

## ESSAY

# Making Research On Sustainable Ecosystems More Productive: An Essay by a Design Science Advocate

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## Abstract

Recent studies of ecosystems have generated important theoretical insights into how multiple actors can collaborate to address major sustainability challenges. However, few scholars have been able to create a real impact in terms of new ecosystem practices, tools, or other artifacts. Almost all research on (sustainable) ecosystems is largely descriptive and explanatory in nature. This generates a deep understanding of how extant ecosystems address sustainability challenges, but also undermines the capability to (co)create real changes. In this essay, I therefore make a case for adopting design science (DS), as a generic methodology, in the quest for actionable knowledge and solutions which advance the practice as well as the theory of ecosystems. The DS approach is illustrated with the development of the ecosystem pie model (EPM), a tool for mapping and analyzing innovation ecosystems. The EPM project demonstrates that the direct engagement of DS research with practice helps to weed out unproductive lines of thinking about ecosystems, especially those that cannot be operationalized into actionable tools. Moreover, it implies an innovation ecosystem is best defined as a collaboration between interdependent actors searching for a shared value proposition that any actor alone cannot accomplish.

**Keywords:** *Ecosystem; Innovation ecosystem; Sustainability; Design science; Research impact*

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Recent studies of innovation and other ecosystems have generated important theoretical insights into how various firms and other actors collaborate to address sustainability and other challenges. For example, Wareham et al. (2014) studied the underlying mechanisms and practices for the governance of a technology ecosystem. Drawing on a case study of Volvo's autonomous drive technology development, Pushpanathan and Elmquist (2022) show how alliances for developing a new technology lead to the emergence of an innovation ecosystem. Another example is Theodoraki's (2020) study of five incubation ecosystems, which demonstrates that incubators seek to achieve ecosystem benefits by employing various combinations of individual and collective strategies. Other studies have focused on how companies respond to sustainability changes and regulations at the ecosystem level (Basu et al., 2024; Schaltegger et al., 2022).

However, few ecosystem scholars have been able to create a real impact in terms of new tools, practices, or other artifacts – despite repeated calls for research that has more impact on

practice (e.g., Aguinis et al., 2014; Beltagui & Hitt, 2024) and studies that help ecosystems deliver sustainable outcomes (Josserand et al., 2024). That is, most scholars studying sustainable ecosystems develop theories that not have any impact on real-world practices.

In this essay, I therefore argue that ecosystem scholars need to adopt design science (DS) (Romme & Holmström, 2023; Romme & Reymen, 2018) to develop actionable knowledge and practical solutions (as artifacts) that advance the practice as well as the theory of sustainable ecosystems. DS is a research methodology at the interface of the creative design disciplines and the natural and social sciences (Romme & Reymen, 2018). It is widely used in engineering, information systems, architecture, education, and other disciplines. In the past few decades, various scholars in the field of management, innovation, and entrepreneurship have advocated DS (e.g., Dimov et al., 2023; Hatchuel, 2001; Romme, 2003) and a growing number of scholars have been applying it to address major practical challenges (e.g., Baldassarre et al., 2020; Eckerle & Terzidis, 2024; Hyytinen et al., 2023; Pascal et al., 2013; Petzolt & Seckler, 2025).

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In the next section, I outline various key challenges in the ecosystem literature. Subsequently, the DS approach is outlined and illustrated with the development of the ecosystem pie model (EPM). This application of DS generates several new insights and helps to weed out various unproductive lines of ecosystem research.<sup>1</sup>

### Key challenges in the ecosystem literature

Practitioners widely use the ecosystem notion. A recent query on a state-of-the-art search machine (in July 2025) with the term 'ecosystem', used in combination with either 'management' or 'organization', produces more than 320 million results. However, the popularity of the ecosystem metaphor among management practitioners is not an accomplishment of ecosystem scholars. My argument in this section is that, despite the fact that management practitioners widely use the ecosystem notion, the academic discourse (1) is highly fragmented, (2) suffers from a huge rigor-relevance gap, and therefore (3) needs more direct engagement with ecosystem practice. In other words, only by directly applying ecosystem theories as prescriptive tools to (creating or adapting) sustainable ecosystems, the unproductive theories can be distinguished from the more productive ones.

