

Moving Beyond Mapping: A Guide to Ecosystem Measurement



ORANGE
SPARKLE
BALL

+

KU

Social
Innovation
Lab

Authors

Teri A. Garstka, PhD., Meaghan Kennedy, MPH &
Michaela Bonnett, MPH

Affiliations

KU Social Innovation Lab & Orange Sparkle Ball

Date

Spring 2025

Moving Beyond Mapping: A Guide to Ecosystem Measurement

© 2025 by University of Kansas Social Innovation Lab & Orange Sparkle Ball

This white paper is licensed under Creative Commons [Attribution-NonCommercial-NoDerivatives 4.0 International](https://creativecommons.org/licenses/by-nc-nd/4.0/) (CC BY-NC-ND 4.0). Users may redistribute this material in any medium or format in unadapted form and for noncommercial purposes only. The author must be credited. More information can be found at <https://creativecommons.org/>



To view a copy of this license, visit <https://creativecommons.org/licenses/by-nc-nd/4.0/>

A free, open-source version of this white paper is hosted at KU ScholarWorks: <http://kuscholarworks.ku.edu/> Access this white paper directly at [LINK](#)

Published by the University of Kansas Libraries
Lawrence, KS 66045

Series: Responsive Ecosystems for Change

The world in which we live and work is fundamentally interconnected in ways both visible and invisible. These connections can strengthen our grand efforts and serve as individual measures of our collective power to change that which cannot move but for our shared force. We think about this potential when we consider some of our most challenging problems – creating the fundamental conditions for driving large-scale innovation, entrepreneurship, or mobility, and moving deeply entrenched equity, health, and well-being outcomes in our communities. We think about what is possible in an ever-changing world in the spaces where people meet, interact, and connect to make change happen. We then take this potential and create the will to act.

What do we mean by **Responsive Ecosystems for Change**? Briefly, we envision a dynamic and adaptable ecosystem composed of diverse, interconnected actors that can evolve and support change. An **ecosystem** is a network or system of interconnected elements (such as organizations, individuals, resources, and policies) that work together in a variety of contexts, including social and civic environments, areas of innovation, industry, entrepreneurship, or sustainable human endeavors and natural resources. These ecosystems are **responsive** because they can react quickly and appropriately to new challenges, opportunities, or shifts. And finally, these ecosystems are oriented toward **change** by facilitating or supporting transformation, innovation, or progress that is equitable and sustainable.

Driving systems-level change is universally challenging. Those focused on building entrepreneurial networks run into the same barriers as inclusive innovation ecosystem builders or community health professionals. This is simply because, while these and other communities and ecosystems may look different, they are all fundamentally dynamic networks. They all evolve as actors move in and out of them, gain and lose influence, and modify their roles. But how can we understand this dynamic process? And better yet, how can we evaluate and measure the dynamic ecosystem over time and use that understanding to drive evolution for maximum impact?

In this series, **Responsive Ecosystems for Change**, we explore concepts, methodologies, and applied practices designed to help ecosystem leaders, community champions, and invested practitioners understand the landscape in **ecosystem science**

Quantifying Ecosystems and Their Impact

Large-scale initiatives often rely on a complex ecosystem of partners, resources, and stakeholders to achieve their different goals. Achieving widespread impact requires diverse partnerships among many different players and the collective momentum of a strong ecosystem. For ecosystem builders, innovative leaders, and scholars, evaluating how effective those ecosystems are at influencing outcomes is a matter of both strategic importance¹ and scientific inquiry.²

Social ecosystems can span focal areas such as entrepreneurship,^{3,4} innovation,^{5,6} mobility,^{7,8} social care,⁹ educational,¹⁰ workforce,¹¹ philanthropy,¹² and beyond. Each is designed or emerges to serve a foundational purpose and operate as complex adaptive systems^{13,14} - organically interrelated at multiple levels and always changing in ways that are not linear or predetermined. In other words, it is like a living organism, ever evolving and adapting to its social context. A sampling of research studies shows that how an ecosystem is structured, how it functions, and its characteristics can have economic,¹⁵ efficiency,¹⁶ health,¹⁷ and well-being¹⁸ consequences depending upon its intended purpose.¹⁹

Designing and leading ecosystems is nuanced and complex work that takes time and effort. This is why ecosystem builders and partners must gain a deeper understanding of the mechanisms that can influence ecosystem strength, structure, and effectiveness. This knowledge can then be leveraged to effectively optimize the ecosystem and enhance its capacity to drive and sustain change.

