Knowledge Ecosystem Approach to Addressing the Wicked Problems

Giedrius Jucevičius
Vytautas Magnus University, Kaunas, Lithuania
giedrius.jucevicius@vdu.lt

Abstract: Knowledge ecosystem is a relatively recent notion, which is primarily associated with the development of new knowledge through joint research and collaboration. They encompass the different actors that come together and search for new solutions and value propositions leading to the generation of new knowledge (Dattée, Alexy and Autio, 2018; Järvi, Almpanopoulou and Ritala, 2018). Knowledge ecosystems represent the networks of geographically co-located actors responsible for generating knowledge at the stage of pre-commercial engagement (Clarysse, 2014). The paper argues that the concept of knowledge ecosystems should not remain focused on public R&D-driven initiatives, but can be extended into the more complex social fields, such as addressing the "wicked problems" in multi-stakeholder environments. Wicked problems are characterized by the lack of clear problem definition and causality. They contain many inherent contradictions, complex stakeholder perspectives, and uncertain outcomes of intervention. The extant traditional research on addressing the wicked problems is dominated by the agent perspective (e.g. design thinking approach to resolving complex issues). In this paper, we argue that the effective tackling of the wicked problems owes primarily to the existence of effective ecosystems as platforms for accessing and managing the diverse social knowledge. We contrast the *ecosystem-as-affiliation* vs. *ecosystem-as-structure* approaches (Adner, 2017), and *prefigurative* vs. *partial* form of knowledge ecosystem (Järvi, Almpanopoulou, Ritala, 2018). The discussion presented in the paper shows that *ecosystem-as-affiliation* view and *prefigurative* form of KE is more suitable for addressing the complexity of wicked problems. On the other hand, the *ecosystem-as*-structure view and *partial* form of knowledge ecosystem is more appropriate for large corporate and public actors in search of the transdisciplinary solutions in a predefined area of expertise.

Keywords: knowledge ecosystem, wicked problems, complexity, complex adaptive systems

1. Introduction

The discourse on organizational and institutional ecosystems has been dominating the research on knowledge and innovation management for more than the past decade. The research on knowledge and innovation systems has seen certain "de-institutionalization" over the recent years by switching its focus away from the institutional systems of innovation (e.g. national SI by Lundvall, 1992, or regional IS by Cooke et al, 1997) towards a more organic fluid network-based ecosystem approach. Originating from the realm of natural sciences, the ecology-related concepts have penetrated the social sciences with notions, such as business ecosystems, innovation ecosystems or knowledge ecosystems (Oh et al, 2016). Compared to the earlier views, the ecosystem approach is often regarded as more appropriate for dealing with the issues in complex dynamic environments.

At the same time, we have also seen the growing preoccupation of social researchers with the wicked problems calling for the collaborative transdisciplinary solutions that cannot be effectively dealt with by individual fragmented actors. The wicked problems are characterized by the absence of clear-cut problem definition and the presence of inherent contradictions, the complexity of stakeholder perspectives and connections, unclear causality as well as the uncertain outcomes of managerial intervention. The extant traditional research on addressing the wicked problems usually takes the agent perspective (e.g. design thinking approach to resolving complex issues). In this paper, we argue that the effective tackling of the wicked problems is less subject to the cognitive and managerial capacities of key agents, but more to the existence of effective ecosystems as platforms for accessing and managing the diverse social knowledge.

This paper presents a conceptual discussion regarding the role of *knowledge ecosystems* in addressing the complex challenges posed by the wicked problems. Following the traditional definition, the knowledge ecosystems encompass the different actors that come together and search for new solutions and value propositions, which leads to the generation of new knowledge (Dattée, Alexy and Autio, 2018; Järvi, Almpanopoulou and Ritala, 2018). They usually represent the networks of geographically co-located actors (primarily centred around the local universities and public research organizations, PROs) responsible for generating knowledge at the stage of pre-commercial engagement (Clarysse, 2014). The classical approach to knowledge ecosystems stresses the public R&D-driven initiatives focused on new knowledge creation through fundamental research (e.g. CERN). However, we argue that such perspective has some inherent limitations. Therefore, we seek extend the concept of knowledge ecosystem into the realm of the wicked problems of social

and economic development, which offers a good potential for research novelty. In this paper, we ask to what extent the knowledge ecosystem perspective can be adopted and serve as an effective tool for addressing the wicked problems, which is an important ***research question***.