For one, the academic literature on ecosystems is *highly fragmented*, with largely disconnected discourses on business ecosystems (Koenig, 2012; Liu et al., 2019), knowledge ecosystems (van der Borgh et al., 2012), entrepreneurial ecosystems (Isenberg, 2010; Stam & van de Ven, 2021), platform ecosystems (Baldwin, 2024; Gawer & Cusumano, 2014), and innovation ecosystems (Adner & Kapoor, 2010; Talmar et al., 2020). While some authors (e.g., Clarysse et al., 2014) have attempted to connect two of these discourses, the literature has remained highly fragmented until today. Moreover, the current discourse on platform and innovation ecosystems also internally suffers from major disagreements about how to conceptualize and define core constructs (e.g., Adner & Euchner, 2022; Holgersson et al., 2022; Jacobides et al., 2024).

Another example of key disagreements involves the demarcation lines between the ecosystem construct and older constructs such as value chains, supply chains, and networks. Many ecosystem scholars define ecosystems as a specific version of a network or value chain (e.g., Adner & Kapoor, 2010; Koenig, 2012). By contrast, Jacobides et al. (2018, 2024) go a long way to differentiate an ecosystem from a (Original Equipment Manufacturer-led) supply chain.

In this essay, I do not seek to (directly) solve this fragmentation of the ecosystem landscape. Instead, my argument here is that this fragmentation is not the root problem, but a symptom of a deeper cause: the widespread *rigor-relevance*

*gap* in the management field (Carton & Mouricou, 2017; Rajagopalan, 2019). That is, the growing preoccupation with theoretical and methodological rigor has been generating many theories that managers perceive as irrelevant and difficult to understand (Johnson & Ellis, 2023). Ecosystem research apparently also suffers from this rigor-relevance gap. In this respect, most ecosystem scholars have backgrounds in the social sciences (instead of, for example, the design or engineering disciplines) and thus prefer to operate as independent observers of the phenomena being studied (e.g., Adner & Kapoor, 2010; Gawer & Cusumano, 2014; Jacobides et al., 2024; Stam & van de Ven, 2021).

Both Schein (1987) and Starbuck (2003) argued that management scholarship has lost its relevance because it lacks a clear societal mission and fails to directly engage with organizational and management practice. Therefore, they both advocated that management scholars *engage in experimentation and interventions in real-life settings*. Interestingly, Schein (1987) also argued that one may not be able to understand any organizational system without substantial efforts to develop and change it, because only the latter tend to uncover backstage realities that are critical to the system's processes and outcomes. Accordingly, management researchers need to proactively collaborate and engage with practice and practitioners, which enables them to uncover alternative interpretations and theories as well as make progress by weeding out unproductive lines of thinking (Dunbar et al., 2008; Starbuck, 2006).

These insights are critical for the ecosystem literature, because ecosystems (regardless of how they are defined) are temporal phenomena involving highly complex dependencies (e.g., Adner & Kapoor, 2010; Jacobides et al., 2024) that cannot be readily detected and measured. Moreover, creating and managing ecosystems inherently is future-oriented and action-driven, with practitioners actively shaping reality by developing collaborative ties, developing shared visions, co-locating activities, developing new products and their components, and so forth. The exclusive application of research methods that focus on explaining existing phenomena falls short in capturing the dynamic and generative nature of any sustainable ecosystem. Accordingly, the interventionist mindset advocated by Schein and Starbuck provides a good entry point to my argument in the next sections.

### What is DS?

As a research methodology, DS operates at the interface of the creative design disciplines and the social and natural sciences (Romme & Reymen, 2018), also inspired by Simon's (1996) *The Sciences of the Artificial*. While advocates of action research have also capitalized on the idea that scholars need to get close to practice (Eden & Huxham, 2006), DS is the only research methodology that embraces the *creation of artifacts* as

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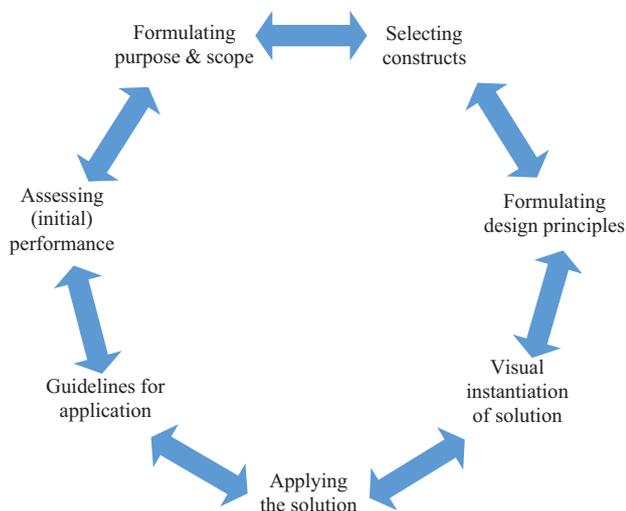
its core mission (Romme & Holmström, 2023; Romme & Reymen, 2018), thereby fully exploiting the interventionist mindset outlined in the previous section. Artifacts can be defined as any facts (i.e., phenomena) entirely or largely created by human beings; this definition implies that many managerial and organizational phenomena can be conceived and studied as factual entities as well as artificial ones. In disciplines like medicine, civil engineering and information systems, it is therefore common to employ both lenses to deeply understand existing phenomena *and* design and create new ones (Simon, 1996).

