

Ecosystem Value Creation and Capture: A Systematic Review of Literature and Potential Research Opportunities

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“Creating value is an inherently cooperative process, capturing value is inherently competitive.”

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Collaboration, co-creation, and competition are essential strategies for success in today's modern businesses. In comparison with former ways of doing business in isolation, ecosystems nowadays have created ample opportunities for generating significantly more values. However, there are also potential threats in the pathway towards success in ecosystems. Ecosystem value creation and capture (EVCC) has recently gained significant attention in the academic literature of business and management. Yet, due to the complex structures of ecosystems and ambiguity in understanding value creation and capture in ecosystems, the contributions heretofore are fragmented, where scholars analysed different aspects of EVCC. The present study offers a systematic review of the literature to shed light on the EVCC studies. The content analysis of a fine-grained sample of articles relevant to EVCC revealed that despite the initiation of discussions in 2007, the topic did not gain noticeable attention until 2016. A 150% increase in the number of papers has since been observed. The paper contributes to the intersection of strategy and studies on EVCC by synthesizing existing knowledge, illuminating current EVCC research, and highlighting potential research avenues.

1. Introduction

The number of papers emphasizing the importance of value creation and capture in ecosystems and collaborative networks has been growing. Especially, the growth has been more noticeable since 2016, with a 150% increase in papers published. However, the contributions are mainly fragmented, where scholars have addressed different themes involving 'ecosystem value creation and capture' (EVCC). Reasons for such fragmentation could include a lack of adequate understanding of the concepts in collaborative networks of innovative organizations (Chesbrough, et al., 2018), complexity of interactions in ecosystems (Ben Letaifa, 2014; Ritala & Almpantopoulou, 2017), and overall ambiguity in the exact structure of ecosystems (Ben Letaifa, 2014; Ritala & Gustafsson, 2018). Furthermore, as it pertains to collaborative networks of innovative firms, the concepts of 'value creation' and 'value capture' have been addressed with ambiguities regarding value perspectives (Chesbrough et al., 2018). Therefore, it is essential to comprehensively analyse EVCC in the academic literature.

'Ecosystem' is a metaphor from the field of ecology, suggested by Moore (1993) to describe the complex, dynamically changing, symbiotic relationships formed among a network of business organizations. 'Value creation' and 'value capture' have been debated conceptually in the fields of marketing, strategic management, industrial organizations, and business models (Chesbrough et al., 2018; Pitelis, 2009). The 'ecosystem value creation' process is regarded as a mechanism for collaboration and activities within an ecosystem to create value for customers and users (Hannu Tuomisaari et al., 2013). 'Ecosystem value capture' refers to firm-level strategic plans that appropriate their share of the total value created by an ecosystem (Hannu Tuomisaari et al., 2013), be it captured purposely or serendipitously (Radziwon, et al., 2017; Ritala et al., 2013). EVCC is an integral part of ecosystem business models (Ceccagnoli et al., 2012) and the sustainability of ecosystems (Chesbrough et al., 2018). It serves to dynamically monitor contributions of actors to the proposed collective value, while determining their share of the total appropriated value.

The research questions (RQs) leading this paper are as follows:

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RQ1: *How have EVCC studies grown and changed over time in the literature?*

RQ2: *What are the underlying research themes in EVCC studies?*

RQ3: *What are the potential opportunities for future research in EVCC?*

The remainder of this paper is structured as follows: The next section describes the research method used to collect data and answer the RQs. The subsequent section presents the results of the analyses and a response to each of the RQs. The paper ends by summarizing the results, highlighting the contributions of the study, and pointing out the limitations in conducting the research.

2. Research Method

The study follows a standard systematic literature review. This section describes the sampling process (conducted in early 2019) used to identify the relevant literature as well as the steps undertaken to answer each of the RQs.

2.1. Identifying the literature

2.1.1. Choice of Database

Web of Science (WoS) was the preferred database to search the literature for several reasons. First, compared to other databases such as Google Scholar, WoS provides the highest number of high quality journals and articles (as cited in Scaringella & Radziwon, 2017) and reliability (Augillo and Falagas, as cited in Prins et al., 2016). Second, Gavel and Iselid (2008) quantitatively showed that the coverage of WoS in social science and humanities is broader than SCOPUS. Third, according to these authors, WoS has a longer time span and citation coverage in comparison with SCOPUS.

2.1.2. Search Rules and Initial Article Extraction

To identify the initial pool of articles to be reviewed, a synthesis of keywords such as “ecosystem”, “value creation”, “value co-creation”, “value capture”, and “value appropriation” were used in two rounds based on the following search rules:

- ecosystem AND ("value creation" OR "value cocreation"),
- ecosystem AND ("value capture" OR "value appropriation").

The first rule identified 313 articles, while the second rule resulted in 32 articles.

2.1.3. Paper Selection and Sample Screening

For this study, only high-quality papers pertinent to EVCC in business and management scholarship and in English language were of interest. As only high-quality papers were of interest, the search was limited to refereed journal articles in WoS. The search process identified 171 unique articles (after removing duplicate results from the two different search rules) at the preliminary step.

The preliminary sample had to be screened for context and content relevance. For value creators, continuous satisfaction of customers must be the main target. This is irrespective of whether the offer is collectively presented or if solutions are offered by an individual enterprise (Bowman, as cited in Hannu Tuomisaari et al., 2013). EVCC includes optimizing, preventive, and radically innovative approaches for efficiency maximization and differentiation in ecosystems. Such approaches are essential for an entity (or a constellation of entities) to be able to create and capture higher value. Based on such an understanding from EVCC, irrelevant papers were excluded from the preliminary sample of articles.

