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ARTICLE

Orchestrating ecosystems: a multi-layered framework

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ABSTRACT

Ecosystems are distinguished from other structural arrangements for value co-production by the nature of their governance and coordination challenges. As ecosystems are marked by their relative non-reliance upon formal, 1–1 supplier contracts to govern and coordinate productive activities, they need to find non-hierarchical ways of orchestrating ecosystem constituents such that a coherent system-level value offering is enabled and targeted at a defined user audience. Importantly, ecosystems cannot rely on 'command-and-control' governance to coordinate inputs from different participants, as would be the case of conventional supply chains. Instead, ecosystem leaders need to persuade others to make voluntary inputs that are consistent with the ecosystem's overarching value offering. I call this task 'ecosystem orchestration'. In this essay I suggest an ecosystem orchestration framework that distinguishes between technological, economic, institutional, and behavioural layers of ecosystem orchestration. I begin by highlighting distinctive governance challenges of ecosystems. I then provide a brief overview of the ecosystem orchestration literature. Then I introduce the different domains in which orchestration can be exercised. I conclude with a framework for orchestrating innovation ecosystems from birth to maturity. In addition to distinguishing between and describing technological, economic, institutional, and behavioural layers of ecosystem orchestration, the model also distinguishes between three stages of ecosystem momentum creation: initiation, scaling, and control. This framework has been designed to help practitioners to design strategies for ecosystem momentum creation.

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Introduction

Firms increasingly choose an ecosystem strategy over alternative arrangements to drive value co-creation, co-production, and capture (Dattée et al., 2018; Hannah & Eisenhardt, 2018; Williamson & De Meyer, 2012). In contrast to market- and industry-based strategies, where the focal firm adapts to its competitive context, an ecosystem strategy is a form of endogenous strategic action: it seeks to shape the competitive context such that the firm can build, leverage, and extend, rather than locate and occupy, a strong competitive position (Adner, 2017; Autio & Thomas, 2018). Because ecosystems are characterised by the presence of stakeholders who make active contributions to the ecosystem offering without relying on formal, one-to-one supplier contracts to coordinate their activities in a 'command and control' mode, achieving such an outcome requires careful

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orchestration to persuade others to behave in ways consistent with the ecosystem vision (Ansari et al., 2016; Dattée et al., 2018; Ozcan & Eisenhardt, 2009). Such orchestration seeks to both establish a desired architecture of stakeholder roles and value-creating interactions among these, and to drive the creation and mobilisation of valuable resources and assets (Autio & Thomas, 2020; Dhanaraj & Parkhe, 2006; Nambisan & Sawhney, 2011; Sirmon et al., 2011).[1]

Although the importance of orchestration has been widely recognised in the literature, there has not been much research focusing on tangible actions firms can take to successfully orchestrate an innovation ecosystem from inception to maturity. Received studies and frameworks with an explicit focus on orchestration have typically taken a high-level conceptual approach and considered, e.g., network structural properties necessary to enhance innovative outputs of the network (Dhanaraj & Parkhe, 2006), identified high-level organisational tasks to effect orchestration (Nambisan & Sawhney, 2011; Sirmon et al., 2011), considered third-party orchestration activities in an established innovation network (Giudici et al., 2018), focused on specific orchestration activities (Ansari et al., 2016; Dattée et al., 2018; Ozcan & Eisenhardt, 2009), or simply side-stepped the need for orchestration altogether and assumed a top-down implementation of the desired ecosystem architecture (Adner, 2017). While informative, none of the above approaches comprehensively addresses tangible steps business managers could take to orchestrate ecosystems in practice – particularly over the life cycle of the ecosystem. In this essay I seek to address this gap by building on my previous work with different co-authors, with whom we have studied ecosystem creation, coordination, and governance challenges over the past several years.

This essay will proceed as follows. I will first discuss the concept of ecosystems in the light of recent theorisation. I will specifically focus on the governance aspects of ecosystems, which then define the orchestration challenge. After this I will highlight different approaches to ecosystem orchestration in the received literature. I will then introduce a multilayered perspective to ecosystems, which distinguishes four layers at which ecosystem orchestration may play out: technological, economic, institutional, and behavioural. I conclude by illustrating tangible actions at each layer that can be brought to bear when seeking to maximise the ecosystem's value co-discovery, co-creation, and appropriation potential.