Therefore, the ***aim*** of our paper is to make a conceptual connection between the knowledge ecosystem and wicked problem research strands.

First, we discuss the notion of wicked problems and the latest research directions in the field. Second, we present the different views to knowledge ecosystems and the ways they may enrich the wicked problems research and practice. We discuss the different theoretical perspectives, such as the ecosystem-as-affiliation vs. ecosystem-as-structure approaches (Adner, 2017), or prefigurative vs. partial form of knowledge ecosystem (Järvi, Almpanopoulou, Ritala, 2018), and assess their potential suitability to the wicked system research. We also present the main challenges that the knowledge ecosystems have to overcome in order to perform the role of effective platforms behind the iterative solutions to the wicked problems.

2. Wicked problems: addressing the complex transdisciplinary issues

The notion of "wicked problems" initially emerged in the context of social policy planning (Rittel, Weber, 1973), but has latter spread into variety of social and technical fields. Nowadays, the wicked problem research covers the general fields of corporate strategy (Camillus, 2008) and public policy (Head, 2022), as well as more specific sectors and issues, e.g. environment and sustainability (Balint et al, 2011; Hull et al, 2020; Head, 2022), food waste management (Närvänen et al, 2020), healthcare (van Berkel, Manickam, 2020), development of software and information systems (Fitzpatrick, 2003), decision support systems (Courtney, 2001), education (Adam, 2016), or even philosophy (Tromp, 2018).

The wicked problems represent "a class of social system problems which are ill-formulated, where the information is confusing, where there are many clients and decision makers with conflicting values, and where the ramifications in the whole system are thoroughly confusing" (Churchman, 1967). They can only be addressed by stepping outside the organizational boundaries and working with various stakeholders, especially the legislators and decision-makers in the public and private sectors, as well as engaging local communities (Kumlein and Coughlan, 2018). They are associated with the so-called "grand challenges" (George et al, 2016), which are reflected by the UN Sustainable Development Goals (Sachs et al, 2018) that, despite their global reach, can be addressed on various levels (e.g. local initiatives that contribute to more global and boundary spanning solutions). Wicked problems are hard to define. They cannot be pinned down to one major cause, but have a variety of mutually reinforcing causes. The wicked problems are ill-structured, they are hard to understand before the solutions are developed. However, no solution is ultimate and neither fully "right" or "wrong", but it leads to further issues that have to be addressed. The wicked problems and their solutions are "one of a kind" and are hard to replicate. The potential for learning and feedback from the solutions to the wicked problems is quite limited not only due to their singularity, but also due to the new problems that emerge from the solutions. The agents dealing with the wicked problems are confronted with the challenge of addressing a constantly shifting target. They often concern the long-term strategic policy dilemmas "in which multiple and compounding risks and uncertainties combine with sharply divergent public values to generate contentious political stalemates" (Balint et al., 2011). The greater the social complexity of the problem and the divergence of different stakeholders in terms of their values and priorities, the greater the "wickedness" level of the problem (Camillus, 2008).

The resolution of wicked problems cannot rely on traditional processes, such as gathering additional data, defining underlying issues more clearly and breaking them down into smaller problems to be addressed (Rittel, Webber, 1973). Moreover, the intermediate solutions often lead to numerous unintended consequences and represents an important challenge in the strategy making (Camillus, 2008). The wicked problems are inherently susceptible to the 'law of unintended consequences' (Ritchey, 2011). Such unpredictability may be due to many components interacting in non-random ways, the chain reactions amplifying the initial events, reinforcing feedback, balancing forces, lock-in effects, adaptation, emergence or disturbed equilibria unleashing unpredictable outcomes (Sherden, 2011).

All of the above makes addressing the wicked problems an extremely challenging task. One can distinguish several major approaches to coping with such challenges.