In this paper, we outline two different, yet complementary approaches to understanding an ecosystem more deeply. We first give an overview of the most common method of **describing or mapping** an ecosystem. This method helps us understand an ecosystem's composition and the relationships and resources within it. We'll then focus on how to improve **measuring or evaluating** an ecosystem. The main purpose of that method is to assess the health, performance, and outcomes of the ecosystem over time. We argue that both methods have value, but ecosystem builders and innovative leaders have not taken full advantage of the latter to power their larger effectiveness and impact goals.

Given the potential for more effective ways of shaping ecosystems designed for change, we suggest bringing the right methods and insights to the table to better inform those efforts. We review these ecosystem methods to guide your work.

Describing & Mapping Ecosystems

Traditional approaches to understanding and describing diverse ecosystems or networks typically involve mapping out lists of partners and cataloging resources. This gives us a static snapshot of the components involved and is often called **network or ecosystem mapping**. Ecosystem mapping is a technique used to describe and visually represent the various components and interactions within a specific ecosystem.²⁰ It can be accomplished by a host of different methods (e.g., interviews, focus groups), techniques (e.g., collaborative workshops, facilitated sessions), and data sources (e.g., resource directories, organizational charts). Sometimes the connections between partners within the ecosystem are drawn by participants, indicated by hierarchical lines of reporting or funding, or assigned based on features such as geography, group, or sector membership.

It is relatively simple and straightforward, as illustrated by the Clark-Fox Family Foundation²¹. This approach typically involves three main steps:

1. **Identifying and categorizing** the different entities (such as partners, stakeholders, and individuals) that make up the ecosystem. Partners can brainstorm ecosystem membership in the form of a list that meets certain criteria (e.g., geographic location, mission, sector, or service) and what type of organization they may be (e.g., public, private, non-profit, community).
2. **Understanding the roles and resources** each entity contributes to the ecosystem as a whole. Partners can describe their roles (e.g., convener, funder or funded, lead or outreach) and what each can contribute to the ecosystem (e.g., services, time, efforts, influence).



[Clark-Fox Family Foundation](#)

3. **Visualizing the ecosystem** as a whole to illustrate the collection of entities. Partners can create a map or visual of all the network entities with categories, roles, and resources noted.

In many cases, leaders of large initiatives seeking to understand the lay of the land focus their time and resources on these **mapping** techniques. We believe this is a foundational descriptive component of ecosystem efforts. It's the first step in understanding who all the players are in a network, along with their resources or roles. It categorizes and displays all of the elements of an ecosystem in one place or map rather than in disparate or dispersed knowledge sources. Ecosystem composition can be described without defining or measuring each relationship within it.

So What Are We Missing?

We can gain significant insights and strategy to drive our ecosystem design by moving beyond mapping. Why? **Mapping falls short in measuring - or quantifying - the strength and interdependent nature of these systems.**

It also does not always allow us to test or evaluate whether an ecosystem changes over time and whether that change is meaningful or significant. Going the extra step to measure an ecosystem allows us to calculate how strong (or weak) relationships are among members and assess the overall structure and connectedness of the entire ecosystem.

When ecosystem leaders or community champions embrace data and move to **measuring** their ecosystem, they are able to derive more value than mapping alone. This is because measurement can more directly guide ecosystem designers and innovation leaders in identifying which evidence-informed activities and interventions within the ecosystem are best suited and most effective for strengthening connections.

We use this method to influence our own models for ecosystem design. It helps us create data-informed strategies to shape our ecosystem in ways that optimize effectiveness, adaptability, and ultimately, ecosystem resilience.²² How do we do this? We turn to design principles and network science to apply measurement rigor to large-scale ecosystems.

Ecosystem Design & Measurement

Most ecosystem builders, innovators, and large initiative leads are given the task of turning partnerships and collaborative efforts into vehicles for progress and large impact. We're doing this systems-level work to transform our efforts into tangible outcomes, to push for change that can be scaled, and to accomplish something larger than any one actor or sector is able to do alone. This is essentially 'systems

change' or 'collective impact' or 'strategic command' - all words to describe more or less the same goal of coordinated actions contributing to a broader systemic impact.