Innovation ecosystems: a definition

Given the burgeoning ecosystems literature, it is not surprising that the 'ecosystem' moniker has been slapped onto a wide range of organisational collectives. In the literature one can find mentions of 'business ecosystems', 'platform ecosystems', 'innovation ecosystems', 'knowledge ecosystems', 'entrepreneurial ecosystems', 'industry ecosystems', 'technology ecosystems', and 'sector ecosystems', to list a few. In many situations the usage is overlapping, yet not conceptually clarified. These terms mingle with a host of other terms to denote various kinds of organisational collectives, regional agglomerations, and value co-production systems, such as 'industry', 'supply chain', 'network', 'value network', 'innovation network', 'cluster', 'knowledge cluster', 'innovative milieu', 'industrial district', and 'regional and national systems of innovation'. This proliferation is problematic, since if the ecosystem label is slapped indiscriminately upon a broad range of different organisational constellations, the concept loses its theoretical distinctiveness, and therefore, its power to inform managerial choice. It is therefore critical to define the concept in such a way that: (1) it meaningfully distinguishes the concept from related concepts; (2) it uniquely defines a phenomenon that either did not exist previously or has been under-researched; (3) it is able to meaningfully inform managerial action.

In my recent work with colleagues we have sought to address this challenge (Thomas & Autio, 2020). We observed that one of the pioneers of the 'ecosystem' approach to understanding industry competition, Jeffrey Moore (1993) never actually defined what exactly he meant with the term, simply asserting that an 'ecological' approach was 'different' from industry- or sector-level analysis. In fact, so strong has been the practitioner orientation of the ecosystem literature that we had to wait until the 2010s for serious attempts to consolidate theoretical and conceptual underpinnings (Adner & Kapoor, 2010; Adner, 2017; Autio & Thomas, 2014; Dattée et al., 2018; Jacobides et al., 2018; Shipilov & Gawer, 2020; Wareham et al., 2014). However, the proliferation of this literature has been such that more work is necessary (for recent reviews, see Aarikka-Stenroos & Ritala, 2017; Gomes et al., 2018; Oh et al., 2016; Scaringella & Radziwon, 2018; Suominen et al., 2019).

In my work, we have identified four distinguishing commonalities across different ecosystem concepts in management: participant heterogeneity, a coherent system-level output, the nature of interdependence among ecosystem participants, and the nature of ecosystem governance (Thomas & Autio, 2020). While none of the above characteristics alone is sufficient to distinguish ecosystems from other forms of organisational collectives, we argued that the combination was unique to ecosystems. As regards participant heterogeneity, although this is a feature exhibited by many organisational collectives, the heterogeneity of participants in ecosystems is often greater and can transcend industry sectors and the boundary between public and private sectors. As regards system-level output, this is a characteristic that helps distinguish ecosystems from inter-organisational networks, which seldom seek to coordinate such an output at the system level, instead limiting themselves to creating benefits for network participants. Distinguishing ecosystems from supply chains, ecosystems rarely if ever feature an 'integrator' firm that combines the outputs of various suppliers into a coherent package for delivery to the end customer, which is a common role in supply chains.

As regards the nature of interdependence, ecosystems tend to exhibit a high level of mutuality in a principal-principal setting, as opposed to a principal-agent relationship characteristic of supply chains. Supply chains are governed through one-to-one formal supplier contracts, which define, ex ante, the contractual obligations of the 'agent' (i.e., the supplier) and of the 'principal' (i.e., the customer), respectively. Importantly, supplier agreements also specify, in detail, the product or service the supplier is expected to deliver. In contrast, although an ecosystem may incorporate formal, one-to-one contracts among some of its multiple stakeholders, characteristic of ecosystems is the presence of principal-principal relationships that the different parties enter upon their own volition, and which are not defined by a formal, one-to-one supplier contract. For example, although the developers of smartphone applications typically accept licencing conditions when making their apps available through mobile application stores, these are standard licencing conditions that apply similarly to all developers and primarily define the sharing of revenue from the sales of the application on the platform. The licencing conditions do not define what kind of application the developer is supposed to develop and by which date. It is the application developers who define the application and whether they accept the standard publishing and revenue share conditions of the platform. This sets up the distinctive governance challenge of ecosystems, since the platform owner cannot contractually oblige application developers to develop anything, nor can they contractually compel these to join their ecosystem, yet the value of the platform is significantly affected by the number and quality of applications that the platform owner is able to attract to the platform.

