Rumy Narayan

Imagining market shaping through innovative organizing for transitions to sustainable energy systems

ACTA WASAENSIA 504

Vaasan yliopisto
UNIVERSITY OF VAASA

ISBN 978-952-395-068-9 (print)
978-952-395-069-6 (online)

ISSN 0355-2667 (Acta Wasaensia 504, print)
2323-9123 (Acta Wasaensia 504, online)

URN https://urn.fi/URN:ISBN:978-952-395-069-6

Hansaprint Oy, Turenki, 2023.

ACADEMIC DISSERTATION

To be presented, with the permission of the Board of the School of Management of the University of Vaasa, for public examination on the 24th of March, 2023, at 2 PM.

Article based dissertation, School of Management, Strategic Management.

Author	Rumy Narayan https://orcid.org/0000-0002-0986-541X
Supervisor(s)	Professor Annika Tidström University of Vaasa, School of Management, Strategic Management. Professor Jukka Vesalainen University of Vaasa, School of Management, Strategic Management.
Custos	Professor Annika Tidström University of Vaasa, School of Management, Strategic Management.
Reviewers	Professor Suvi Nenonen Stockholm School of Economics. Department of Marketing and Strategy. Professor Stefanos Mouzas Lancaster University Management School. Department of Marketing.
Opponent	Professor Stefanos Mouzas Lancaster University Management School. Department of Marketing.

Tiivistelmä

Markkinoiden muokkaaminen verkostojen innovatiivisen organisoinnin avulla on keskistä yritysten kestävän kehityksen siirtymässä. Koska energiajärjestelmät muokkaavat yhteiskunnan ekologisia olosuhteita, siirtymäprosessien järjestäminen edellyttää kestävien energiajärjestelmien yhdistelmiä. Tällaisten prosessien ymmärtäminen perustuu innovaatioiden, monimutkaisuuden ja teknologian mahdollisuuksiin, jotka ovat lähtöisin innovaatio-, teknologia-, organisaatio- ja johtamistutkimuksista. Näkökulmat kuvaavat miten sosiaalisten, taloudellisten ja ympäristöjärjestelmien vuorovaikutus kehittyy, täyttävät aukon yritysverkostojen kestävään kehitykseen siirtymisessä ja tarjoavat kaivattua markkinanäkökulmaa. Siirtymiin liittyy luovien yhdistelmien löytäminen. Innovointi on merkityksellistä, koska se on pohjimmiltaan luovaa löytämistä. Monimutkaisina ja laajenevina prosesseina siirtymät tarvitsevat uudelleenjärjestelyjä varten resurssiekologioita, jotka ovat usein nykyisten yritysverkostojen ulkopuolella, mutta saatavilla yhteisten resurssien kautta. Narratiivit takautuvan jäsentämisen välineinä auttavat tunnistamaan järjestelmien välisiä suhteita, joissa nämä resurssit sijaitsevat, sekä tarjoavat uusia tapoja lähestyä kestävään kehitykseen siirtymistä yritysverkostoissa. Lähestymistavoilla jäljitetään teknologian mahdollistamien innovatiivisten organisaatiomuotojen syntymistä ja rooleja. Teknologiat ylittävät välineellisyytensä, ja niiden avulla voidaan käsitellä informaatio- ja kannustinongelmia vuorovaikutussuhteiden kautta. Innovaatioprosesseista tulee mielikuvituskenttiä, joissa syntyy jatkuvasti uusia malleja ja käytäntöjä. Niillä voidaan vastata resurssiekologioiden yhdistämisestä aiheutuviin seurauksiin, joka ilmentää uusia tiedon ja energian vuorovaikutussuhteita. Artikkeleissa esitellään kolme ulottuvuutta kestäviin energiajärjestelmiin tähtäävässä innovaatiotoiminnassa: siirtymä innovaation kognitiivisessa representaatiossa, vuorovaikutteisten toimijaverkostojen ja tiedon rooli sekä tällaisen siirtymän mahdolliset vaikutukset. Tämä prosessin relationaaliseen ontologiaan perustuva tutkimus mahdollistaa siirtymäprosessin ymmärtämisen kahdella tasolla: prosessi kertomuksena kokemisen kautta ja prosessi toimintana tulemisen kautta. Ensimmäinen auttaa perustelemaan väitteitä siirtymävuorovaikutuksen kontekstin laajentamisesta globaaleista ulottuvuuksista planetaarisiin ulottuvuuksiin. Jälkimmäinen tarjoaa pragmaattisia tapoja tehdä niin. Laajentuminen on avainasemassa yhdistelmien toteuttamisessa innovatiivisen organisoinnin avulla, ja se on tämän tutkimuksen tärkein panos.

Avainsanat: Verkostot; tarinat; kertomukset; innovaatiot; teknologia; organisaatiot; tieto; prosessi; yhteisöt; siirtyminen; syntyminen; kestävä; energiajärjestelmät.

Abstract

Market shaping through innovative organizing of networks is key for business transitions towards sustainability. As energy systems shape the ecological conditions of social life, organizing transition processes require combinations for energy systems that are sustainable. The understanding of such processes is located in the potentialities of perspectives on innovation, complexity and technology, from innovation studies, science and technology studies, organization and management studies. These perspectives capture how interactions between the social, economic and environmental systems evolve and fills a critical gap in business networks understanding of transitions to sustainability, while offering a much-needed markets perspective for sustainability transitions. Transitions entail discovery of creative combinations and innovation is relevant, as innovation is, in its essence, creative discovery. As complex and emergent processes, transitions need diverse resource ecologies for the reconfigurations, that often lie outside of present business networks, but are accessible through commons. Narratives as tools for retrospective sensemaking help in identifying the complex relationships that link the diverse systems where these resources are located, and offer approaches to transitions to sustainability in business networks. Approaches trace the emergence and roles of innovative organizational forms enabled by technologies. Technologies transcend their instrumentality and materiality to address information and incentive problems within contexts through a diversity of interactions. Innovation processes, therefore, become fields of imaginaries where new patterns and practices emerge continuously, to address the consequences of combining resource ecologies embodying new information-energy interactions. The articles highlight three distinct dimensions of innovation towards sustainable energy systems – the transition in the cognitive representation of innovation, role of interacting networks of actors and information, and the possible implications of such transition. Grounded in a process relational ontology, this thesis makes it possible to understand the transition process at two levels, process as narrative through experiencing and process as activity through becoming. The process as narrative through experiencing helps in justifying claims for expanding the context of transition interactions from global to planetary dimensions. The process as activity through becoming offer pragmatic ways of doing so. The expansion is key to enacting the combinations through innovative organizing, and that is the main contribution of this thesis.

Keywords: Networks; Stories; Narratives; Innovation; Technology; Organizations; Information; Process; Commons; Transition; Emergence; Sustainable; Energy Systems

ACKNOWLEDGEMENT

It is important that I list all the names who have, at various stages, encouraged and egged me on during the process, mainly because those actually reading this work can identify who all to blame. Just kidding. Or not.

First my family, thank you for being so freakishly outlandish. Gaia, you are the instigator-in-chief and I love you for that. My other family members, Sanjoy, Shruti, Shevanti, Ahel, Sanjeev, Mala, and the late and utterly wonderful Purnendu and Sumitra, thank you for the experiences without which I'd never be the person I needed to become to go on this wild goose chase I continue to be on. The members of the sisterhood of crazy pants, Shalini (shalu bhalu), Smarinita (fats), Suhasini (Su), Sujata (just Sujata), Vinny (buns), Namita (gums), Meret (meretlein), Judith (judithsan), Tina (the dancer), Petra (pets), Heli (helicat) you are extraordinary women and I am truly priviledged to have you in my life. I carry a bit of each one of you within me and you will find yourselves embedded in these pages. Georg, given how popular you are with the ladies (there I said it, you can put that on your wall!), it's only fair you come next. You deftly waltzed into my life, annoyingly I must add, and promptly settled in with your yum yums to watch this show take shape. Thank you for letting me challenge you. Do not get mad, get even dude. Mona, thank you for championing my crazy ideas, Bruno, I owe you my home, Asko, you sure fired me up with some of the best Indian food, and Lisa, you unleashed those parts of me that I never knew even existed, thank you for that.

I wanted to acknowledge just my research group but that would let the rest of the management school members off the hook, who have at various points cheered me on. The enablers you know who you are, but just to be sure I will name each one of you: Marko, Rodrigo R, Jukka, Riitta, Susanna, Anni, Kati, Ana, Ausrine, Vesa, Liisa, Niina, Jenni, Anne, Maria J, Maria P, Shuwei, Rodrigo M, Tania, Tiina, and lest I forget, the leader of the pack, Adam. Eze and Khalid, you came late into the party and dived right in, kudos for earning a place on this list. However, the Mistress of (censored) everything is Annika. Without Annika this boat would have sunk under its own cargo, literally. Thank you Annika for meticulously trimming the fat and being so determined about whipping this baby into shape. I will never forget how your face gets when I start my journey into rabbit holes. That's my cue to stop digging.

On a serious note, thank you all for coming along for this ride with me. On the same note, I would like to express deep gratitude for the support from the Finnish Cultural Foundation (Suomen Kulttuurirahasto) without which I would not have

been able to research and publish one of the most important articles of this thesis, '*Tokenizing coopetition in a blockchain for a transition to circular economy*'. I would also extend this gratitude to the project OpenInnotrain and Anne-Laure. This project introduced me to new ideas and people. I would like to give a shout out to the genial Scotsman with a dry sense of humour, Alastair, for inspiring another article for this thesis, '*Leveraging Digital Intelligence for Community Well-Being'*. I am so looking forward to my badge that says PhD survivor.

Contents

Figures

Tables

Abbreviations

AI	Artificial Intelligence
CE	Circular Economy
DLTs	Distributed Ledger Technologies
II	Information Infrastructures
MLP	Multi Level Perspective
SOHO	Self-Organizing Holarchic Open

Publications

Narayan, R., & Tidström, A. (2019). Circular economy inspired imaginaries for sustainable innovations. In *Innovation for Sustainability* (pp. 393-413). Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-319-97385-2_21. © 2019 The Author(s).

Narayan, R., & Tidström, A. (2019). Blockchains for accelerating open innovation systems for sustainability transitions. *Blockchain economics: Implications of distributed ledgers: markets, communications networks, and algorithmic reality*, 85-101. https://doi.org/10.1142/9781786346391_0005. © 2019 World Scientific Publishing Company.

Narayan, R., & Tidström, A. (2020). Tokenizing coopetition in a blockchain for a transition to circular economy. *Journal of Cleaner Production*, *263*, 121437. https://doi.org/10.1016/j.jclepro.2020.121437. ©2020 Elsevier Inc.

Narayan, R., & Tidström, A. (2020). Leveraging resource ecologies for sustainability transitions–a waste management case. *Journal of Business & Industrial Marketing*. https://doi.org/10.1108/JBIM-12-2019-0516. ©2020 Emerald Publishing Limited all rights reserved.

Narayan, R. (2020). Leveraging Digital Intelligence for Community Well-Being. *International Journal of Community Well-Being*, *3*(4), 539-558. https://doi.org/10.1007/s42413-020-00085-4. CC BY 4.0.

1 INTRODUCTION

1.1 Research background and motivation – Innovative organizing for planetary well-being

In setting off a discussion on organizations of the 21st century, The MIT 21st Century Manifesto Working Group (1999), begins with a question: What do we really want? Assuming that prosperity that fosters well-being, specifically planetary well-being (Kortetmäki et al., 2021) is what we really value, the answer would depend on how the question is approached in terms of organizing – individually, collectively, planetary. Yet, at every level – individual (actors/firms), collective (globalized society/markets) or planet (earth systems) – the subjectivity and the relatedness of the levels while framing the answers is difficult to ignore. Perhaps, that is one of the points the Manifesto seeks to highlight when it notes that even though organizations appear to be working well in many dimensions, their activities and practices are far short of their potential for contributing to societal well-being. This is part of an ongoing theme within management and organizational studies (see Gümüsay & Reinecke, 2021; Hallin et al., 2021; Vandeventer & Lloveras, 2021; Chakrabarti et al., 2020; Möller et al., 2020; Valentinov & Pérez-Valls, 2020; Allen et al., 2019; DesJardine & Bansal, 2019; Bansal & Song, 2017; Morrar et al., 2017; Painter-Morland et al., 2017; Shrivastava & Guimarães-Costa, 2017; Nonaka et al., 2014; Gao & Bansal, 2013; Whiteman et al., 2013; Markard et al., 2012; Hart, 2010; Bansal & Gao, 2006; Shrivastava & Hart, 1995). These studies articulate in diverse ways how even as firms are increasingly becoming technically capable and economically efficient through innovation and free market mechanisms, their practices of organizing are intensifying economic inequity, eroding critical environmental systems and inflicting stress on people and communities. This is not sustainable and calls for a transition.

A transition that involves an understanding of sustainability as not some idealized vision or a discovery but as a continuous and evolving process that helps highlight the differences that lie beneath the interacting identities. For instance, Hultman et al (2021) have used the concept of 'resourcification' to turn the attention on social processes through which things are converted to resources, away from essentialist queries about the nature of resources. This allows for a systematic search for knowledge about the diversity of contexts, conditions, modes, and temporalities of resourcification, implicating the underlying energy system. Firms function within these structures held together by practices that constrain action. Yet these

practices themselves open up new spaces for critique that illuminate how what appears to be bound in this seeming inevitability, could also offer new forms of intervention where existing practices can be applied and their purposes reimagined.

It serves as a reminder that the word "fact" comes from the Latin *factum*, a noun derived from *facere* which means to do or to make. The social, material and political infrastructures that sustain the physical laws and facts, frame our sense of available choices in life, and in that, facts often constitute dominant discourses. This pulls us into believing that ways of responding to contemporary issues and debates are limited, when they are not. As Perez (2010) has offered, the narrative of social unrest and collapse need not be inevitable. Creating new and better ways of organizing requires a new economic fabric that is able to weave together imaginaries of social order that draw from the past and the present to create the future. Given that the future is unpredictable, coping with challenges of the future through optimal choices cannot be based on existing understanding alone, but requires the creation of imaginaries of the future (Beckert, 2021; Garud et al., 2014; Boje, 2011 a, b). Narratives play an important role, both through stories about how the future will unfold, and in illustrating how decisions are rooted in story-based sense-making processes (Beckert, 2021). Therefore, questions related to transitions to sustainability, need to be framed in terms of how and what it could be, and assumes that while the future is shaped by the past, nothing that occurs in the past determines the future. This privileges an open-ended creativity and opportunities for exploring relational side of all actions. Here activities that encourage exploration remove the restrictions that identity imposes without necessarily diminishing its relevance.

Gehman et al (2022, p. 259) in addressing these issues as 'grand challenges', have called for activities that are participatory, inscribed with multiple voices, and distributed experimentation. It indicates a need for response mechanisms where sensing and responding to market change is inadequate (Nenonen & Storbacka, 2021, 2020; Kaartemo et al., 2020). The implication being, a transition from relationship management to ecosystems orchestration for shaping markets (Möller et al., 2020; Nenonen & Storbacka, 2021, 2020) that requires innovative organizing. ***Innovative organizing could be framed as participative activities that take cognizance of multiple voices implying complexity represented in information on energy use, managed through distributive experimentation with technological tools, for what Nenonen & Storbacka (2021, 2020) refer to as market shaping.*** This thesis draws on perspectives related to innovation, complexity, and technology, from innovation studies, management and organizational studies, and science and

technology studies, to imagine and explore market shaping through innovative organizing and offer how it is key to transitions.

The innovation perspective grants access to the idea of commons (Potts, 2019; 2018; Potts & Hartley, 2015) that enable participatory activities. Complexity enables access to the multiple voices and by association, perspectives of values that could be visualized through energy use as a mode of human-nature interaction (Cederlöf, 2021). Technology offers the imaginative tools for innovative organizing of the physical and information flows through distributed experimentations (Ahl et al., 2020). The interactive milieu underpinning innovative organizing embodies social normativities through diverse disciplinary understanding of societal transitions and disparate conceptualizations of sociotechnical diversity. This is crucial for correcting persistent forms of 'misplaced concreteness' in literature (Stirling, 2011, p.82). The objective is to understand the process of becoming (Lowe & Rod, 2018) for developing a sense of how organizations might think about sustainability through an expansion of relationships implicated in business networks. The thesis argues that this expansion become key for sensing the connections and imagining the necessary organizational elements to shape markets (Nenonen & Storbacka, 2021, 2020) for transitions to sustainable energy systems. The Fig 1 below illustrates the perspectives that help in weaving the connections for imagining and presenting innovative organizing.