Similarly, the ecosystem literature can draw on DS to reduce the rigor-relevance gap and build a coherent body of knowledge, one that is well theorized but also highly actionable in practice (Hatchuel, 2001; Romme, 2003). In doing so, ecosystem scholars may benefit from the momentum of a growing number of management scholars applying this methodology (e.g., Baldassarre et al., 2020; Eckerle & Terzidis, 2024; Hyytinen et al., 2023; Pascal et al., 2013; Petzolt & Seckler, 2025).

The remainder of this section outlines what DS is and how to apply it. Figure 1 depicts a typical DS research cycle (Talmar et al., 2025). For similar cycles see, for instance, Dimov et al. (2023), and Romme and Reymen (2018). Each step in this cycle is outlined below.

### Formulating purpose and scope

Defining the problem addressed and deciding on the main purpose and scope of the solution for it. This step is often the first one in any DS project, but needs to be revisited again and again, especially when new learnings and insights with regard to purpose and scope arise. By setting up an expert panel, the project team can discuss the project's purpose and scope in a



**Figure 1.** A typical design science cycle. Source: Adapted from Talmar et al. (2025, p. 4).

transparent manner with expert-practitioners (van Haaren-van Duijn et al., 2024). Especially in case of ill-defined problems, it is better to formulate a broader purpose and scope for the project, one that leaves some space for creative thinking in the next few steps.

### Selecting constructs

Reviewing the literature to formulate an (initial) set of theoretical constructs to be used. This step also needs to be taken early in the process, unless the extant literature on the problem and its potential solutions is extremely thin – which is often the case for an ill-defined problem. In the latter case, one can formulate an initial set of constructs by interviewing experts in the field and/or consulting the expert panel set up earlier (e.g., van Haaren-van Duijn et al., 2024). Moreover, ill-defined problems invite abductive reasoning, for instance, by getting inspiration from adjacent disciplines that may provide novel perspectives (Hodgkinson & Healey, 2008).

### Formulating design principles

Developing an (initial) understanding of the main links between the constructs in the form of design principles (DPs). These DPs form the heart of any tool, as a prescriptive theory. Next to formulating DPs, it can also be helpful to develop a process model that connects the constructs previously selected. If the two preceding steps did not yet generate any helpful constructs and DPs, a generic principle like 'anything goes' can be adopted to allow the project team to play around with multiple solution ideas and directions in the next step. Multiple iterations through the entire cycle in Figure 1 tend to generate a final set of DPs, which depict generalizable insights in terms of the broader space in which the specific solution-artifact is positioned.

### Visual instantiation of solution

Creating a visual representation of the constructs and DPs. Effective visualization of information improves comprehension and decision-making (Eberhard, 2023). The visual instantiation of the information provided in the constructs and principles can be done in the form of a paper-based template or an interface on a computer screen (e.g., app), or both. Notably, the visual instantiation in this step needs to go beyond the conventional visual frameworks or models widely used in academia (e.g., flow diagrams). Visual instantiation is especially critical in guiding users through the solution (process), so it needs to be adapted to the needs of user-practitioners. If the previous steps did not yet generate any substantial output in

terms of DPs, the visualization step creates space for the project team to brainstorm about possible solution directions, using free-form drawings, Lego play, or any other brainstorming tool.

### **Applying the solution**

Trying out (and possibly implementing) the solution with practitioners. Once an initial set of DPs as well as a visual instantiation is available, this step involves applying them to the relevant challenges of practitioners. In the case of preliminary solutions, they can be applied in (co-creation) workshops or in pilot studies, with practitioners trying out the solutions and providing formative feedback. The latter feedback should focus on the solution's pragmatic validity, that is, whether the solution artifact works in practice in terms of its usefulness, feasibility, desirability, and novelty. When the solution is more fully developed, after having been revised and extended with the help of practitioner feedback, the solution can be more systematically tested and/or even fully implemented.

