A soft ecosystems methodology of digital innovation through a case study of the insurance industry’s response to connected cars.

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Abstract

Digital innovations are increasingly the result of the combination of resources and skills beyond organisational boundaries and/or industries, resulting in the rise of a new organisational form – the digital innovation ecosystem. Studies of ecosystems have considered the structural, conceptual, and temporal aspects such as emergence, however, understanding of ecosystems in flux remains nascent. In particular, existing research focuses on change in the ecosystem rather than imagined (anticipated) change and its impact on the ecosystems future. To address this, we adopt a systems thinking perspective that builds on soft systems methodology and British Cybernetics to propose what we refer to as ‘soft ecosystems methodology– and introduce the notion of ecosystem-as-was, ecosystem-as-is, and ecosystem-to-be. We discuss this emergent methodology in light of the disruptive digital innovation faced by the car insurance industry.

Keywords: Systems thinking, Ecosystems, Digital innovation, ecosystem-as-was, ecosystem-as-is, ecosystem-to-be, imagining, soft ecosystem methodology.

1.0 Introduction

Digital innovations are increasingly the result of leveraging resources and interacting with entities beyond a single organisation’s boundary (Seo 2017). This has led to a “new organisational form of digital innovation” (Wang 2021) – the digital ecosystem. Such digital ecosystems form a collective aggregate of loosely coupled autonomous actors lacking hierarchical control, but collectively undertaking activities around the development and implementation of digital technologies (ibid).

Existing research has addressed the structuring roles of actors within digital innovation ecosystems leading to an intense firm-centric focus on platform ecosystem dynamics in which one actor (the “platform” or lead firm e.g. Apple or SAP) is dominant (e.g. Parker et al., 2017; Qiu et al., 2017; Schreieck et al., 2021).

Yet the term ecosystem draws upon an ecological metaphor of symbiotic relations between actors (Moore 1993) in which such dominance of an actor is rarely seen.

Furthermore, recent research has highlighted a lack of research into integration (the whole) of an ecosystem in contrast to the dominant focus on key actors (the parts) – a focus which inherently overlooks the wider ecosystem dynamics (Wang, 2021). Wang (2021) usefully addresses this gap through an ecosystemic lens that builds upon ecology, and in particular part-whole relations (ibid). Digital ecosystems are thus constituted from parts which interact to form a whole, albeit, we argue, those parts may vary from simple API services, through companies of various forms, to entire digital infrastructures (such as the Internet).

Literature predominantly adopts a static view of ecosystems. While some researchers have studied ecosystems' evolution (Pujadas et al., 2024), the collective actions undertaken for that change to happen are understudied. Particularly, how knowledge and the imagined futures about the ecosystem shape both ecosystems and actors' evolution. We believe systems thinking can help address this gap. We introduce and build upon a socio-technical, British and soft systems (Checkland, 1981) perspective to the study of digital innovation ecosystems – one which, we believe, better accounts for digital innovation ecosystems' ontology.

We thus seek to contribute a systems perspective to the study of digital innovation ecosystems and in particular digital ecosystems in flux. From these ideas we intend to build a practical soft ecosystems methodology (based on SSM) which has practical benefit. We are starting to research this empirically through a design science informed study of the insurance industry as it faces the disruption of increasingly digitised (and indeed self-driving) cars and transport – disruption that is seriously affecting many actors within the ecosystem. In designing our **soft ecosystems methodology,** we seek to develop a lens by which we can illuminate the emergence and transformation of the actors and the ecosystem they inhabit. Our design activity is informed by Design Science (Hevner et al., 2004) using soft systems thinking as a *kernel theory* which is elaborated through cycles of empirical research within the insurance industry as we build our theory. Our over-arching aim is to build "tough, analytic, partly formalizable, partly empirical, partly teachable doctrine" (Simon 1996, p.113) to address the strategic challenges of digital innovation ecosystems by creating an artefact that can apply, test, modify, and extend 'kernel theories' (Markus et al. 2002; Walls et al. 1992). Our overarching aim – in keeping with other design science is relevance to practitioners in the field (Straub and Ang 2011) and for this reason we are working closely with an insurance provider facing the challenge of connected cars and digital transformation influencing its digital ecosystem.

Our aim then is to address a broad research question of "*How can practitioners understand the emergence of a digital ecosystem as a sociotechnical process, and how can systems thinking assist in this understanding?"* We do this as follows. First, we review the ecosystem literature in greater detail as we seek to identity how it might align with our systems perspectives. Second, we introduce our systems thinking approach which is informed by European research on systems thinking. Third we briefly outline our case study from the insurance industry in which we aim to test our designed soft ecosystem methodology. Finally, we outline our soft ecosystem methodology and discuss our future research plans for testing and further refining our design.