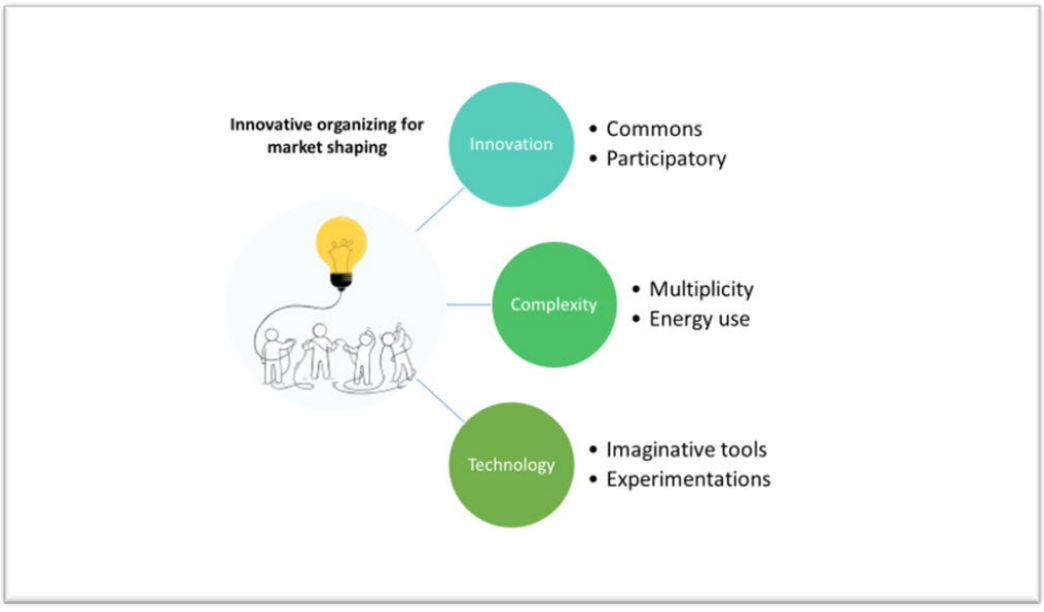


Figure 1. Imagining market shaping through innovative organizing

1.1.1 Sensing the connections for transitions

Connections are core to economies and knowledge, where economic performance is dependent on knowledge gathered from close connections (Loasby, 2005) making firms enmeshed in networks of complex interlocking interdependencies with each other (Ford & Mouzas, 2008; Ford & Håkansson, 2006; Mouzas, 2006; Gadde et al., 2003; Gnyawali & Madhavan, 2001; Axelsson, 1992) and business networks a relevant and critical arena for such transition. This further relates to the interdependence of business, society, and the planet (Edwards et al., 2021; Valentinov et al., 2021; Wasieleski et al., 2021).

In linguistics, transition is a word or phrase that illustrates the relationship between paragraphs or sections of a text or speech (Rappaport, 2010). Transitions provide greater cohesion by making ideas explicit or signaling how they relate to one another, and act as bridges that help one navigate from one section to another (Rappaport, 2010). Transitions enable readers to navigate texts through steps of logic, increments of time, or through physical space. Thomas Kuhn (1970) described transitions within scientific communities as a process where new paradigms emerge and take shape, to replace the incumbent ones. Understanding transition, at societal levels, involve considering a wide constellation of concepts, values, perceptions, and practices shared by a community held together through interlinked stories that act as information networks, disseminating facts, to form a certain vision of reality (Boje, 2021). This reality is neither consistent not constant as new stories emerge to challenge established visions (Boje, 2021). This could be understood as an assemblage, an idea that describes how diverse aspects of life congregate at particular times and spaces (DeLanda 2016; Guattari, 2000). ***Therefore, transitions could be understood as multi-stage processes of social-learning implying social practice***.

Here, the role of markets as a distinct body of knowledge gains relevance, owing to the decisive role it has played in contemporary capitalism. It has done so by highlighting the importance a market economy places on circulation of knowledge, improving concepts, implementing new ideas and practices, which result in transformations that renew social identities of actors and modify the orientation of economic activities (Cochoy, 1998). The unique positioning between supply and demand as well as science and practice (Cochoy, 1998) and contribution to the construction and operation of markets through interactions (Araujo, 2007; Håkansson & Prenkert, 2004) make markets key to transitions. As markets are constructed through a range of practices involving varied forms of expertise and material devices, they are often arenas of multiple and even conflicting sets of practices, and offer insights into forms markets can take during efforts to shape

them (Araujo et al., 2010; Callon, 2007b, 1998b). Markets through socio-technical arrangements contribute actively to production of 'matters of concern' (Callon, 2007b, p.140). The concerns are linked to the choices made during the formation of such arrangements, for instance, new technologies imply reconfiguration of current networks, and the externalities that result from the new arrangements (Callon, 2007b). Both concerns offer possibilities for innovative organizing, either in the establishment of a set of material and technical devices, incentives and forms of organization, or in confronting lock-ins that narrow down the options and possible worlds to explore possibilities for new configurations by striving to produce lock-outs (Callon, 2007b; Garud & Karnøe, 2003; von Hippel, 2005).

Yet, markets continue to be underrepresented in sustainability transitions research. The multilevel perspective (MLP), for instance, conceptualizes transitions through an engagement with the multi-dimensional complexity within socio-technical systems that such shifts imply, through changes in consumer practices, policies, cultural meanings, infrastructures and business models (Geels, 2020; Geels, 2010; Geels & Schot, 2007; Geels, 2004; Geels, 2002; Rip & Kemp, 1998). The treatment of markets in transition research is mostly limited to diffusion of sustainable innovations through user involvement (Loorbach & Wijsman, 2013). It has consequences for sustainability transitions as the missing focus on markets obscure the links between material devices, embodied skills and mental representations and the various configurations in which they come together (Shove & Pantzar, 2005). The complexity of these connections emerge through a multidisciplinary research approach. Tracing issues in one industry reveals the complexity of such networked relationships, and how they combine to deliver outcomes that challenge the sustainability of our societies.

Food offers insights into a complex network of global production and consumption (Franz et al., 2018) and is a convenient entry point. The rise and acceleration of corporate concentration and control in agriculture and extractives is attributed to a combination of technological change, weakening state regulations, and financial pressures (Clapp & Purugganan, 2020). This has resulted in a concentration of control by a handful of corporations with outcomes that contribute to inequality, environmental harm, and human rights violations (Clapp & Purugganan, 2020). From the economic sustainability perspective, the spate of mergers and acquisitions over the years, in a range of sectors, have allowed corporations to consolidate, become larger, sending their profits and average revenues soaring, while weakening competition (Clapp & Purugganan, 2020; Guinea & Erixon, 2019). New firms are likely to face barriers in innovation in larger and less competitive markets as the incumbents are better equipped to capitalize on the capabilities required for coordinating complementary assets that the new firms

often do not have access to (Dean et al., 1998; Tripsas, 1997; Schoonhoven et al., 1990).

The role of finance in such consolidation is an important factor, as it drives concentration and consolidation of power organized through institutional investment patterns (Clapp, 2019; Krippner, 2011; Epstein & Jayadev, 2005). Institutional investment in index-based funds have resulted in influx of capital into some of the world's largest firms providing them with the funding and leverage for purchasing less well-financed rivals (Clapp, 2019). This translates into market power for a few select companies and it can serve as a powerful mechanism for transferring wealth from working and middle classes to those at the top of the income and wealth distribution (Khan & Vaheesan, 2017). Consolidation of market power translates into social power and ability to influence institutions, endangering their ability to uphold the democratic ideals necessary for maintaining the conditions that legitimize social contract (Blackburn & Pelling, 2018). Evidence from the United States indicate how excessive market power allow firms in industries ranging from agriculture to airlines collude, merge, and exclude rivals, raise consumer prices above competitive levels, while pushing down prices below competitive levels for suppliers (Khan & Vaheesan, 2017). Further, literature seeking to problematize the intersection of finance and information technology, offer insights into impacts of technology on financial markets and analysis on the economic and social consequences of financialized economies. This literature presents a wider context within which firms operate, and offer different perspectives on financial and technological innovations. These perspectives help in understanding the shaping of innovation in technology-enabled financial products and services, and how they serve to influence the policies and practices that drive modern industrial economies (Funk & Hirschman, 2014), and the negative effects of such innovations (Currie & Lagoarde-Segot, 2017; Lazonick, 2012). For instance, the focus on financialization is contributing to a global economic shift in capital accumulation towards monopolization and rentiership (Birch, 2020; Birch et al., 2020; Rikap, 2020; Botta et al., 2019). These innovations relate to the changes in the ways firms are organized and managed, more frequently in the financial industry but increasingly in manufacturing and non-financial services as well (Nelson, 2013).

Birch et al (2020) have argued that the innovation-finance nexus is unlike innovation that delivers new products, services, and markets, but a form of rentiership defined by the extraction, and capture of value through different modes of ownership, and control over resources and assets. Increasingly driven by the pursuit of "economic rents" Birch et al (2020) note that this shift is evident in the transformation of personal data into a private asset and question how such

innovation itself might be a problem instead of solution to global challenges. The insidiousness of such models are visible in how digital platforms use mechanism design methods for leveraging data science and automation towards goals that dispense with the commitments assumed in its economic theorization to undermine social welfare and distort collective interest for the platform firms' own ends (Viljoen et al., 2021). The way digital platforms deploy mechanism design is what Mirowski and Nik-Khah (2017) call the "de-humanizing" of markets. In these instances, firms use their information-processing function with little regard or interest in human cognition or preferences, and in that sense, they carry forward the normative justification of markets into settings that appear like markets but operate more like control infrastructures (Viljoen et al., 2021). In this context, Vergne's (2020) argument that previous understanding of 'distributed' and 'centralized' as polar opposite concepts are inadequate for describing the multidimensional diversity of platform designs that exist today, become relevant. In response to this conceptual shortcoming, Vergne (2020) has described decentralization as the dispersion of coordinated communications within organizations and distribution as dispersion of organizational decision-making. Beginning with this conceptualization, Vergne (2020) discusses the possibilities of avoiding the pitfalls of dystopia created by dominant platform oligopolies and calls for regulations at the level of data for better social outcomes, with blockchains enabling platforms that are both decentralized and distributed.

Drawn from diverse research arenas, these studies help in understanding the complex mechanisms through which social disruptions and rising inequality, energy-intensive production and consumption are related. They showcase a global value creation network within a certain nexus of organization of economic activities that is taken for granted, implying that transitioning towards a sustainable system would require innovative forms of organizing. These could be understood as activities that contribute to market shaping (Nenonen & Storbacka, 2021). Considering that firms are enmeshed in networks of complex interlocking interdependencies with each other (Ford & Mouzas, 2008; Ford & Håkansson, 2006; Mouzas, 2006; Gadde et al., 2003; Gnyawali & Madhavan, 2001; Axelsson, 1992), these interdependencies are key for addressing the consequences that are emerging from them. Here, the network approach with its focus on actual, observable economic activities where networks typically feature those that are related through their actual economic value creating and distributing interactions (Olsen, 2013), and now with increased connectivity, interdependence, and co-evolution of actors, technologies, and institutions, the ecosystems approach (Aarikka-Stenroos & Ritala, 2017) gain relevance. They offer the possibility for locating the theoretical commitments that influence the ways in which problems

like those, for instance, of reducing carbon emissions are framed and addressed (Shove & Walker, 2014).

Locating these commitments strengthen arguments for enacting proactive market-shaping strategies for dealing with crisis situations (Nenonen & Storbacka, 2021, 2020) that include sustainability issues resulting from firm activities. This suggests an alternative perspective of networks, where change is something that the network is, as opposed to what the network has (Lowe & Rod, 2018). Assuming change as something the network is, introduces process metaphysics (Garud et al., 2018) where identities are temporary or waves of stability in a constantly evolving and complex sea of change (Lowe & Rod, 2018). In this perspective, 'innovation itself is a continual unfolding process' (Garud et al., 2018, p. 227). Here, organizing as a process involves a constant creation of identity, and the connections or relationships are a continuous reminder of the presence that motivates this movement towards becoming (Lowe & Rod, 2018; Callon 2007b; Bakken & Hernes, 2006). In practical terms, this would require, for instance, taking cognizance of networks and relationships implicated in the production and consumption of everyday items — frying pans, rain jackets, face masks, pizza boxes — that repel water, grease and stains, but entail exposure to chemicals linked to cancer and other serious health problems (see Conley et al., 2019; Grandjean et al., 2017; Looker et al., 2014). While also acknowledging how the same chemicals are being pumped into fracking sites for extracting fossil fuels, to enable the sale of products with more of the same chemicals.

It helps in connecting the fundamental dependence of all economic activity on availability of energy in appropriate forms at sufficient rates and how this dependence is entangled in societal structures. Profound changes in the dominant modes of production and consumption are an important aspect of this knowledge (Floyd et al., 2020). How firms manage relationships and coordinate networks to access resources during organizing change could offer useful knowledge frameworks not just for understanding how transitions happen but also imagine new organizational combinations that allow for effective knowledge coordination towards context-specific sustainable energy transitions. The Fig 2 below captures these connections in referring to the energy-information interactions within the context of nature, economy, and society.

Here, the concept of a comprehensive systems level perspective (Pasmore et al., 2019; Folke et al., 2016) that allows for understanding of interconnectedness of matter through quantum entanglement (Dyck & Greidanus, 2017) is key. More importantly, the entanglement helps in conceptualizing how the system of life forms share a symbiotic relationship in the way all life forms are made of other life

forms, and evolutionary in the way all life forms derive from other life forms (Morton, 2010). The interconnectedness of everything makes it impossible to conceptualize any definite background and as a consequence foreground. It does however, evoke a certain familiarity that is strange, and a strangeness that is familiar, thus allowing for visualizing a collective where the idea is not be to part of something bigger but to be intimate (Morton, 2010). The intimacy acknowledges desire and manages the consequences of such desires through innovations. Such innovations demand a commons approach to offer sustainable outcomes through a continuous process of imaginative coordination for addressing issues such as - what kind of innovations are needed, and the knowledge needed to make them work, what will the innovations be used for, who will use them, how, and in what combinations, variation in costs of production, delivery, consumption, and reuse or waste, business models, and unintended effects.

The innovation commons framework that uses the evolutionary theory of cooperation and the institutional theory of commons offers a new approach for managing the knowledge coordination problem in innovation (Potts, 2019; 2018; Potts & Hartley, 2015). Moreover, it directs attention towards energy use as a mode of human-nature interaction and how energy systems integrally shape the ecological conditions of social life (Cederlöf, 2021), and also how technologies are harnessed not for relentless economic growth but in diminishing the energy intensity inherent in human production and consumption systems (Smil, 2021). As this involves piecing together of distributed knowledge, in essence innovations towards sustainable energy systems is an issue of cooperation that involves coordinating within particular contexts and competing in others. The physical and information flows in energy systems are increasingly complex and distributed, leaving centralized structures inefficient (Ahl et al., 2020). It helps in contending with social normativities related to alternative directions for innovation, divergent disciplinary understanding of societal transitions, and disparate conceptualizations of sociotechnical diversity itself, while confronting persistent forms of 'misplaced concreteness' in literature (Stirling, 2011).

Directing the focus of transitions towards sustainable energy makes it possible to acknowledge whether such a transition can meet the current demands for work, heat transfer, lighting and data manipulation that the current globalized and growth-oriented economies demand (Floyd et al., 2020; Alexander & Floyd, 2018). This highlights the importance of transition as a form of beginning which cannot be understood just as an experience but rather 'an interruption of one way of seeing through which another way of seeing opens up' (Ross, introduction to Stiegler, 2018a, p.7). Ross (2018a) urges that this way of seeing has to transcend divisions and conflicts as the convergence of limits – societal, economic, and environmental

– reveals an existential crisis. The existential crisis demands a reconsideration of the economic system and its relationship to the speed and power made possible by the digitalized, networked and algorithmic technical system. For such reconsideration, Stiegler (2018a) draws on Whitehead's speculative cosmology to bring the notion of reason back into the discussion. This would require thinking about constructivism ontologically, rather than epistemologically, where being is a process of self-construction rather than being constructed by thought alone. Animals adapt to their environment while humans actively modify it for the purpose of making things better, and this modification has given rise to the Anthropocene, Stiegler (2018a, b) states. However, he argues that the reason which drives this modification for the pursuit of a good and better existence also has the transformational capability to address the problems brought about by the Anthropocene, defined as a new human-dominated geological epoch driven by recent global environmental changes (Lewis et al., 2015). The function of reason is ultimately in the possibility of opening bifurcations that would be not just probabilistic, but highly improbable, as is suggested by Nenonen and Storbacka (2020) when they urge firms to shape their environments during crisis situations. Orchestration of the network connections for such shaping requires innovative organizing by expanding the context to include nature and society, in addition to the economy as visualized in Fig 2 below.