Some researchers stress the importance of early engagement and collaboration with the diverse stakeholders outside the organizational or institutional boundaries (Kumlein and Coughlan, 2018) in order to receive different perspectives on complex issues. Addressing the wicked problems at the corporate level is usually based on involving the stakeholders, building and documenting the shared understanding of the problem as well as the joint commitment, defining the corporate identity through shared values, competences and aspirations, focusing on action in order to receive the early feedback and introduce the needed adjustments. Conklin (2003a; 2003b; 2006) proposes the 'dialogue mapping' framework as the means for overcoming the fragmentation of perspectives and building the shared understanding of wicked problems. Balint et al (2011) stress the role of the learning networks where public managers, experts and stakeholders collaborate in the analytic, iterative and deliberative decision-making processes.

Other authors stress the role of agents, their knowledge base and mindsets – both on the individual and organizational levels. It is based on the assumption that coping with the wicked problems calls for specific transdisciplinary competences and value systems that can be developed via educational means. Confronting the wicked problems calls for 'transdisciplinary imagination' in order to conduct the open-ended enquiries (Brown et al., 2010). Adam (2016) proposes the theory of bi-relational development that stresses the resolution of wicked problems through the reconciliation of opposites. It provides different actors in the system with conceptual tools for dealing with the strategic tensions and paradoxes in such complex settings. Addressing the wicked issues calls for the transformation of organizational culture away from integrated and monolithic models towards more pluralist, dynamic and flexible models and identities (Ney and Meinel, 2019). Large organizations can tackle the wicked problems by adopting the principles of design thinking and embracing 'messy' institutional frameworks in order to achieve breakthrough innovations.

Other researchers (Majchrzak, Malhotra, 2020) find value in adopting the crowdsourcing-based collaborative solutions by encouraging the open-ended innovation challenges through the IT platforms. The wicked solutions require us to go beyond the mainstream approach in the crowdsourcing practices that tend to lock out those without prior knowledge of the problem. The search for solutions to the wicked problems may challenge the very definition of the problem, therefore crowdsourcing platforms need to have very fluid boundaries.

To conclude, the debates regarding the potential solutions to the wicked problems revolve around at least two major aspects: the aspect of *knowledge* (i.e. regarding the problem itself, as well as tools, frameworks, mindsets for addressing it) and the aspect of *platforms / networks* (i.e. areas of interaction where new knowledge and solutions get generated). In our further discussion, we argue that the discourse on knowledge ecosystems shows some good yet underexplored potential to be adopted for approaching the wicked problems.

3. Knowledge ecosystems: diversity of views and their application to the context of wicked problems

In the general ecosystem-related research, the knowledge ecosystem is a relatively recent concept among other wider known concepts, such as business ecosystems (Clarysse et al., 2014; Iansiti and Levien, 2004) or innovation ecosystems (Adner (2006). Knowledge ecosystem can be regarded as a branch of the wider innovation ecosystem research (Almpanopoulou, 2019; Clarysse, et al., 2014) or an ecosystem in own right (Valkokari, 2015). It comprises „diverse actors bound together by a joint search for valuable knowledge while having independent agency also beyond the knowledge ecosystem" (Järvi, Almpanopoulou, Ritala, 2018). They take the shape of vertical and horizontal networks for generating the new knowledge in order to solve certain technological / societal issues or scientific problems (Jucevicius et al., 2021). In the mainstream literature, knowledge ecosystems are geographically co-located hotspots steered by either universities, research institutes (Leten, et al., 2013; Clarysse, et al., 2014), or firms (van der Borgh, Cloodt, Romme, 2012) that focus on collaborative knowledge search (Valkokari, 2015). The role of knowledge ecosystem is to enable the development of new knowledge / knowledge base through joint research work and collaboration. Knowledge ecosystems enable the different actors to come together and search for the new solutions and value propositions, which leads to the generation of new knowledge (Dattée, Alexy and Autio, 2018; Järvi, Almpanopoulou and Ritala, 2018). The *raison d'être* of knowledge ecosystems is enabling the joint search for solutions to the complex problems that cannot be solved by individual actors, and collaborative creation of knowledge (Jucevičius et al., 2021). The solutions and knowledge generated by the actor networks in knowledge ecosystem can be extended and put for a productive use in other above-mentioned ecosystems. Knowledge

ecosystems call for a sufficient diversity of actors, their different yet complementary competences, level of trust, as well as the adequate mechanisms for coordination across multiple organizational boundaries.