### **Guidelines for applying the solution**

Articulating a set of detailed heuristics and recommended processes for applying the solution, to enable others to apply it. These guidelines can be developed and written up in a manual or checklist, or any other accessible form. Application guidelines are especially important for more complex problems and their solutions. Despite its importance, academics often forget to flesh out the practical guidelines associated with their (prescriptive) theories.

### **Assessing (initial) performance**

Evaluating how different users apply the solution in various settings and how they assess its usefulness and completeness. These more summative forms of assessment serve to evaluate the solution's effectiveness, ease of use, mutability to different settings, and so forth. If an expert panel was created at an earlier stage (see first step), it can be used to assess the solution's performance, but one also often needs to collect interview, survey, or other data on the performance of the solution. Here, research methods may include pretest/post-test experiments (Meulman et al., 2018), interviews (Petzolt & Seckler, 2025), questionnaires (Fahrenbach, 2022), or any other empirical method that is appropriate. In this step of the research cycle, design scientists theorize to explain more deeply why and how the solution as a new artifact operates, also by revisiting the initial set of constructs and DPs and revising them in view of the performance data. These theorizing efforts can also produce a revised process model of the solution.

The cycle in Figure 1 is highly iterative in kind. In other words, a typical DS project involves many iterations in which the project's purpose and scope are gradually deepened, the prototype or blueprint of a (potential) solution becomes more sophisticated and adapted to user needs, the theoretical underpinnings in terms of DPs and/or process models become more precisely formulated, and therefore the solution (as final artifact) is increasingly validated regarding its mechanisms and outcomes (e.g., Baldassarre et al., 2020; Eckerle & Terzidis, 2024; Pascal et al., 2013).

Figure 1 also creates the (correct) impression that scholars and practitioners can start anywhere in the cycle. Most scholars initiating a DS project will prefer to start with formulating the project's purpose and scope, with the help of an initial literature review to map the extant body of knowledge in terms of key constructs and their relationships (e.g., Pascal et al., 2013). Alternatively, it is also possible to start with evaluating the current solutions that are already in place (as artifacts), to create a better understanding of the problem addressed (e.g., via interviews with inside actors as well as outside experts), as input for formulating the purpose and scope of a project that seeks to improve the existing solutions (e.g., van Haaren-van Duijn et al., 2024). In any case, many iterations through the cycle in Figure 1 are typically needed to reach a saturation point – which occurs when the solution is fully developed and evaluated as very satisfactory, the underlying constructs and DPs are clear, and a body of evidence on the solution's efficacy exists.

### **Applying DS to sustainable innovation ecosystems**

This section outlines one specific example of innovation ecosystem research informed by DS: the design and development of the EPM as a tool for mapping and analyzing prospective ecosystems that contribute to at least one sustainable development goal (SDG). The EPM case illustrates how DS informs the development of tools, as a specific type of artifact. Generally speaking, a tool (as a prescriptive theory) is an attractive type of output of DS work, because it provides entrepreneurs, managers, and other practitioners with 'scaffolding structures for creativity and interaction' (Iandoli, 2023, p. 350), similar to the enabling and supportive role of scaffolds on construction sites.

### **Developing the EPM for risk assessment of innovation ecosystems addressing SDGs**

The development of the EPM started in 2014, when Madis Talmar (as a doctoral student) collaborated with several practitioners on various sustainable ecosystem challenges, for which they found hardly any support from the extant literature. The remainder of this section outlines how the EPM tool was

developed, drawing on Talmar et al. (2020, 2025). This outline also serves to illustrate the iterative processes depicted in Figure 1; that is, for each step, I point at various learnings and extensions which arose from revisiting this step later in the process.

### Formulating purpose and scope

The development of the EPM was motivated and triggered by the increasing complexity and specialization in technological innovation processes, which increasingly require extensive collaboration among multiple actors to realize complex value propositions (Talmar et al., 2020). The extant literature at the time offered fragmented insights into ecosystem strategy, lacking a comprehensive and actionable framework for practitioners to analyze and design innovation ecosystems. To fill this gap, we envisioned a new tool that would enable ecosystem pioneers to map and assess their (prospective or nascent) innovation ecosystems. While iterating through the cycle in Figure 1, the purpose and scope of the tool being developed became increasingly more focused on the risk assessment of prospective or nascent innovation ecosystems. Early on in the project, we also embraced the 'design theory' perspective (Gregor & Jones, 2007) in developing the tool; this argument (Talmar et al., 2025) is outside the scope of this essay.