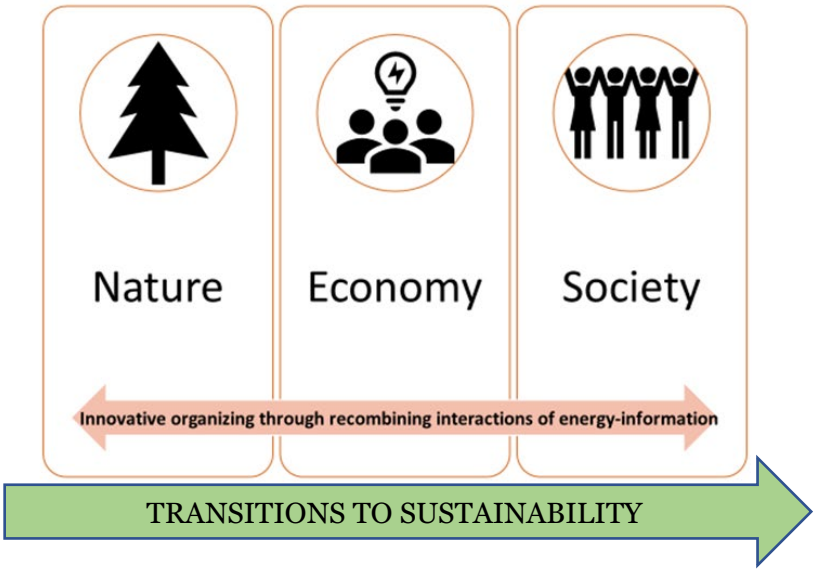


Figure 2. The context of innovative organizing

Revealing the connectedness of collective existences offers hope that such thinking exists and requires revival strategies for imagining pathways towards anticipating an optimistic future (Gare, 2000). Anticipating new assemblages for transitions in

such semantically linked networks is complex, and require imaginative processes with capabilities for redesigning the intricate knowledge networks that hold them together (Loasby, 2011; Loasby, 2001a, b). Knowledge has an intimate connection with meaning (Yolles, 2007) and when the patterns during transitions begin to emerge, the design of those patterns incorporate the old with the new. New designs emerge through working with distinctions and recursively operating on previous designs (Kauffman, 2017). Therefore, while designing coordination mechanisms for transitions there needs to be communication of value propositions that incorporate elements of stability during organizing in order to drive consensus towards meaningful activities with anticipation of the future. As activities associated with such coordination are required to deal with increased complexity of diverse knowledge frameworks, narratives could act as translation and relationship building mechanisms (Augenstein & Palzkill, 2016) to diffuse tensions and encourage anticipation. Narratives offer means of retrospective sensemaking through looking backwards and generalizing and abstracting while interacting within a dominant culture that resists change (Boje, 2021). Stories, on the other hand, embody the complexity in the unfolding of situations through their interactions with and relationships to diverse systems (Boje, 2021). The process of living everyday lives forces interactions between narratives and living stories, as Boje (2021) calls them, and embodies a form of making sense that borrows from the past while performing activities in the present with perspectives that accommodate future imaginations. Throughout human evolution, technologies have underpinned the communication mechanism for these interactions between narratives and living stories, first through language (Dor, 2017), then printing press and now the Internet (Last, 2015a) for sensemaking. Taking cognizance of these interactions could help leverage a range of management technologies for constructing credible interpretations of the past and anticipating compelling versions of the future to enlist support and mobilize resources (Araujo & Easton, 2012).

For living systems, anticipation is important as it helps in adaptation as well as learning, and for social living systems such anticipatory models enable dynamic projections for potential behavior (Yolles & Fink, 2015). Anticipation as a cognitive mechanism and a social process (Kinsley, 2012), is often used to transform, intervene, and even govern the present for the purpose of the future (Adams et al. 2009; Anderson 2010; Rip 2012). Implied in this understanding of organization through anticipation, is imagination that plays an important role in guiding choices (Loasby, 2011; Shackle, 1982). Imagination, here is understood as a shaping or modifying force as opposed to fancy, which is an aggregative and associative power (Weick, 2005). When anticipation occurs through cognitive/mental models, it has the possibility to impact the current structure of

the system, and when it comes about from within the structure itself, the reset is systemic. Nenonen and Storbacka (2020) have argued that crisis situations offer firms opportunities for shaping markets by focusing on building appropriate network configurations to address the specific needs that emerge during such periods. In addition to adaptation and resilience, this implies imagining change as a system (Nenonen & Storbacka, 2020). Imagining change as a system would require acknowledging the energy embedded in practices and behaviors, and digital information infrastructures (Hanseth & Lyytinen, 2016; Lee et al., 2006) play an important role in doing so. It requires recognizing what Stiegler (2018b, 2013) has described as the reticular or net-like reading and writing made possible through networks accessible on the Internet. The Internet, is a new stage of technological development instrumental in impacting society through access to diverse knowledge systems and interruption and suspension of social rules and behaviors. Such an environment becomes conducive for market shaping (Nenonen & Storbacka, 2021, 2020).

1.2 Research gap and theoretical positioning – from global to planetary reality

Organizations dominate our socioeconomic landscapes and have only grown in importance (Moran & Ghoshal, 1999) making them essential networked units of influence and change. If organizational success and the infrastructure supporting their networked relationships are threatening the well-being and sustainability of societal ecosystems, then within the field of business, networks is a relevant perspective for discussions on sustainability (Finke et al., 2016; Veal & Mouzas, 2010). The focus of business networks research on interrelated or nested layers that include behaviors across levels and entities, institutional systems and their dynamics, and markets, industries, and cultures and their dynamics (Möller et al., 2020; Möller, 2013; Olsen, 2013; Möller et al., 2009) are important. They direct attention towards an earlier transition in framing exchanges within business environments from transaction based to relationship based, thus emphasizing perspectives informed by behavioral sciences rather than rational economic models (Möller & Halinen, 2018; Hadjikhani & LaPlaca, 2013) suggesting an acknowledgment of realities in social dimensions within these environments. Yet, the economic, social, and natural are invariably entangled through relationships in simple yet profound ways (Latour et al., 2018), a reminder that there remains a gap in terms of including the evolving natural systems in the framing of transition process within business networks. This includes a limitation in understanding how technology interacts in shaping markets and innovation (Kaartemo & Nyström, 2021). The adoption of process metaphysics (Garud et al., 2018), where change

and process is subjective, and substances such as actor identities are not understood as fixed entities (Lowe & Rod, 2018), is relevant for closing this gap. This adoption is key to sensing the environment (Möller et al., 2020) for the purpose of shaping markets (Nenonen & Storbacka, 2021, 2020).

The sensing reveals, for instance, how the innovation and growth in commercialization of chemicals did improve healthcare and access to food but also changed humanity's relationship to the planet in ways that we are only beginning to comprehend (Von Hippel, 2020). The contributions of science and technology to economic prosperity are important in how they reveal the complex set of challenges, related to climate change, inequality, and rise in societal conflicts that have resulted from such progress (Lenzen et al., 2012a & b; Wiedmann et al., 2015; Kanemoto et al. 2014; Ivanova et al., 2016; Moran & Kanemoto 2017). These challenges are visible through the current economic and institutional arrangements that systematically exclude contributions to innovation processes, and in doing so, show how they lead to inequality (Lewis, 2020; Scott, 2021, 2020; Potts, 2019; Lazonick & Mazzucato, 2013) while urging for better conceptualizations of the various crises we are facing (van den Bergh, 2013). Market shaping activities would involve engaging with green growth (Geels, 2013, Van Der Ploeg and Withagen, 2013), degrowth (Kerschner et al., 2018; Kallis, 2013; Kallis et al., 2012), alternative currency experiments (see Allen et al., 2020b; Marshall & O'Neill, 2018; Seyfang & Longhurst, 2013), and ideas of social contracts that reveal the dynamic boundaries of social acceptances that accommodate change (Blackburn & Pelling, 2018). Further, the rise of digital technologies signal the dawn of innovative organizational forms that are able to deal with this complex assemblage (Last, 2017; Morrar et al., 2017; Floridi, 2019, 2014; Rifkin, 2014).

Such assemblages are far too complex than any single theory assumes and dominant theories are unable to match the scale of this challenge as each can only point to different bits of the problem (Grubb et al., 2015). As North (1999) has noted, it is not possible to theorize in the face of uncertainty. Theorizing, in this context, needs to be understood as a form of organizing where research movements arrange sociomaterial elements continuously (Clegg et al., 2020), thus fostering open theorizing processes through sharing concepts, framings, theoretical relations, and case examples, in addition to research policies and debates about values (Leone et al., 2021). Here theoretical framings are secondary to the process and gain relevance for the purpose of cataloguing change, thus requiring a meandering from theory to experience, back to theory, in a self-correcting and iterative process (Rosile et al., 2021; Watson, 2012). This process could be compared to that of building a conceptual article that can "bridge existing theories in interesting ways, link work across disciplines, provide multi-level

insights, and broaden the scope of our thinking" (Gilson & Goldberg 2015, p. 128). To create an understanding for making sense of the phenomenon, this thesis draws on theoretical perspectives related to innovation, complexity, and technology from innovation studies, management and organizational studies, and science and technology studies. The objective is to make sense of the process of becoming of the network (Lowe & Rod, 2018) for transitions to sustainable energy systems.

Chakrabarti et al (2020) have drawn on literature in the areas of sustainability, open approaches, and open innovation to develop the concept of open sustainability. It refers to the orchestrated and distributed process, both during short and long terms, through which a focal company interacts with actors across organizational boundaries to better achieve its own (micro-level), its direct nets' (meso-level), and the broader networks' (macro-level) sustainability objectives (Chakrabarti et al., 2020). However, studies have also indicated that sustainable business practices are difficult to implement as business networks are inadequate for managing the complexity associated with such sustainability challenges, and additionally, activities and practices associated with such challenges, create tensions and impact a wider network of existing actors (Tura et al., 2019; Wittneben et al., 2012). This could be understood as the consequences of applying specific market-based policies in a networked and interactive business landscape with established and related social and material resources that result from prior investments (Waluszewski et al., 2019). The relationships acquire a certain form of path dependency and resist any meaningful change and highlight how they influence the direction of policy-supported change processes, including innovation, in an uneven manner (Waluszewski et al., 2019).

This is why even though ideas related to transitions to sustainability are now mainstream, the term 'sustainability' remains contested, and lacks a definitive meaning (Hallin et al., 2021). It has led to interpretations attracting labels that range from weak to strong, depending on the integration of its elements and extent of actor collaborations (Hallin et al., 2021; Landrum & Ohsowski, 2018; Philippe & Bansal, 2013). The weaker framings are significant, as they clarify how sustainability is conceptualized within dominant narratives of growth. A narrative that is committed to a process dedicated towards continuous search and absorption of things representing an idea of abundance running through the micro to the macro scales of modern life, from individual personality to the culture and political economy of modern society (Byrne et al., 2009; Byrne & Yun, 1999). This abundance is legitimized through concepts such as sustainable growth or applying the label 'green' to enhance the moral value of a commercial activity (Hallin et al., 2021; Broadstock et al., 2019; Fuentes, 2014; Banerjee & Bonnefous, 2011), or a 'business case' for sustainability (Painter-Morland et al., 2017). It points to a

particular issue where the different framings reduce the idea to a list that takes the focus away from how to implement or do it in practice (Hallin et al., 2021). Reducing sustainability to a mere accounting system is simply not enough for achieving sustainability transitions owing to the notions of morality, processes of power dynamics, institutional logics, and cultures and mores associated with such transitions, rather, transitions emerge through translation, use, and daily practice (Hallin et al., 2021).

The performative element in sustainability transitions involving structural changes over time requiring co-evolutionary changes in technology, economy, culture, and organizational forms (Hallin et al., 2021; Köhler et al., 2019; Loorbach et al., 2010) points to the insufficiency and inability of individual firms' to have impact on such transitions (Loorbach et al., 2010). Sustainability framed as firm innovation activities reflecting transitions in philosophy, values, and behavior (Smith & Stirling, 2018; Adams et al., 2016; Seebode et al., 2012; Smith et al., 2010) remain elusive. What becomes apparent is that firms are compelled to make sense of the elements of sustainability within the economic system where concerns specific to that system, particularly growth, dominate norms and activities. The meaning of sustainability emerges through the power of association whereby humans, ideas, and events are mobilized and associated with the concept in verbal as well as nonverbal actions (Hallin et al., 2021; Callon, 2007b; Latour, 1986). The continuing growth of business networks are testament to their success as well as inherent abilities for coordination, organization, and management of complex and evolving economic environments of production and consumption (Möller & Halinen, 2018; Möller & Halinen, 2017). The sustainability problem could then be understood as a conceptual disconnect that arises from the inability to decipher what has been referred to as the black-boxed networks (Prenkert, 2017; Guercini, et al., 2014). Enclosed in each other, these networks constitute sub- and supra-networks of increasing complexity, and sub-networks that are black-boxed can be seen as entities in themselves producing inputs and outputs to the supra-network, and networks once black-boxed, can assume the functions of generative mechanisms within a wider supra-network (Prenkert, 2017). Imagining innovative organizing in such a context would require prying open the black-boxed networks (Prenkert, 2017; Guercini, et al., 2014) as such boxes are 'never really secure enough to withstand challenges' (Latour, 1987, p. 137). Prying open would reveal the numerous assemblages and the complex ways in which energy is woven through these networks (Smil, 2008).

Anticipating new assemblages for transitions in such semantically linked network of systems require organizations to develop capabilities for redesigning the intricate knowledge networks that hold them together (Loasby, 2001a, b). Afterall,

organizations are not limited to offering efficient solutions to informational problems arising out of contract incompleteness and uncertainty, they also shape the "visions of the world," interaction networks, behavioral patterns, and, ultimately, the very identity of the agents (Dosi & Marengo, 2007). It highlights the role of innovation for organizing new products, services, business models, technologies, social patterns, institutions and behavior among other new material or immaterial things (Bucher, 2019). Imagination and anticipation are important for innovation processes where actors coordinate through the creation of a shared agenda (van Lente & Rip, 1998) across diverse networks. For Callon (2016) innovation is a process where interconnected agents compete continuously to create unique networks. These acts of imaginative configurations drive the processes of organization through discovery and selection and perhaps that is why innovation is viewed as collective actions of world-making and an important factor in economic growth and social progress (Bucher, 2019; Pfotenhauer & Jasanoff, 2017; Chesbrough, 2003; Fagerberg & Verspagen, 2002; Fagerberg, 1994). Bucher (2019), has argued for a particular focus on imagination as a driver of human progress in general and innovations in particular. The evolution and diffusion of imaginations through their manifestations in innovations could help in visualizing collective sustainable futures (Bucher, 2019). The idea of collective for accessing this transformational capability is quite distinct from community, as it emphasizes a conscious choosing of a coexistence that already exists whether we think it or not (Morton, 2010). Communities imply boundaries that externalize anything that is deemed problematic, whereas collectivism accepts problems and contradictions as a distinct feature of coexistence that needs to be engaged with as illustrated by Fig 3.

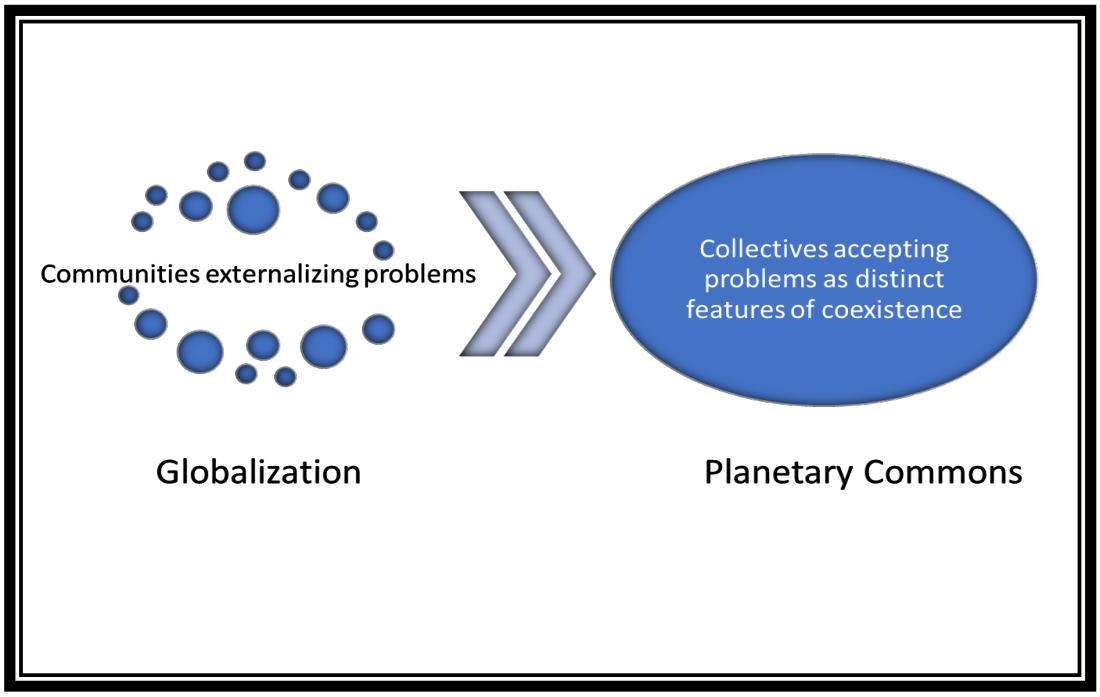


Figure 3. Transition in addressing problems emerging as a result of global activities

This form of collective framework or commons is also used to expand the understanding of innovation as the origin of economic growth. For instance, externalizing result in challenges becoming persistent, while also weakening innovation capabilities (Callon, 2016; Callon, 1998a), and limiting access to critical learning opportunities (Bessant et al., 2012). As a response, Potts (2019) draws attention to a distinct understanding of innovation as an economic process that begins at, what he refers to as, the innovation commons. Expanding the theory of innovation from Schumpeter, innovation commons combines Elinor Ostrom's governance of commons with Friedrich Hayek's ideas on distributed knowledge and information under uncertainty (Potts, 2019). The ideas contributing to this theoretical development relate to an approach that allows a wider scope for diverse organizational forms within innovation systems to experiment with devising their own rule-based solutions to so-called systems failures (Lewis, 2021). If current innovation trajectories are unable to address challenges to social, economic, and environmental systems, then they could be understood as contributing to systems failure. In such eventualities the suggestions from within innovation systems have been based on shaping the institutional environment within which innovation occurs rather than intervening directly (Lewis, 2021; Edler & Fagerberg, 2017; Weber & Truffler, 2017; Metcalfe, 2005). However, the informational demands for shaping such an environment is too complex for institutions alone to manage, and such demands on policy makers inherent in the innovation systems approach is

under-estimated (Lewis, 2021). In addition, institutional inertia as one of the underlying reasons why institutions lag is often ascribed to external factors such as distribution of wealth and income, however, internal factors like mental models complement this view (Rosenbaum, 2021). While a set of institutional rules help actors to do certain things, they also require complementary mental models. These contain not only knowledge about the rules and the context in which they are applied, but also about how to apply the rules successfully, implying that institutions and their representation are interdependent and mutually stabilizing, thus resist change (Rosenbaum, 2021).