The widespread presence of principal-principal relationships in ecosystems means that the value of the outputs generated by any individual ecosystem participant is partly defined by the presence of complementary outputs independently and voluntarily generated by others – over whom the focal participant has little or no formal hierarchical authority. This defines the orchestration challenge of ecosystems: how can ecosystem participants persuade others to behave in ways such that the value of the focal participant's offering increases in the eyes of the eventual recipient of the ecosystem's collectively generated value offering? It is this nature of ecosystem governance that sets ecosystems apart from supply chains, which are, in essence, upward-branching chains of formal, one-to-one supplier contracts. In ecosystems, these are replaced by less hierarchical arrangements, such as one-to-many licencing conditions, agreed role definitions, non-formal conflict resolution mechanisms, network effects, and ecosystem structural properties such as the architectural facilitation of supermodular complementarities (Jacobides et al., 2018). On the basis of the above, I suggest the following definition for an innovation ecosystem (Thomas & Autio, 2020):

> An innovation ecosystem is a community of hierarchically independent, yet interdependent heterogeneous participants who collectively generate a coherent, ecosystem-level output and related value offering targeted at a defined user audience.

As can be discerned from the above definition, I consider ecosystems as structures for value co-production: ecosystems are organisational collectives that combine efforts to create a coherent, system-level value offering that targets a defined audience. Ecosystems 'do' something to create value for someone. In contrast to conventional supply chains, the offerings co-created and co-produced by ecosystems are more malleable and offer more opportunities for users to define what the exact value offering would be in their case. This means that users in ecosystem structures assume a more active role than is characteristic of conventional supply chains. To illustrate this point, consider the example of cars. OEM manufacturers (who act as system integrators) offer customers a defined range of options. Say, the customer may choose the colour of the car, among the many options regarding upholstery, audio systems, lighting systems, and so on. Even though the number of resulting configurations is large enough to permit an individualised car for each customer, it is still the OEM who performs the final integration. The customer chooses, but the OEM integrates. In ecosystems, particularly those organised around digital platforms, the customer may play a more active role, for example, as the assembler of the final offering and as a source of generative inputs into the ecosystem (Zittrain, 2006).

Another point worth elaborating concerns the notion of hierarchical independence. As noted above, as a rule, ecosystems do not rely extensively on formal, 1-to-1 supplier contracts as the principal governance mechanism to coordinate the actions of different ecosystem participants (Jacobides et al., 2018). As noted above, the relationships between ecosystem participants are predominantly principal-principal relationships. This creates a distinctive challenge for ecosystem orchestration. In supply chains, suppliers are commissioned to deliver goods and services to predetermined contractual specification. Both the supplier's and the buyer's obligations are defined ex ante and made explicit in the contract, meaning that the only uncertainty the supplier faces concerns the buyer's ability to pay upon delivery. In ecosystems where formal 1-to-1 contracts are largely absent, the roles and obligations of different stakeholders are more implicit and more difficult to enforce. Participation in the ecosystem is therefore more voluntary, meaning that each participant needs to find sufficient reason to join the ecosystem. For supply-side participants, common motivations include the prospect of being able to access a large customer audience (e.g., when joining a digital platform marketplace), or the prospect of being able to benefit from indirect network effects, where the presence of complementary products and services enhance the value of the supplier's offering in the eyes of prospective buyers. For user-side participants, common motivations are provided by direct and indirect network effects, where the use value of the platform and its offerings increases as a function of the number of other users and as a function of compatible offerings. Common to all is that their materialisation depends on the voluntary actions of hierarchically independent others – who need to anticipate some benefit for themselves before committing to making their contributions. As the very realisation of participant benefits again depends on the actions of independent others, those benefits, as a rule, cannot be guaranteed contractually. Therefore, if the ecosystem fails to gain momentum, the desired network effects fail to materialise, and ecosystem participants fail to see the benefits that would compel them to join the ecosystem. A key challenge in early ecosystem orchestration, therefore, is to overcome the 'catch-21′ challenge of compelling voluntary participation to a sufficient degree for the participation to justify itself – with prospective participants facing the risk that if ecosystem momentum fails to materialise, any early investment in participation may be lost.