Knowledge ecosystems focus on the early stages of knowledge creation, i.e. pre-market stage as far as the innovation process is concerned (Clarysse et al., 2014). The majority of "wicked problems", however, are more of a complex social nature and only indirectly related to the processes of commercialization. On the other hand, in order to be effectively addressed, they usually have to involve various market actors (e.g. firms, employees, supporting organizations), each with their distinct competences in diverse knowledge fields. The engagement of actors from the private sector is also important for the latter stage of implementation of the newly emerged knowledge (aka "wicked solutions", Ranabahu, 2020). Besides, every knowledge ecosystem has to resolve the issue of the multidisciplinary knowledge brokering, which is often the core prerequisite behind the emergence of new knowledge.

Although the concept of ecosystem as used in the social contexts is often criticised for its vagueness (Oh et al, 2016) and unclear boundaries (Klimas and Czakon, 2020), it is also often praised for versatility and inclusiveness of the diverse actors in unstructured environment, thus promoting open-ended solutions (e.g. Aarikka-Stenroos and Ritala, 2017; Almpanopoulou, 2019). Knowledge ecosystems have the characteristics of complex adaptive systems as they represent the organizational and institutional *networks* characterised by the knowledge flows and intensive *interactions* of multiple actors possessing a significant degree of autonomy and self-organisation (Anderson, 1999; Laihonen, 2006).

Based on the prevailing discourse, we can approach the knowledge ecosystems in at least two ways with regard to resolving the transdisciplinary 'wicked problems'. On one hand, they can be treated as relatively structured and purposefully designed systems of knowledgeable actors in the general area of the problem that needs to be resolved. On the other hand, they can be approached as loose, emergent, open-ended networks of knowledge actors that have no specific boundaries and can be flexible (re-)arranged to address the constantly evolving problem area. Here we have several useful conceptual categorizations that can be adopted for the context of addressing the transdisciplinary wicked problems.

Adner (2017) makes the disctinction between the *ecosystem-as-affiliation* and *ecosystem-as-structure*. *Ecosystem-as-affiliation* approach stresses the affiliation of ecosystem actors (to the network or focal actor). It presents a more open-ended network perspective where spontaneous collaborations may lead to different outcomes and the network welcome different members with no prior objective in sight (Jucevičius et al., 2021). The boundary of such ecosystem emerges spontaneously from the relationships of network actors *Ecosystem-as-structure* view largely focuses on the value proposition that network actors are co-creating. It stresses the purposeful alignment of resources and activities of diverse partners in order to create new value proposition (or new knowledge), and members are invited to join based on these specific needs (Adner and Kapoor, 2010, 2016). The boundary of ecosystem is determined by the specific value proposition (in our case, the 'wicked problem' to solved) that collaboration is focused upon.

Järvi, Almpanopoulou, Ritala (2018) propose a complementary view with regard to knowledge ecosystems that involve users and producers of knowledge, organized around a joint knowledge search. The authors make distinction between the knowledge ecosystems, organized in *prefigurative* form, searching *for* a knowledge domain, and the knowledge ecosystems, organized in *partial* form, searching *within* an identified knowledge domain. The first type of ecosystems are focused on probing and formulating a common goal, whereas the later are focused on reinforcing the pre-existing common goal. One can assume that addressing the "wicked problems", due to their inherently complex nature, should call for the first type, i.e. prefiguratively organized knowledge ecosystems.

One can argue that the mainstream view to the knowledge ecosystems with its focus on large public R&D initiatives (e.g. CERN) still has strong elements of the *ecosystem-as-structure* view and *partial* form of knowledge ecosystem. Such public initiatives are often purposefully structured around the pre-defined (yet in broad terms) knowledge area with relatively clear set of knowledge actors that are expected to contribute to the new knowledge creation. Similar approach can be observed in the large corporate environments where the creation of new transdisciplinary knowledge is taking place in the 'leadership-based strategic communities' (Kodama, 2007; 2018). In such cases, the knowledge ecosystems are purposefully created by the corporations (across the organizational boundaries) in order to achieve the synergies out of the different disciplinary perspectives, yet

the processes of new knowledge creation are coordinated by the managers within the corporate hierarchy. Such ecosystems enable the creation of new knowledge (and new products out of unexpected technological combinations) for the strategic renewal of firms. We can argue that the *ecosystem-as-structure* and *partial* form of knowledge ecosystem perspectives are well applicable for addressing certain 'wicked' issues on the organizational or corporate level, but face limitations in more complex problem settings.