The innovation commons approach offers an intellectual as well as practical resolution to this problem by infusing it with democratic features (Smith & Stirling, 2018). Ostrom's idea of the commons, is influenced by liberal and free-market thinkers, and informed by interdisciplinary perspectives based on empirical approaches to understanding problems within their contexts. It draws attention to user self-governance or community-based management, to address Hardin's critique of 'The Tragedy of the Commons' that describes the destruction of a commons due to overuse (Sarker & Blomquist, 2019). It explains why commons as an idea is being put forward to play a specific role in regeneration of societies affected by the extractive wave which has resulted in the current societal challenges (Fritsch., 2021; Motesharrei et al., 2014; Turchin & Nefedov, 2009). The extractive wave is the consequence of ideas embedded in social progress which is measured by material affluence made possible through particular arrangement of relationships that are capable of planning and delivering a boundless frontier of expanding production and consumption (Byrne et al., 2009). A commitment to enabling this process of continuous search for and absorption of more represents an abundance embedded in the micro to the macro scales of modern life, from the personality of the individual to the culture and political economy of modern society (Byrne et al., 2009; Byrne & Yun, 1999). Implicated in this abundance is a continuous stream of engineered change in products and production in concert with change in consumption preferences through advertising for the creation of complex social dynamics that sustains an ethos of unconstrained producing, shopping, and buying (Byrne et al., 2009). The practice of planned obsolescence now apply to all goods, as well as social relationships, fueling continuous market demand and the potential for such incessant growth can only be exploited if an ever-present capacity to fuel such growth exists (Byrne et al., 2009). These are woven into concepts that revolve around 'business case for sustainability', where the objectives are correlated to a distinctly materialistic bias and are at odds with well-being (Painter-Morland et al., 2017).

Purely market-based solutions, could, therefore, have unforeseen consequences by crowding out or displacing behaviour that could potentially be relevant to conservation, for instance, willingness to engage in collective action and civic duty, tolerance for inflicting harm on others (third-party externalities), and desire for equity (Cinner et al., 2021). Here commons management schemes built around cooperative arrangements offer possibilities for addressing problems that result out of market-based solutions (Cinner et al., 2021). The commons approach is rooted in a polycentric system of governance (Aligica & Tarko, 2012), where the users of resources have the authority to experiment with different configurations of operational rules governing their interactions (Lewis, 2021). Such autonomy enable communities, that include managers within organizations, to try out different rule combinations owing to their local knowledge of particular circumstances they face, and discover a combination of rules that work for them within their contexts (Lewis, 2021).

For instance, coopetition or collaboration among competitors could either serve to maintain the current systems in perpetuity and affect change incrementally, if the focus remains current products, processes, suppliers, customers, and shareholders, instead of technologies, markets, partners, customers, and stakeholders (Hart & Milstein, 1999). In doing so, the conceptualization of business networks, from being confined within business environments with narrow markets that focus primarily on business relationships and management, widens to capture the evolving contemporary contexts (Möller et al., 2020). Broadening perceptions does increase complexity but improves managerial and organizational responses to transitions and selection of theoretical perspectives that illuminate actor agency along with system level consequences (Nenonen & Storbacka, 2021). The complexity is intentional as the perceptions are not entities established through a generalization from particulars, but a network with multi-layered structures (Deleuze, 1994; Deleuze & Guattari, 1991; Deleuze & Guattari, 1987/1980; Deleuze & Parnet, 1987). Each of these networks has a combination of components consisting of figures, metaphors, elements that may or may not form a unity, yet are defined by them (Deleuze, 1994). Therefore, this process of broadening requires sensing and discovering how combinations come together and then designing innovative activities that help address the consequences of such combinations and transition to better combinations.

In addition to being complex, a coordination process that seemingly extends beyond traditional organizational boundaries, implies diverse perspectives of value and therefore incentives. To make sense of and understand a destabilizing environment characterized by climate change and mass extinction brought about by human disturbance, and its connection to deteriorating social dynamics would

require a set of theoretical tools across several disciplines. All of that is not within the scope of this thesis, instead it urges for acknowledging the complexity by proposing an exploration of transition paths towards sustainable energy systems. Such an exploration could contribute towards expanding the knowledge framework to reflect evolving contemporary contexts for business networks, made possible by approaching transitions by drawing on theoretical perspectives that expand rather than limit conceptual boundaries of activities for transitions. This has two functions, first it helps in visualizing socio-technical systems as assemblages, and second, it opens up innovative ways to reimagine them within different contexts for addressing sustainability needs for transitions. Organization is, in this sense, a dynamic quality, and change and organization are overlaid in each other in ways that draw attention to the elements that subvert, disrupt, escape, exceed, and change organization. The concept of organization is not set against change, but a creative pluralism of organization based on enfoldedness, relational connections, and becoming, and in that embodying desire, as a motivational force that responds by rearranging elements that repress the process of organizing (Linstead & Thanem, 2007). The attempt here is to practice theorizing by highlighting the role of organizational practices and the paradoxical tensions in a manner that allows for the integration of discursive, material, and cognitive components of theorizing, to be able to integrate contradictory evidence for renewing theoretical foundations rather than defending theoretical constructions (Clegg et al., 2020).

Innovative organizing entail framings that enable a deeper and broader understanding of the process of emergence of these networks. Using these frames to articulate the current reality of business networks and relationships requires a pivot from narratives of globalization towards narratives that involve the planet. A pivot would involve imagining bridging mechanisms or protocols. These would help perceive the interior vitality of business networks and the interconnecting exteriors, thus extending the manifesto for researching the interactive business world (Waluszewski et al., 2019) into realms unknown while continuously referencing the known. Selection of relevant methodological and conceptual approaches create transparency in the role of accumulated social and material resources. This includes the different logics of private and public actors, novelty and innovation, economic boundaries, emerging relationships, measuring value and value appropriation, the translation of value into monetary flows and their distribution and the role of policy in an interactive business landscape (Waluszewski et al., 2019). Reorienting current coordinating networks through interactions of energy and innovation systems require an understanding of the entangled social, technical, economic, and ecological relationships that define planetary existence (Folke et al., 2016). As managerial actions in changing

environments are intrinsically linked to how they perceive themselves and their focal networks and systems (Penttilä et al., 2020; Makkonen et al., 2012), such perceptions need broadening. The broadening could emerge through innovative practices for uncovering new domains and methods of intervention for generating awareness of and leveraging the diverse and distributed knowledge paradigms, and nurturing relationships that enable them (Nenonen & Storbacka, 2020; West et al., 2020).

For businesses, the innovation commons could be a useful frame, particularly for managing relationships with the purpose of orchestrating ecosystems through collaborative strategizing involving a wider set of actors (Möller et al., 2020). Innovation commons helps establish the contextual ecosystems where the close relationship between innovation and competition unfolds (Callon, 2016). Here, energy choices become an integral part of such coordination (Smil, 2008), because any coordination process implicates energy choices (Sorman & Giampietro, 2013), at individual (Quinn & Dutton, 2005), organizational (Marchi et al., 2019) and societal (Vogel et al., 2021) levels. The array of choices increases when seen from this perspective, as the actions are not a determinate response to circumstances, rather encourage the possibility that actions can vary in any given set of circumstances (Lewis & Dold, 2020), implying interactions between levels. This view attempts to capture how actors cooperate under uncertainty of not knowing, and differs from the conventional where rational actors face well-defined problems and eventually arrive at some optimal behaviour. The assumption is that actors differ, often have imperfect information about others, and make sense of their contexts through exploration and reaction, and constantly changing their actions and strategies in response to the outcomes they create through mutual interactions (Arthur, 2021; Håkansson & Johanson, 1993).

These combinations involve a range of actors that infuse them with properties synonymous with those of public goods (Potts, 2019; Arrow, 1971, 1962; Romer, 1990) thereby increasing complexity. As the relationships emerge within these dynamic contexts, complexity metrics help in identifying inputs and how these inputs interact for specific activities (Hidalgo, 2021). The various combinations reflect the relationship between inputs, and reveal what the input becomes as it evolves. Firms and governments as institutions of hierarchy, and markets as indicators of property rights and price signals are often poor at dealing with such combinations (Allen & Potts, 2016). This coupled with Dunbar's (1992, p. 469) argument related on cognitive capacity which 'limits the number of relationships that an individual can monitor simultaneously' and Luhmann (1995, p. 208) 'ungraspable unity', reinforces the need for distributed as well as decentralized organizing, requiring technological tools that facilitate the governance and

organization of context specific and decentralized activities (Narayan, 2020; Narayan & Tidström, 2020a; Vergne, 2020). In this context, institutional technologies like blockchains or distributed ledgers (Allen et al., 2020a; Abadi & Brunnermeier, 2018; Beck et al., 2018; Berg et al., 2018; De Filippi, 2016; Narayanan et al., 2016; Böhme et al., 2015) offer possibilities for innovative coordination through contracts, transactions, resource attributes, ownership, knowledge, and governance.

The applications and incentives on the blockchain help focus on contexts and their specific challenges to encourage innovation by reimagining societal interactions, including energy choices (Howson, 2021; Di Silvestre et al., 2018; Raworth, 2017; Sorman & Giampietro, 2013). Interactions in these contexts also require negotiations that converge around the ethics and governance of data systems. Ethical concerns about technology use, on one hand, and barriers to user acceptance on the other, demand creative approaches of collaboration and orchestration for imaginative and open infrastructures that offer possibilities for investigating the legibility and ethics of such systems while building visibility and literacy around its capabilities and consequences (Hemment, 2018). It recognizes that information societies increasingly depend on technology to thrive, and require healthy environments to flourish. In addition, it points to the importance of addressing the increasing demands on energy and urges for new ways of conceptualizing value creation through innovative organization of information.

This builds on the long tradition of debate on humanism and cybernetics, including the informational turn in economics and the need for an algorithmic understanding of markets (Mirowski, 2010, 2007, 2002). While this informational turn confer markets a position of power (Mirowski & Nik-Khah, 2008), it also brings into focus how Internet access changes the economy in ways that cannot be anticipated and is hard to measure. For example, making mobile phones accessible to fishermen in India made it possible for them to exchange demand information, which stabilized prices and reduced waste (Jensen, 2007). The informational turn opens up possibilities for engaging with the idea of information as a digital object and once identified as such, becomes relational (Hui, 2012). Understanding information as digital objects that we copy, paste, drag, delete, modify, and so on, also introduces the Internet as an interface between users and digital objects, and as a world in which these digital objects reveal and conceal elements of everyday life (Hui, 2012). Information as a digital object is contingent as an object of knowledge and its value lies within modes of interactions that are revealed according to the different modes of functionalities, thus going beyond the idea of cybernetic 'control' (Hui, 2020, 2017, 2012).

Information brings transparency into the evolving contexts within human social structures to show how all forms of organizations – individual, firm, networks, ecosystems, markets, states, the planet – comprise of others forms of organizational systems and are also connected to them. Making sense of such a transition requires an understanding of networks as assemblages akin to Guattari's (2000) description of three ecologies, the environment, social relations, and human subjectivity and Morton's (2010) *mesh*, used to describe the interconnections. It offers a comprehensive ontology of nonhierarchical complex material systems comprising of human as well as non-human elements, defined by their process of production and consumption within an energetic environment (Debizet et al., 2016; Smil, 2008). This implies levels of complexity where centralized models can work only in tandem with distributed and decentralized ones. The Fig 4 provides a brief snapshot of the contribution of the theoretical perspectives to business networks transitions to sustainable energy systems.

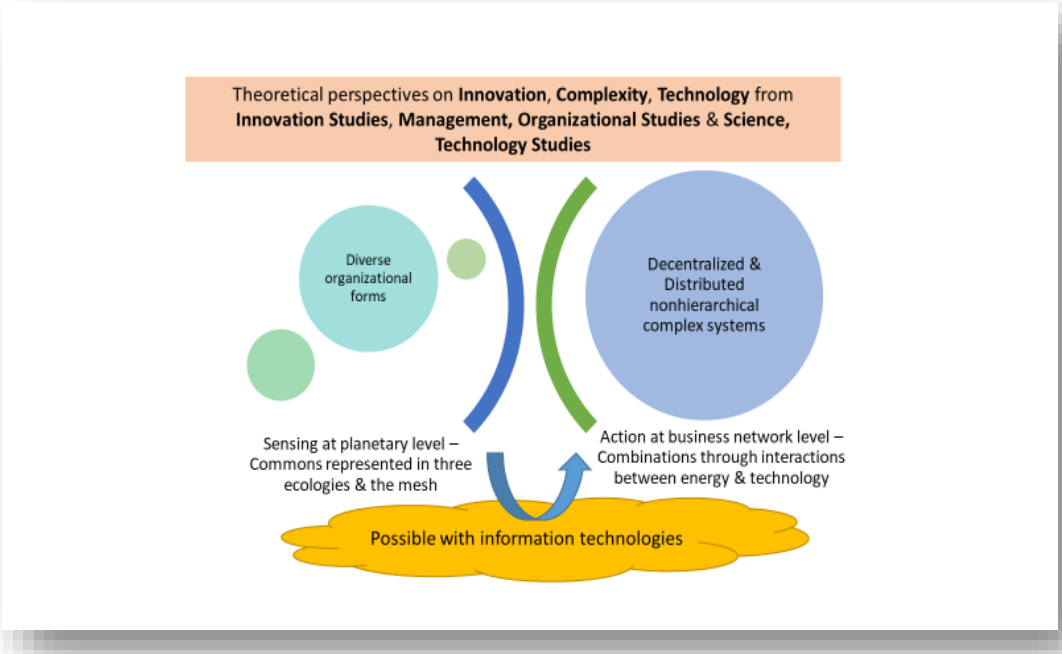


Figure 4. The theoretical positioning – From organizations to innovative organizing

Not doing so concentrates too much responsibility, which coupled with access to few resources forces strategic paths that are focused on continual compression of complexity by progressively reducing and abstracting rich and context-specific information. This results in views and models that become detached from real-world phenomena with limited understanding of contemporary contexts (Möller

et al., 2020) and solutions to complexity just compounds them as the existing management architecture with its relationships renders it insensitive to solutions. Energy use embody complexity and allow for opportunities to pry open the network black boxes (Prenkert, 2017; Guercini et al., 2014) but the challenge for organizations and managers as agents during the transition towards sustainable energy systems is framing new ways of understanding the constantly evolving interconnectedness. Even though not every element is connected to every other, the effects of any system depend on both the elements that are included and the form of this incompleteness, which is the way these elements are organized and that is why connections are relevant (Loasby, 2007; Potts, 2000). Connections highlight the importance of distribution and decentralization during organizing, thus preserving the role of control, but making it fluid and transferable. The theoretical progress here is an interaction between two levels of theorizing, formal and appreciative, where the flow of influence is bi-directional, as neglecting appreciative theory takes away the opportunity to cope with real world phenomena (Nelson & Winter, 1982).

1.3 Research purpose and questions

The objective of this thesis is twofold, first is to develop a sense of how organizations might think about sustainability through an expansion of relationships implicated in business networks to be able to imagine the necessary organizational elements for market shaping. To achieve the first objective, this thesis draws upon theoretical perspectives on innovation, complexity, and technology, and captures how these interact to imagine possibilities for action. This helps in broadening the foundations of existing understanding of ecosystems and business fields (Adner & Kapoor, 2010; Möller & Svahn, 2009) to incorporate real-world phenomena (Möller et al., 2020). By fulfilling this objective, the thesis offers a process for experiencing and accessing the diversity of knowledge through wider disciplinary engagements.

The second objective is to offer a pragmatic approach for these engagements and relationships to evolve, grow, and manifest themselves in unlikely ways. Here the focus is on process as an activity of becoming. The second objective is achieved through the published articles.

The Fig 5 below illustrates the process for such innovative organizing. Here, what is 'this' a case of (Langley, 2021) is explored in two ways, tied to the two objectives.

The main research question, linked to the first objective, considers transition as a phenomena in motion, unfolding over time, as becoming, based on the notion of

narrative, implying an experiential ontology of sensemaking (Langley, 2021). The focus is on sensing through stories and narrative accounts collected during interactions and comparing them from different sources and different times (Langley, 2021) for articulating how transitions to sustainable energy systems could be understood and is explored through the following research question (RQ):

Main RQ. How might one conceptualize innovative organizing towards transitions to sustainable energy systems?

The main RQ is explored using a narrative approach relying on rhizomatic storytelling, to understand the networked relationships that define interactions as well as change them, and how to broaden this understanding by treating ecology as a comprehensive ontology. This ontology attempts to present an understanding of systems as an assemblage of nonhierarchical complex material systems, both human and non-human, defined by their process of production and consumption within an energetic environment (Debizet et al., 2016; Smil, 2008). Actors and artefacts within energetic environments can be traced through interactions (Debizet et al., 2016). The need for framing the main research question arose during the process of developing the articles.

The main research question helped in developing the thinking about the transition process and understanding it within the realm of action, the published articles offer both practical and imaginative forays into what and how this transition could be enacted through a process of becoming (Langley, 2021). They offer potentialities for answering:

RQ 1. What is innovative organizing?