2.0 Ecosystems research through the lens of systems perspective

Adopting the term business ecosystems, coined initially by Moore (1993), ecosystems are "*literally and phenomenologically systems*" (Phillips & Ritala, 2019, p. 2), that illustrate the dynamic interactions between, and co-evolution of various actors in ecosystems. Scholars have studied this in context of varied ecosystems like technology, knowledge, business, innovation, platform, and entrepreneurial ecosystems, [see for instance (Gawer, 2021; Gomes et al., 2021; Meynhardt et al., 2016; Scaringella & Radziwon, 2018)].

Drawing on above such studies and synthesising seminal papers on ecosystems, Hou & Shi, (2021) and Phillips & Ritala, (2019) highlight that our understanding of ecosystems is limited to – 1) Ecosystems' boundaries, 2) ecosystem actors and the activities and relationships between them, 3) the temporal evolution and emergence of ecosystems. Yet further research is needed to understand the mechanisms which underpin such emergence (Baldwin 2019, Kapoor 2018) in general.

Phillips & Ritala (2019, p. 3) underscore the importance to draw on systems thinking to address this by emphasising the *"need to link our (ontological) knowledge about systems to systems thinking (which is conceptual and epistemological)".* Where ecosystems literature has adopted systems thinking perspective, Badinelli et al. (2012, p. 499) note that scholars have looked at studying the structure of ecosystems by identifying actors, activities, and interconnectedness of entities, but have lacked applying *"system thinking principles, which often disrupt the traditional thinking."*[1]

Ecosystems are best understood as systems and better studied using systems theory because it *"provides insights into the emergence…. [of] … the complex constellation of connections among ecosystem components"* (Roundy et al., 2018, p. 2). Distinguishing between 'general systems' – systems which do not exhibit complex dynamic interactions and non-linearity and are therefore studied using simple systems theory that isolate and parametrise individual components – and 'complex systems' as evidenced in biology, management etc., Roundy et al. (2018, p. 2) claim that ecosystems are *"complex adaptive systems (CAS) - that cannot be explained using general systems theory."*

Barnes et al. (2003, p. 276) define Complex Adaptive Systems as "***open** systems in which different elements interact **dynamically** to exchange information, **self-organize**, and create **many different feedback** loops, relationships between causes and effects are **nonlinear**, and the systems as a whole have **emergent properties** that cannot be understood by reference to the component parts.*" Wollmann & Steiner (2017, p. 2) echo this by adding that *"the evolution of the system is the result of interactions between agents, where each of them acts in response to the behaviour of the other agents in the system, which ensure it has its own dynamic."*

Of late, scholars have been adopting CAS principles to study ecosystems. Phillips & Ritala (2019) adopt a CAS lens to propose a methodology to study ecosystems. In doing so, they provide an epistemological tool to study ecosystems by focusing on either conceptual, structural, or temporal dimensions. Looking at data ecosystems as CAS, Brous et al. (2019, p. 3) discuss how interactions between ecosystem elements

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[1] Interestingly in a professional development workshop titled "Fostering Rigor in Innovation and Entrepreneurial Ecosystem Research: Concepts, Methods and Theory" at the 2017 Academy of Management Annual Conference, it turned out that the majority (44% of scholars) supported the need for aligning research on ecosystems with systems thinking principles (Ritala & Gustafsson, 2018).

take place *"without any singular entity deliberately managing or controlling them. CASs are "dynamic systems" which are able to adapt and evolve to changing circumstance."* CAS are systems in which macro level behaviour emerge from and is influenced by interactions between system elements at the micro level (Roundy et al., 2018).

These dynamic interactions shed light on the unique behaviour, or rather characteristics of ecosystems understood as CAS. Synthesising the works of (Brous et al., 2019; Roundy et al., 2018), we note that the characteristics are – 1) *Non-linearity*: nonproportionate response to stimuli; interactions between agents is complicated and that the behaviour cannot be predicted by simply understanding how each component and agent behave; 2) *Self-organisation and feedback* as a means of co-ordination and knowledge/information exchange between agents in the system across multiple levels. Feedback can be further understood as '*positive feedback loop' – described as autocatalytic* (Morrison, 2008)*, that result in system behaviour to increase or decrease indefinitely* (Roundy et al., 2018); or '*negative feedback loop'* that moves the ecosystem *to a steady or equilibrium state, even if temporarily* (Lichtenstein & Plowman, 2009); 3) *Aggregation-* means by which agents cluster or combine in groups that contributes to the system's identity; 4) *(Co)-evolution* where activity or event at one element affects the rest in the system; and finally, 5) *open with ill-defined boundaries* where unlike closed systems, such ecosystems do not follow a predictable path and are far from equilibrium, engaging and reacting to disturbances with elements internal and external to the ecosystem (Bhardwaj et al., 2023; Roundy et al., 2018).