What we suggest is that **ecosystem design and strategy is a valid method for effectively making this happen by building in measurement and methods that validate all levels of action within a larger network.**

In our opinion, the field of systems change at large falls short by not utilizing methods for assessing the overall effectiveness of solid ecosystem design and strategy. We have seen a pressing need for large-scale initiatives to move beyond static mapping of their partnerships and ecosystems and to adopt network analysis as a more dynamic measurement methodology.²³ It is one of the linchpins of our Ecosystem Evaluation Framework because it focuses on how the system as a whole - the cumulative power of multiple levels of strategies, activities, and interventions - can move system-wide outcomes. This technique quantifies the complex interactions and relationships across an ecosystem that can drive impact.

Traditional evaluation methods tend towards more linear approaches, such as assessing whether an intervention is effective at changing a related outcome closest to the intervention. Or do these strategies produce the outputs and check-box activities that were initially implemented?

Meanwhile, ecosystem leaders (and those that may fund this work) expect long-term systems change at scale. This mismatch between how we evaluate or measure large-scale initiatives and the cumulative multi-level potential of an ecosystem means **we need to do something different.**

We need to design ecosystem-level structures and strategies and effectively measure this dynamic system to better understand how it leads to long-term change. By shifting our methods, we can maximize our most actionable insight that allows us to improve, test, and iterate on our strategies. When we do this well, we can create more effective and transparent collaboration and coordination across the ecosystem, which we know enhances the resilience and adaptability of our work.

So, what we are talking about is infusing our cross-sector initiatives with **network analysis** as a quantitative technique within our Responsive Ecosystems for Change evaluation framework. This helps leaders, organizations, and ecosystems move beyond basic mapping to measuring the structure, relationships, influences, and potential present within their ecosystem. **And once you quantify your ecosystem, you can then analyze and test whether its structure is associated with the**

change and desired outcomes that define its purpose and intent. This essentially moves an ecosystem map to an ecosystem engine.

Network Analysis for Ecosystem Measurement

Let's review one of the key techniques for measuring an ecosystem. Simply put, network analysis is a statistical technique used to study the relationships and interactions of an ecosystem. Here is where we use the words *network* and *ecosystem* interchangeably when we refer to what is being measured. Network analysis is the measurement method, and an ecosystem is what is being measured. This method is not novel; it's been used for decades in a variety of applications and fields. The basic ideas, methods, and purpose do not change when we apply them within our ecosystem evaluation methods. How we interpret and use the results in tandem with ecosystem design is where we differentiate the value for leaders and initiatives.

Quick Primer on Network Analysis

Network analysis helps us understand relationships and interactions within a system, often represented as a network. A network is made up of nodes (individual entities such as people, organizations, or institutions) and edges (the connections between these entities, such as friendships, partnerships, or collaborations). At its core, network analysis is grounded in graph theory, which is a mathematical approach for studying how elements are interconnected. Basic network metrics such as degree centrality (number of connections per node), closeness centrality (how quickly a node can reach others), and betweenness centrality (how frequently a node bridges others) are some of the fundamental measures calculated from these relationships. There are other network metrics available that tell us even more detailed information about the ecosystem structure and efficiency. We won't go into detail on how to conduct a network analysis, but we will highlight its value for our ecosystem measurement and evaluation purposes.

Importantly, the results of network analyses can be translated into meaningful information about the overall ecosystem itself and the interconnectedness that exists between everyone or everything in it. It is one of the stronger tools and methods for not only measuring an ecosystem, but is foundational to how we then test the effectiveness and impact of that ecosystem on systems-level outcomes.

Interpreting network analysis results involves understanding metrics relative to your ecosystem goals. For example, nodes or organizations with high centrality scores

may represent essential influencers or key points for intervention. Identifying isolated nodes or disconnected groups can highlight areas needing strategic attention or support. Analyzing patterns of connectivity helps ecosystem leaders make informed decisions about resource allocation, collaboration opportunities, and potential partnerships.

For example, strongly interconnected ecosystems can indicate robust collaboration but can risk inefficiencies due to redundancy. Sparse networks might allow innovation through unique connections but risk fragmentation and reduced collective resilience. Clusters or modules within networks reveal areas of specialized knowledge or expertise, suggesting opportunities for targeted resource sharing or partnership initiatives.