The titles, abstracts and conclusions of the papers were thoroughly analysed. Findings where ecosystem was applied as a ‘buzzword’, ‘wrong metaphor’ or ‘irrelevant analogy’, without being considered as the proper unit of analysis (Aarikka-Stenroos & Ritala, 2017; Ritala & Almpantopoulou, 2017; Suominen et al. 2019), were excluded from the sample. Similarly, those studies that tested non-technological contexts in service ecosystems or marketing studies were removed from the sample (See Scaringella and Radziwon (2017) for the same approach). The sample was shrunk to 50 papers after this stage.

2.1.4. Sample refinement

It was found out that some other studies in the reference list of the papers in the shrunk sample (N = 50) were relevant to EVCC but they had not appeared in the preliminary search phase. One reason is that author keywords were not used in some of the papers relevant to EVCC, hence those papers were not listed in the initial search attempt in WoS. Examples include papers from R&D Management, Journal of Product Innovation Management, Strategic Management Journal, and Technology Innovation Management Review. Therefore, adding the most relevant papers in the backward citations list, the shrunk sample was complemented to increase the percentage of recall for the sample (the measure used to indicate the share of the number of papers in a sample from all possible number of papers in

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Fig. 1. Step-by-step sampling process

the sample) and a more precise content analysis (See Takey and Carvalho, 2016, for an example of such an approach in sample refinement).

The same quality screening criteria (only relevant and English journal articles in the WoS database) were applied in the sample refinement phase. Applying this strategy, 10 more papers were added to the sample. In total, the final sample consisted of 60 papers, which formed the foundation of the content analysis. Fig. 1 describes the step-by-step sampling process.

2.2. Data analysis

Descriptive statistics of the sample used for observing the trend in popularity and trajectory of EVCC studies in the relevant literature, i.e., for responding RQ1. Next, content analysis was conducted and all the 60 papers of the sample were carefully analysed to explore the main themes discussed heretofore in the scholarly research of EVCC (response to RQ2). The sample was not too large and for higher precision, text mining was not applied for theme exploration. The content analysis provided the required input for identifying the research puzzles in the literature of ecosystem studies and EVCC, thereby

responding to RQ3.

3. Results

3.1. Trajectory of EVCC using descriptive statistics of the final sample

The final sample ($N = 60$) was analysed according to the year of publication to explore the publishing trend in EVCC. Despite a fall in 2015, there has been an upward trend in publishing papers on EVCC since 2012. However, the growth is more notable since 2016, with 36 papers (60% of the sample and a 150% increase of the sample size), out of which 16 papers (26.7%) were published in 2018 (See Fig. 2).

Table 1 lists the 13 authors (first author or co-author) in the sample with more than one paper. From all 142 authors in the sample, Annabelle Gawer and Paavo Ritala had the highest number of contributions in the final sample.

Fig. 3 illustrates the number of papers per authors' affiliation in the final sample for the top 25 organizations. As can be seen, scholars affiliated at

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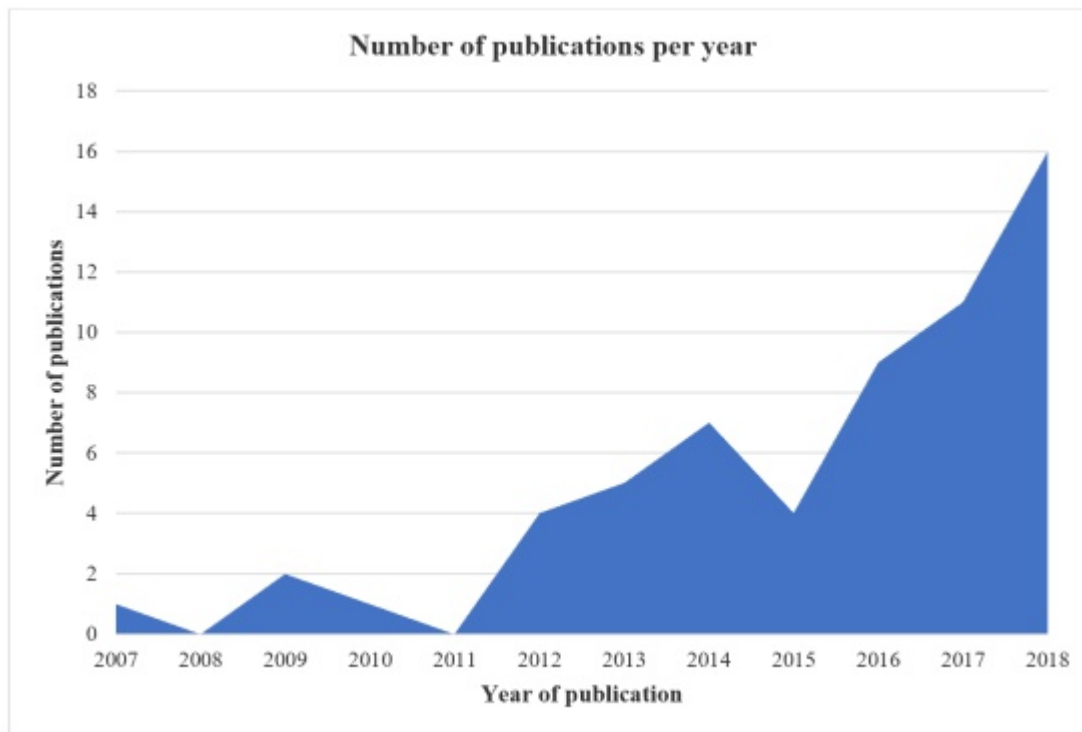


Fig. 2. Number of publications per year for the final sample of articles (N = 60)

American, British, and Finnish organizations have engaged the most in EVCC research.