For clarity, it is useful to clarify the distinction between an 'innovation ecosystem' and a 'platform ecosystem'. Platform ecosystems are ecosystem communities whose members are connected to a defined 'platform'. Most common types of these include digital platforms such as digital marketplaces (e.g., Amazon, Alibaba, AirBnB) or digital social networks (e.g., Facebook, YouTube, TikTok). Platforms can be non-digital, too, as is the case of many two- and many-sided markets such as credit cards, yellow pages, or even physical marketplaces. To the extent that the participants of such ecosystems can create generative inputs (i.e., unprompted and hierarchically un-coordinated innovative inputs), such platform ecosystems also qualify as innovation ecosystems (e.g., TikTok, AppStore). However, innovation ecosystems do not need to have a platform at their core: a set of shared technical standards will suffice. For example, the photovoltaic solar panel ecosystem is enabled by a set of shared technical standards that ensure compatibility among inputs generated by hierarchically independent participants, yet there is no digital platform or a marketplace at its core (Hannah & Eisenhardt, 2018). Similarly, the 'Wintel' ecosystem of personal computers and equipment is not a platform ecosystem, as it is coordinated by a shared technical standard. Finally, the reason why I like to refer to 'innovation ecosystems' instead of, e.g., 'business ecosystems' is in order to emphasise the generativity that is inherent in ecosystems but typically lacking in supply chains.

Generativity is the ability of ecosystems to facilitate unprompted, unpredictable innovative outputs from large, uncoordinated audiences (Zittrain, 2006). Ecosystem participants join the ecosystem on their own volition, often with the motivation to offer innovative inputs such as, e.g., novel content or innovative applications and features. The features of those features are not defined and largely not even constrained *ex ante*. This is an important distinction from supply chains, where the required inputs are contractually defined prior to delivery. Even though suppliers may innovative (e.g., car parts supplier inventing a novel monitor to ensure that the car does not stray beyond its lane), any such innovations must be approved by the OEM manufacturer and contractually defined in the supplier contract. This robs supply chains of much of the spontaneous generativity that ecosystem arrangements are able to facilitate. I submit that ecosystems are inherently more innovative than supply chains, hence my preference for the term: 'innovation ecosystem'.

Summarising, ecosystem orchestration represents a distinctive governance challenge that largely arises from the absence of formal 1-to-1 contracts to define relationships among ecosystem participants and their reliance on the voluntarily created inputs by hierarchically independent participants for the co-production of ecosystem-level value offering and for the facilitation of ecosystem benefits[2] for the participants of the ecosystem. Yet, orchestration is required to enable the ecosystem to generate a coherent system-level offering targeted at a defined audience. Successful ecosystem governance needs to strike a balance between standardisation and variation, autonomy and control, and individualism and collectivism (Wareham et al., 2014). Two basic approaches have been suggested in the literature to address these challenges; I call them the top-down and bottom-up approaches (Adner, 2017; Dattée et al., 2018). In the following a first highlight ontological challenges associated with the top-down approach and then elaborate an ecosystem orchestration model based on the bottom-up approach.

Orchestrating innovation ecosystems: top-down and bottom-up approaches

The key difference between the top-down and bottom-up approaches concerns the ontological assumptions these make regarding the ecosystem architecture. As such, I define the ecosystem architecture to be composed of three layers: the technical architecture, which defines the functionalities the platform performs and how ecosystem participants may connect to it; the activity architecture, which defines the roles in which the different ecosystem constituents may operate within the ecosystem, as well as the relationships among these; and the value architecture, which defines what valuable contributions ecosystem participants contribute through their interactions with others and how individual ecosystem participants extract benefits from their interactions with others.