Thus, when dealing with the wider socio-economic challenges, the *ecosystem-as-affiliation* view (Adner, 2017) and *prefigurative* form of knowledge ecosystems (Järvi, Almpanopoulou, Ritala, 2018) are more reflective of the complex nature of the wicked problems,. They are more open to the exploration of the new knowledge domains outside the predetermined organizational boundaries. They encourage the open-ended communities of the continuously interacting and co-evolving actors. The general ecosystem perspective for addressing the issues of wicked problems has already been proposed by several researchers. For example, Kazlauskas and Hassan (2010) advocate the usefulness of digital ecosystems for providing social technological solutions to the wicked climate change problems. The Cynefin framework (Kurtz, Snowden, 2003; Snowden, 2002) provides a conceptual lense for the adoption of complexity-based ecosystemic view. The core emphasis here is the resistance towards the adoption of a single idealised model, but instead focusing on raising "an awareness and understanding of the borders between different domains and the acquisition of tools and techniques to enable border transitions when needed" (Kazlauskas, Hassan, 2010). The understanding and solutions to the wicked problems fall under the domain of unordered complex or chaotic systems with their emphasis on the dynamic, emergent, bottom-up approaches, instead of focusing on planning and idealised design.

So the traditional view of knowledge ecosystems as structured networks of knowledge actors centred around the public R&D projects has rather strong limitations when confronted with the context of open-ended wicked problems. Should the knowledge ecosystem be capable of addressing such complex issues, it has to possess the qualities and characteristics in line with the nature of problems to be solved. Our earlier research has shown that although the notion of ecosystem originates from complex dynamic contexts and phenomena, its current usage in the social-institutional contexts often becomes rather static (e.g. with greater emphasis on elements and system's structure than on dynamic relationships). Using Cynefin terminology, the *complexity* of the wicked problems can hardly be addressed by relying on the platforms that are designed with the mentality of *complicated* systems. To be effective, the knowledge ecosystems need to be accessible to the diversity of actors, encourage their spontaneous sociability, situational awareness and relations based on individual and collective learning. They have go beyond the disciplinary confinement, which can be achieved through transdisciplinary leadership. Such leadership does not imply the presence of top-down design or hierarchical structures. The leaders of effective knowledge ecosystems act primarily as moderators and coordinators who are well aware of the complex dynamic nature of both the ecosystem and the wicked problems at hand. It means focusing more on the boundaries and attractors in the ecosystem rather than on the rules and control. Building and sustaining the effective knowledge ecosystems for addressing the wicked issues also means avoiding the pitfalls of managerialism that can create perverse incentives and lead to the unintended consequences.

4. Concluding remarks

The conceptual adaptation of the knowledge ecosystem approach from the context of public R&D-centred large scale initiatives (e.g. CERN) towards more flexible, loose and open-ended networks of diverse actors is linked with adopting the *ecosystem-as-affiliation* view and *prefigurative* form of knowledge ecosystems. It is important to keep in mind that wicked problems call for a continuous adjustment to the evolving context. Their outcomes and solutions cannot be controlled with the fixed mindsets of knowledge actors, no matter their competence or diversity. Therefore, the emergence of new knowledge for dealing with the wicked problems is a continuous iterative process among the actors that do not necessarily share the same values, competence fields or levels of power. The knowledge ecosystem is not only about the collaborative generation of new knowledge, but also about obtaining the needed feedback and taking the corrective actions. It means that the ecosystem actors need adequate meta-knowledge as well as the collaboration and learning skills. These are important challenges to be considered when identifying the leverage points, designing and testing the systemic solutions, and minimizing the unexpected consequences.

References

Aarikka-Stenroos, L. and Ritala, P. (2017) "Network management in the era of ecosystems: Systematic review and management framework" *Industrial Marketing Management,* 67, pp 23-36.