Table 2 details the number of papers per each source title in the sample. According to the results, International Journal of Technology Management, Research Policy, Technological Forecasting & Social Change, and Technology Innovation Management Review were the top four popular journals among the scholars.

3.2. Major research themes emerging from content analysis

The findings of the content analysis were classified into four categories according to the emerging research themes: mechanisms of EVCC, drivers of EVCC,

challenges of actors for EVCC, and effective strategies and operational practices for EVCC. Below, scholarly research in each of the themes is highlighted.

3.2.1. Mechanisms of EVCC

While ecosystem value creation requires collaboration, ecosystem value capture forces firms to protect themselves. This “paradox of openness” (Laursen & Salter, 2014) makes understanding the mechanisms of EVCC complex. Not only are the mechanisms for value creation different from those for value capture, but also the mechanisms of EVCC differ from one type of ecosystem to another. Such differences stem from their unique mutual intentions (“baselines”), players in the ecosystem, their roles, interactions between players, and the logic of action (Valkokari, 2015). Different

Table 1. Authors with more than one paper in the final sample

Authors	Number of Papers
Annabelle Gawer, Paavo Ritala	3
Ron Adner, Rahul Kapoor, Michael Jacobides, Katri Valkokari Carmelo Cennamo, Jens Dibbern, Shaz Ansari, Raghu Garud, Arun Kumaraswamy, Thomas Kude, Christopher Lettl	2

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Fig. 3. Number of papers per authors' affiliation for the top 25 organizations

mechanisms of EVCC can be the result of differences in complementarities; direction of relationships, symmetry or asymmetry of the effect location, and modularity of ecosystems (Jacobides, Cennamo, & Gawer, 2018). Fig. 4 depicts the determinants for different mechanisms of EVCC.

Business ecosystems consist of focal actors, suppliers, complementors, and users. The interaction between actors are non-linear and geographical boundaries do not limit the operations of the business ecosystem. Co-creation and co-capture of value are mainly realized through resource exploitation (as a shared intention), cooperation (Dagnino & Padula, 2002), and provision of a unique platform by a focal actor for complementarities (Valkokari, 2015). Platforms and developers play a crucial role in value creation involving creative industries and business ecosystems (Parker et al., 2017). The co-created value is co-captured through sharing (distributing) the revenue among business ecosystem members (Oh et al., 2015). A decent appropriability regime is therefore essential in ecosystems to ensure of the realization of value capture (Ceccagnoli et al., 2012; Oh et al., 2015).

Knowledge ecosystems are comprised of universities, research centres, and entrepreneurs. Co-exploration of new knowledge in decentralized networks is the mutual objective of actors, assisted by innovation

intermediaries, and by co-innovation within defined geographical clusters (Valkokari, 2015). Having said that, the new definition for knowledge ecosystems indicates the increasing blurriness of spatial boundaries and nowadays, knowledge ecosystems are operating in a more global scale (Järvi et al., 2018). Unlike in business and innovation ecosystems, focal actors in knowledge ecosystems (universities and research centres) are not involved in direct competitions (Clarysse et al., 2014). Furthermore, the value creation process in knowledge ecosystems is a linear process with the flow moving from upstream to downstream actors (Clarysse et al., 2014). Depending on whether a knowledge ecosystem specializes in a knowledge domain or is still in pursuit of one, EVCC mechanisms can differ. In the former case known as 'partial forms', more formal mechanisms for membership and access to knowledge and resources are common, whereas in the latter case known as 'prefigurative forms', less formal and more voluntary mechanisms are used (Järvi et al., 2018). In the same vein, value capture mechanisms in knowledge ecosystems differ according to the technology lifecycle. Less formal IP strategies such as secrecy are more common in pre-development phases, whereas more formal strategies such as patenting are used near the beginning of the development phase (Toma et al., 2018).

The main actors of innovation ecosystems, the lead producers, suppliers, competitors, policy makers,

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Table 2. Number of papers in the final sample per publication

Source Title	Number
International Journal of Technology Management	6
Research Policy, Technological Forecasting & Social Change, Technology Innovation Management Review	5
California Management Review, Strategic Management Journal, Journal of Product Innovation Management	4
MIS Quarterly	3
Organization Science, Electronic Markets, Journal of Management Studies	2
Academy of Management Journal, Advances in Strategic Management, Business Process Management, Creativity and Innovation Management, European Journal of Information Systems, European Management Review, IEEE Transactions on Engineering Management, Information Systems Research, International Entrepreneurship and Management Journal, International Journal of Innovation Science, International Journal of Innovation and Technology Management, Journal of Information Technology, Journal of Management, Management Decision, Management Science, R&D Management, Technology Analysis and Strategic Management, Technovation	1

intermediators and public and private funding agencies, are geographically bounded in innovation hubs. Actors and their interdependencies, activities, positions and links are the main constructs of innovation ecosystems (Adner, 2016). In lieu of incremental improvements, focal actors are keen (together with their long-term partners) on co-inventing radically new and non-replicable solutions (Ritala et al., 2013; Valkokari, 2015). Value creation process in innovation ecosystems is described dynamically from the “building” phase to “management” (Ritala et al., 2013), where the mechanism becomes clearer over time (Ben Letaifa, 2014; Chen et al., 2016; Ritala et al., 2013). Similar to value creation, value capture is a dynamic process in innovation ecosystems. In fact, for effective value capture, an actor needs not only the ability to capture a share of the collectively created value, but also the ability to capture value through other actors’ efforts in further stages of value creation (Chesbrough et al., 2018).