The Value of Measuring an Ecosystem

How we use the results of the network analysis matters. Of course, network analysis tells us a great deal about the structure, strength, and interconnectedness of our ecosystem. As a stand-alone method, it does its job in quantifying the relationships within an ecosystem beyond simply mapping it. But there is more.

This is the big idea: We use network analysis for measuring ecosystems, AND we can use that measurement to predict change in ecosystem-wide outcomes. When we take the results from our network analysis and incorporate them into our statistical modeling, we can test the network's overall influence on system outcomes. This is a tool and technique every ecosystem leader should have in their toolbox.

We also highly recommend measuring an ecosystem over time and collecting data on the connections between organizations longitudinally. Why? Because an ecosystem changes and its structure is not static. Therefore, measuring it over time allows us to describe how the ecosystem as a whole transforms - naturally or through interventions. This is an essential component of evaluating ecosystems and understanding how their structure and composition influence important system-wide outcomes over time.

By incorporating measurement and analysis into their work, ecosystem leaders and stakeholders gain actionable insights to **optimize ecosystem structure**, enhance collaboration, and strengthen overall impact.

Quick Note About Network Data

Network analysis relies heavily on quality data about relationships and interactions, but gathering such data presents challenges, particularly regarding data availability, granularity, temporal dynamics, and accuracy. We have found that publicly available information often captures formal relationships, but critical informal connections like collaborations or influence pathways require more in-depth methods like stakeholder interviews, surveys, and iterative data collection. This takes time and effort. Sometimes it's better to start easy with what data is available than to dream about the best possible data we could collect. There are tradeoffs inherent in this process, whether it's resources, statistical rigor, or access barriers. We know that capturing the evolving nature of ecosystems demands consistent, longitudinal data collection strategies and dynamic management tools. We also know that we need to make sure that the accuracy of our insights is validated through triangulation (i.e., multiple confirmation checks), stakeholder feedback, and transparent analytical processes. When we understand these data collection nuances, we can better assess what data is 'absolutely necessary', 'good enough', or 'the best possible'. We simply must keep in mind that better data directly informs stronger decisions. For a deeper dive into overcoming these data challenges, see our forthcoming white paper dedicated to ecosystem data methods and strategies.

Putting the Pieces Together: A Concrete Example

Let's describe a concrete example: Say that we are conducting a network analysis on a regional innovation hub where startups, universities, investors, and government agencies collaborate to drive technological advancements. Each entity, such as a startup, research institution, or funding body, is a **node**, and their partnerships, knowledge exchanges, or financial investments are the **edges** connecting them. Network analysis can help identify which organizations are central to the ecosystem by calculating metrics like betweenness centrality, which highlights entities that act as bridges connecting different groups. We can also understand the structure of this innovation ecosystem and why it might matter.

For example, if a university serves as a hub, collaborating with startups on research and development while also receiving funding from investors, it may emerge as a critical facilitator of innovation. Network analysis can also reveal isolated nodes, such as startups with few connections, that may benefit from targeted support or integration into the network. By understanding these patterns, policymakers and

ecosystem managers can design strategies to strengthen collaboration, improve resource flow, and foster a more inclusive and sustainable innovation ecosystem.

The structure of this network may resemble a **decentralized and modular system**, where multiple hubs, such as universities, investors, and government agencies, play critical roles in connecting startups and facilitating resource flows. Ecosystem structure matters for outcomes because it allows for resilience; if one hub fails, others can maintain the network's functionality, while also fostering specialization and innovation within clusters. Identifying and strengthening hubs or bridging isolated nodes can enhance collaboration so that resources and opportunities can be distributed effectively across the ecosystem, driving technological advancements and regional economic growth.

Measuring Ecosystems in the Real World

Here are four reasons to use network analysis in ecosystem work and examples of real-world applications of this method.