### Selecting constructs

Regarding the selection of theoretical constructs from the extant literature, we distinguished between constructs at the innovation ecosystem level and the actor level; see Talmar et al. (2020) for a more detailed overview. The ecosystem-level constructs inferred from the literature included, for example, ecosystem value proposition (EVP) (Adner, 2017; Clarysse et al., 2014), user segment (Clarysse et al., 2014; Williamson & De Meyer, 2012), and actors (Autio & Thomas, 2014). The actor-level constructs inferred from the literature included, for example, resources (Davis, 2016; Koenig, 2012), value addition also known as complement (Autio & Thomas, 2014; Nambisan & Sawhney, 2011), value capture (Lepak et al., 2007; Teece, 1986), dependence (Adner & Kapoor, 2016), and actor-specific risk (Koenig, 2012; Williamson & De Meyer, 2012). While iterating through the cycle in Figure 1, we later more explicitly defined 'ecosystem risk' by combining the various ecosystem-level and actor-level constructs in the construct of ecosystem risk; that is, by drawing on conjunctive probability logic (cf. Adner & Feiler, 2019), the likelihood of accomplishing an EVP can be calculated by multiplying the likelihoods that each critical actor is willing and able to contribute to the EVP (Talmar et al., 2020). This probabilistic exercise serves to aggregate the actor-specific risks into a

risk assessment of the entire ecosystem, in terms of the likelihood that the EVP can be effectively accomplished within the projected timeline (Talmar et al., 2025).

### Formulating DPs

We initially formulated a flow diagram that connects all the constructs selected (see Talmar et al., 2020, p. 4), as such forming an implicit set of DPs. At a later stage in the process, we formulated a more explicit set of principles. Talmar et al. (2025, p. 6) report the final set of four DPs:

*DP1:* A set of actors that wants to explore the success chances of an envisioned EVP, for which each actor provides a complement, has to assess the likelihood (or risk) that this innovation ecosystem accomplishes a timely and successful launch of the EVP by (1) estimating the likelihood that each critical complement will be delivered in the required form and at the expected point in time and (2) subsequently multiplying these likelihoods to obtain an overall risk assessment.

*DP2:* A set of actors that wants to estimate the likelihood that actor X will deliver its critical complement in the required form and at the expected point in time has to assess (1) the willingness as well as (2) the ability of this actor to create and deliver its complement.

*DP3:* A set of actors that wants to estimate the likelihood that actor X is willing to deliver its complement in the required form and at the expected point in time has to assess this actor's incentives in terms of the expected value captured, its opportunities to redeploy resources and activities (for the EVP) elsewhere, and its dependence on the success of the ecosystem.

*DP4:* A set of actors that wants to estimate the likelihood that actor X is able to deliver its complement in the required form and at the expected point in time has to assess this actor's available resources, its technological capability and its legal capability.

These DPs depict how a set of actors that collectively contribute to a prospective or nascent ecosystem can assess whether the shared value proposition and its required ecosystem composition are likely to be accomplished, or, alternatively, compare various possible ecosystem compositions in terms of their success chances (Talmar et al., 2025). However, despite the precise language used in these DPs, ecosystem practitioners may struggle to apply them without visual support.

### Visual instantiation

To visualize the key constructs and DPs in an interface that is user-friendly and visually appealing, we selected the widely used metaphor of the stakeholder value 'pie' (Tantalo & Priem, 2016).

This 'pie' division of value is typically presented in the form of a rounded figure, which can be divided in sectors that represent particular actors (Bourne & Walker, 2005). With the aim of creating a two-dimensional paper-based artifact, we embedded the constructs and principles developed in previous steps in a rounded visual structure. And after several iterations and try-outs, we arrived at a set of visual templates, one of which is reproduced in Figure 2. Key elements are, for example, that (1) various actors in the ecosystem are separated by radial lines around the center; (2) the actor-level constructs (e.g., value addition, value capture, and risk) are mapped for each distinct actor (positioned within its radial lines), and (3) the actor's dependence on the ecosystem's viability and success is assessed on one radial line (Talmar et al., 2025). Again, the first attempts to visualize the constructs and DPs resulted in a graphical template that increasingly became more polished and easier to understand, by adapting and improving it in response to user feedback. More details are available in Talmar et al. (2020, 2025).