Other integral ecosystem features are knowledge transfer, and collaboration and competition between ecosystem actors - key foundations governing ecosystem functioning (Scaringella & Radziwon, 2018). In what the authors refer to as a 'territorial ecosystem', that builds on literature on business and innovation ecosystems and the triple/quadruple helix (Schütz et al., 2019), they argue that an understanding of transfer of tacit and explicit knowledge between ecosystem actors is essential, and that it depends on the proximity between them leading to ecosystem dynamics.

Through the above properties, although integral to understanding of ecosystems, we realise that our understanding of such *ecosystems in flux* remains limited. A field that is embedded in complexity science (Benbya & McKelvey, 2006), – i.e. how system elements interact with each other and the embedded environment to adapt and create new structures, processes and system wide properties across levels (Lissack & Letiche, 2002; Werder & Maedche, 2018) – needs further attention. To elaborate (Choi et al., 2001) note that the most productive stage for a CAS is the '*quasi-equilibrium state'* that maintains balance between complete order and incomplete disorder – what Sapir (2019) refers to as the '*edge of chaos'*. Our understanding of such stages of flux and how new knowledge processes lend to accommodate and adapt to these changes demands further investigation.

3.0 British soft systems perspectives brought into digital innovation ecosystems.

The review above has shown how researchers have sought to understand digital innovation ecosystems through systems theory. This is however dominated by approaches focused on systemic complexity (e.g. Complex Adaptive Systems theory (Holland, 1995)) with a functionalist bent (drawing upon its origins in natural sciences) (Jackson, 2019). Such North American systems' perspectives towards ecosystems therefore focus on a hard systems (realist) ontology. Ontology, or the metaphysics of "being" is more akin to a spectrum of dimensions than a taxonomy – extreme positions are unrealistic[2]. Hard systems ontology see social reality as existent from naturalistic causes (e.g atoms, biology), and causality derivable through natural science methods (e.g. Lawson (2012) or Searle's ontological positions (2006) seek repeatability) and even extending as far as causal relations or features. Ecosystems then are modelled as constituted from isolated agents who adapt based on their interactions leading to evolution. In contrast, we were influenced by Jackson's assertion that the complexity theory upon which such studies are based: *"sees structure as micro-emergent but as possessing no independent reality and causal powers of its own. By contrast many sociologists tend to see humans as born into*

[2] As Sokal[2] famously argued, anyone wholly believing in subjectivity should experiment by throwing themselves off a tall building, however we could also add that extreme objectivity involves throwing human subjectivity, religion, and social critique of science off a building too. Metaphysics remains a complex domain of debate.

social structures which constrain life opportunities and socialise individuals in ways that make it more likely that their agency will reproduce rather than change existing arrangements" (Jackson, 2019, p.127). Our ontological position then is more relational and performative whereby stability is only enacted through ongoing accomplishment of actors within the digital ecosystem, whereby the subjective actions of those within the ecosystem performatively create the ecosystems. This ontological position led us back to the origins of systems thinking and more British softer perspectives based on an arguably more constructionist ontology.

Cybernetics emerged in the 1940s as a science of "control and communication in the animal and machine" (Wiener, 2019, originally 1948), and was pushed forward, by what Jackson (2019, p.95) terms, "British Cybernetics" - a particular branch that reflected a "performative idiom" (Pickering, 2002) in which systems are subjective and perform an active role embedded within contexts. For this branch, systems focus upon that which they broadly encounter in relation to its impact upon them. Ashby's famous law of Requisite Variety (Ashby, 1956) is thus described as understandable in terms of a relationship between a biological system and its whole environment rather than mechanistic system actors' interaction *per se* (Espejo, 1993). Indeed Stafford Beer, in his "management cybernetics", sought to employ cybernetic concerns (feedback, black-box, and Ashby's management of variety) to model an organisations response to all possible external stimulus (Beer, 1984). Beer's Viable Systems Model (VSM) thus sought a dynamic equilibrium between the organisation and its whole environment (just as a biological ecosystem– say a pond[3] - might).