Adam, R.J. (2016). *Education for Wicked Problems and the Reconciliation of Opposites: A theory of bi-relational development.* New York: Routledge.
Adner, R. (2006) "Match your innovation strategy to your innovation ecosystem", *Harvard Business Review*, 84(4), pp 98-107.
Adner, R. (2017) "Ecosystem as structure: An actionable construct for strategy", *Journal of Management,* 43(1), pp 39-58.
Adner, R. and Kapoor, R. (2010) "Value creation in innovation ecosystems: How the structure of technological interdependence affects firm performance in new technology generations", *Strategic Management Journal,* 31, pp 306-333.
Adner, R. and Kapoor, R. (2016) "Innovation ecosystems and the pace of substitution: Re-examining technology S-curves", *Strategic Management Journal,* 37, pp 625-48.
Almpanopoulou, A. (2019) *Knowledge ecosystem formation: an institutional and organisational perspective: PhD Dissertation*, Lahti University of Technology (LUT), https://www.researchgate.net/publication/332801781
Anderson, P. (1999) "Complexity Theory and Organization Science. Organization Science", 10 (3), *Special Issue: Application of Complexity Theory to Organization Science*, (May - June, 1999), pp 216-232.
Balint, P.J., Stewart, R.E, Desai, A. and Walters, L.C. (2011). *Wicked Environmental Problems: Managing Uncertainty and Conflict.* Islandpress: Washington, Covelo, London.
van Berkel, K. and Manickam, A. (2020). *Wicked World: Complex Challenges and Systems Innovation*. Noordhoff, Routledge.
van den Borgh, M., Cloodt, M. and Romme, A. G. L. (2012) "Value creation by knowledge-based ecosystems: Evidence from a field study", *R&D Management*, 42, pp 150-69.
Brown, V.A., Harris, J.A. and Russell, J.Y. (2010). *Tackling Wicked Problems: Through the Transdisciplinary Imagination*. London, Washington DC: Earthscan.
Camillus, J.C. (2008). "Strategy as a Wicked Problem". *Harvard Business Review*. 86, pp 98–101.
Churchman, C.W. Guest Editorial: Wicked Problems. *Management Science* 1967, 14, B141–B142.
Clarysse, B., Wright, M., Bruneel, J. and Mahajan, A. (2014) "Creating value in ecosystems: Crossing the chasm between knowledge and business ecosystems", *Res. Policy,* 43(7), pp 1164–1176.
Conklin, J. (2003). "Dialog Mapping: Reflections on an Industrial Strength Case Study" (PDF). In Kirschner, P.; Shum, S.J.B; Carr, C.S. (eds.). Visualizing Argumentation – Tools for Collaborative and Educational Sense-Making. London: Springer.
Conklin, J. (2003b). Dialog Mapping: An Approach for Wicked Problems. CogNexus Institute.
Conklin, J. (2006). Dialogue mapping: building shared understanding of wicked problems. Chichester, England: Wiley Publishing. ISBN 978-0-470-01768-5.
Courtney, J. F. (2001). "Decision making and knowledge management in inquiring organizations: toward a new decision-making paradigm for DSS". Decision Support Systems. 31 (1): 17–38. doi:10.1016/s0167-9236(00)00117-2. ISSN 0167-9236.
Dattée, B., Alexy, O. and Autio, E. (2018) "Maneuvering in poor visibility: How firms play the ecosystem game when uncertainty is high", *Academy of Management Journal*, doi:10.5465/amj.2015.0869.
Fitzpatrick, G. (2003). *The Locales Framework: Understanding and Designing for Wicked Problems.* Springer-Science+Business Media Dordrecht.
George, G., Howard-Grenville, J., Joshi, A. and Tihanyi, L. (2016) Understanding and Tackling Societal Grand Challenges Through Management Research, Academy of Management Journal, 2016, Vol. 59, No. 6, pp 1880–1895.
Head, B.W. (2022). *Wicked Problems in Public Policy: Understanding and Responding to Complex Challenges*. Palgrave Macmillan.
Hull, R.B., Robertson, D.P. and Mortimer, M. (2020). *Leadership for Sustainability: Strategies for Tackling Wicked Problems.* Washington: IslandPress.
Iansiti, M. and Levien, R. (2004) "Strategy as ecology", *Harvard Business Review*, March, pp 69-78
Järvi, K., Almpanopoulou, A. and Ritala, P. (2018) "Organization of knowledge ecosystems: Prefigurative and partial forms", *Research Policy,* 47(8), pp 1523-37.
Jucevičius, G., Grumadaitė, K. and Staniulienė, S. (2021). Knowledge ecosystems as complex adaptive systems: between myth and reality. Proceedings of European Conference of Knowledge Management.
Kazlauskas, A. and Hasan, H. (2010). Web 2.0. solutions to wicked climate change problems. Australasian Journal of Information Systems, Vol. 16, No. 2, pp 23-36.
Klimas, P. and Czakon, W. (2021) "Species in the wild: a typology of innovation ecosystems", *Review of Managerial Science*, https://doi.org/10.1007/s11846-020-00439-4.
Kodama, M. (2007). *The Strategic Community-Based Firm*. Palgrave Macmillan UK. https://doi.org/10.1057/9780230625761
Kodama, M. (Ed.). (2018). Collaborative Dynamic Capabilities for Service Innovation: Creating a New Healthcare Ecosystem. Palgrave Macmillan. https://doi.org/10.1007/978-3-319-77240-0
Kumlein, A de A. and Coughlan, P. Wicked Problems and How to Solve Them, The Conversation, October 18, 2018 (http://theconversation.com/wicked-problems-and-how-tosolve-them-100047)
Kurtz, C. F. and Snowden, D. J. (2003) The New Dynamics of Strategy: sense-making in a complexcomplicated world, IBM Systems Journal, Fall 2003
Laihonen, H. (2006) "Knowledge flows in self-organizing systems", *Journal of Knowledge Management*, 10 (4), pp 127-135.
Leten, B., Vanhaverbeke, W., Roijakkers, N., Clerix, A. and Van Helleputte, J. (2013) "IP models to orchestrate innovation ecosystems", *California Management Review*, 55(4), pp 51-64.