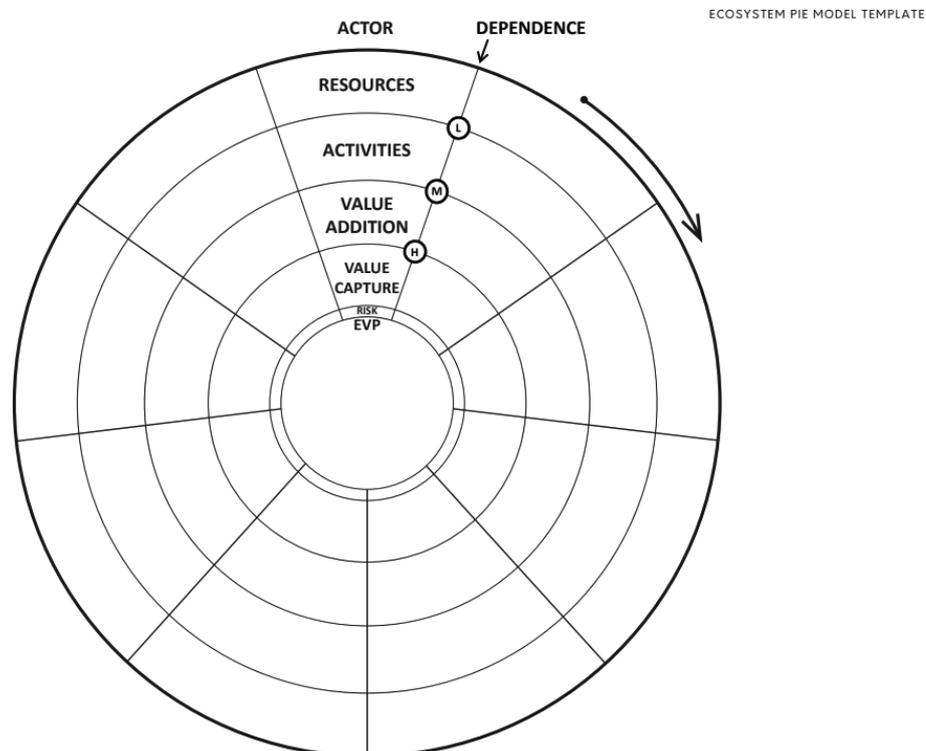
### Applying the solution

In the first applications of the EPM, we used the DPs and the EPM template in various workshops to map and analyze participants' specific ecosystems. At a later stage, a first version of the user manual became available as an additional artifact

(see below), which was further developed with the help of the feedback of participants. Talmar et al. (2025) provide a detailed overview of all applications and their learnings, including an extensive description of two applications. Overall, the focus of these applications shifted over time, while iterating through the cycle in Figure 1: in the first applications, participants were especially invited to assess the clarity and usefulness of the various constructs and DPs; subsequent applications increasingly focused more on using the visual EPM template and the assessment of ecosystem risk (Talmar et al., 2025). In total, the application step involved the creation of 241 risk assessments using the EPM tool; all these filled-in templates were collected (Talmar et al., 2025).

### Guidelines for applying the solution

The lead author in the EPM project (Madis Talmar) started developing a manual with user guidelines, which should especially also enable other users to apply the tool, independently from the design team that created it (Talmar et al., 2025). Drawing on the feedback from participants in a large number of workshops in which EPM was applied, this first draft of this manual was gradually improved and extended. The latest version of the manual (Talmar, 2021) is available online (<https://ecosystempie.com>). It includes a detailed description of EPM's



**Figure 2.** Example of an EPM template divided in eight sectors.  
Source: Talmar, 2021.

template and modeling process, an FAQ section, and various versions of the EPM template (Figure 2 provides one version).

## Assessing performance

The outline of various previous steps already served to clarify that the four artifacts constituting the EPM – its core constructs, DPs, visual template, and user guidelines – were created and adapted over time. This means that our initial performance assessments addressed early versions of each of these artifacts, while assessments later in the process pertained to more mature versions of each artifact. Most importantly, our performance data suggested that EPM users are able to effectively model a wide variety of envisioned or emerging ecosystems, by filling in the template based on publicly available data, interviews with key actors, and their own interpretations and observations (Talmar et al., 2025). Overall, Talmar et al. (2025, p. 10) conclude that all applications of EPM ‘underline the prospective functionality of EPM’; that is, it ‘is especially helpful when a focal actor (possibly together with complementors) seeks to evaluate the risk profiles of the prospective ecosystem(s) needed to accomplish a shared value proposition’.