3.2.2. Drivers of EVCC

Four major drivers that influence EVCC in ecosystems were identified in the content analysis: ecosystem attractiveness, efficient architecture and platform design, proper management of intellectual properties (IPs), and government intervention. Fig. 5 represents a visualisation for the major drivers of EVCC.

Ecosystem attractiveness

The literature review identified ecosystem attractiveness as one of the main drivers of EVCC. Value maximization and risk minimization were regarded as the two major incentives for actors to join ecosystems. Maximizing financial value (Chesbrough & Appleyard,

2007; Herskovits et al., 2013), having competitive advantage and higher degree of innovativeness (Herskovits et al., 2013; Luo & Triulzi, 2018; Mäkinen et al., 2014), and creating social value (Fulgencio, 2017) are the main incentives for ecosystem partnerships. Reduction of risks and uncertainty impacts also has a positive outcome in ecosystems, such as leading to higher motivation for external complementarities, cost reduction, more consistent and trustful knowledge sharing, and ecosystem differentiation (Williamson & De Meyer, 2012).

Efficient architecture and platform design

Standardization of platforms enables better access to partners’ knowledge and resources and thus to better EVCC (Tura et al., 2018). In addition, a proper and explicitly designed platform allows firms to grow more symbiotically and systematically (Li, 2009). The application of a wrong ecosystem architecture per se can lead to failure of the ecosystem. Therefore, considering the ecosystem architecture at all stages of the conceptual platform design is paramount (Tee & Gawer, 2009).

Proper management of IP

Proper IP management by ecosystem orchestrators not only positively affects their captured value, but also increases the entire EVCC (Azzam et al., 2017; Leten et al., 2013). Therefore, R&D investments for smart selection and implementation of appropriability mechanisms are essential, which in turn helps to minimize negative effects of spillovers, and also to maximize R&D productivity (Teece, 2018). Furthermore, focal firms can allow complementors to use their IPs to develop their own technologies in new markets as well

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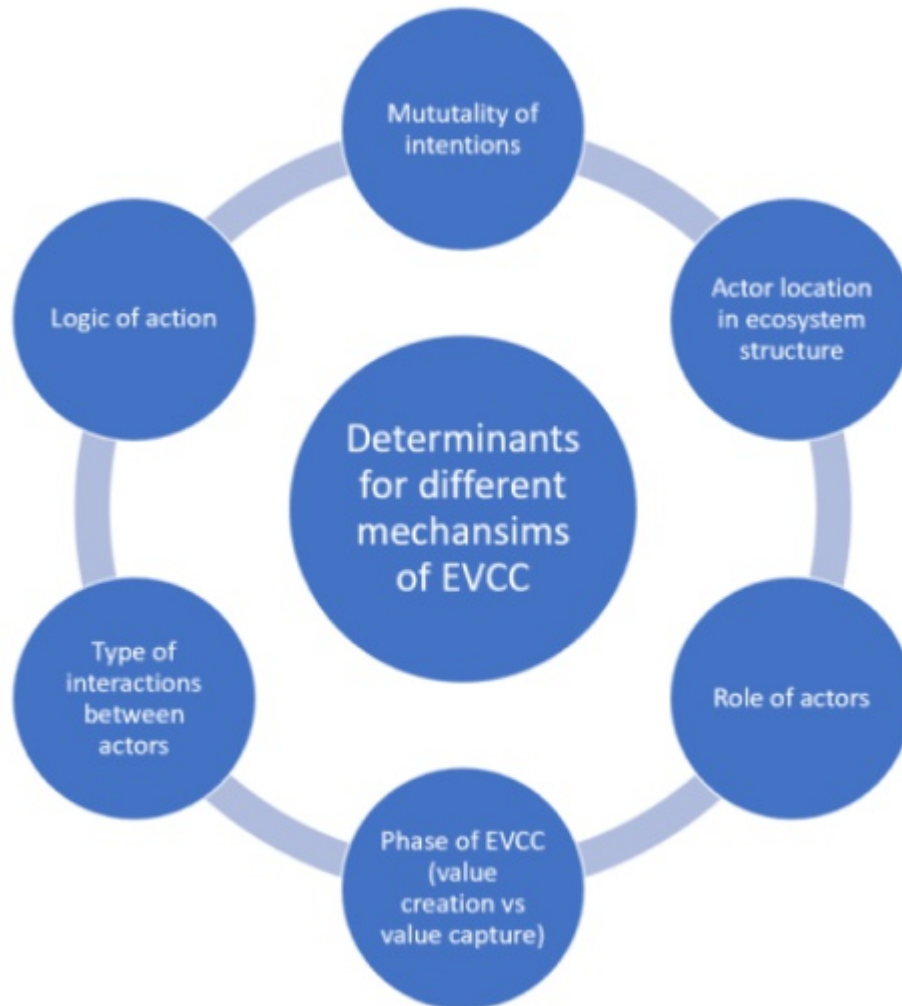


Fig. 4. Determinants for different mechanisms of EVCC

as generate new and diversified sources of revenue for their ecosystem (Azzam et al., 2017).