RQ2. How does such organizing enable transitions to sustainable energy systems?

The five published articles serve as devices for exploring the information and energy nexus for understanding transitions to sustainable energy systems. The articles represent instances that expand the idea of networks for innovations towards sustainable energy systems using theoretical perspectives drawn from innovation studies, science and technology studies, organization and management research. They present the different kinds of coordination possible for context specific assemblages to understand and address issues related to transitions towards sustainable energy systems. In doing so, they encompasses three distinct dimensions of innovation towards sustainable energy systems – the transition in the cognitive representation of innovation, role of interacting networks of actors and information in such transitions, and the possible implications of such transition.

The Fig 5 captures the process and locates the main research question along with the first and second research questions. Table 1 offers a summary of the articles included in the thesis that help answer the first and second research questions.

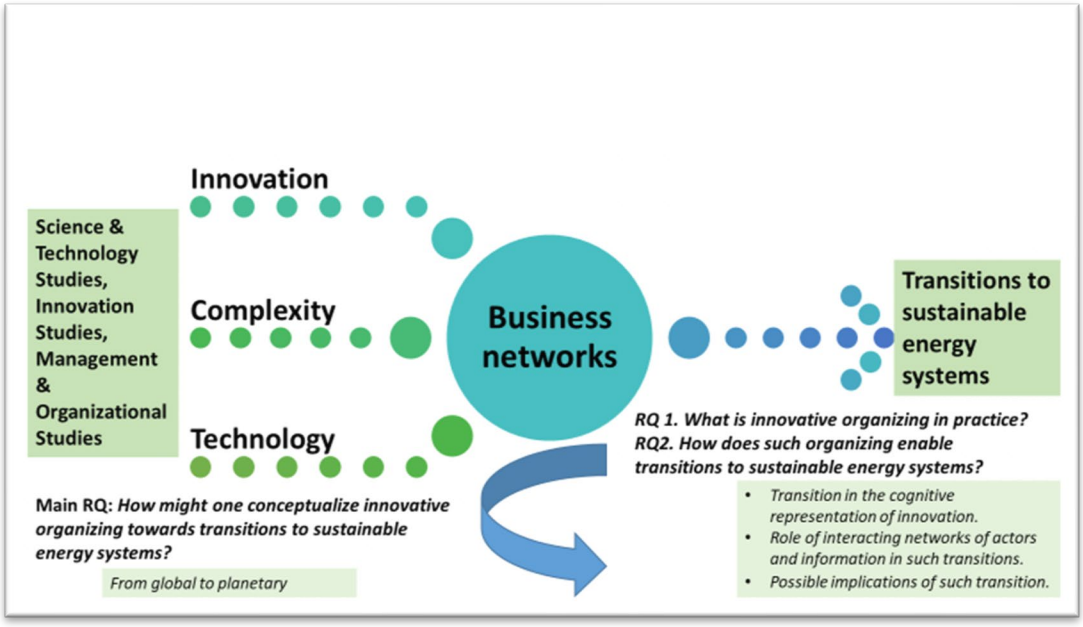


Figure 5. Locating the Research Questions

Table 1. Brief summaries of the articles and their contributions linked to the RQs

Articles	Contribution
Narayan, R., & Tidström, A. (2019). Circular economy inspired imaginaries for sustainable innovations. In *Innovation for Sustainability* (pp. 393-413). Palgrave Macmillan, Cham. The book chapter draws upon the concept of imaginaries from STS (science and technology studies) to show how Circular Economy (CE) could be used to evoke existing values that enable sustainable innovation. The findings highlight how in addition to models and best practices, sustainable innovations are deeply rooted in specific social, cultural, political and economic contexts and that those contexts shape how innovations could be understood as sustainable. The idea that emerges here is that models and best practices need not limit possibilities, instead they could offer continuing value through endless combinations	Expanding business networks through commons & energy-information nexus is represented through the CE framework. This article contributes to the understanding of commons as a space for developing imaginaries for sustainable innovations that initially draw from what is known. As interactions emerge and grow through what is familiar they create opportunities for change. These interactions could be understood as recursive activities that in repetition deviate to accommodate change in the environment. RQ1: This case illustrates the assemblages that take place during the exploration process of the idea of CE, the evolution in the narratives of progress, that allow existing

Articles	Contribution
that consider the needs of these various contexts. Theoretical Perspectives – Innovation, Complexity & Technology (CE, Sustainability, Innovation, Socio-technical Transitions) Methods – Qualitative (Interviews, workshops, research notes, documents)	management technologies to be repurposed for organizing such an innovation process. RQ2: In articulating the possibility for such progress through collaborations and cooperation the case illustrates how possibilities for transitions to sustainable energy systems could be realized.
Narayan, R., & Tidström, A. (2019). Blockchains for accelerating open innovation systems for sustainability transitions. *Blockchain economics: Implications of distributed ledgers: markets, communications networks, and algorithmic reality*, 85-101 This article presents the possibility of blockchains for addressing the inherent complexity and interconnectedness of challenges related to sustainability. It explores how features of blockchains could enable new mechanisms for coordinating various combinations of skills, capabilities, and knowledge across open innovation networks, and contextualize the value creating potential of such combinations. These combinations allow for values to emerge from both, sharing as well as capturing information, a distributed and decentralized vision of organizing. Theoretical Perspectives – Innovation, Complexity & Technology (Blockchain, Sustainability, Innovation, Socio-technical Transitions) Methods – Qualitative (Literature review & literature beyond peer-reviewed academic journals (Adams et al., 2016; Sharma et al., 2015)	<u>Understanding business networks through energy-information interactions and blockchain introduces the commons perspective through open innovation.</u> This article contributes to the expansion and change in the roles of interacting actors through diverse organizational forms made possible with information technologies. It introduces the idea of organizational networks that can explore coordination at planetary level through distributed and decentralized mechanisms. RQ 1: This case explores how technology could be leveraged for complex assemblages, through narratives of enabling that contributes to innovation becoming open through context-specific coordination. RQ2: In presenting how the new technological features of decentralization and distribution enable open innovation processes within contexts, this article creates the grounds for exploring innovative combinations that allow for sustainable energy systems to be part of such combinations.
Narayan, R., & Tidström, A. (2020). Tokenizing coopetition in a blockchain for a transition to circular economy. *Journal of Cleaner Production*, *263*, 121437. The article presents how coopetition could be operationalized and optimized using tokens in a blockchain to support a transition to circular models of value creation and appropriation. The findings indicate that tokens could enable previously disconnected product ecosystems to converge and unleash the waves of creativity and innovation required for circular business models. Facilitating such convergence would require the coopetition models to transition from comprising the current stages of value creation and appropriation to being based on value creation and circulation. Value is often	<u>Organizing networks at planetary level through digital information technologies. Blockchain represents the commons perspective and CE the information-energy nexus.</u> This article contributes by offering a strategic framework for deploying sustainable innovations through CE by reimagining product biographies that are distinct from the linear ones. It prepares the ground for expanding distributed networks activities through incentives that allow for decentralization with context specific value creation and circulation. RQ1: This article builds on the idea of a product or a service as an assemblage, how this allows for different narratives to emerge in their becoming, and incentives like tokens

Articles	Contribution
located in things we tend to devalue, like waste. Theoretical Perspectives – Innovation, Complexity & Technology (Sustainability, CE, Coopetition, Blockchain, Token economy) Methods – Qualitative (Literature review)	on a blockchain enable the different coordination processes for innovative organizing RQ2: In presenting a model for such coordination, this article allows for a visualizing the information-energy nexus through product biographies and the innovative opportunities for combinations that enable transitions to sustainable energy systems.
Narayan, R., & Tidström, A. (2020). Leveraging resource ecologies for sustainability transitions–a waste management case. *Journal of Business & Industrial Marketing*. 'Leveraging resource ecologies for sustainability transitions–a waste management case' (Narayan & Tidström, 2020b), aims to showcase how organizations develop the ability to identify and integrate diverse groups of actors using social intelligence to build an ecology of resources to address such inefficiency. Social intelligence is a powerful element in organizing, and could be leveraged for creating dynamic models that contribute to community well-being as well. Theoretical Perspectives – Innovation, Complexity & Technology (Sustainability, Ecology, Networks, Resources, Transition, Social intelligence) Methods – Qualitative case study (Interviews, Interactions, Workshops, Documents, Research Notes)	Expanding business networks through commons and the energy-information interactions are implicit in the idea of waste. This article contributes to an understanding of how individual firms while being embedded in an existing network develop the ability to leverage new and wider network capabilities using social intelligence to create distributed and decentralized mechanisms for addressing the consequences of their activities. RQ1: This article explores the case of a global packaging company and how it creates opportunities for innovative organizing to manage waste. It uses narratives of becoming to access and coordinate resources that embody the information-energy interactions. RQ2: The company sets in motion innovative organizational activities that combine and recombine to address material recovery and recycling goals, and is indicative of a strategy for transitioning to sustainable energy system through deeper engagement with the story of the product.
Narayan, R. (2020). Leveraging Digital Intelligence for Community Well-Being. *International Journal of Community Well-Being*, *3*(4), 539-558. The article looks at the growing influence of artificial intelligence (AI) and the opportunity it offers for innovative social designs specific to communities and their understanding of well-being. In presenting how improving community well-being using AI, the knowledge, insights, and impressions or analysis required for activating such improvement necessitate a frame of reference, and that when well-being is understood within the current paradigm of technological innovation as a driver of economic growth, such an understanding limits its potential.	Understanding business networks through energy-information interactions and organizing networks at planetary level through digital information technologies This article contributes towards the transition in understanding of well-being from within current socio-technical network configurations towards a wider frame. It introduces the potential of AI to contribute to innovative social designs that are not limited to economic growth as understood within the current network configurations. RQ1: This article advocates for an assemblage of value tied to diverse contexts instead of a singular notion of value tied to economic growth. It does this through a narrative that captures the importance of acknowledging the diversity of values to

Articles	Contribution
Theoretical perspectives – Innovation, Complexity, Technology (Artificial Intelligence, Well-being, Sustainability Transitions) Methods – Qualitative (Literature review & literature beyond peer-reviewed academic journals (Adams et al., 2016; Sharma et al., 2015)	enable a richer and diverse understanding of well-being, and how AI can help in locating and coordinating such value propositions. RQ2: In highlighting diverse value spheres implicated in understanding well-being, this article indicates how the current organizing of information and energy systems need to be reconfigured to accommodate these diverse values.

1.4 Structure of the dissertation

There are two parts to this dissertation. The first part consists of five sections, and the second of reprints of five articles. The first introductory section prepares the background of the dissertation and its objective. The second section presents the theoretical framework of the study, followed by the third section that focuses on the methodological choices of the dissertation. The fourth section explains the findings and the last section provides a discussion of the main research question and summarizes the role of the published articles in answering the related questions, and the dissertation's overall contribution to business networks, limitations, and suggestions for future research. The second part of the dissertation consisting of two published book chapters and three published articles.

2 THEORETICAL BACKGROUND

2.1 Conceptualizing transitions with theoretical perspectives from innovation, complexity and technology

Theorizing involves a range of activities, but it is conceptualization that is core to all forms, involving activities that name and frame the topic of interest in terms of specific theoretical concepts (Cornelissen et al., 2021). Specific theoretical concepts become resources upon which a whole range of activities occur, that includes categorization through which decisions related to the topic being studied are made (Cornelissen et al., 2021). These resources maybe available in existing literature around a topic, or it is possible to conceptualize a topic in a new way, by inducing a different theoretical framing or by drawing in concepts and theoretical discourses as new resources from other domains and literatures (Cornelissen et al., 2021). The complexity inherent in theorizing transitions to sustainable energy systems from the perspective of business networks would mean drawing on a diversity of resources, but that is outside the scope of this process. Instead this process acknowledges the complexity and focuses more broadly on enabling conditions that encourage a shift towards the role of emergence during transitions.

This style of theorizing is less concerned with explaining a particular outcome (Cornelissen et al., 2021) and more focused on emphasizing theory building as a process that does not follow a series of sequential steps (Nayak, 2008). This process attempts to string together existing theoretical perspectives from innovation studies, science and technology studies, and management and organizational studies, to offer paths for exploring the continuous emergence of organizational forms. The conceptualization enables an understanding of the 'temporally embedded interactive contingencies that might drive events and activities in different directions' (Cloutier & Langley, 2020, p. 5). In that sense, this theoretical exploration embodies the perspective of organization as being everywhere, including human activities, other life forms, and inanimate phenomena. It offers the means to visualize the interactions of energy and information that make such organization possible, and helps in infusing energy with what Mirowski (1991, p. 64) calls the 'accidents' of temporal, spatial, and human observations, that allows for a loose phenomenological account.

The claim that organizations do a lot of things without presupposing their capacity to act (Bencherki & Cooren, 2011) including the ability to consider varieties of organizational systems with access to diverse knowledge structures has been

observed even in hunter gatherer communities (Acemoglu & Robinson, 2009). This framing incorporates the role of formal organizations as means for developing and using complex knowledge contained within these systems by forming categories and postulating connections between them (Loasby, 2007). Organizing as a manifestation of economizing and evolutionary principles is grounded in cognitive capacities and motivations of humans which leads to the differentiation and integration of knowledge (Dougherty & Dunne, 2011; Loasby, 2007). This makes complexity not just a feature of these systems (Hidalgo, 2021) but also the way thinking about these systems is organized (Tsoukas & Hatch, 2001), implying coordination. As a process, coordination encourages actors to tailor and arrange activities towards accomplishing objectives that may or may not be consciously agreed upon or even shared, and is often a conversational experience (Tsoukas et al., 2020; Cannon-Bowers et al., 1995; Boden, 1994; Locke & Latham, 1990; Weick, 1979). A conversational approach that considers the interactions between dominant narratives and continuously emerging stories, is compatible in practicing such thinking (Boje, 2021).

Managing the complexity implicit in such an orchestration process requires an understanding of connections afforded by what Stiegler (2019; 2018b) describes as reticular networks made possible through the Internet and the blockchain as an enabler of decentralized and distributed organizing (Vergne, 2020). They make it both, imaginable and viable for renegotiating network relationships to accommodate planetary ecologies (Heikkurinen et al., 2021; Featherstone, 2020). Thus, offering the possibility to embrace complexity through a 'system of picturing' consisting of an 'open-world ontology, a performative epistemology, and a poetic praxeology' where 'every drop of experience' offer possibilities for reconstructing experiences (Tsoukas, 2017, p. 132). One could draw upon Dijkstra's (1972, p. 864) perspective on the role of abstraction to offer that these experiences enable the simplicity in abstractions emerge, and reveals how 'the purpose of abstracting is not to be vague, but to create a new semantic level in which one can be absolutely precise'. The complexities implicit in subjective experiences are constantly interacting with the abstractions, and rather than place complexity on a collision course with simplicity as Donaldson (2021) has argued, these interactions offer opportunities for discovering value embedded in them, leading to semantic progress.

This interactive milieu helps in negotiating the tensions between understanding networks as bundles of relations or as things-in-themselves (Latour et al., 2011), to present an ecosystem of ideas that allow for imagining how what is real can also be remade (Law, 2009). The idea ecosystem, in this context, expands and unfolds through a discursive exploration, representing an assemblage that encourages a

rhizomatic approach to understanding business network infrastructure through what Clegg et al (2020) have referred to as an organization of ideas. The objective is to demonstrate possibilities through innovation and creativity (Koivunen & Rehn, 2009), for directing attention to the progress in ideas of networks from global to planetary for understanding the implications of transitioning to sustainable energy systems. This process of uncovering the various relational webs (Morton, 2010) demands a simultaneous responsibility towards what is real and what is good (Law, 2009), an important element in market shaping (Nenonen & Storbacka, 2021).

Management and organization scholars study social structures of prevailing eras through a process of inquiry to bring empirical data into existence, therefore, data gathering and analysis have elements of the past that brings along with it the predominant institutional infrastructures and their implied practices (Gümüsay & Reinecke, 2021). Building a theoretical frame to transition from this current state of existence towards the future would require the creation of what Gümüsay and Reinecke (2021) have called 'real utopias' or in some cases 'noble lies', a reference to imaginative collaborative strategies (Harwick, 2020). An environment of imperfect information requires subjective preferences to diverge from objective payoffs, where actors are able to put aside their subjective preferences to collaborate on issues that have an objective payoff (Harwick, 2020). One can extrapolate from this to offer that for innovation to have better outcomes, socially and environmentally, information technologies enable firms to diverge from subjective preferences (those activities that contribute to the challenges) towards collaborative strategies that offer objective payoffs (new value creation and entrepreneurial opportunities and continued license to operate in the future, with better outcomes for society). Real utopias or noble lies have a liminal existence between imaginaries and practice as they involve developing visions of future alternatives to predominant institutions while being rooted in the potentialities of the present (Gümüsay & Reinecke, 2021; Wright, 2010). The understanding of transitions is drawn from three such interactive and relational potentialities – innovation, complexity, and technology. Fig 6 below captures the knowledge framework.

