]	
Human Resource Practices	Existence of rewards, but no sanctions [32, 45]	Monetary compensation [e.g., 46] or non-financial rewards for digital innovation actors in user community [e.g., 10, 44]
	Performance appraisal based on innovation-promoting behavior [e.g., 30] or innovation accomplishment [e.g., 45]	Definition of key performance indicators on executive level [e.g., 11]
	Hiring employees with distinct personalities [e.g., 30]	Hiring employees with high experience inside and outside organization [e.g., 41]
		Hiring diverse group of individuals with complementary skills, knowledge and social networks [e.g., 29]
	Hiring leaders of community as gatekeepers [e.g., 44]	
	Training of employees [e.g., 31, 37]	Training of external users [e.g., 44]
Culture & climate	Culture supportive towards innovation [e.g., 31, 32]	Long-term outcome orientation [e.g., 34]
	Long-term outcome orientation [e.g., 30]	Culture tolerant of failure and risk rewarding culture [e.g., 10]
	Culture tolerant of failure and risk rewarding [e.g., 31, 32, 47]	Adaption of culture to users' participative role [e.g., 43]
		Identity convergence of user community and organization [e.g., 44]
Resource allocation	Provision of financial resources and time [e.g., 32]	Availability of digital technology and technological capabilities [e.g., 33, 48]
	Management legitimization to use existing resources and networks [e.g., 47]	Lack of internal control allowing the diversion of funds [e.g., 34]
		Allocation of resources to user community [e.g., 10, 44]
Knowledge Mgmt.	General learning orientation of organization [e.g., 31]	Tools and databases supporting the sharing, exchange and creation of knowledge [e.g., 10, 50]
	Organizational support towards knowledge exploitation and recombination [e.g., 49]	Creation of interaction possibilities in user community [e.g., 10, 44]
		Sharing knowledge with external users [e.g., 10, 44]
Strategy		Effective IT governance structure [e.g., 36]
		Opening content to user community without losing control [e.g., 43, 44, 46]

Knowledge Management. With respect to knowledge management, non-digital literature is relatively silent and only proposes that a general learning-orientation in organizations [e.g., 31] and organizational support towards knowledge exploitation and recombination [e.g., 49] strengthen innovation actors' emergence and effectiveness. In a digital context, tools and databases that support the exchange and creation of knowledge promote digital innovation actors' effectiveness [e.g., 10, 50]. In innovation processes incorporating a user community, organizations can promote digital innovation actors' effectiveness by creating multiple possibilities of interaction (e.g., setting up discussion areas) to foster the exchange of explicit and tacit knowledge and by actively sharing knowledge [e.g., 10, 44].

Strategy. While non-digital literature is relatively silent on the role of strategy for innovation actors' emergence and effectiveness, digital technology poses new challenges that need to be addressed. Thus, for digital innovation actors on the executive level an effective information technology (IT) governance structure is a requirement for their effectiveness [e.g., 36]. In innovation processes involving a user community, organizations' optimal strategy to promote digital innovation actors' emergence incorporates opening (proprietary) content [e.g., 46] without losing control of the innovation outcome [e.g., 43, 44].

4 Discussion and Areas of Future Research

This research offers a comprehensive literature review on differences in innovation actors' roles (RQ1) and organizational antecedents (RQ2) in a digital and non-digital context. Theoretically, we contribute to literature by providing an in-depth analysis of research in four subdisciplines. By contrasting findings on innovation actors in a digital and non-digital context and taking both an individual and organizational perspective, our literature review offers insights into changes caused by the distinct materiality of digital technology and aims to close the identified gap in literature [12]. Based on our findings, we also provide recommendations and research questions for promising avenues of future research (see below).

Practically, we contribute to literature by offering organizations' management important insights into changes in innovation actors' roles due to the digital transformation. By synthesizing differences in organizational antecedents in a digital and non-digital context, we also enable organizations to provide adequate framework conditions to support innovation actors and enable the championing of innovation.