The digital ecosystems we are seeking to examine then are an entanglement of social, material and symbolic factors (Benbya et al., 2020). Yet existing CAS based approaches fail to account successfully in the social and symbolic aspect of this entanglement. British Cybernetics, with its links to the Tavistock institute[4] and its long history of sociotechnical studies (Mumford, 2000), offers an alternative lens that emphasises the social, and in which systems thinking is moved from an attempt to

[3] Indeed, interestingly, these cyberneticians sought to experiment whether a pond might be connected such that it could act as the control for the production of a factory!
[4] Tavistock Institute of Human Relations (tavinstitute.org)

formally model agents interaction within an ecosystem, to being an epistemic lens to carve out elements of the sociotechnical mess (including a broad environment and subjective elements) as though it were systemic (Checkland, 1981; Checkland, 1997) –that is to "*bring rigor to the subjective*" (Checkland, 2002). Yet such pragmatic and interpretive approaches as SSM can fail to account for the role of complexity of material agency within such modern socio-technical contexts where various digital infrastructures (Tilson et al., 2010), cloud-based services, and AI systems which learn and act autonomously (Berente et al., 2021) are increasingly involved. We thus need a new approach.

Before designing our approach though it is useful to have an example context in which to discuss the emerging theory. For this we turn to digital innovation ecosystem of car insurance – a relevant site for the study of digital ecosystems in flux as it involves a range of different digital actors working to define what the future of transportation will be – and working to create that future.

4.0 The car insurance digital innovation ecosystem in flux

The future of car insurance is highly uncertain. Rapid technological developments, changing regulatory environments and a competitive environment with threat of new entrants continues to challenge traditional ways of working and operating business models.

Once a mechanical artefact, a car is now mostly equipped with and connected to a wide range of digital technologies, providing digitally-enhanced functionalities and services, such as driving support or automation, real-time road updates and route recommendations, car maintenance support, infotainment, etc. (Lenfle and Midler 2009; MarketsandMarkets 2021; McKinsey & Company 2014; Seiberth and Gruendinger 2018). The development of smart and (semi-)autonomous cars relies on a complex range of interconnected technologies such as cameras, sensors, computers and Artificial Intelligence-based systems to monitor the environment and support or automate driving decisions (Tu et al. 2022). These systems involve hardware, software and immense amounts of data, making the automotive one of the industries that generates most volume of data (Seiberth and Gruendinger 2018, p. 11).

At its core, insurance consists of risk transfer- i.e. pooling risks and sharing those through commercialisation of that pooling. It essentially involves risk analysis based on actuarial science (Rana et al., 2022). This defines its unique characteristic of being a historically data informed business model to assess and distribute risks. With the incorporation and deployment of advanced technology and IoT devices, these sources of data have increased manifold resulting in opportunities for innovative business models and services. Traditional approaches to calculating risk and assigning liability need to be revised. Partly-autonomous safety features are reducing accidents, so some insurers offer discounts to drivers who use these (Wiggers 2021). Furthermore, risks models for (semi-)autonomous cars cannot be based only on driver attributes but need to consider "technology viability, sensor shelf life, and the impact of local road conditions and infrastructure" (Deloitte US n.d.). In addition, risks related to cybersecurity or the malfunctioning of systems become significant (Deloitte US n.d.; Tu et al. 2022). Insurers will need to develop new skills and expertise to develop adequate risk assessments (Huckstep n.d.). These new risks might also require new kinds of protection, for instance, against identity theft.

New entrants, particularly big tech companies, InsurTech start-ups, and OEMs at the forefront of car automation such as Tesla, are disrupting the insurance market through data-driven models and competing with their own insurance offerings (Deloitte US n.d.; Quantalyse Belgium and Schönenberger Advisory Services 2019). Insurance companies are also adapting to data-driven business models. Leveraging data analytics, insurers can offer personalised rates, usage-based insurance premiums, improve their risk assessments (Nicley et al. 2020; Quantalyse Belgium and Schönenberger Advisory Services 2019), and overall can be "a potential game-changer for underwriting, pricing, claims, and business-line shifts." (Deloitte US n.d.) However, data-driven business models present challenges in terms of controlling access to or acquiring these data (this may involve partnering with OEMs), integrating and ensuring the quality of data from a range of sources, and developing the necessary analytical skills and capabilities (Huckstep n.d.; Karp and Kim 2017; Nicley et al. 2020). They also raise ethical, and legal concerns around privacy, and customers attitudes also need to be considered (Huckstep n.d.).