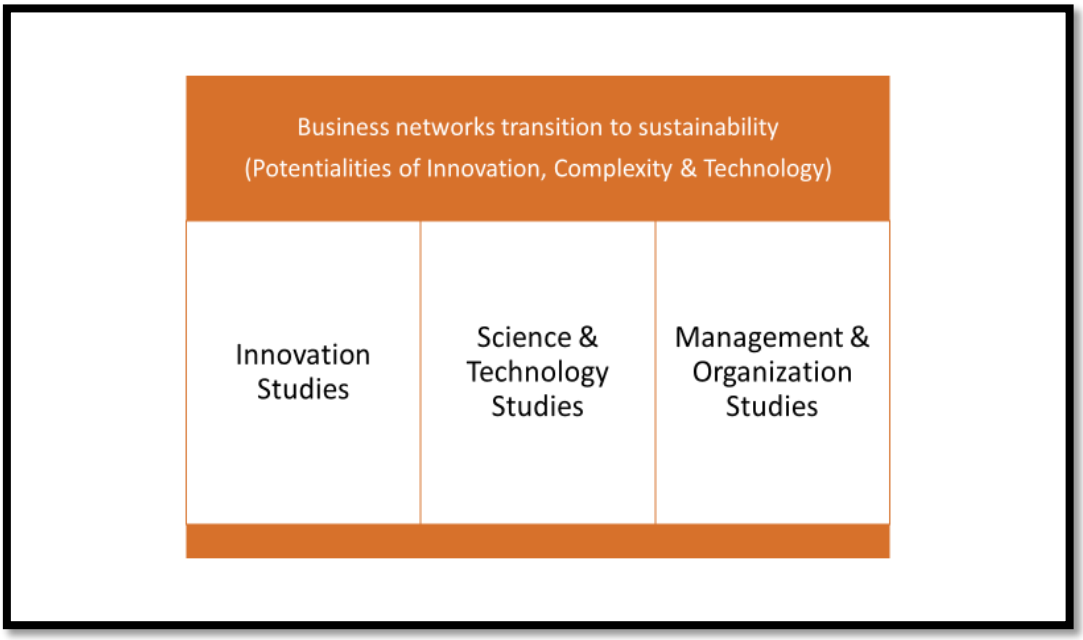


Figure 6. Theoretical diversity representing the knowledge framework for sensemaking

The potentialities of these perspectives become meaningful through narratives that expand, highlight, and demonstrate their contribution towards transitioning towards a sustainable energy system. The Fig 7 below illustrates the contribution.

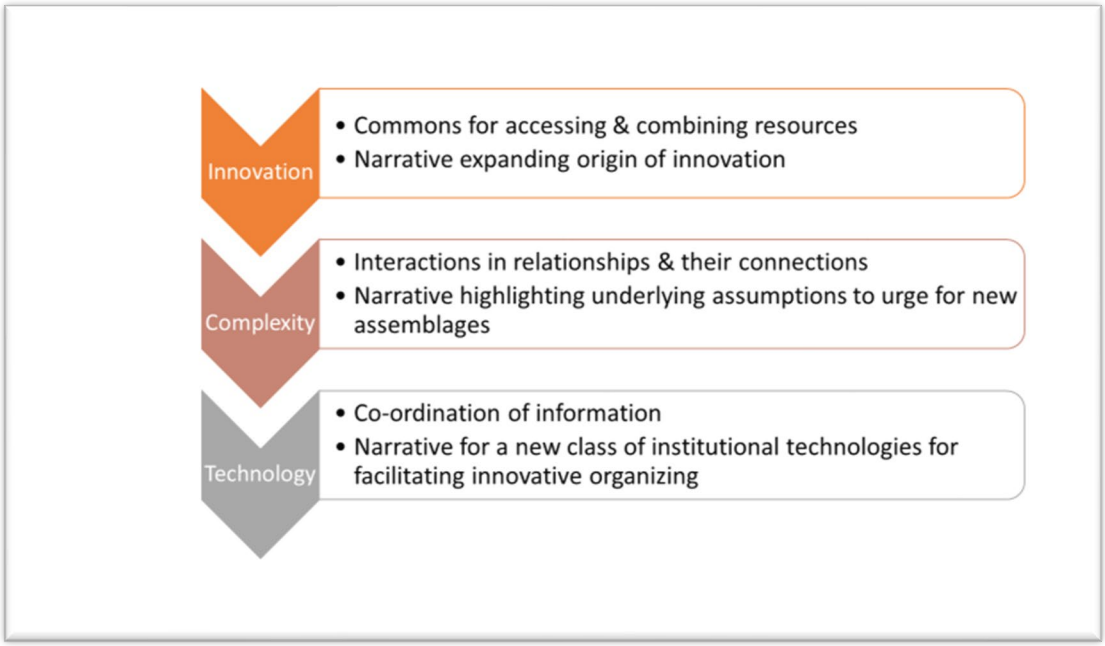


Figure 7. The contribution of potentialities of innovation, complexity & technology

2.2 The innovation potential

Innovation's place in society has transitioned over time, and Godin (2010) reveals how its framing has evolved. Innovation as understood from thirteenth century legal texts was used in the context of renewing contracts that signified newness not creativity, and the word acquired a positive and prestigious association with invention related to science and technology during the Industrial Revolution. Schumpeter framed its meaning to reflect acts of intellectual creativity, thus infusing the ideas behind the word with imagination. For Schumpeter, the value was distributed, and not concentrated in one final objective. Within Schumpeter's framing this form of creativity was not given any overt economic objective, rather, it was to illustrate the various ways in which inventions could be imagined to reflect unique ways to run businesses (Fagerberg, 2018; Fagerberg, 2007). Therefore, innovation is essential for adapting organizational practices to address the challenges related to sustainability, and as innovation involves a certain sense of newness (Van de Ven, 1986), it may pertain to any activity at any level of analysis (Gupta et al., 2007). This is evident in references to technological innovation (Utterback, 1971), product innovation (Dougherty, 1992), marketing innovation (Levitt, 1962), process innovation (Davenport, 1994), service innovation (Frambach et al., 1998), organizational innovation (Blaug, 1999; Daft, 1978), strategic innovation (Tushman & Anderson, 2004), and even innovation in national governance (Kitschelt, 1991) and political innovation (Gehl & Porter, 2020). These descriptions of innovation relate to specific social systems or domains within them and the innovations are designed for optimizing those systems and domains. While adaptation presents opportunities to enter an established domain, it is shaping that brings tangible change (Nenonen & Storbacka, 2020). Sustainability challenges emerge when innovations do not consider the entangled relationships of these social systems and their domains (Cillo et al., 2019; Callon, 2016) and shaping enable discovery of alternative systems. It is this framing that links innovation to firm competitiveness. For instance, Hayek and Schumpeter saw competition as a process of discovery and creation of disequilibrium, respectively, where, it is important to note, price is just one aspect, and not a significant one at that (Lewin, 2016; Dodgson et al., 2011).

A critical insight from Godin's (2010) account of the history of innovation is that the word has always been infused with the social and cultural climate of a particular time and the history that this climate emerged out of. For instance, the significance of structures referred to as innovation systems driven by cooperation (Godin, 2010a; Freeman, 1987; Nelson, 1993) gained clarity during the OPEC oil crisis in the 1970s when traditional economic policies ceased to have effect, and policy makers began focusing on innovation as the source of economic change,

with innovation systems as frameworks for shaping such dynamics (Fagerberg, 2018; Lundvall, 2010). Systems theories highlighted the conditions impacting firms' innovation decisions and trajectories, and acquired significance as innovation became central to firm competitiveness (Cantwell, 2005; Lazonick, 2003) and in that, underpins growth at the national level (Freeman, 2002). Godin (2010a) notes that Freeman (1974, p. 20) refers to them as a system of cooperation for the production of new products and processes, management and marketing, diffusion and interaction with scientific research as 'the ultimate source of economic advance'. The growth of this form of professional coordination was an important social and economic change in the twentieth century. The inclusion of competition and collaboration enables innovation to embrace a continuing purpose rather than arriving at a solution. Extrapolating from Godin's account, one can say that innovation enables the creation of ontological frameworks that allow people of a particular time grasp its meaning within their context, and in that innovation, at its core, is a creative practice.

Modern approaches to innovations have thus taken on a systems perspective (Johannessen, 2013, Smith, 2000). The approach is driven by, among other things, the understanding that innovations by firms cannot be explained at the level of the firm but through interactions between the firm and its environment, at two levels (Bergek et al., 2008; Smith, 2000). The first involves the network interactions of customers and suppliers, within business fields, ecosystems, and platforms that help shape the learning, practice, and technology creation (Möller & Halinen, 2017; Smith, 2000). The second involves broader factors like social, cultural, institutional, organizational structures along with the processes that create and distribute scientific knowledge (Smith, 2000). In the field of business studies, this coordination has been observed and framed variously as open innovation (Chesbrough, 2003) and democratizing innovation (Weigt-Rohrbeck & Linneberg, 2019; Mollick & Robb, 2016; Von Hippel, 2009). The idea of network organizations offering possibilities for addressing the development needs of social ecosystems that could enable and support complex innovation processes (Dougherty & Dunne, 2011) is now established in literature (Van de Ven, 2017; La Rocca & Snehota, 2014; Gupta et al., 2007; Dubois & Araujo, 2006; Chesbrough, 2003).

2.2.1 Innovation through business network perspective

Specifically, the business network perspective seeks to analyze and understand phenomena across three closely interconnected levels of analysis, namely, the firm, relational, and network (Ramos et al., 2013; Snehota & Håkansson 1995), and how these levels of analysis influence one another through interaction and

interdependent coevolution (Welch & Wilkinson 2002). In doing so, it presents a framework that helps to shape a 'shared network view' and offers a collective understanding of different network actors hold on a particular topic (Henneberg et al., 2010). It has added to knowledge about how firms organize and manage networks for value creation (Lacoste, 2016), where innovation plays a critical role (Rampersad et al., 2010; Moller & Svahn, 2009). The view stems from learning that a single firm focus does not lead to any significant understanding of business processes (Ritter et al., 2004). Inter-firm interaction at the core of business network research (Andersen et al., 2020; Möller & Halinen, 2018), highlights the role relationships play in producing knowledge for innovation, as businesses are required to access a 'distributed knowledge system' external to the firm (La Rocca & Snehota, 2014). Research on studied firm behaviors from network perspectives have contributed towards building concepts that explain the interactions through which firms strategize in diverse circumstances. Empirical examples have presented the broader dimensions that capture innovation processes where networks are designed not only for the purpose of innovation, but the embeddedness of innovation processes in business exchanges as well (Öberg, 2019). The evolution in understanding ranges from collaborative advantage (Kanter, 1994), specific interaction processes and their occurrences between particular combination of firms (Ford et al., 2008), and the role and importance of cooperative strategies and alliances (Contractor & Lorange, 2002). This has extended to cooperation and competitive advantage (Dyer & Singh, 1998, Wilkinson & Young, 2002), and coopetition, the conceptual explanation of the interplay between cooperation and competition in business networks (Ritala et al., 2016; Tidström & Rajala, 2016; Bengtsson & Kock, 2000), and more recently how network initiation works for integrating sustainability in a new venture's business activities and resources through interaction with network actors (Sabatini et al., 2021).

As networks are dynamic, process views are integrated into this field of research as well (see Andersen et al., 2020; van Fenema & Keers, 2020; Halinen et al., 2012) and how business networks exist within multiple intersecting practices (Holttinen, 2014). These practices represent managerial understanding of networks through a constant process of building and re-building as a way of establishing continuity in organization (Andersen & Medlin, 2016) and the interactive ontology of process enhances the ability to uncover the dynamics of network enactment and innovation (Olsen & Håkansson, 2017; Möller, 2010; Håkansson & Lundgren, 2006). The content of these processes covers firms' business strategy, values, knowledge, communications, activity patterns, properties of products and services, and structural properties of how actors organize (van Fenema & Keers, 2020). This extends to organizing innovation processes, where business networks

facilitate the use of the knowledge of others by continuously creating shared learning through relationships (La Rocca & Snehota, 2014).

2.2.2 Relationships reveal the need for commons

Relationships offer access to resources like knowledge and markets, and through them access to indirect relationships, which enable firms to perform important functions (Walter et al., 2001; Snehota & Håkansson, 1995; Håkansson, 1987). For instance, knowledge on multi-level portrayal of the interactions influencing organization through technological transitions (Rip & Kemp, 1998) and the social factors, besides techno-scientific knowledge and technology and markets, that contribute to such transitions (Geels, 2002) have resulted in understanding the emergence of new business fields (Möller, 2010). The ways in which these transitions are developed, maintained, and transformed by networks of interrelated actors, have contributed to this understanding (Möller, 2010). The intertwined socio-techno-economic interactions through networks of knowledge economies, global firms, and technological complexity (Geels, 2002) have led to investigations into how firms make sense of their network environments and try to influence the sense-making of other actors, thus shaping their network pictures and behavior (Möller & Halinen, 2017; Möller, 2010).

Studies of successful inter-organizational service systems comprising of actor-to-actor structures show how actors co-create value with mechanisms supporting the roles and processes underlying value co-creation, and common platforms serve as innovation venues facilitating access to appropriate resource combinations (Lusch & Nambisan, 2015). Emergent network-based organizational designs appear particularly successful in addressing difficult challenges of today's complex, fast-paced business scenarios (Fjeldstad et al., 2012). The implication here is that traditional organizing and planning need to be replaced by formats that involve network organizations positioned to develop robust action strategies and support future lines of action open to accommodate learning and local failure (Ferraro et al., 2015). Ferraro et al. (2015) have called for such action in the form of diverse discourses and artifacts, supported through participatory institutional architecture and distributed experimentation and learning based on both success and failure. Through such action, they argue, network organizations will stimulate sustained actor engagement and novelty generation enabling a flux of innovation with distributed outcomes. As sites for developing innovation processes, such networks facilitate the use of the knowledge of others by continuously creating shared learning through relationships (Ford et al., 2017; La Rocca & Snehota, 2014; Håkansson & Waluszewski, 2007; Ahuja, 2000). The development has a lot

to do with creating a new language through shared learning that takes place across firm boundaries. The learning is through relationship building by combining elements of stability and variety that are economically positive (Håkansson, 2006). The challenge is to expand this combination to include those elements that have been left out because their contributions to these economically positive relationships are either not immediately apparent or even when they are, externalizing them reduces management complexity.

In such dynamics, innovative firms draw on a combination of resources and this helps in expanding the understanding about innovation by drawing attention to an institutional coalition that guides a kernel of an idea by offering a set of conditions for cooperation (Potts, 2019). Directing attention towards such a coalition invites the opportunity to imagine innovation as a common pool resource and means that the idea of innovation is no longer limited to something individuals do and when it fails the state steps in to fix it. As a commons, innovation could then be governed through mechanisms that incentivize actors to pool information, knowledge, and other inputs for facilitating innovation under uncertainty (Potts, 2019). The narrative of entrepreneurial action as identified by Schumpeter (1939) is presented as the beginning of the innovation process (Potts, 2019; Perez, 2002; Dosi, 1982), however, an explanation for the discovery of opportunities is an important part of such entrepreneurial action (Shane, 2000). In modern evolutionary economics (see Nelson & Winter, 2002; Cyert & March, 1963; Penrose, 1959) this activity is subsumed into the role of the innovating firms as vehicles of cooperative activities through industrial organization of research and development. These organizational units located within innovation systems, transform into structures of metacooperation (Freeman, 1987; Nelson, 1993). However, the narrative of innovation commons that highlights the role played by shared and cooperative mechanisms that come together for addressing complex challenges, places the origin of innovation within a wider frame. Antonelli (2017) notes that while the economics of innovation has made it possible to understand how and where innovation takes place, there remains very little understanding of why innovation is introduced and even less when. The understanding of the determinants of innovation is unclear and the task of understanding innovation as an endogenous product of the working of economic activity remains unfulfilled (Antonelli, 2017).

2.2.3 Relevance of the commons

Expanding the frame helps. For instance, while issues emerging from industrial development in the pursuit of growth (Meadows et al., 1972) have been discussed (see Freeman, 1979), the ideas have been limited to eco-innovation. However,

highlighting the issues has made it possible to redirect production towards environmental goals, including decoupling economic growth from environmental degradation (Hajer, 1995; Spaargaren & Mol, 1992; Jänicke, 1985). Indeed, these ideas have contributed to the expansion of the problem framing from the realm of economic growth to scrutinizing other elements that contribute to and influence such growth as well as impacts related to such growth. This has also meant an expansion of the analytical framing from price-led signals for innovation influenced by neo-classical environmental economics towards a wider system led signaling for innovation processes (Dodgson et al., 2011; Smith et al., 2010), informed by contributions from innovation studies ranging from eco-innovations (Kemp, 2011), transformative innovations (Steward, 2012), and mission-oriented innovations (Mazzucato, 2017). These efforts have led to new products and services with a focus on improving environmental standards, and studies have contributed towards how and why such environmental- leaning production and consumption practices occur, or not, and offer suggestions that could enable the acceleration of such practices (Smith et al., 2010).