Government intervention

Government intervention by means of supportive funding plans and regulatory policies also often affects EVCC. External funds and common objectives of regional knowledge and innovation ecosystem actors have proven to have a significantly positive influence on EVCC (Radziwon et al., 2017). However, funding regional knowledge ecosystems without proper commercialization plans does not necessarily culminate in shaping a network of industrial firms for better innovation output (Clarysse et al., 2014). In the absence of regional players that commercialize innovation outputs from knowledge ecosystems, governments can intervene by inspiring global technology players,

investors, financial agencies, and crowd-funding to support regional knowledge ecosystems (Clarysse et al., 2014). City governments have a critical orchestrating role by providing integrated solutions for end customers and also of facilitating the interactions between ecosystem members through the making of local 'platform hubs' (Visnjic et al., 2016). Inconsistent decision-making in multi-layered governments, however, has a tendency to delay the potential value appropriation process of new technologies (Teece, 2018).

3.2.3. Challenges for realization of EVCC

Challenges for realizing EVCC have been discussed mainly with regard to innovation and business ecosystems. In innovation ecosystems, focal actors encounter challenges where applying certain strategies

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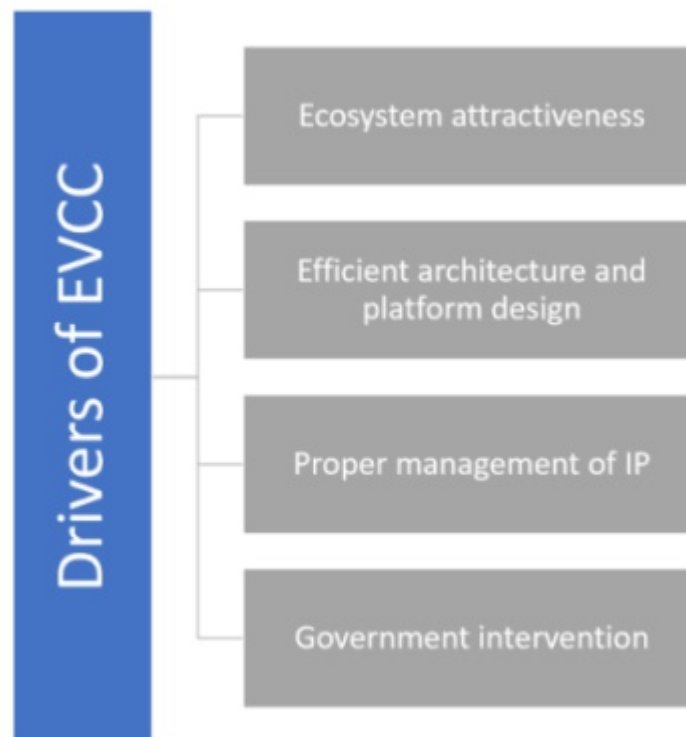


Fig. 5. Major drivers of EVCC

are essential to survive the ecosystem. Overlooking systematic partner selection in innovation ecosystems may result in serious consequences as radical changes in technologies and platforms are expected (Pellikka & Ali-Vehmas, 2016). The effect of challenges with upstream and downstream sectors are asymmetric and unlike the positive effects of bottlenecks related to suppliers' delay in innovation, such bottlenecks emerging by complementors curb the speed of innovation for leaders (Adner & Kapoor, 2010). Despite the positive effects of upstream bottlenecks for value creation, the risk of opportunistic behaviours by upstream sector for changing contracts in their favour is high. Although focal actors' complementary technologies may differentiate their platforms, it is likely that their core technology would permeate because of such disclosures and allow other players (with the same expertise) expropriate the focal technology (Toh & Miller, 2017). Start-up companies face serious challenges in persuading incumbents for further support of technology development and commercialization (Ansari et al., 2016). The absence of ecosystem culture, improper or no orchestration mechanism and replacement of rivalry instead of competition are the main threats for innovation ecosystems (Ben Letaifa, 2014).

In business ecosystems, keystones must be mindful about domination and the extent of access to platforms by complementors. Domination has been known as a big challenge in ecosystems as it can make the ecosystem vulnerable and easier to fail (Tellier, 2017). Despite the benefits of 'kingpins' in industry segments, their presence and dominance increases the heterogeneity in value and R&D leadership within the segment over a long run (Jacobides & Tae, 2015). Access of complementors to platforms owned by focal firms have been among the challenges in business ecosystems. In software ecosystems, access of complementors to the resources and knowledge of platform owners is essential for value co-creation. The motivation for open source software vendors is not benefiting from the product itself, but the complementary and intangible assets such as tacit knowledge and differentiation (Morgan et al., 2013). Despite success stories in open business models, their implementation and governance could be challenging (Huber et al., 2017). Attraction and retention of complementors, lack of innovation and support from complementors, and revenue generation are among those challenges (Chesbrough & Appleyard, 2007). Table 3 concisely demonstrates the discussed challenges for ecosystem actors taking the location of actors (structure-wise) into account.