Although the conundrum remains regarding the extent to which these new entrants are a threat to the traditional insurance firm - given the high variable costs, easy access to capital and lack of customer awareness (Lekkerkerk, 2023; Palmié et al., 2020; Ralph, 2023) – our empirical observations suggest that incumbents are addressing these changes in the environment and expected disruption by developing new capabilities, and new business models. Yet, in the midst of an important digital transformation taking place, the sense of flux is strongly felt by the incumbent financial firm we are studying, as their future seems uncertain. In trying to make strategic decisions, our firm tries to make sense of the emerging ecosystem and based on such imagined future, acts upon it – and thus changes it.

5.0 Our soft digital ecosystems methodology

The flux of our case study suggests the need for a temporal perspective on ecosystems. For this we define an **ecosystem-as-is** (today's insurance ecosystem – always in flux) and an **ecosystem-to-be** (the future ecosystem as currently imagined). Each of these are highly subjective notions (depending upon who we interview for example) and based on an individual or groups **Weltanschauung** (the *"stocks of images in our heads put there by our origins, upbringing and experience of the world which we use to make sense of the world and which normally go unquestioned"* (Checkland, 2013)). **Transformation** (also taken from Checkland) is, (based on the Weltanschauung adopted by the relevant actor) an ecosystem participant's action within the ecosystem, or action to change the ecosystem. Ecosystems thus evolve over time by the interrelationships of Transformations (undertaken by actors with intended purpose) – moving from ecosystem-as-is towards one specific ecosystem-to-be. Ecosystems are thus **emergent** and influenced by the power (broadly defined) within actors' transformations.

Each of these ecosystems are **open** (in that all are influenced by 'outside' things which actors might not consider part of the ecosystem such as culture, or globalisation or deglobalisation (Nambisan & Luo, 2022)). Actors within the ecosystem-as-is are involved in **sociotechnical self-organizing actions** that seek to bring *their **anticipated*** ecosystem-to-be into existence. They thus both learn from the current environment and **imagine** into existence the future environment (including through AI or predictive analytics). The relationship between cause and effects are thus highly non-linear with significant feedback. In addition, the past influences the future – there is an ecosystem-as-was (the historic insurance market) which imposes norms, structures and roles (Checkland, 1999) (e.g. legislation, roles such as actuaries, norms such as expecting yearly insurance policies), but also an installed base of technology, upon the current and future plans.

An equilibrium is achieved by ***autopoietic*** **actors**– that is by actors that organise themselves to recreate themselves in relation to their ecosystem, and which is self-referential – rearranging them itself in the face of new knowledge to continue to maintain existence (Demetis & Lee, 2016) see also (Von Krogh et al., 1994). Actors within the insurance ecosystem are thus attempting (through their imagining and learning) to recreate themselves in relation to what others are doing and how they imagine the emergence of the ecosystem-to-be. New actors are also entering the ecosystem and putting forward their own images of ecosystem-to-be.

Within the ecosystem actors therefore **knowledge is emergent**, "it is always in the making, emerging from interactions between systems and forever leaving new things to be discovered" (Jackson, 2019, p.95) – but also agential as knowledge changes the ecosystem-to-be and thus the ecosystem-as-is. *"The interactions of a living system with its environment are cognitive interactions, and the process of living itself is a process of cognition. To live is to know"* (Maturana & Varela, 1980) – and as the actors within the ecosystem are live (companies have humans within them) so they are cognitive and imagining. Emergent unanticipated behaviour will thus occur through process of interaction between imagining, knowing, and acting leading to an inherent unknowability becoming of the ecosystem (Pickering, 2002). Learning and action are entwined as actors not only learn and imagine but also create (for example by setting up new insurance services to test new ideas or collaborating on legislative changes to influence other actors to share data). These imaginings thus become and the ecosystem-as-is moves forward. See table below for summary.

Our soft ecosystems concepts	**Our interpretation for digital innovation ecosystems**