However, this is inadequate in dealing with strategic challenges relating to transforming systems of innovation, production, and consumption, due to its focus on improving innovation capabilities of firms and institutional settings that support them (Weber & Rohracher, 2012). They have been limited to product and process efficiencies, and introducing environmental efficiencies, where the focus has been on changing some kind of technological artifact (Geels et al., 2004). Shove (2018) while raising issues related to rebound effects associated with efficiencies, has also noted that bounding objects of efficiencies discourage any discussions on the current practices that are unsustainable. Creating such boundaries limit the ways in which solutions could be imagined. For instance, circular economy (CE) has been offered as an idea that has the ability to direct innovation activities towards sustainability (De Angelis, & Ianulardo, 2020; Konietzko et al., 2020; Martin, 2020; Narayan & Tidström, 2019a; Busch et al. 2018; Larsson 2018; Prendeville et al., 2018; Sarasini & Linder 2018; Geissdoerfer et al., 2017; EMF 2015). However, the possibility in the idea depends on leveraging cooperation for better, longer, more productive outcomes which require acknowledging the significance of distributed value (Spring & Araujo, 2017). Merely focusing on designing products and services that meet our present needs (Brockway et al., 2021; Levänen et al., 2021) obscures the possibilities for imagining what might be the design of products and services that support, sustain, and enable far less energy intensive ways of living. Growth, therefore, continues to be generated through a collection of socio-technical systems that are supported by fossil fuels, resource intensive, and wasteful (Giuliani, 2018; Schot & Steinmueller, 2018). Evidence shows that even though firms as innovators generate value, they

are capable of significant negative impacts (Freeman & Soete, 1997; Nelson, 1977, 2011). This turns the focus back on how innovation is conceptualized and its role in framing firm competitiveness. Callon (2016) offers the idea of 'market agencing', referring to the collective actions without which markets would collapse. When market actions, structured by socio-technical devices, are intent upon establishing bilateral commercial transactions and promoting them, they become means for extending market activities by driving competition. This links innovation to a continued process of competition and collaboration where all challenges and issues are converted to opportunities for innovation, thereby internalizing the political and moral elements. However, where innovation is deployed as a strategy to avoid competition, and the questions of qualification and choices of products are left unanswered. In externalizing these questions and issues, the expectation is that some other mechanism will debate and decide what can be sold, including how income from such sale should be redistributed (Callon, 2016). This results in the emergence of power structures that counter-balances the market machinery, and also misses out on learning and innovation possibilities by externalizing the collective process of design, production, and distribution of products. The problem therefore is not that of coordination within firms and markets but the inability to make explicit the relationships and the perceptions guiding them resulting in these networks externalizing the outcomes of their activities (Chouinard et al., 2011). The externalizing leads to persistent challenges while also weakening innovation capabilities of networks (Callon, 2016; Callon, 1998a), as externalizing prevents such networks from critical learning opportunities (Bessant et al., 2012).

Understanding the externalizing is important as it relates to how firms are organized through complex networks incentivizing combinations of information and energy systems networks that privilege a certain understanding of contracts, transactions, resource attributes, ownership, knowledge, and governance. This understanding is incompatible with the economic value of a new idea, as such value is not immediately apparent given that the information pertaining to the idea is distributed. This is why Barnard (1968) proposed that a formal organization is a form of cooperation that is conscious, deliberate, and purposeful, thus, making coordination one of the central problems of organizational research (Heath & Staudenmayer, 2000; March & Simon, 1958; Follet, 1949). Therefore, the study of organizing innovation processes that embrace challenges as opportunities (Callon, 2016), require a broader focus than the one offered by incentive-compatibility, the basis of economic analysis (Loasby, 2007). For instance, in managing climate change and associated risks there have been calls for an expanded research agenda on social contracts, defined as multiple and constructed as opposed to singular and fixed that includes three distinct yet intersecting forms of contracts, imagined, practiced, and legal-institutional (Blackburn & Pelling, 2018).

Innovation commons offer an economically efficient governance mechanism for coordination between diverse actors (Potts, 2019). From the perspective of firms, excluding actors and elements beyond the firm and the market, limit their ability to expand their innovation capabilities. Callon (2004) has earlier demonstrated through the idea of 'hybrid collectives' how allowing heterogeneous actors, comprising of human as well as non-human entities, a strategic role in the dynamics and organization of design collectives induces as new vision of human agency. Such agency is diversified and variable and the needs, demands, expectations, feelings, capacities of action, and cognition of such agency depend on the socio-technical configurations of the collective. The term 'collective' is significant as it resolves the dichotomy between society and economy (Cochoy et al., 2016). The assumption here is that in contemporary society, market settings need to be regarded as ongoing collective experiments where political, social, economic and techno-scientific concerns are articulated and revised continuously (Callon, 2009). The concern emerges from the markets, as participants seek diverse combinations of entities involved in social life as well as economic exchanges that are socially, morally, and politically acceptable (Cochoy et al., 2016; Geiger et al., 2014).

2.2.4 Consequences of extending innovation commons to business networks

There appears to be a fundamental analytical issue when it comes to integrating a diversity of value spheres that a collective implies. This results in the development of a set of rational methods for planning and action where certain decisions are privileged over others, creating an artificial separation of activities that are in fact interdependent. For instance, innovation at the level of firms comprise of organizational activities relating to design, production, and distribution involving complex networks caught in webs of evolving relations that continually sense and ensure adaptations and adjustments with the intent of creating value (van Fenema & Keers, 2020; Andersen & Medlin, 2016). The skills and resources required for taking an idea from its inception to market are distributed across actors from multiple domains (Karnøe, 1996). Such distributed agency has been reported by Garud and Karnøe (2003) while observing technology entrepreneurship as a process of steady accumulation of inputs through various actors generating a momentum that both enable and constrain the activities of distributed actors thus shaping technological paths. The term 'ecosystems' is often used in the context of business, (see Schot, 1998; Moore, 1993; Hannan & Freeman, 1989; Carrol, 1988) to draw attention to such interdependency among different actors, and the co-evolutionary aspect that bind them together over time (Aarikka-Stenroos & Ritala,

2017; Ritala & Almpanopoulou, 2017). As Scaringella and Radziwon (2018) have pointed out, the term has been applied to study topics within business studies such as innovation (Adner, 2006), entrepreneurship (Prahalad, 2005), and more recently, knowledge (Van der Borgh et al., 2012). It serves as a useful analogy or metaphor, but has also been criticized for not being representative enough (Oh et al., 2016). Perhaps, the adoption of the term 'innovation ecosystems' in management literature to describe profit-driven systems of innovation around focal companies, technologies, or platforms (Ritala & Almpanopoulou, 2017) is inadequate. It signals that the measure of innovation is possible only through firm profitability, and thereby the negation of value inherent in the innate diversity and plurality of the institutional and non-institutional actors that populate the various hubs of knowledge and their collaborative capacities. This is not to say that such measurement metrics are not needed, they are part of establishing a system that links science and innovation (Freeman & Soete, 2009). However, for designing a system for measuring the link, it is also important to clarify the underpinning rationale, or the context. Unless the reason for measuring something is clearly articulated, an evaluation process is unlikely to provide any useful outcomes. A measure that becomes a target ceases to be useful as a measure (Strathern, 1997).

It is this design stage at the beginning, as Potts (2019) demonstrates, involving a process of discovery that has been ignored so far. The innovation process is visualized as having a beginning, middle and end, with specific focus on problematizing innovation and therefore visibility of activities and data being concentrated on middle and the end (Potts, 2019). This has consequences as it places innovation within the realm of adoption and diffusion through competition between firms, as venture capital and market disruption, new business models and industries, and even innovation policies tend to focus on the middle while the most difficult part is the beginning (Potts, 2019). The beginning of innovation comprises of discovery costs (technological, research and development and entrepreneurial discovery and experiments) that are incurred while creating the environment for entrepreneurial opportunity (Hausmann & Rodrik, 2003). Also included in this discovery cost are broader costs associated with uncovering potential use and benefits, and to whom, and the costs that these new ideas might impose on others. Current innovation models sidestep these elements and focus on transformation costs (production inputs like capital, labor, technology) and transaction costs (search and information, bargaining, monitoring and enforcement costs). The innovation problem is problem of discovery, that relates to finding the right combinations of pieces of distributed knowledge that reveal valuable opportunities for actors (Potts, 2019). Discovery failure occurs when relevant information does not find its way into the entrepreneurial process due to the lack of an effective governance mechanism for coordinating the required information, knowledge,

and resources towards opportunity discovery (Potts, 2019). In bundling discovery with transformation (production of innovation) and transaction costs (information search) the innovation process misses out on accounting for activities dynamically as they happen, and restrict opportunities to match innovation activities suited to diverse contexts.

Therefore, innovations for transition call for agility and compasses that allow roles to emerge and gain relevance in time and space. This is because the issues are complex and interrelated, so no one person, organization or institution can manage them alone. The cyclical relationship between diversity and inclusion, and innovation highlights contribution towards improving innovation performance (Brimhall, 2019; Brimhall & Mor Barak, 2018; Godenhjelm & Johanson, 2018; Birch, 2017). As more people get involved these innovation processes take the shape of collaborative games that create further opportunities for ever increasing participants through contributions such as infrastructure, ideas, questions, and even new problems. Collaborative networks foster shifts in behavioural attitudes in terms of increasing trust and acceptance among collaborating members (Mor Barak, et al., 2016; Shore et al., 2011) and such organizational constructs are more likely to take risks and share ideas, both essential ingredients for innovation processes. For innovations towards sustainable energy systems this complexity is embodied in the interactions between technologies, actors, and institutions entangled through economic, social, cultural, and political ties (Bale et al., 2015) implying a commons. From the perspective of firms, innovation commons expands the notion of innovation activities beyond the entrepreneurial one of discovery of an economic opportunity (Shane, 2000). In doing so, it expands the pictures that contain the organization of business activities (Möller et al., 2020) to include human as well as non-human actors into the innovation ecosystem. This necessitate imaginaries that embrace the complexity of information-energy interactions, to transition from relationship management to ecosystem orchestration (Möller et al., 2020) for market shaping (Nenonen & Storbacka, 2020, 2021) through innovative organizing with technology.

2.3 The complexity potential

The idea of commons expands the understanding of innovation beyond current economic and business networks, implying an assemblage of complex systems. Complexity introduces a cognitive element in understanding the organizational dimensions of innovations towards transitions to sustainable energy systems. Complexity sciences have gained relevance in the research of behaviour of phenomena on large scale to investigate emergent, dynamic, and self-organizing

systems interacting in ways that influence the probabilities of future events (Preiser et al., 2018; Urry, 2005). Irreducible to elementary laws or simple processes, complexity approaches combine system and process thinking (Urry, 2005). The idea of complexity draws attention to a system of thoughts and their relations that help in bridging different levels of activities and lay the ground for approaching the cultural and technical realms together (Hui, 2020, 2012). Complexity helps explain how contemporary contexts become possible, and through the underlying concepts and their relationships steer discussions about possible adaptations that encourage transitions reflecting sustainable outcomes (Chakrabarti et al., 2020; Cillo et al., 2019; Markard et al., 2012; Smith et al., 2010; Loorbach & Rotmans, 2006; Kemp et al., 1998).

2.3.1 Complexity – from adapting to shaping

Developments within network research have engaged with perspectives on whether business networks could be addressed as partially closed sub-systems (Möller et al., 2005), understood from a systems ontology perspective (Prenkert, 2017), and examined from a configurational perspective (Raab et al., 2015). These explorations have offered opportunities for developing the field (Möller & Halinen, 2017) and indicates a growing recognition for including multiple network constituents. It shows that business network research is open to looking beyond linear narratives of global value chains (GVC) (Gereffi et al., 2005) and global production networks (GPN) (Hendersen et al., 2002) to incorporate all kinds of network configurations (Coe et al., 2008), through what Möller et al (2020) have characterized as ecosystem orchestration. In the context of challenges related to transitioning towards sustainability, the complexity implied in the current nexus of networks and the related uncertainty characterized by multidimensionality, requires research that is future-oriented and effective in gathering experiences across disciplines, sectors, and scales (Howarth & Monasterolo, 2016). Such an orchestration, implies shaping through adaptation.

Adaptation processes involve innovation, as it is central to society and the subsystems that constitute it, such as countries, industries, organizations, groups of individuals, or an individual (Gupta et al., 2007; Drucker 2006, Van de Ven 1986; Schumpeter 1976). Adaptations at any level could potentially impact other parts of the system in different ways inducing changes and impacting outcomes that are partly predictable and partly emergent; necessitating an emergent form of management (Gupta et al., 2007). Innovation during adaptation processes imply creative combinations of old and emerging ideas, as well as organizational practices. For instance, learning to adapt can be far more challenging for firms

than knowledge or competence-based learning. Adaptability, therefore, requires a combination of fixed and flexible governance structure where returns are sustained but also changed, to discourage any kind of lock-in, sclerosis, and overreliance on established routines (Amin & Cohendet, 1999). These features indicate how the purpose of adaptation is not to protect the current system configurations but enable firms to identify and shape, as urged by Nenonen and Storbacka (2020), their minimum viable systems during rapid and unexpected change. However, this is not an easy process given the complexity inherent in the context of transitions to sustainable energy systems.

Unruh (2000), for instance, has described transitions to sustainable energy systems as difficult processes, due to the existing energy system that is woven into everyday existence in the form of transport, housing, agri-food system through investments, behavioral patterns, vested interests, favorable subsidies, infrastructure, and regulations. While acknowledging that widespread diffusion of technological innovations and new infrastructures are essential for the achievement of many sustainability goals (Thacker et al., 2019), progress in that direction has been limited, owing to high degrees of inertia within the existing systems of production and consumption (Sachs et al 2019), exemplified by existing business network configurations.

2.3.2 Market complexity in sustainability transitions research

The inertia and the dynamics of innovations are at the center of a novel, interdisciplinary field of research on 'sustainability transitions' (Markard et al., 2012). Sustainability transitions are fundamental changes in socio-technical systems such as energy, food or transport that aim to address challenges in a way that meets the needs of the present without compromising the ability of future generations to meet their own needs. Transition research through a multi-level perspective (MLP) investigates how innovations emerge, struggle with incumbent interests, and eventually lead to major system changes (Geels, 2011). The MLP has become a popular framework for understanding transitions towards sustainability. It engages with the multi-dimensional complexity within socio-technical systems that such shifts imply through changes in consumer practices, policies, cultural meanings, infrastructures and business models (Geels, 2020; Geels, 2010; Geels & Schot, 2007; Geels, 2004; Geels, 2002; Rip & Kemp, 1998). The framework represents three analytical levels comprising of niches, where radical innovations are located, socio-technical regimes that are locked in and stabilized on several dimensions, and an exogenous socio-technical landscape. Transitions are depicted as regime shifts that come about through interacting processes within and between

these levels. The MLP is rooted in Social Construction of Technology, evolutionary economics and neoinstitutional theory (Geels, 2020), and has so far been used for analyzing historical, contemporary, and future transitions (Geels, 2020; Moradi & Vagoni, 2018; Morrissey et al., 2014; Berkers & Geels, 2011; Geels & Schot, 2007; Geels, 2002).

Advocates of the MLP find it useful because of its ability to accommodate radical change through the concept of niches, dynamic stability through the concept of socio-technical regimes representing their institutional structuring, and landscapes that represent influences from broader contexts representing slow changing elements (Geels, 2020). While MLP offers a rich and layered understanding of transitions, it is limited to single system transition typologies when inter-systems interactions are important for transitions (Wanvik & Haarstad, 2021; Mancarella, 2014). In addition, even though complexity is implied within the framework, it is not explicitly employed for capturing the socio-technical interactions (Wanvik & Haarstad, 2021; Vasileiadou & Safarzyńska, 2010) considering that majority of transitions involve interactions between more than one system (Papachristos & Adamides, 2016; Papachristos et al., 2013). For instance, interdisciplinary collaborative research has made it possible to highlight the links between many of the current issues and past innovations, which grew out of several organizational experiments adhering to the existing organizational theories and economic systems. Through an interdisciplinary collaborative effort, a mathematician, an atmospheric scientist, and an economist (Garrett et al., 2020) argue that past innovations determine the trends in current growth, energy consumption, population, and standard of living.

The implication is that these innovations had a specific purpose, that of economic growth. While such innovations have contributed to economic production efficiencies and enabled use of less energy for production and consumption systems, future efforts to combat carbon emissions will render such innovations largely useless, unless the underlying assumptions of innovations and growth are dealt with (Feola, 2020; Byrne et al., 2009). This is consistent with Spreng's (1993) argument that even though information technologies could be used more effectively to conserve energy, they are deployed for speeding up processes that end up consuming far more energy. Further, there is a strong leaning towards analyzing material flows and life cycle analysis as tools for facilitating transitions. However, these tools ignore the socio-material continuities that characterize lived experiences where creating any bounded unit of analysis clouds the multi-scalar patterns of resource use and distribution (Cederlöf & Hornborg, 2021; Floyd et al., 2020; Sorman & Giampietro, 2013).

Therefore, in not tackling underlying assumptions, the MLP remains limited in its ability to account for transition stories of innovative organizing of markets emerging through, for example, the evolving architectures of information technology (Allen et al., 2020a; Potts, 2019; Spring & Araujo, 2017) commons (Last, 2017; Potts & Hartley, 2015; Byrne et al., 2009), and energy-information interactions (Last, 2017; Last, 2015a, b). Founding frameworks in transition studies regard markets and market formation as critical for transitions to unfold (Geels, 2004) and innovation systems to emerge (Dewald & Truffer, 2011; Hekkert et al., 2007) but they have, so far, not been elaborate. This could be perhaps because empirically sustainable technologies have begun scaling only recently (Hyysalo et al., 2018) or because markets are regarded as rational trade arenas (Diaz Riuz, 2012). Currently, markets are mostly treated as target areas for sustainable innovation and emphasis is on diffusion and user involvement, and firms and business networks as critical actors and their interactions continue to remain underrepresented within transitions research (Loorbach & Wijsman, 2013).