In the top-down approach, the ecosystem architecture is assumed to emerge through purposeful design and implementation activities performed by an ecosystem designer. This ontological standpoint is illustrated by the 'structural' perspective to ecosystems (Adner, 2017). In this perspective, the main task of the platform owner and the ecosystem implementor is to design an 'ecosystem value blueprint' – i.e., a planned ecosystem architecture for the realisation of the ecosystem value offering: who should do what, and how is the offering delivered to the customer. The ecosystem designer then implements this ecosystem value blueprint in a top-down fashion by recruiting ecosystem participants and assigning these to predefined roles.

While undoubtedly pertinent in many situations, especially when implemented in a well-established market, a top-down view to ecosystem orchestration carries two ontological assumptions that potentially undermine its viability in situations where the market context is less structured. First, to be able to design a value blueprint, the designer must have an idea of what is 'valuable'. Defining value is easy when a market exists with a properly functioning price mechanism: in such a situation the designer can simply ask the market. However, judging value becomes more difficult with offerings that are so new that a market for trading similar offerings does not yet exist. This would have been the case of, e.g., social media platforms when these remained a novel concept. Second, to implement a value blueprint, the designer has to compel others to accept the roles the designer envisioned for them. Paradoxically, this becomes more difficult when the ecosystem becomes more 'ecosystem-like' – i.e., when the ecosystem relies more on non-hierarchical coordination instead of formal, 1-to-1 supplier contracts (Thomas & Autio, 2021). In short, the viability of a top-down approach to value blueprint design and implementation appears to become increasingly constrained in high-uncertainty situations (Dattée et al., 2018).

In reality, evidence suggests complex ecosystems rarely emerge in their final form from scratch, especially when their value offering is new and unfamiliar to the intended user audience (Dattée et al., 2018). As the case study of TiVo nicely illustrates in the context of a well-established industry architecture, the creation of an ecosystem can be a multi-stakeholder negotiation process where the participants rarely have a good idea of what the final ecosystem would look like and what their position might be in it, if any (Ansari et al., 2016). The final form of the TiVo ecosystem was negotiated over years of collective and messy negotiations with established industry incumbents, and the final ecosystem architecture incorporated technological and organisational innovations that did not even exist at the outset. To implement its ecosystem, TiVo had to overcome strong resistance and outright hostility by established industry incumbents who initially viewed TiVo as a mortal threat. TiVo had to navigate a complex geography of an established industry architecture, identify points of weak resistance and gradually shape its offerings towards various players in the US television industry to eventually come up with a solution that redefined the industry architecture such that it could accommodate TiVo's platform. This was a messy, complex, and drawn-out process, not a straightforward implementation of a preconceived ecosystem blueprint. The case examples by Dattée et al. (2018) paint a similarly messy process in the context of de novo ecosystems and emphasise the importance of 'dynamic control' of collective ecosystem visioning (as opposed to static control of assets) in steering prospective ecosystem participants towards desired futures.

The messy reality of ecosystem creation appears to call for a more bottom-up approach, one where the ecosystem orchestrator engages in multi-sided conversations with prospective ecosystem participants to co-discover an ecosystem architecture that is palatable to all those concerned. In the final section of this essay I sketch out a multi-layered framework designed to guide such an effort.

Bottom-up ecosystem orchestration: a multi-layered framework

Above I highlighted how the ecosystem orchestrator cannot rely on an exogenous market to inform on resource value when the offering is so new that a market does not yet exist. As 'value' is not exogenously determined, it needs to be negotiated and co-discovered endogenously, in a multi-sided negotiation with prospective ecosystem participants. This negotiation ultimately determines not only what offerings are valuable, but also, by implication, what ecosystem roles and assets are valuable by virtue of their centrality to the collective generation of the ecosystem value offering (Garud et al., 2002). This kind of negotiation characterises contexts where technological standards and specifications remain open, where ecosystem roles and expected behaviours remain undetermined, and where the rules of the game need to be agreed (Autio & Thomas, 2018). In high-uncertainty situations, the ecosystem orchestrator and prospective ecosystem participants can enjoy significant scope to shape the context where they will collaborate and compete (Garud & Karnoe, 2001; Gawer & Phillips, 2013; Kaplan & Murray, 2010).