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Table 3. Challenges of ecosystem actors for realization of EVCC

Challenge No	Challenge	Actor location
1	Systematic partner selection	Focal actors
2	Delay in complementary contributions to the major platform	
3	Expropriation of focal technologies by other ecosystem actors	
4	Absence of ecosystem orchestration mechanisms	
5	Extent of complementors' access to the focal actor's platform	
6	Continuously attracting and retaining complementors	
7	Lack of innovativeness in complementary contributions	
8	Dangers of domination	
9	Persuasion of incumbents for supporting radically new technologies	Start-ups and new entrants
10	Absence of ecosystem culture	All actors
11	Replacing constructive competition (for better EVCC) with destructive rivalry	
12	Business models and revenue generation	

3.2.4 Effective strategic and operational practices for EVCC

Ecosystem business models and collective approaches towards characterizing roles and strategies for all actors are crucial (Borgh et al., 2012; Ikävalko et al., 2018; Papert & Pflaum, 2017). Despite the criticality of orchestrating roles of keystones, a collective approach towards ecosystem orchestration with more flexible and extensible business models (Rong, Patton, & Chen, 2018) is essential for improving EVCC (Valkokari, Seppanen, Mantyla, & Jylha-Ollila, 2017), because ecosystems' constructs and interdependencies cannot be predicted ahead of time (Dattee, Alexy, & Autio, 2018). Flexible and collective approaches in ecosystem business models support start-ups to manage uncertainties while developing radically innovative technologies (Vasconcelos et al., 2018). Invention of disruptive technologies and disruptors' entry stimulate the emergence of 'business model adaptation' and formation of ecosystem business models by incumbents to source external knowledge (Cozzolino et al., 2018). An ecosystemic approach towards cybersecurity enables identifying the major stakeholders, prioritizing risk mitigating plans, and creating more value for end customers (Tanev et al., 2015). In contrast, a "performative approach" collectively frames and reframes all the plans and joint activities within an ecosystem, giving an example of practices that offer

firms flexibility and respond to uncertainties more efficiently (Kumaraswamy et al., 2018).

Applying certain strategies and practices in ecosystem business models can significantly enhance EVCC. Identifying and involving universities and research centres, integrating knowledge, and disseminating knowledge are considered as essential practices for enabling innovation ecosystems (Spena et al., 2016). Network visualization is an invaluable practice for identifying opportunities by extracting information on current interactions (Li, 2009; Still et al., 2014). In addition, dynamic capabilities support platform leaders (Helfat & Raubitschek, 2018) and complementors (Ehrenhard et al., 2017) to overcome ecosystem challenges more effectively. Facilitating innovation processes in individual organizations and creating innovation communities (Hooge & Le Du, 2016) serve to strengthen value creation in knowledge ecosystems (Borgh et al., 2012).

Essential strategies are required for focal firms prior to becoming an ecosystem leader. Leaders need to define a clear vision for the ecosystem, design a modular platform with open modules for other members' contributions, continuously monitor the relationships, make continuous innovations, and ensure the platform is always interesting for complementors (Pelikka & Ali-

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Vehmas, 2016). Managers must also have a correct perception of the limits of their knowledge, the higher value of integrating intellectual properties, and the importance of the proposed value (Williamson & De Meyer, 2012).

Platform leadership strategies have significant influence on EVCCs and ecosystem survival. Proper architecture that enables convenient interactions between players, control over the relationship with other ecosystem actors, and monitoring the competitiveness of the platforms is the responsibility of the platform leader (Helfat & Raubitschek, 2018). But this is insufficient for success in the ecosystem game. Idea evaluation, partner selection and incentivization, making continuous improvements to core competencies, proper orchestration, continuous revision of business models, and adopting appropriate expansion strategies are among other keystone responsibilities (Gawer & Cusumano, 2014). In order to expand an ecosystem's boundaries, mergers and acquisitions (M&A) could be a helpful and effective strategy. A key success factor in M&A is leaving the assignees' culture and employees virtually unchanged, while providing them with new leadership training, instead of recruiting a new labour force (Li, 2009). Vertical integration has been shown as a successful strategy in order to prevent the risk of opportunistic behaviour by firms in upstream sectors (Adner & Kapoor, 2010).

Assessing partners before and during partnerships is paramount for all ecosystem actors. Assessing core competencies and the extent of internal complementary activities enables platform vendors to identify the need for complementarities, thereby informing the selection of the right partners (Kude et al., 2012). Setting up rules and unique practices for each dyad, as well as explicitly defining the optimum degree of openness (Parker et al., 2017), minimizes risks and provides co-creation of the maximum possible value (Huber et al., 2017). Keystone leaders must have appropriate strategies for attracting complementors under various market and dominance conditions (Mantovani & Ruiz-Aliseda, 2016). However, focal actors must pay special attention to the risk of core technology disclosure. A higher degree of firm-complementor collaboration is possible only when the core technologies and competencies are distinct (Kapoor, 2013). Analysis of EVCC from the perspective of complementors and how they evaluate partnerships in ecosystems are crucial as they create a large share of value in ecosystems (Gawer & Cusumano, 2014; Teece, 2018). Access to keystone resources and taking

advantage of their innovativeness and reputation, enable complementors to help expand the firms production (Morgan et al., 2013). The main motivation for complementors to collaborate with platform leaders is to improve the platform's attractiveness and viability (Chesbrough et al., 2018; Morgan et al., 2013). Input-oriented views (resource motivation and hub capabilities) and output-oriented views (product-level complementarity) should be combined to evaluate the motivation of "spokes" for partnering with "hubs" (Kude et al., 2012).

In platform-based business ecosystems, it is crucial to pay special attention to retaining end-users (rather than complementors), reducing the application review time, and lowering the frequency of platform updates (Song et al., 2018). Diversity of users is one of the keys to success in value creation for platform ecosystems (Kim, 2016). System usability, service variety, and user connectivity influence user value (Haile & Altmann, 2016). Beta products are essential for the competitiveness of a business ecosystem in a new product development phase (Mäkinen et al., 2014). Some platform leaders such as LEGO go even further to build sustainable producer-user ecosystems. Such ecosystems benefit from lower risks for entrepreneurship, increase in product lines and market segments, and higher level of awareness or "buzz" surrounding new ideas (Hienerth, Lettl, & Keinz, 2014). Due to the heterogeneous behaviours and preferences of customers in platform lifecycles, complementors must contemplate different option strategies in the early stages, and develop the most successful ones afterwards (Rietveld & Eggers, 2018). Table 4 demonstrates the effective strategies and practices for EVCC by taking various types into account.