4.1 Roles of Innovation Actors

With regard to the roles of innovation actors (see subsection 3.1), our analysis shows that most roles of innovation actors hardly vary in a digital compared to a non-digital context. At the same time, research points to the rise of a new role, lead users in innovation collectives (i.e., user communities), and puts a higher emphasis on one role already known in a non-digital context: sponsors (e.g., chief digital officers) [11, 43]. The reason and importance of these changes remain unclear throughout existing

literature. Furthermore, we observe that research on digital innovation actors' roles is rare, indistinct and ambiguous. Literature in a digital context rarely provides a characterization of innovation actors that goes beyond a description of innovation actors' behaviors and incorporates their knowledge, skills and personality profile.

Additionally, innovation actors show different degrees of homogeneity in a digital and non-digital context. Thus, innovation actors' roles in a non-digital context are characterized by similar behaviors and share common objectives (i.e., innovation champion and corporate entrepreneur) [27]. In contrast, innovation actors' roles in a digital context vary more greatly. While sponsors in a digital context, such as chief digital officers, are part of the management board [11], lead users can rarely influence organizations' strategic decisions [42]. At the same time, these heterogeneous, digital innovation actors are increasingly part of a group or innovation community [29, 42]. Since, the scarcity of research on groups of innovation actors in a non-digital context limits the implications that can be derived for a digital context, the characteristics and compositions of such groups offer another area for future research. By considering and combining the results on innovation actors' role, Table 4 integrates and concludes with recommendations for future research and proposes research questions.

Table 4. Research agenda for future research on innovation actors' roles⁴

<i>Recommendation</i>	<i>Selected research questions for future research</i>
Researchers should investigate innovation actors' roles in a digital context	<p>Why do new roles, such as lead users in innovation collectives, arise and why does the emphasis with respect to existing roles change? How important are these changes for digital innovation?</p> <p>What characterizes digital innovation actors' knowledge, skills and personality?</p> <p>How do digital innovation actors' goals and motivation differ from those of non-digital innovation actors due to the rise of digital technology?</p> <p>How do innovation actors develop the skillset required for digital innovation?</p>
Researcher should analyze characteristics and compositions of groups of digital innovation actors	<p>How can groups of innovation actors as well as their composition be characterized?</p> <p>What are the factors enabling or hindering the collaboration of digital innovation actors in a group?</p> <p>Does artificial intelligence change the collaboration of digital innovation actors in innovation communities?</p>

4.2 Organizational Antecedents

With regard to the organizational characteristics that enable or hinder innovation actors, our results reveal changes in organizational antecedents associated with the distinct materiality of digital technology. We find that literature focuses on different aspects of innovation actors' organizational antecedents in a digital compared to a

⁴ All research questions in Table 4 and 5 were derived from the literature review's findings. Research questions in bold are discussed in detail in the respective subsection.

non-digital context. Digital innovation literature puts a stronger focus on the inclusion of innovation actors outside the organization (i.e., lead users), for example, by allocating resources and training these actors. Moreover, only a small number of articles examine organizational antecedents in a digital context [e.g., 33, 46]. These papers remain very generic and have mainly other research foci, so that organizational antecedents are only covered shallowly. Since organizational antecedents have been shown to play such an important role in enabling organizational innovativeness [e.g., 24], future research should explore a number of aspects in depth.

The existing literature on organizational antecedents in a digital context points in one direction: the digitization of work environments initiates change, which rapidly redefines the interaction of individuals and organizations. We observe that organizational boundaries are weakened as user communities play an increasingly important role. For instance, with respect to the organizational structure, literature finds that a structure enabling collaborative and interactive innovation not only inside the organization but also in user communities outside the organization is beneficial for digital innovation actors [43]. Similarly, in a digital context organizations not only need to create a culture internally but also have to establish a shared culture with the user community [44]. In the future, digital technology could lead to the dissolution of traditional organization structures towards virtual organizations with a loose accumulation of innovation actors and new forms of collaboration between them [1]. Challenges connected to these developments have not been addressed in existing literature so far.