In my previous work (Autio & Thomas, 2018) we considered endogenous strategies for ecosystem creation. Recognising that innovation ecosystems are organised around a shared core and characterised by hierarchical interdependence, we consider four distinct arenas for endogenous strategic action in innovation ecosystems: technological, economic, cultural-behavioural, and institutional. Of these, the technological layer of ecosystems comprised the focal platform, or alternatively, a set of shared technological standards that underpins the ecosystem and around which the ecosystem community – its activity system – is organised. As such, the platform could be digital – e.g., a set of shared algorithmic functionalities accessible through a shared interface. The required coordination could also be achieved without a central platform – e.g., through a set of shared technological standards and technological assets dedicated to supporting it (e.g., the Wintel ecosystem). The economic layer of innovation ecosystems comprised of economic assets and policies – such as economic incentives targeted at one side of a multi-sided platform with the intent of mobilising ecosystem participation. The institutional layer of innovation ecosystems comprised rules, regulations, and externally facing institutional activities dedicated to enhancing the embedding the ecosystem to its broader societal and economic context. The behavioural layer of ecosystems comprised participant behaviours and behavioural norms defining desirable and undesirable behaviours. Building on this, I suggest that effective ecosystem orchestration should entail orchestration activities in four layers: technological, economic, institutional, and behavioural. I now suggest a multi-layered framework of ecosystem orchestration which distinguishes between the four layers, and also, between three stages of ecosystem emergence: initiation, momentum building, and maturity. The framework suggests examples of orchestration strategies and activities for each layer and emergence stage. The framework is shown in Figure 1.

Technological layer

The technological layer defines the ecosystem's platform architecture or a set of shared standards and so doing also influences its activity architecture and its value architecture. The principal function of the technological layer is to set up the foundation of the

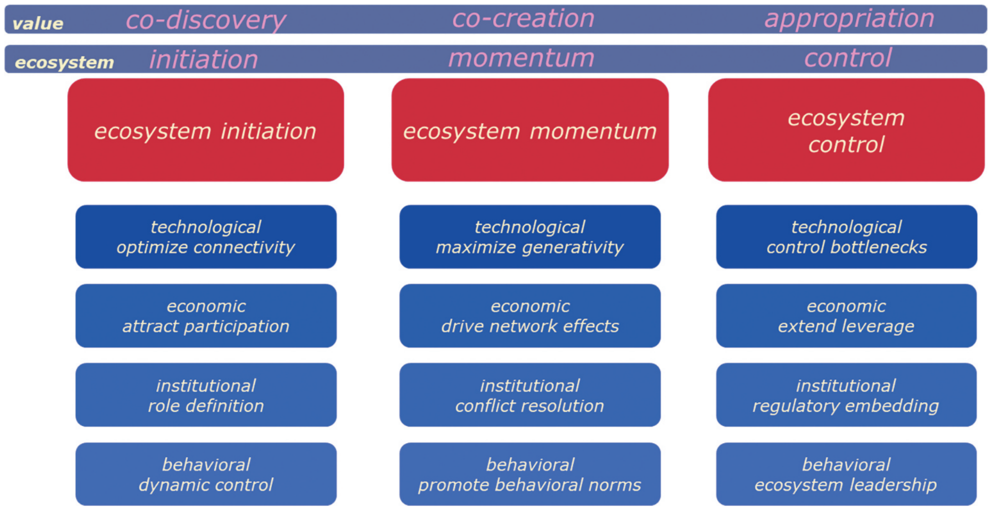

Figure 1. Multi-layered framework for ecosystem orchestration.

ecosystem architecture, notably, its activity and value architectures. Therefore, associated design decisions are central for ecosystem orchestration. These decisions include the definition of the modular architecture of the ecosystem's product and service offerings; the definition of the connectivity architecture of the ecosystem's focal platform (if any), including any associated licencing and other conditions; and the definition of technological compatibility standards for the ecosystem offering's constituent modules. Combined, the architecture of the ecosystem's focal platform and or its shared technological standards defines the intrinsic technical performance of the ecosystem offering.