3.3. Potential avenues for future research

Content analysis of the final sample shows that there are missing puzzle pieces in the literature of ecosystems and EVCC. This could signify potential for further research development.

3.3.1. Empirical studies on non-focal actors for EVCC

Most research in ecosystems and EVCC is shaped around focal actors (Aarikka-Stenroos & Ritala, 2017) and how they influence EVCC. Much less focus is on how complementors, policy makers, investors, start-ups, and intermediaries influence EVCC. Only a few studies drew on the role of innovation intermediaries, business incubators, and business accelerators (Carvalho & Galina, 2015; Ngongoni, Grobbelaar, & Schutte, 2017) in entrepreneurial ecosystems. For a

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more established concept, it is crucial to have a deeper understanding of all participating actors and how they operate in the ecosystem. For instance, it would be interesting to examine the ways ecosystems address the tensions among all actors as it pertains to cannibalization over resources. Thus, although radical innovation may create invaluable opportunities for ecosystems, it could also be in some ways challenging to actually benefit from the radical idea, since all partners in an ecosystem need to fully respond to a major change with respect to their various platforms and portfolios.

3.3.2. Appropriability regimes in ecosystems

In comparison with ecosystem value capture, scholars have focussed more on value creation in ecosystems. Increase in an ecosystem's value creation does not necessarily result in higher appropriated value by the actors, unless a precise value appropriation regime (Veugelers & Cassiman, 1999) exists in the ecosystem. To this end, collective and dynamic strategies for protecting intellectual property rights are required in ecosystems. Notwithstanding a few studies (see for example, Huang et al., 2014; Hurmelinna-Laukkanen & Puumalainen, 2007; Hurmelinna et al., 2007), the current level of knowledge regarding collaboration and ecosystem appropriability regimes remains limited.

3.3.3. Consequences of technological and industrial convergence for ecosystem actors

Industrial and technological convergence are not new phenomena (Athreye & Keeble, 2000; Rosenberg, 1976). Although numerous contributions have been made on the process of convergence (Hacklin et al., 2009), including challenges in technological convergence (Jeong & Lee, 2015), asymmetries in technological diversification (knowledge enhancement), and business portfolio diversification (Gambardella & Torrisi, 1998), as well as other case studies for technological and industrial convergence (Geum, Kim, & Lee, 2016; Li & Ouyang, 2017, 2018), nevertheless, still too little is known about the consequences of industrial and technological convergence on the performance of ecosystem actors. For example, the ability to predict possible new technology fusion futures would be highly beneficial for organizational strategies or to help with the adjustment of innovation policy instruments, as a consequence of technological and industrial convergence and new waves of change in technology platforms.

3.3.4. Applying lean thinking in ecosystems

Although analysing ecosystems is complex and system thinking cannot easily be applied to ecosystems, there

are still handy practices from systems engineering and new product development that can be applied to an ecosystems approach. Lean thinking for frugal innovation (Zeschky et al., 2011) is among such practices. The majority of papers relevant to EVCC analysed management strategies to increase EVCC in the contexts where highly competitive markets require ecosystems to have differentiation advantages through a variety of complementary solutions. The papers discussed either how mature ecosystems retain their competitive advantages or how radically innovative ecosystems emerge from disruptive technologies. There is, however, a lack of understanding about how lean manufacturing with cost reduction incentives and frugal innovation practices can bring various actors together to collectively deliver products, in particular where the main functionalities (in comparison with incumbent technologies) are included, but at a cheaper cost.

3.3.5. Diversifying knowledge sources and analytics for systematic knowledge exploration

Another issue to empirically address is the relationship of using different sources of information by ecosystem actors with EVCC. Although data science has long been used in both academia and industry, less attention has been paid to how all actors within ecosystems may benefit from using diverse electronically available data sets in combination with a variety of analytics techniques such as scientometrics, patentometrics, social network analysis, and text mining. The key translation requirement is how to "humanize" new value creation and capture for the mutual benefit of various actors within these combined digital and "offline" ecosystems.

Consider a wind energy ecosystem, for example, where the ecosystem consists of different types of actors in different locations including the upstream sector (basic applied research units, R&D departments, universities, raw material providers and suppliers of wind turbine components), downstream sector (complementors facilitating the distribution and consumption of wind power, service and maintenance sector, infrastructure providers, etc.), governments, unions and associations, research funding agencies, investors, end-users, and more (Valkokari, 2015). In this ecosystem, patentometrics, social network analysis, and text mining enable industry managers to access valuable knowledge regarding technological trajectories, promising technologies, and major industry players (See for example, Castriotta & Di Guardo, 2016; Daim et al., 2006; Kapoor et al., 2015; Ranaei et al., 2016).