Actor	An element of the ecosystem which is autopoietic – usually a company offering a service within the ecosystem who has humans who learn and imagine. AI/ML models, robots are also considered as actors in this system.
Transformation	The perceived intentional action undertaken by an actor (or group of actors) which changes some element of the ecosystem. Transformation is strongly influenced by power within the ecosystem. Transformation can be conceptualised in systems terms as input transformed into output – but remains subjective since, in SSM terms, we are using systems theory as an epistemic device rather than realist model.
Ecosystem-as-is and emergence	The contemporary ecosystem as it is understood by a human actor within it. This is highly subjective as the extent of the ecosystem can never be known and as actors hold differing Weltanschauung. Ecosystems-as-is however emerge over time as various transformations impact upon it moving it into a future (which may or may not reflect imagined ecosystems-to-be).
Ecosystem-to-be	The future ecosystem as it is imagined by a human actor within it. This is highly subjective and based upon actors' Weltanschauung.
Ecosystem-as-was	The *roles, norms and structures* (Checkland 1999) of the past ecosystem continue to influence the contemporary ecosystem-as-is. Similarly, the installed base of technology (e.g. cars). It is thus necessary to consider history in the analysis.
Weltanschauung/Worldview	The held beliefs of individuals and actors within the ecosystem.
Imagining	The act of making sense of the present and building mental models of the future. The process of imagining is human though it may be collective and sociotechnical (e.g. within a company and using predictive analytics or modelling tools and simulations).
Knowledge	Knowledge can be both tacit and explicit. Explicit knowledge can be digitised and non-digitised. This also includes AI/ML models since knowledge can also be based on predictions.
Feedback	In contrast to the CAS, for us feedback is both action and imagining – it can be the subjective view of what actors think others will do, and the inertia of previous actions combined. Views on feedback's positivity or negativity are somewhat subjective (though companies' failures can obviously be observed).

Table 1. Soft ecosystems perspective of digital innovation

6.0 Future research plans

Having developed this emerging theory we are working with an insurance provider to undertake a qualitative study of how they are learning, and acting, within the insurance ecosystem-as-is and how this may influence the future of that ecosystem (the insurance-ecosystem-to-be). Thus far we have undertaken 5 initial exploratory interviews and a workshop. Our aim is to use this set of ideas within our analysis of the ecosystem's emergence and flux. We also intend to work with actors/organisations beyond the insurance firm, such as car manufacturers and data aggregators, to understand the ecosystem as a whole.

References

Ashby, W. R. (1956). An introduction to cybernetics. Methuen & Co Ltd.

Badinelli, Ralph, Barile, Sergio, Ng, Irene, Polese, Francesco, Saviano, Marialuisa, & Di Nauta, Primiano. (2012). Viable service systems and decision making in service management. Journal of Service Management, 23(4), 498–526.

Barnes, Marian, Matka, Elizabeth, & Sullivan, Helen. (2003). Evidence, Understanding and Complexity: Evaluation in Non-Linear Systems. Evaluation, 9(3), 265–284.

Beer, S. (1984). The Viable System Model: Its provenance, development , methodology and pathology. Journal of the Operational Research Society, 35, 7-36.

Benbya, Hind, & McKelvey, Bill. (2006). Toward a complexity theory of information systems development. Information Technology and People, 19(1), 12–34.

Benbya, H., Nan, N., Tanriverdi, H., & Yoo, Y. (2020). Complexity and information systems research in the emerging digital world. MIS Quarterly, 44(1), 1-17.

Berente, N., Gu, B., Recker, J., & Santhanam, R. (2021). Managing Artificial Intelligence. MIS Quarterly, 45(3).

Bhardwaj, Rohit, Srivastava, Saurabh, Bindra, Sunali, & Sangwan, Sumit. (2023). An ecosystem view of social entrepreneurship through the perspective of systems thinking. Systems Research and Behavioral Science, 40(1), 250–265.

Brous, Paul, Janssen, Marijn, & Herder, Paulien. (2019). Next Generation Data Infrastructures: Towards an Extendable Model of the Asset Management Data Infrastructure as Complex Adaptive System. Complexity, 2019, 5415828.

Checkland, P. (1981). Systems Thinking, Systems Practice. Wiley.

Checkland, P. (1997). A basic introduction to soft systems methodology.

Checkland, P. (2002). Launch Speech of Phronesis: The centre for Appreciative Systems Research. In U. O. Salford (Ed.). Salford.

Checkland, P. (2013). Soft systems methodology. Encyclopedia of operations research and management science, 1430-1436.

Choi, Thomas Y., Dooley, Kevin J., & Rungtusanatham, Manus. (2001). Supply networks and complex adaptive systems: control versus emergence. Journal of Operations Management, 19(3), 351–366.

Deloitte US. (n.d.). Autonomous vehicles and the insurance industry. *Deloitte United States*.

Demetis, D. S., & Lee, A. S. (2016). Crafting theory to satisfy the requirements of systems science. Information and Organization, 26(4), 116-126.

Espejo, R. (1993). Giving Requisite variety to strategy and Information systems. In F. Stowell (Ed.), Systems Science (Stowell,FAet all ed.). Plenum Press.