The technological layer of ecosystems sets up the foundation of the ecosystem value creation. However, the set-up of the technological architecture is not a one-off decision. Instead, the emphasis of technological orchestration activities changes over the ecosystem development stages. In the initiation stage, the primary goal is to set up the conditions for the creation of ecosystem momentum, and also, to set up the activity architecture of the ecosystem. In this stage, the ecosystem's technological architecture needs to encourage participation by prospective ecosystem participants and provide guidance in terms of appropriate ecosystem roles. This is essential to kick off ecosystem momentum. Central actions in this stage would include, for example, the design of interfaces that set up ecosystem connectivity, as well as the design of a modular architecture that enables supply-side participants to create offerings that complement one another. Implicitly, these also set up the initial definition of ecosystem roles – i.e., in which roles prospective participants may join the ecosystem.

In the momentum facilitation stage, the emphasis on technological orchestration shifts towards facilitating and maximising generativity. To build momentum, it is important both to continue attract participation and set the generative processes in motion. As such, generative inputs can be facilitated by adding functionalities in the platform that make it easier for supply-side and user-side participants to contribute content, complementary applications, and other generative inputs such as reviews and ratings. To enhance supply-side generativity, the ecosystem orchestrator may also provide specialised software applications to further facilitate the generation of supply-side inputs. As an example, the Nokia-Microsoft alliance provided tools for application developers to port their applications from other mobile operating systems to Windows Mobile, in an effort to drive the growth of the Windows Mobile ecosystem (Thomas et al., 2018).

In the ecosystem control stage, the emphasis of technological orchestration shifts to maximising appropriation. At this stage, the ecosystem's network effects should be well established and ecosystem roles set. As the ecosystem is self-sustaining and network effects provide the necessary lock-in, it is important to control technological bottlenecks and leverage any resources (e.g., user data) that the ecosystem accumulates. In addition to controlling technological bottlenecks critical to the functionality of the ecosystem platform, it is also important to retain architectural control of the platform in case changing circumstances necessitate architectural modifications.

Economic layer

This layer comprises economic orchestration activities in ecosystems. Such activities cover, for example, strategic investment in complements and support structures, as well as economic incentives to encourage ecosystem participation. In the ecosystem inception stage, attracting participation is key and can be accomplished, e.g., by freemium strategies, reward incentives to reward the recruitment of new participants, offering subsidies to one side of the two (or multi) sided market to overcome the 'chicken and egg' problem, and direct investment in important complements to initiate indirect network effects. As an example, in the case of Windows Mobile, Nokia and Microsoft offered prospective application developers substantial cash rewards for developing applications on the Windows Mobile platform, only demanding a 4-month exclusivity before the developers were allowed to port their applications to competing platforms. Nokia also operated a dedicated accelerator, the AppCampus, to attract and nurture application developer teams, particularly from Eastern Europe and South Asia, where developer salaries were low.

In the ecosystem momentum stage, the emphasis of economic orchestration focuses on the promotion of indirect network effects. Whereas direct network effects are typically set up by the ecosystem's technological layer, indirect network effects may require active promotion. Such orchestration is particularly visible in application platforms, where the platform operator often selectively promotes different applications in order to build and sustain ecosystem momentum.

In the ecosystem control stage, the dynamic of the ecosystem is well established and self-sustaining, and the emphasis of economic orchestration often shifts towards leveraging ecosystem dominance by extending the ecosystem to related offerings. This is a strategy that software companies and internet giants such as Microsoft, Facebook, and Google have performed particularly aggressively, with the ultimate goal of creating walled gardens to own and lock in their user base. In the control stage, the economic orchestrator may also device novel ways to monetise its user base, as was the case of Facebook who was quite late to discover how to effectively monetise its social network ecosystem.

Institutional layer

The institutional layer of ecosystem orchestration involves establishing and negotiating the rules of the game, both internally within the platform ecosystem and externally, towards the wider society the ecosystem is embedded in. Institutional orchestration activities include role definition, conflict resolution, institutional embedding, and lobbying to secure regulatory adjustments. In the ecosystem initiation stage, it is important to start shaping the roles in which different stakeholders can participate in the ecosystem. Although partly defined by the technological architecture of the ecosystem, these roles need to be reinforced through the definition of behavioural norms and role expectations. Perhaps the most important way of achieving this is designing the one-to-many contracts and licencing conditions that regulate participant connectivity to and the use of the ecosystem platform, and user and supplier rights regarding their data, contributed content, and contributed applications. These should be open and inviting, as the emphasis in the momentum initiation stage is on encouraging participation.