The attractiveness of EPM for pioneers prospecting sustainable ecosystems is also evident from several applications by others. For example, De Moraes et al. (2023) used the EPM to assess the key enablers and barriers for alternative protein innovation as an envisioned ecosystem in Brazil – also in the context of the United Nations’ sustainable development goals (i.e., SDG 2) for improved nutrition and sustainable agriculture. Sylos Labini et al. (2024) employed EPM to assess what type of future ecosystem is needed for integrating blockchain technology into satellite onboard computing systems – thereby contributing to SDG 9 with regard to a resilient and inclusive digital infrastructure. Peron et al. (2025) used it to design a prospective ecosystem for additive manufacturing of medical implants and devices in the medical sector (Peron et al., 2025), pursuing substantial contributions to SDG 3 on healthy lives and well-being for all ages. Finally, Sourmelis et al. (2024) adopted EPM to explore how new cementitious materials could replace clinker volumes and reduce carbon footprint in the cement industry, also in view of the more than 150 M tons of bauxite residue resulting from worldwide alumina production; their study resulted in a promising ecosystem configuration that would effectively link the alumina and cement industries regarding bauxite residue – which would especially contribute to SDG 13 on reducing greenhouse gas emissions.

Consequently, the main purpose of the EPM project appears to have been accomplished. That is, the EPM tool enables ecosystem pioneers to map and assess the risk profile of an envisioned or nascent innovation ecosystem pursuing sustainability

goals. Notably, we did not measure and evaluate the long-term contribution of the EPM tool to the users’ attempts to either actually create their envisioned ecosystems or further develop the nascent ecosystems already in place; this would require a longitudinal research approach, drawing on interviews and/or surveys with the participants long after (e.g., 4 and 8 years) they employed the EPM.

## Which learnings for ecosystem research arise from the EPM project?

A key learning is that focal actors (as prospective orchestrators) found the EPM tool very useful in comparing possible EVPs and their associated ecosystem compositions, in the sense that they can make such comparisons in a highly time-efficient manner; that is, in a few hours. In turn, this helps them pivot between alternative ecosystem options and make an informed decision on the most promising option (Talmar et al., 2025). This implies that the EPM tool is most useful for focal actors that are still prospecting various ecosystem options (e.g., De Moraes et al., 2023; Sourmelis et al., 2024; Sylos Labini et al., 2024), and less so for a nascent ecosystem in which several choices regarding its composition have already been made. The latter choices make it more difficult to pivot to an alternative composition and its EVP – given the path-dependent nature of how an ecosystem evolves over time.

In this respect, the ecosystem literature pays a lot of attention to categorizing various types of interdependency and modularity in ecosystems (e.g., Borner et al., 2023; Jacobides et al., 2024; Koenig, 2012; Nambisan & Sawhney, 2011) that have already moved beyond the prospective phase and developed into an ecosystem network in which ‘joint value is created through innovations whose components are (by definition) both complementary and modular’ (Baldwin et al., 2024, p. 3). Such conceptualizations of innovation ecosystems in terms of their final state – see the phrase ‘joint value is created’ in the latter definition – may not be productive in informing and guiding ecosystem practitioners. Especially practitioners trying to envision and create ecosystems operate in settings in which the shared value proposition as well as the ecosystem’s composition are in flux. The EPM project suggests that ecosystem prospectors, who are exploring the opportunities and risks arising from an envisioned ecosystem, cannot yet assess whether the interdependency between key actors in a permanent state of this ecosystem is moderately modular or super-modular in nature (cf., Jacobides et al., 2018); ecosystem prospectors can only assess to what extent specific actors are willing and able to deliver complements to the envisioned ecosystem. The creation and development of an innovation ecosystem, according to Talmar et al. (2025, p. 1), involves

the search for a novel shared value proposition that requires the focal actor's innovation as well as all relevant complements needed to materialize that value offering in the future. That is, its function is not (yet) to produce and supply but to *search* and *align* across all (envisioned) complementary value offerings and their prospective suppliers [...]. The innovation ecosystem's output in terms of a shared value proposition and associated products and services is therefore not yet known, with (at least some of) the complementary offerings not yet existing.