Network analysis gives us **the concrete means of tracking how information, ideas, or resources are exchanged and spread among partners.**

- From this, we can design more efficient workflows, identify where gaps or risks exist in the exchange of supplies or actionable information within the larger system, or propose policy changes or interventions that reduce barriers to collaboration, coordination, or service delivery across missions, sectors, or geography. [See how Panasonic's Recruit and Career Create division used this methodology to strengthen their internal network.](#)

Network analysis allows us to **measure how densely interconnected (or not) an ecosystem is.**

- From this, we can determine if our ecosystem is optimally structured for our purpose. A more loosely structured ecosystem might be best for spreading ideas or resources far and wide or promoting innovation through novel collaborations. A more densely connected ecosystem may be better for timely, coordinated responses that must engage many. [See how Legacy Health used this methodology to analyze nurse staffing strategies across their network.](#)

Network analysis provides **specific information on the level of influence and position of one or more central or influential actors or organizations in the ecosystem.**

- From this, we can utilize these influential players to champion efforts or direct actions that others follow. We are also able to create strategies or policies that encourage these influential hubs of organizations to connect with more distant members of an ecosystem, such as community groups or start-ups, to increase new opportunities. [See how the Consultative Group on International Agriculture Research used this methodology to identify key relationships and stakeholders in resilient food systems and the Genebank Platform.](#)

Network analysis (combined with ecosystem mapping) gives us the **visual information and tools to understand the diversity or alignment of people or organizations based on resources, services, or sectors.**²⁴⁻²⁶

- From this, we can assess the desired reach and inclusivity of an ecosystem relative to its surrounding environment. We can determine if our ecosystem is representative of the full range of talents and resources needed to contribute to or influence a shared outcome. [See how the FCC used this methodology to understand the national broadband ecosystem relative to health equity indicators.](#)

Summary & Conclusion

If we both map and measure an ecosystem, we can uncover not only the structure of the network but also the effectiveness and outcomes of its interactions. Mapping highlights the entities and connections within the ecosystem, revealing critical hubs, gaps, and potential synergies, while measuring provides quantifiable evidence of performance, such as the rate of innovation or resource utilization. Together, these approaches allow stakeholders to identify areas for strategic intervention, monitor progress over time, and optimize the ecosystem's ability to support growth and collaboration.

Network analysis as a methodology is not new, but it is underutilized by ecosystem leaders and community champions to inform action. Two main reasons for this include: 1) Difficulty in collecting or identifying meaningful data about the relationship that exists between individuals or organizations in an ecosystem; and 2)

Limited access to analytic tools or the expertise needed to transform meaningful data into results, insights, and action.

However, with the right data and expertise, network analysis offers a more rigorous approach to quantifying system-wide efforts and identifying strategies to improve inclusive ecosystem strength. For ecosystem builders and community champions, it also offers a concrete way to evaluate success and future directions across many different fields and at different scales.^{27,28}

Shifting the rigor of methods used by ecosystem champions can lead to deeper insights, improved strategic planning, more effective collaboration, and enhanced resilience and adaptability of your initiative. Both mapping and measurement have value, and we encourage ecosystem leaders to take an “And/Both” approach to adopting these methods. The additive effect offers distinct and complementary value in understanding and shaping an ecosystem for a greater purpose.

Here’s a quick overview of key principles of how to foundationally describe and more rigorously measure your ecosystem:

Moving Beyond Mapping: Foundation + Impact Guide for Ecosystems		
Elements	Mapping Ecosystems	Measuring Ecosystems
Focus	Composition, Characteristics, Linkages, Resources	Structure, Outcomes, Performance, Change
Method	Stakeholder Facilitation, Relationship Signification, Descriptive Characteristics	Network analysis, dashboards, metrics, statistical tests
Tools	Visualization tools (e.g., KUMU, Miro, Lucidcharts, Canva), Resource directories	Data analysis and statistical software (R igraph package, Gephi, SPSS)
Data	Organizational information, Resources or functions, Qualitative linkages by function or type	Interactions between organizations, Quantitative

Timeframes	Static or real-time	Cross-sectional or Longitudinal
Primary Value	Understanding, Describing, and Coordinating	Accountability, Impact, and Optimization

In this paper, we argue that equipping ecosystem leaders and community champions with more rigorous methods, such as network analysis, for measuring their impact potential is crucial to driving systems change at scale. **We advocate for moving beyond simply mapping an ecosystem to measuring it.** This means adding rigor to your efforts by quantifying an ecosystem’s strengths and challenges, its structure and functioning, the influencers and the outliers, and the dynamic interrelationships that exist. These aspects are what matter for ecosystem science.