In the ecosystem momentum stage, conflicts often emerge, as different participants adjust their roles and redefine their interactions. Different participants may hold different visions regarding how the ecosystem should evolve. Therefore, it is important to establish conflict resolution procedures that enable the effective resolution of conflicts such that these do not interfere with ecosystem scaling. In addition, it is important to further formalise and reinforce ecosystem roles, as these act as an informal governance and coordination mechanism and help avoid and mitigate conflict situations. In the ecosystem control stage, the societal and economic effects of the ecosystem are likely to become more visible also to the wider society and may sometimes give rise to external conflicts. It is therefore important to concentrate institutional orchestration efforts to contextual embedding to ensure that the regulatory regime adapts to the scaling ecosystem and the ecosystem itself proactively adjusts to evolving regulations. Institutional orchestration has been arguably a dominant orchestration activity for internet giants such as the Facebook, which has had to invest considerable effort to administer its continually growing social network to minimise societal harm.

Behavioural layer

The behavioural orchestration of ecosystems entails behavioural strategies to influence both other ecosystem constituents and societal stakeholders (Dattée et al., 2018). In the ecosystem inception stage, the emphasis of behavioural orchestration is to compel others to join the ecosystem even in the early absence of compelling network effects. A good example of early behavioural orchestration was provided by Ozcan and Eisenhardt (2009). They described how ecosystem orchestrators in the mobile gaming industry promoted a sense of urgency among industry stakeholders by promoting an impression that the ‘train was to imminently leave the station’, and therefore, the time to commit to the emerging ecosystem was now. This behavioural strategy was very effective in expanding early participation, and also, by virtue of locking in key industry players, created barriers to entry for followers. In their work, Dattée et al. (2018) described how ecosystem orchestrators were able to overcome uncertainty in the inception stage by exercising ‘dynamic control’ over early ecosystem visioning, and by highlighting early commitments (both internal within the incumbents and external, within the ecosystem) as uncertainty-reducing signals of early momentum.

In the ecosystem momentum stage, the emphasis of behavioural orchestration tends to shift towards pragmatic legitimation and the reinforcement of behavioural norms. Behavioural norms – i.e., agreed rules how to behave in different situations – operate as an important informal coordination mechanism in the absence of formal 1-to-1 contracts. Behavioural norms supportive of ecosystem momentum define acceptable behaviours and can take the form of, e.g., the 'hacker's ethic', under which the ecosystem community provides social rewards to those who contribute to technology commons. An important aspect of behavioural norms is generalised reciprocity, which encourages voluntary contributions towards the ecosystem in the expectation of third-party reciprocation (Wincent et al., 2009).

Finally, in ecosystem control stage, the emphasis of behavioural orchestration shifts towards ecosystem leadership, as the established ecosystem momentum starts opening up opportunities to extend the ecosystem dominance to related sectors. In this stage, behavioural orchestration may include, for example, creating and promoting visions of extended dominance, and demonstrating ways how the ecosystem offerings can be expanded in ways that benefit current stakeholders.

Conclusion

In this paper, I have attempted to provide some tangibility to the notion of ecosystem orchestration. While network and ecosystem orchestration has been addressed by several authors, many of the existing accounts remain fairly conceptual and offer only limited guidance to purposive managerial action. I have attempted to address this gap by offering a multi-layered framework of ecosystem orchestration for ecosystem initiation, momentum, and control stages. Although inevitably sketchy, I hope the framework nevertheless offers pointers for future research in this important area.

Notes

1. Consistent with established definitions, I define ecosystem orchestration as the set of deliberate and purposeful actions undertaken by the ecosystem orchestrator to encourage voluntary, value co-creating inputs and effect coordination among hierarchically independent ecosystem of the ecosystem (e.g., Dhanaraj & Parkhe, 2006; Giudici et al., 2018; Nambisan & Sawhney, 2011). Note that although the ecosystem orchestrator often is the 'hub' firm, any participants of the ecosystem may engage in orchestration activity in an effort to shape the functioning of the ecosystem.
2. Ecosystem benefits are benefits that any individual ecosystem participant may expect from their participation in the ecosystem. Different from the ecosystem value offering, which is collectively created and targeted at a defined user audience, ecosystem benefits are operationalised at the level of individual ecosystem participants.

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