Gawer, Annabelle. (2021). Digital Platforms and Ecosystems: Remarks on the Dominant Organizational Forms of the Digital Age. *Innovation: Organization & Management*. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3900105
Gomes, Leonardo Augusto de Vasconcelos, Facin, Ana Lucia Figueiredo, & Salerno, Mario Sergio. (2021). Managing uncertainty propagation in innovation ecosystems. *Technological Forecasting and Social Change*, *171*, 120945.
Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design Science in Information Systems Research. *MIS Quarterly*, *28*(1), 75-105. https://doi.org/10.2307/25148625
Holland, J. (1995). Hidden Order: How adaptation builds complexity. Basic Books.
Hou, Hong, & Shi, Yongjiang. (2021). Ecosystem-as-structure and ecosystem-as-coevolution: A constructive examination. Technovation, 100, 102193.
Huckstep, R. (n.d.). Four Ways Autonomous Vehicles will Change Auto Insurance. *The Digital Insurer*.
Jackson, M. C. (2019). Critical systems thinking and the management of complexity. John Wiley & Sons.
Karp, L., & Kim, R. (2017). *Insuring Autonomous Vehicles. An $81 Billion Opportunity Between Now and 2025*. Accenture & Stevens Institute of Technology, The Innovation University.
Lawson, T. (2012). Ontology and the study of social reality: emergence, organisation, community, power, social relations, corporations, artefacts and money. *Cambridge Journal of Economics*, *36*(2), 345-385. http://www.jstor.org.gate3.library.lse.ac.uk/stable/24232451
Lekkerkerk, Pieter. (2023). Letter: Another reason insurance has proved technology-shy. Financial Times. https://www.ft.com/content/c4c9dbac-67cd-4ef2-b6e1-769416bb6245
Lenfle, S., & Midler, C. (2009). The launch of innovative product-related services: Lessons from automotive telematics. *Research Policy*, *38*(1), 156–169.
Lichtenstein, Benyamin B., & Plowman, Donde Ashmos. (2009). The leadership of emergence: A complex systems leadership theory of emergence at successive organizational levels. Leadership Quarterly, 20(4), 617–630.
Lissack, Michael, & Letiche, Hugo. (2002). Complexity, Emergence, Resilience, and Coherence. Emergence: Complexity and Organization, 4(3), 72–94. https://eco.emergentpublications.com/Article/e8e4594d-e1fd-41c8-b310-d77bd91d8039/jats
MarketsandMarkets. (2021). *Connected Car Market* (No. AT 5974).
Maturana, H., & Varela, F. (1980). Autopoiesis: the organisation of the living. In H. Maturana & F. Varela (Eds.), Autopoiesis and Cognition. D.Reidel.
McKinsey & Company. (2014). *Connected car, automotive value chain unbound*. McKinsey & Company.
Meynhardt, Timo, Chandler, Jennifer D., & Strathoff, Pepe. (2016). Systemic principles of value co-creation: Synergetics of value and service ecosystems. *Journal of Business Research*, *69*(8), 2981–2989.
Moore, James F. (1993). *Predators and Prey: A New Ecology of Competition Harvard Business Review*.
Morrison, Keith. (2008). Educational philosophy and the challenge of complexity theory. Educational Philosophy and Theory, 40(1), 19–34.
Mumford, E. (2000). A socio-technical approach to systems design. Requirements Engineering, 5, 125-133.

Nambisan, S., & Luo, Y. (2022). The digital multinational: Navigating the new normal in global business. MIT Press.

Nicley, D. L. D., Lazaros, E. J., Truell, A. D., Zhao, J. J., & Davison, C. B. (2020). The Connected Car: A Glimpse into the Future of Transportation. *Issues in Information Systems*, *21*(2), 49–56.

Palmié, Maximilian, Wincent, Joakim, Parida, Vinit, & Caglar, Umur. (2020). The evolution of the financial technology ecosystem: An introduction and agenda for future research on disruptive innovations in ecosystems. Technological Forecasting and Social Change, 151, 119779.

Parker, G., Van Alstyne, M., & Jiang, X. (2017). Platform Ecosystems: How Developers Invert the Firm. MIS Quarterly, 41(1), 255. https://doi.org/10.25300/MISQ/2017/41.1.13

Phillips, Mark A., & Ritala, Paavo. (2019). A complex adaptive systems agenda for ecosystem research methodology. Technological Forecasting and Social Change, 148.

Pickering, A. (2002). Cybernetics and the Mangle: Ashby, Beer and Pask. Social Studies of Science, 32(3), 413-437.