We also know that ecosystems change over time; it is a complex system that evolves and morphs both in its composition and structure, as well as the strength of connections and relationships within it. Framing ecosystems as complex adaptive systems introduces a more sophisticated way of understanding these evolving networks and leveraging their coordinated strength to drive impact. Without measuring the complex and dynamic nature of entire ecosystems, it is difficult to identify critical nodes, understand information flow, allocate resources efficiently, and anticipate potential vulnerabilities or opportunities. There are more effective methodologies that an ecosystem initiative can use to strategically pivot, innovate, and achieve sustainable impact.

Ultimately, mastering the art of measuring and guiding ecosystem evolution brings great value to those seeking to understand the impact of their collaborative ecosystem work. When we do that, we unlock the full potential of ecosystems to drive systems-level change across various domains, from entrepreneurship to innovation to community health and beyond.

What's Next?

When it comes to driving systems-level change, anticipating what to do next requires a paradigm shift. We think that it is crucial to move beyond simply recognizing the dynamic nature of ecosystems and communities as networks.

The next big idea involves utilizing advanced network analysis tools to not only observe but actively design and shape the evolution of these networks over time for greater resilience and impact. By predicting shifts in influence and strategically guiding the ecosystem's trajectory, leaders and practitioners can target precise strategies for enhancing collaboration, resilience, and inclusivity. This proactive approach transforms ecosystem management, enabling the anticipatory design of systems that are more adaptable and better equipped to achieve long-term, sustainable outcomes.

Inclusive ecosystems harness the potential and power of the connections we build with each other to fuel what is possible. We believe we have the tools to make what's next happen now.

References

1. Adner R. Ecosystem as Structure: An Actionable Construct for Strategy. *J Manag.* 2017;43(1):39-58. doi:10.1177/0149206316678451
2. Garstka TA, Kennedy MB, Bonnett M. Ecosystems Designed for Change: An Evaluation Framework for Innovators & Leaders. Lawrence Univ Kans. Published online November 2024. doi:https://hdl.handle.net/1808/35612
3. Isenberg D. The Big Idea: How to Start an Entrepreneurial Revolution. *Harv Bus Rev.* Accessed June 19, 2025. <https://hbr.org/2010/06/the-big-idea-how-to-start-an-entrepreneurial-revolution>
4. Spigel B. The Relational Organization of Entrepreneurial Ecosystems. *Entrep Theory Pract.* 2017;41(1):49-72. doi:10.1111/etap.12167
5. Adner R. Match Your Innovation Strategy to Your Innovation Ecosystem. *Harvard Business Review.* April 2006. Accessed June 19, 2025. <https://hbr.org/2006/04/match-your-innovation-strategy-to-your-innovation-ecosystem>
6. Autio E, Thomas LDW. Innovation Ecosystems: Implications for Innovation Management? In: Dodgson M, Gann DM, Phillips N, eds. *The Oxford Handbook of Innovation Management.* Oxford University Press; 2014:0. doi:10.1093/oxfordhb/9780199694945.013.012
7. Geels FW. Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. *Res Policy.* 2002;31(8):1257-1274. doi:10.1016/S0048-7333(02)00062-8
8. Bonnett M, Garstka TA, Ladetto A, Kennedy MB, Fernandez J, Swiecki B. Mapping the Detroit mobility ecosystem: A case study of a regional initiative centered on future mobility solutions. *J Urban Mobil.* 2025;7:100108. doi:10.1016/j.urbmob.2025.100108
9. Burn E, Needham C. What Does the Concept of an Ecosystem Offer to Social Care? A Narrative Review of the Ecosystem Literature. *CIIRCLE;* 2023. Accessed June 19, 2025. <https://centreforcare.ac.uk/publications/review-of-ecosystem-literature-2023/>
10. Scott IL. A New PK-12 Education Ecosystem Framework for a New Normal. *Harvard ALI Social Impact Review.* 2020. Accessed June 19, 2025. <https://www.sir.advancedleadership.harvard.edu/articles/a-new-pk-12-education-ecosystem-framework-for-a-new-normal>
11. Altman EJ, Schwartz J, Kiron D, Jones R, Kearns-Manolatos D. *Workforce*