Lundvall, B-Å. (ed.) (1992), N*ational Systems of Innovation: Towards a Theory of Innovation and Interactive Learning*, London: Pinter Publishers.
Majchrzak, A. and Malhotra, A. (2020). *Unleashing The Crowd: Collaborative Solutions To Wicked Business And Societal Problems*. Palgrave Macmillan.
Närvänen, E., Mesiranta, N., Mattila, M. and Heikkinen, A. (2020). *Food Waste Management: Solving the Wicked Problem.* Springer International Publishing; Palgrave Macmillan.
Ney, S. and Meinel, Ch. (2019). *Putting Design Thinking to Work: How Large Organizations Can Embrace Messy Institutions to Tackle Wicked Problems*. Springer.
Oh, D. S., Phillips, F., Park, S. and Lee, E. (2016) "Innovation ecosystems: A critical examination", *Technovation*, 54, pp 1-6.
Ranabahu, N. (2020). "'Wicked' solutions for 'wicked' problems: Responsible innovations in social enterprises for sustainable development," Journal of Management & Organization, Cambridge University Press, vol. 26(6), pp 995-1013, November.
Ritchey, T. (2011). *Wicked Problems – Social Messes: Decision Support Modelling with Morphological Analysis.* Springer-Verlag Berlin Heidelberg
Rittel, H. W. J., and Webber, M. M. (1973). "Dilemmas in a General Theory of Planning." *Policy Sciences* 4, pp 155–169.
Sachs, J., Schmidt-Traub, G., Kroll, C., Lafortune, G. and Fuller, G. (2018): SDG Index and Dashboards Report 2018. New York: Bertelsmann Stiftung and Sustainable Development Solutions Network (SDSN) (http://sdgindex.org/reports/2018/)
Sherden, W.A. (2011). *Best Laid Plans: The Tyranny of Unintended Consequences and How to Avoid Them*. Santa Barbara: Praeger.
Snowden, D. (2002) Complex Acts of Knowing: Paradox and Descriptive Self-Awareness. *Journal of KM*, 6(2).AS5037(Int) Interim Australian Standard Knowledge Management, Standards Australia, 2003.
Tromp, C. (2018). *Wicked Philosophy: Philosophy of Science and Vision Development for Complex Problems*. Amsterdam University Press.
Valkokari, K. (2015) "Business, innovation, and knowledge ecosystems: How they differ and how to survive and thrive within them", *Technology Innovation Management Review,* 5(8), pp 17-24.

Acknowledgements

The paper was prepared with the support of the Research Council of Lithuania under the research project "Smart development of organizational knowledge ecosystems" (contract No. S-MIP-21-49).