Pujadas, R., Valderrama, E., & Venters, W. (2024). The value and structuring role of web APIs in digital innovation ecosystems: The case of the online travel ecosystem. *Research Policy*, *53*(2), 104931. https://doi.org/https://doi.org/10.1016/j.respol.2023.104931

Qiu, Y., Gopal, A., & Hann, I.-H. (2017). Logic Pluralism in Mobile Platform Ecosystems: A Study of Indie App Developers on the iOS App Store. Information Systems Research, 28(2), 225-249. https://doi.org/10.1287/isre.2016.0664

Quantalyse Belgium, & Schönenberger Advisory Services. (2019). *The automotive digital transformation and the economic impacts of existing data access models* (Technical Report).

Ralph, Oliver. (2023). Why technology has failed to disrupt insurance. Financial Times. https://www.ft.com/content/d2dffd24-8a14-4832-8ea0-1937268849f4

Rana, Aradhana, Bansal, Rajni, & Gupta, Monica. (2022). Big Data: A Disruptive Innovation in the Insurance Sector. Big Data Analytics in the Insurance Market, 165–183.

Ritala, Paavo, & Gustafsson, Robin. (2018). Q&A. Innovation and Entrepreneurial Ecosystem Research: Where Are We Now and How Do We Move Forward? Technology Innovation Management Review, 8(7), 52–57.

Roundy, Philip T, Bradshaw, Mike, & Brockman, Beverly K. (2018). The emergence of entrepreneurial ecosystems: A complex adaptive systems approach. Journal of Business Research, 86, 1–10.

Sapir, Jonathan. (2019). Thriving at the Edge of Chaos. In Thriving at the Edge of Chaos. https://doi.org/10.4324/9780429356582

Searle, J. R. (2006). Social ontology: Some basic principles. *Anthropological Theory*, *6*(1), 12-29. https://doi.org/10.1177/1463499606061731

Seiberth, G., & Gruendinger, W. (2018). *Data-Driven Business Models in Connected Cars, Mobility Services & Beyond* (BVDW Research No. 01/18) (p. 58). BVDW & Accenture.

Scaringella, Laurent, & Radziwon, Agnieszka. (2018). Innovation, entrepreneurial, knowledge, and business ecosystems: Old wine in new bottles? Technological Forecasting and Social Change, 136, 59–87.

Schatzki, T. R. (2000). The social bearing of nature. *Inquiry*, *43*(1), 21-37.

Schreieck, M., Wiesche, M., & Krcmar, H. (2021). Capabilities for value co-creation and value capture in emergent platform ecosystems: A longitudinal case study of SAP's cloud platform. Journal of Information Technology, 36(4), 365-390. https://doi.org/10.1177/02683962211023780

Schütz, Florian, Heidingsfelder, Marie Lena, & Schraudner, Martina. (2019). Co-shaping the Future in Quadruple Helix Innovation Systems: Uncovering Public Preferences toward Participatory Research and Innovation. She Ji, 5(2), 128–146.

Searle, J. R. (2006). Social ontology: Some basic principles. *Anthropological Theory*, *6*(1), 12-29. https://doi.org/10.1177/1463499606061731

Tilson, D., Lyytinen, K., & Sørensen, C. (2010). Digital Infrastructures: The Missing IS Research Agenda. Information Systems Research, 21(4), 748-759.

Tu, Y.-J. (Tony), Shang, S. S., & Wu, J. (2022). Is your autonomous vehicle as smart as you expected? *Communications of the ACM*, *65*(2), 31–34.

Von Krogh, G., Roos, J., & Slocum, K. (1994). An Essay on Corporate Epistemology. Strategic Management Journal, 15(Special Issue), 53-71.

Wang, P. (2021). Connecting the Parts with the Whole: Toward an Information Ecology Theory of Digital Innovation Ecosystems. MIS Quarterly, 45(1), 397. https://doi.org/https://doi.org/10.25300/MISQ/2021/15864

Werder, Karl, & Maedche, Alexander. (2018). Explaining the emergence of team agility: a complex adaptive systems perspective. Information Technology and People, 31(3), 819–844.

Wiener, N. (2019). Cybernetics or Control and Communication in the Animal and the Machine. The MIT Press. https://doi.org/10.7551/mitpress/11810.001.0001

Wiggers, K. (2021, August 23). Autonomous car insurance drives new opportunities. *VentureBeat*.

Wollmann, Dewey, & Steiner, Maria Teresinha Arns. (2017). The strategic decision-making as a complex adaptive system: A conceptual scientific model. Complexity, 2017. http://www.jstor.org.gate3.library.lse.ac.uk/stable/24232451