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Table 4. Effective strategies and practices for EVCC

Types of strategies and practices	
Dynamic leadership essentials	User-related
Provision of proper architecture to enable convenient interaction between actors	End-user retention
Monitoring platform competitiveness	Reducing application review time and number of updates
Continuous ideation for platform attractiveness	Having a diverse range of users
Continuous complementor incentivization	Enhancing usability
Continuous orchestration	Enhancing service variety
Continuous revision of business models	Enhancing user connectivity
Appropriate expansion strategies	Producer-user platforms
Continuous partner assessment	Real option strategies based on heterogeneity of users
Attention to dyad-specific rules, unique practices and openness optimum	
Core technology IP protection	
Maximizing the value of accessing ecosystem resources	

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Table 4. Effective strategies and practices for EVCC (cont'd)

Strategy/ practice No	Collective	Leadership prerequisites
1	Collective approach towards characterizing roles and strategies	Clear vision for ecosystems
2	Ecosystemic approach towards cybersecurity	Designing a modular platform with open modules for complementarities
3	Flexible business models	Ensuring the monitoring system and governance infrastructure
4	Collective knowledge creation and dissemination	Ensuring continuous attraction of the platform in the design phase
5	Network visualization for monitoring interactions	Acknowledging the limitations of the platform
6	Enhancing dynamic capabilities	Understanding the value of shared IP
7	Facilitating innovation process	
8	Creating innovation communities for knowledge creation	
9		
10		
11		

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Scientometrics in combination with social network analysis and text analytics allow managers of research organizations and universities to access insightful information about the emergence of basic research in wind energy, state-of-the-art research topics and the network structure of knowledge workers and actors in wind energy research (See for example, Bonilla et al., 2015; Facin et al., 2016; Randhawa et al., 2016). Market research and consumer analytics provide market analysts and managers with valuable knowledge about the past, present, and future of technology markets in the wind energy ecosystem (See for example, Erevelles et al., 2016; Tirunillai & Tellis, 2014).

However, these sources of knowledge must not be considered separately, but rather only together as a whole for forecasting, strategizing, or adjusting innovation policy instruments. This is because the ecosystem actors have ongoing interactions with each other and as a result the “real time” output from each of the actors’ analyses of the ecosystem may be relevant to all ecosystem actors. In many cases, subscribing to most data sources required for data extraction and analysis are free of charge, or at least available to analysts and researchers at reasonable costs. Therefore, using electronically available data sets may serve to assist with reducing the amount of resources required for collecting primary data in organizations (Khademi, 2019).

4. Discussion and Conclusion

A recent upward trend in publishing papers relevant to EVCC has occurred in the literature. However, the contributions remain fragmented and up until now highlight several different themes of EVCC. Therefore, in this paper a systematic review of literature was conducted to shed light on the growth of EVCC studies over time (RQ1), to explore the hitherto underlying themes discussed in the scholarly research of EVCC (RQ2), and to identify potential opportunities for future research for EVCC (RQ3). In response to RQ1, the literature on ecosystems has been accommodating an increasingly growing number of research papers on EVCC. Sixty percent of the papers in the sample have been published since 2016, with 26.7% in 2018. This finding is in line with Scaringella and Radziwon (2017) in that the number of papers relevant to ecosystems has started to significantly grow over the past few years. The *International Journal of Technology Management, Research Policy, Technological Forecasting & Social Change*, and *Technology Innovation Management Review* have been the most popular journals among

scholars in EVCC research. Scholars affiliated to American, British and Finnish organizations have showed the most interest towards EVCC research.

The results of content analysis in response to RQ2 revealed that the underlying themes in the fragmented EVCC literature were different EVCC mechanisms and their determinants, major drivers of EVCC, challenges for realising EVCC and, effective strategies and practices for EVCC. The output of the content analysis served as an input to help identify some of the remaining research puzzles in the fields of ecosystems and EVCC, hence the response to RQ3. Among the many possible future research opportunities, this study implied the potential for response to the paucity of empirical research on several areas: non-focal actors for EVCC, proper appropriability regimes in ecosystems, consequences of technological and industrial convergence for ecosystem actors, application of lean thinking in ecosystems, and diversification of knowledge sources and analytics for systematic knowledge exploration in ecosystems.

The study contributes both to academic research and practice. It extends the existing literature on the intersection of ecosystems, value creation and capture, and strategy by synthesizing the contributions on EVCC. Although other scholars have previously conducted systematic literature reviews on the co-evolution of ecosystems (Makinen & Dedehayir, 2012), roles of different actors in the start-up phase of ecosystems (Dedehayir et al., 2018), empirical research in ecosystems (Järvi & Kortelainen, 2017), varieties of ecosystems and their invariants (Scaringella & Radziwon, 2017), service ecosystems (Kohtamaki & Rajala, 2016) and, terminologies and concepts used in ecosystem literature (Aarikka-Stenroos & Ritala, 2017; Alvedalen & Boschma, 2017; Oh et al., 2016; Ritala & Almpantopoulou, 2017; Stam, 2015), there has not yet been an attempt to organize and synthesize the various different studies that have focussed on and proven relevant to EVCC. Furthermore, this study contributes to theoretical knowledge by ushering forward into view some of the potential avenues for future research in ecosystems and EVCC. Managers can thereby benefit from this research irrespective of the position of their firms in ecosystem game dynamics, especially C-suite managers can use the content analysis results to aid with better strategic planning and operations management.

Similar to all academic research, this study was subject to limitations. First, due to the scholars’

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recommendations on the advantages of WoS to Google Scholar and SCOPUS for conducting review or bibliometric analyses in management studies, the data collection process was limited to extracting data only from the WoS database. Second, non-peer reviewed documents including book sections, non-peer reviewed conference papers, and non-English papers were excluded from the final sample. Although these strategies may have resulted in the absence of some relevant articles from the sample, nevertheless it included most of the relevant high-quality papers involving EVCC. Third, the opportunities identified for future research were subjective and limited to the experience of the author of this paper. Other researchers with different academic or practical experiences may have identified other missing pieces of the research puzzle that as a community we may also strive in our own way and together to complete or to solve.

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