- Ecosystems: A New Strategic Approach to the Future of Work. Deloitte; 2021. <https://sloanreview.mit.edu/workforce-ecosystems/>
12. Patton MQ, Foote N, Radner J. A Foundation's Theory of Philanthropy: What It Is, What It Provides, How to Do It. *Found Rev.* 2015;7(4). doi:10.9707/1944-5660.1263
 13. Benham-Hutchins M, Clancy TR. Social networks as embedded complex adaptive systems. *J Nurs Adm.* 2010;40(9):352-356. doi:10.1097/NNA.0b013e3181ee42bc
 14. Dentoni D, Pinkse J, Lubberink R. Linking Sustainable Business Models to Socio-Ecological Resilience Through Cross-Sector Partnerships: A Complex Adaptive Systems View. *Bus Soc.* 2021;60(5):1216-1252. doi:10.1177/0007650320935015
 15. Jackson MO, Rogers BW, Zenou Y. The Economic Consequences of Social-Network Structure. *J Econ Lit.* 2017;55(1):49-95. doi:10.1257/jel.20150694
 16. Cowan R, Jonard N. Structural holes, innovation and the distribution of ideas. *J Econ Interact Coord.* 2007;2(2):93-110. doi:10.1007/s11403-007-0024-0
 17. Ostovari M, Yu D. Impact of care provider network characteristics on patient outcomes: Usage of social network analysis and a multi-scale community detection. *PLoS ONE.* 2019;14(9):e0222016. doi:10.1371/journal.pone.0222016
 18. Garstka TA, Bonnett M, Kennedy MB, Fernandez J, Harms R. The Relationship Between Community Networks and Population-Level Outcomes. In: *Networks and Resilience.* KU Scholarworks; 2024. doi:<https://hdl.handle.net/1808/35216>
 19. Cobben D, Ooms W, Roijackers N, Radziwon A. Ecosystem types: A systematic review on boundaries and goals. *J Bus Res.* 2022;142:138-164. doi:10.1016/j.jbusres.2021.12.046
 20. Derr A. How To Build Resilient Community Networks: 7 Tips From Systems Theory. *Visible Network Labs.* January 17, 2024. Accessed February 5, 2024. <https://visiblenetworklabs.com/2024/01/17/how-to-build-resilient-community-networks/>
 21. Clark-Fox Family Foundation. Clark Fox Family Foundation - Home. Clark-Fox Family Foundation. 2025. Accessed June 19, 2025. <https://clarkfoxstl.com/>
 22. Garstka TA. Resilient by Design: What Strong Communities Have in Common. *Resilient by Design.* May 2025. Accessed June 19, 2025. <https://www.ku-socialinnovationlab.com/features/resilient-by-design>

23. Garstka TA. Modeling Community Resilience: Is Network Analysis the Most Effective Method? In: SocioEconomic Mathematical Epidemiology: Developing Mathematical Modelling Theory. ; 2024. <https://www.birs.ca/events/2024/5-day-workshops/24w5286/schedule> doi:10.1097/01.PHH.0000333889.60517.46
24. Leppin AL, Okamoto JM, Organick PW, et al. Applying Social Network Analysis to Evaluate Implementation of a Multisector Population Health Collaborative That Uses a Bridging Hub Organization. *Front Public Health*. 2018;6. Accessed May 18, 2023. <https://www.frontiersin.org/articles/10.3389/fpubh.2018.00315>
25. Varda DM, Chandra A, Stern SA, Lurie N. Core dimensions of connectivity in public health collaboratives. *J Public Health Manag Pract JPHMP*. 2008;14(5):E1-7.
26. Isada F. The Partnership Network Structure of Automakers under Radical Technological Change. *Bus Syst Res J*. 2021;12(2):95-113. doi:10.2478/bsrj-2021-0021
27. Calliari E, Michetti M, Farnia L, Ramieri E. A network approach for moving from planning to implementation in climate change adaptation: Evidence from southern Mexico. *Environ Sci Policy*. 2019;93:146-157. doi:10.1016/j.envsci.2018.11.025
28. Valente TW, Palinkas LA, Czaja S, Chu KH, Brown CH. Social Network Analysis for Program Implementation. *PLOS ONE*. 2015;10(6):e0131712. doi:10.1371/journal.pone.0131