Issues could, for instance, arise with respect to resource allocations to digital user communities. A virtual organization would not only need to provide appropriate IT infrastructure and resources to the digital user community, but also ensure the correct and targeted usage. Yet, the tracking of resources to secure efficient usage in a digital environment could prove to be more challenging as innovation actors would be scattered all around the world. Moreover, with the increasing heterogeneity of the innovation actors, the individual requirements to IT infrastructure might diverge [4], further adding to the challenge. Therefore, questions on how to allocate and use resources efficiently to avoid the waste of resources need to be explored in-depth in the future. Similarly, if innovation actors collaborate with organizations spontaneously using digital platforms in user communities, it will be difficult to track their knowledge and skills. Due to the nature of platforms, innovation actors will vary and their composition fluctuate [51]. As a result, knowledge becomes more tacit and fluid [3]. To face this challenge new knowledge management systems have to be created and new avenues for future research exist.

While we have discussed on a limited number of potential avenues for future research in the following, Table 5 integrates and concludes with more elaborate recommendations and research questions for future research on organizational antecedents.

Table 5. Research agenda for future research on innovation actors' organizational antecedents

<i>Recommendation</i>	<i>Selected research questions for future research</i>
Researchers should investigate innovation actors' organizational antecedents in a digital context:	<p>Why do organizational antecedents promoting or hindering digital innovation actors change due the rise of digital technology?</p> <p>Do organizational antecedents that promote or hinder non-digital innovation actors also affect digital innovation actors?</p> <p>Which additional organizational factors could hinder the evolution and development of digital innovation actors?</p>
Structure	<p>Which structure is required to enable collaborative and interactive innovation among digital innovation actors not only inside the organization but also in user communities outside the organization? How can organizations establish such a structure?</p>
Human Resource Practices	<p>What are appropriate incentives to motivate digital innovation actors?</p> <p>How can HR departments identify digital innovation actors?</p> <p>How can non-digital innovation actors evolve into digital innovation actors? How can organizations support non-digital innovation actors in this endeavor?</p>
Culture & climate	<p>How can organizations create a culture that supports digital innovation actors both inside and outside an organization in their endeavor to promote innovation?</p>
Resource allocation	<p>What are the requirements for appropriate IT infrastructure and resource allocation to digital innovation actors in virtual organizations?</p> <p>How can organizations promote efficient use of resources among heterogeneous innovation actors in innovation communities?</p> <p>What are the diverging requirements of digital innovation actors with respect to IT infrastructure and resources?</p>
Knowledge Management	<p>What are the requirements for organizations' knowledge management systems to track knowledge and skills of digital innovation actors in user communities?</p> <p>How can organizations ensure an appropriate and complementary composition of innovation actors' knowledge and skills in user communities?</p>
Strategy	<p>How can organizations manage the strategic challenge of opening proprietary content to digital innovation actors in innovation communities without losing control of innovation outcomes?</p>

5 Limitations of the Literature Review

After the preceding analysis and discussion of our findings we also acknowledge some limitations. The selection of publications of our review restricts the results of our analysis. The review is based on 149 publication outlets selected using a meta-ranking (Journal Quality List [19]), covering 12 different journal rankings. Although this selection ensures the high quality of our literature base, some relevant

contributions, such as scientific books [e.g., 52] or whitepapers, may be missing in the review due to the restriction of our sample to peer-reviewed publications. Similarly, by limiting the time frame of our search to 1995 to 2018 we risk the exclusion of relevant literature. Since the concept of the innovation actors was first mentioned in 1963 [5], relevant research articles might have been published prior to 1995. However, we solve this problem by relying on backward search to complement our sample of the relevant literature [22].

Moreover, the coding and categorization of innovation actors' roles and organizational antecedents may have been subject to mistakes. Yet, since we relied on two independent coders, who followed an orderly and rigorous coding approach, the number of mistakes was kept to a minimum. Accordingly, a high reliability and validity of the findings of our analysis was secured [53].

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