Categorizations of the level and nature of interdependency and modularity (e.g., Jacobides et al., 2024; Koenig, 2012) therefore need to be translated and operationalized into prescriptive tools, so that ecosystem practitioners can apply and evaluate these tools in terms of their pragmatic validity (Worren et al., 2002). Without this type of validation from practitioners, theorizing about the nature and level of interdependency or modularity is not likely to be productive.

The EPM project suggests it is more productive to define innovation ecosystems in a more general manner (cf., Pushpanathan & Elmquist, 2022; Remneland Wikhamn & Styhre, 2023) by emphasizing the notion of interdependence in relation to their search mode. Accordingly, an *innovation ecosystem* is a collaborative arrangement of hierarchically independent, yet interdependent actors – with the latter interdependence primarily arising from the search for an ecosystem-wide value proposition that any firm alone cannot accomplish. This definition also serves to demarcate an innovation ecosystem from a supply chain or value chain. Such a chain is transactional in nature and can actually arise from an innovation ecosystem as previously defined. Following Talmar et al. (2025, p. 2):

Notably, some innovation ecosystems will, over time, develop into (typically multiple) supply chains or be integrated into existing ones. Examples are innovation ecosystems exploring how additive manufacturing technology can be used to create a new generation of medical implants and devices (Peron et al., 2025) or developing a software-hardware solution for demand-side management of residential heating systems (Peltokorpi et al., 2019). Other innovation ecosystems may evolve into ecosystems (without the explicit 'innovation' adjective) characterized by co-evolution, super-modular interdependence and continued generativity (Jacobides et al., 2018), as in the case of integrating blockchain technology into the onboard computing systems in satellites to create a new generation of satellite-based Internet of things applications (Sylos Labini et al., 2024).

## Concluding remarks

Starbuck (2003, 2006) observed that organization and management researchers put too much effort into producing and discussing meaningless findings, which tend to obscure discoveries that would be more useful. To quote Starbuck (2003, p. 449):

a focus on naturally occurring phenomena generates data dominated by uninteresting events [...]. To expose differences between theories, [...] scientists must be able to select settings that are likely to yield interesting, revealing observations – meaning that scientists have predicted what they will observe. Lastly, until organization theorists test their theories by suggesting ways to improve organizations, their research will remain a version of historical analysis.

More specifically, direct engagement with practice by developing actionable and prescriptive theories can help to weed out unproductive lines of thinking as well as guide scholars to more productive ones (Dunbar et al., 2008; Starbuck, 2006). In the second section, I therefore argued – by also drawing on Schein's work – that sustainable ecosystem scholars should engage more deliberately with practice by developing prescriptive theories and tools.

The subsequent sections in this essay served to outline DS as a solution-oriented methodology, one that is highly instrumental in developing actionable knowledge as well as practical tools or other artifacts in the field of sustainable innovation ecosystems. More specifically, I outlined a typical DS cycle and illustrated it with the development of the EPM tool. The EPM case demonstrates how DS can be applied to formulate a project's purpose and scope, select key constructs, formulate DPs, develop a visual instantiation, apply the solution, develop application guidelines, and assess the solution's performance – as a highly iterative research cycle.

The EPM project generates several key insights for ecosystem scholarship – as detailed in the previous section. For one, entrepreneurs and other professionals prospecting various ecosystem options may be the most interesting audience for – and users of – studies of sustainable ecosystems. The EPM appears to be very useful for practitioners who want to assess and compare different constellations of sustainable ecosystems to inform their decisions on the most promising constellation. Second, detailed categorizations and typologies of interdependency and modularity, published in the ecosystem literature, need to be operationalized into actionable tools. Practitioners can then use and assess their pragmatic validity; without pragmatic validation, deep theories of interdependency and modularity are not likely to advance the field of ecosystem research toward a coherent, robust and actionable body of knowledge.

In this essay, I advocated DS as a powerful methodology that enables ecosystem researchers to produce knowledge that is theoretically robust as well as practically impactful. I'm not advocating here that all ecosystem scholars should become design scientists, because descriptive-explanatory as well as critical-narrative approaches are also critical. But any research group or program with the explicit ambition to make both academic and societal impact would benefit from having a DS expert on board, to turn theories into tools

(Romme & Holmström, 2023). Moreover, sustainability challenges in the area of climate change, energy consumption, poverty and other domains have become so urgent (Basu et al., 2024; Valente & Oliver, 2018) that, as ecosystem scholars, we have to contribute directly to creating sustainable ecosystems.

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