2.3.3 Multidimensionality through complexity

While transitioning to sustainable energy systems is urgent and appropriate, it is important to consider whether such a transition can meet the existing expectations of full demand for work, heat transfer, lighting and data manipulation that the current globalized and growth-oriented economies require (Floyd et al., 2020; Alexander & Floyd, 2018). This requires a multidimensional perspective. One where the modern empirical understanding of human behaviour is not limited to rational utility maximization, and economies are viewed as complex, evolving, socio-ecological systems, a departure from the neoclassical equilibrium view (Beinhocker, 2020; 2006; Loasby, 2007, 2004; Potts, 2000). This view is consistent with complexity which regards economies as open, dynamic systems, made up of heterogeneous agents, lacking foresight albeit with learning and adaptive capabilities (Allen, 2015; Foxon et al., 2013; Loasby, 2007; Beinhocker, 2006; Arthur, 1999).

Multidimensionality brings a diversity of perspectives and the resulting complexity highlights the value of revisiting assumptions rooted in economic thought. Such assumptions shape management practices through mechanisms of institutional design, social norms, and language (Ferraro et al., 2005). The manner in which shared ontology dominates management and organizational theories have been discussed extensively (Allen et al., 2019; Dyck & Greidanus, 2017; Sharma & Hart, 2014; Ferraro et al., 2005; Ghoshal, 2005; Pfeffer, 2005; Ghoshal & Moran, 1996).

Ferraro et al (2005) have discussed how theories become self-fulfilling as they shape institutional designs and management practices, in addition to social norms and expectations about behaviour, that in turn, influence the creation of the behaviour they predict. Nonaka et al's (2014) critique of the measurement of success solely in economic terms without the ability to factor in the diversity of systems that enable individual success draws attention to a limited framing of resource allocation and flawed decision making at all levels of society. These connections to established theories and their relevance and influence on management and organizational thought are often taken for granted (Ghoshal, 2005). This is evident in the intellectual incoherence of an idea like shareholder value which has gained prominence despite lacking support from history, law, or empirical evidence (Stout, 2012).

To introduce multidimensionality in economic thinking, Beinhocker (2006) has drawn from ideas of Georgescu-Roegen (1971) and Nelson (2005), among others. Such thinking urges for understanding of the processes of coevolution of physical and social technologies in concert with business plans underlying wealth creation, and property-rights that encourage innovations for creating and meeting market demands. This offers insights on how to enhance and distribute prosperity while factoring in the social and environmental impacts, and turn the focus away from productivity towards progress; the possibilities of which are being explored in ideas of degrowth (D'Alisa & Kallis, 2020; Kish & Quilley, 2017; Asara et al., 2015; Kallis, 2013; Sorman & Giampietro, 2013; Sekulova et al., 2013). Such a focus paves the path towards building narratives in which progress is not just about increasing output, but about improving outcomes that highlight the qualitative aspects of progress, an important indicator of sustainability (Jackson & Senker, 2011). This could be attributed to what Dosi (2013, p. 112) refers to the separation of 'what keeps the system together' from 'what keeps it going' or coordinating for order vs. transforming for change of economic systems (Robert et al., 2017; Dosi, 2013; Dosi & Orsenigo, 1988).

Multidimensionality is evident in the emergence of complexity within the realm of innovation systems to address the inadequacies of policies targeting market failure and systems failure (Frenken, 2017). A complexity approach begins with the observation that most innovations are related to existing activities and to encourage activities leading to unrelated diversification, that are needed for addressing societal challenges, require a combination of temporary collation of actors. These actors work within a broad coalition and tentative governance mechanisms that have the ability to cope with the inherent complexity of modern-day innovation. (Frenken, 2017). Complexity enables an understanding of the inherent, irreducible nature of uncertainty and limits to knowledge and prediction.

In doing so it introduces the idea of how complex evolutionary systems are ongoing, continuous internal processes of exploration, experimentation, and innovation at their underlying levels (Allen, 2015).

Applying complexity tools enable the emergence of new data and methods that make it possible to, for instance, predict economic growth, income inequality, and greenhouse gas emissions (Hidalgo, 2021). This is distinct from traditional approaches to economics that aggregate factors like outputs or assume the nature of inputs, for instance, capital, labour, institutions, and knowledge. Instead of trying to make assumptions about the input factors, complexity metrics try to estimate their combined presence through relatedness, to answer questions related to specific combinations that lead to certain outcomes in order to anticipate changes, for instance, in specialization patterns. Such techniques help in summarizing the geography of economic output and could be deployed for exploring any location's diversification and developmental potential (Hidalgo, 2021) that could be directed towards improving economic, social, and environmental outcomes.

Complexity highlights the connections between appropriate allocation, compatibility between complementary fields of knowledge, and the output of the goods and services that result during the process of applying differentiated knowledge (Loasby, 2007). During this process problems need not be externalized but re-specified by the continuous growth of knowledge and redefinition of categories, and the connections such redefinition entails. (Callon, 2007b; Loasby, 2007). The complexity emerges in the formation of organizational structures, their effects, how they are conserved and changed.

In doing so, complexity undermines the ontological coherence that have strengthened singular conceptualization of value. For instance, Wootton (2018) has documented the intellectual and philosophical lineage, from Thomas Hobbes' premise of human beings as pleasure seekers, to Jeremy Bentham's utilitarianism, and the subsequent development of the theory of utility and welfare theorems of Kenneth Arrow. These have propped up the notion of maximizing GDP as the ultimate societal good. These ideas emerged, mainly to engage with the social problems that stemmed from industrialization and the mass migrations from the countryside to the cities and have since morphed into problems of inequality in the current environment, as discussed by Atkinson (2015), Piketty (2014), Stiglitz, (2012). The contemporary focus carries some of the older themes while leaving others behind and in that reveals the significant shift in economic theory as a theory of society that revolved around the material and moral aspects of economic actions, to a theory of rational action that reduces the social question to a problem

of material inequality (Wagner, 2019). Such reductionism is key to recognizing the institutional arrangements through which resources are organized. These organizational forms exist to privilege narratives of growth that seek to undermine the classical approaches where social progress occurred when the material conformed to the moral aspects of progress.

This is evident in the framing of 'business case' dominant in business sustainability discourses (Painter-Morland et al., 2017). Firms are required to make a business case for sustainability convincingly before committing themselves to it, as they want to be able to confirm how such investments will translate back into financial gain. This financial gain, ironically, will be employed for the pursuit of further growth, which contributed to the problem in the first place. The preoccupation with reinvesting the surplus labor into further growth seems to yield, on the level of the general economy even more wasteful consumption (Painter-Morland et al., 2017). These narratives embody certain moral conceptions, and in the area of sustainable development, they offer clues towards understanding their modes of existence, their relation to how life is experienced, and their influence in how thoughts are processed and argued (Painter-Morland et al., 2017).

Drawing upon two normative frames (Hahn et al., 2015, 2014) of the business case and paradoxical frames, within sustainable development discourses, Painter-Morland et al (2017) show how the objectives of business sustainability are at odds with those of sustainable development. Sustainable development goals are tied to well-being, however, the materialistic bias that informs the understanding of well-being as equaling wealth have led researchers to focus their analysis on the relationship between materialism and well-being (Painter-Morland et al., 2017). They draw correlations with economic literature where happiness has been used as a synonym for 'welfare' and 'well-being', when happiness is a far broader concept than economic well-being. Easterlin (2015) notes that long term trends in happiness and income are not related, though short term fluctuations in happiness and income are positively associated. Well-being measures appear to lead to overconsumption and consumerism that is depleting resources at higher rates, causing waste accumulation, and generating pollution (Painter-Morland et al., 2017). Well-being may determine higher levels of productivity, but the ways and means through which this is pursued appears to potentially undermine well-being (Isham et al., 2020).

Robert et al (2017) have highlighted how complexity allows for a resolution of the two themes of coordination and order vs. transformation and change of economic systems. A complexity view, in such resolution, renews focus on how the economy really works. It serves as a reminder that a system consists of elements. These

elements could be systems themselves, and the connections between them, and the changes thereof can be traced to changes either in the elements or the connections, or interactions between these two kinds of change (Allen, 2015; Potts, 2000). This view is distinct from general equilibrium modelling which postulates that any model should be fully connected, and consequently, any difference between the models must be attributed exclusively to differences in their elements. The assumptions of complete connections within these models, therefore, demand omissions from elements' costs of running the system, that include energy cost of cognition, which are a significant part of human energy costs, and creation and operation of markets and organizations (Loasby, 2004). Such omissions limit these models' competence in handling externalities (Callon, 1998b) and institutions, both of which are results of incomplete connections (Loasby, 2004; Potts, 2000).

The norms of perfect rationality (agents solve well- defined problems using perfectly rational logic to optimize their behaviour), representative agents (agents are similar and fall into one or a small number of representative types), common knowledge (all agents have the same knowledge), and finally equilibrium (aggregate outcome is consistent with agent behaviour, in that it gives no incentive for agents to recalibrate their actions) are accepted because they simplify analysis (Arthur, 2021). Even if they are not entirely devoid of significance, these assumptions limit other perspectives, thus making no allowances for behaviour ecologies that contribute to the creation of new products or arrangements, formation of new institutions, exploration of new strategies, or for events that might trigger new ones (Arthur, 2021), in short, innovation. The outcomes may not always be in equilibrium, but in fact, display patterns and emergent phenomena that is not immediately visible. Complexity, in Colander and Kupers' (2016) view, makes it possible to induce creativity in innovation processes where the focus shifts from control towards channeling social instincts, where profits become tools for solving societal problems instead of goals.

The idea of complexity, exposes the fallacy in traditional growth narratives that are ultimately at the heart of innovation systems and indicates how such a focus actually constrains innovation. The notions of market failure and system failure direct resources towards incumbents while starving new entrants, in addition, they also restrict economies from exploring unrelated diversification strategies (Lewis, 2021; Frenken, 2017; Hidalgo et al., 2007). Complexity makes it possible to understand innovation as emergent activity shaped by and explained through the interactions of heterogeneous agents, embedded in the organized complexity of the economic system (Antonelli, 2017; Arthur, 2014; Antonelli, 2009).

2.3.4 Relating complexity to business networks transitions for sustainability

Chesbrough (2003) has used the term open innovation as an umbrella construct to indicate the connected and integrated range of activities. Chesbrough's (2003) contribution enabled innovation scholars and practitioners, to visualize the design of innovation strategies in an increasingly networked and interconnected world, paving the path for conceptualizing complexity inherent in relationships. However, this perspective of networked relationships in business has historical precedence (Wilkinson, 2001) and their role and importance in value creation and delivery is well documented in marketing and business literature (Ritter et al., 2004). Business networks are self-organizing systems where order emerges from local interactions taking place among firms within specific relationships, thereby posing problems in developing and implementing strategies (Ritter et al., 2004). The inherent complexity makes managing them tricky (Spekman et al., 2000) and firms can never effectively control them and at times relationships within networks create outcomes that could be manipulative, undemocratic and politically questionable (Tura et al., 2019; Olsen et al., 2014; Håkansson, 2006). Business relationships and networks are therefore interaction processes that are continuously recreated and understood over time and space (Andersen et al., 2020; Purchase et al., 2016; Medlin & Saren, 2012) to gain access to resources for managing the complexities associated with business environments (Ritter et al., 2004; Håkansson & Waluszewski, 2002; Håkansson, 1987), making relationships valuable resources for a firm (Håkansson, 1987).

Openness, an important feature of relationships is implicit in innovation processes, however in literature there is a distinction made between open and closed innovation (Huizingh, 2011). Here, business network literature has contributed by illustrating open processes in emerging innovation networks comprising of businesses, research organizations, universities and government working together to achieve shared innovation goals (Rampersad et al., 2010; Möller & Svahn, 2009). Complexity in business networks emerges through the interactions and relationships. As relationships evolve over time and space through complex interactions, they become key to understanding any business process (Andersen et al., 2020), including those implicated during innovation processes for transitioning towards sustainable energy systems (Purchase et al., 2016). The time and space dimensions require imagining simultaneously what the envisaged state of such sustainable networks could be as well as the transition in the idea of a sustainable network, as both ideas, of networks (Andersen et al., 2020) and sustainability (Hallin et al., 2021) evolve. The temporality inherent in such interactions makes them difficult to define and research (Hallin et al., 2021;

Andersen et al., 2020; Makkonen et al., 2012) yet descriptive accounts often illuminate the processes through which actors assemble knowledge frameworks. This relates to interactions being information rich spaces, as they constitute conceptual understandings and assumptions related to actors, contexts, events, activities, resources, relationships, and networks (Andersen et al., 2020; Makkonen et al., 2012). It also means that as actors continue to learn more about interacting networks and as their knowledge frames expand, they have the possibility to select unfamiliar and inconsistent solutions for identical problems based on how they perceive and frame knowledge, as it emerges. This is evident from past understandings of interaction in business networks (Möller & Halinen, 2018; Håkansson & Snehota, 2017; Håkansson & Johanson, 1992) that business relationships and networks are not consistent structures of predetermined categories (Medlin & Saren, 2012).

The network perspective, therefore, offers an existing approach to complexity that is both rich and diverse through a tradition of research that is practical and normative, however, there is a need for expanding the understanding of relationships, from relations to processes of relations to incorporate connections between wider aspects of society and the economy (Lowe & Rod, 2018; Callon, 2017; Cochoy et al., 2016). It calls for an assimilation of material semiotics, as that enables an understanding of markets that take different forms in different places, and in that they become arenas for performativity generating realities through webs of heterogeneous material and social practices that produce them (Callon 1998b, 2007a, b). It could be made possible by revisiting the perceptions and studies on business markets, the stability of products and services that are taken for granted, and the interactive environments offered through the deployment of digital technologies (Spring & Araujo, 2017). This requires breaking out of the some of the traditional ideas and exploring those that allow for a shift in focus, from relationship management towards ecosystem orchestration (Möller et al., 2020). Here, perspectives that privilege markets to focus essentially on dyadic business relationships and their management, limit insights into current managerial realities of complex contexts comprised of nested systems with multiple interacting non-linear elements, where small shifts carry the possibilities of inducing unseen consequences (Möller et al., 2020). Nenonen and Storbacka, (2020) have advocated that in addition to building resilience and adaptation, firms need to focus on building networks that will allow for shaping or supporting markets to develop strategic responses to crisis. It requires an understanding of a minimum viable system for supporting the market shaping vision, and as this entails higher-level learning (Storbacka & Nenonen, 2015) the process of learning not just within the system, but learning as a system (Nenonen & Storbacka, 2020). However, this view needs to address the current assumptions of energy flows,

established through the institutionalization of laws, norms, practices, and customs, underlying the system. For instance, circular economy (CE) is presented as an example of market shaping vision (Nenonen & Storbacka, 2020), and while this is indeed an encouraging step, visualizing change without questioning the pattern of human activity within a given metabolic regime is difficult. As Levänen et al (2021) have demonstrated, many CE strategies present a high risk of rebound, where activities aimed at environmental benefits are not realized because of external reasons, and also there appears to be a limited understanding about the behavioral changes required by extensive implementation of circular practices.

Imagining change as a system (Nenonen & Storbacka, 2020), needs to embrace complexity through variety. This is because any control system lacks the requisite variety to cope with the variety in the environment, therefore there needs to be variety in the control system (Beer, 1989). Understood from this perspective, innovations towards sustainable energy systems represent a unique challenge for managers and organizations in terms of making sense of the interconnectedness of activities across systems and their constantly evolving outcomes. In these contexts, developing social intelligence for leveraging appropriate network resources to enable connections between such networks within contexts, for creating solution-oriented ecosystems become imperative (Narayan & Tidström, 2020b). It is related to what Luhmann (1995, p. 208) refers to as an 'ungraspable unity'. The totality of facts or elements or the environment of a system become real or observable only when the system's activities differentiate it in a way that provokes some kind of regularity from it. The environment is always more complex than the system and no single system can summon the requisite variety to match its environment, thus forcing systems to continuously differentiate themselves from the environment to deal with the complexity (Luhmann, 1995). This is required for conducting every day activities within systems, where actors combine available information for performing tasks. As other legitimate observational perspectives become available, the process is repeated. However, it is not a mere repetitive process, but a recursive one, a general term for looping, which manifests like a spiral, meaning that as an action repeats, it deviates from itself each time it references itself, to incorporate the change in the state of knowing. This demands an open design organizational architecture that is able to illuminate the broad range of multidimensional perspectives needed to address the outcomes that emerge as a result of the system activities.

For instance, the outcomes resulting from the current system activities are reflected in the remotely activated networks. These networks have delocalized production units to form and control markets, while structurally separating the industrial and financial aspects of market economies, and build permanently

interconnected electronic financial markets that control all markets in real time (Stiegler, 2019). The artificially engineered environments of business networks are increasingly isolated from the entangled social and natural relationships that constitute planetary existence. The processes of automated decision-making have becoming functionally tied to drive-based automations controlling consumer markets mediated by mass media. Through data economies, these networks have short-circuited the deliberative functions of the mind and encouraged what Alvesson and Spicer (2012) have described as 'functional stupidity' (Stiegler, 2019, 2018b). Factoring these interactions into the network perspective means considering digitalization, and the implications of a platformized society where powerful and unaccountable corporations form oligopolies with global surveillance and behavioral prediction capabilities (Tirole, 2020; Vergne, 2020). This is also related to the ways in which human and non-human actors increasingly participate in business and social networks seamlessly and demand a distributed understanding of what constitutes these new forms of socio-economic communities, their cultures, and nested relationships (Russell & Smorodinskaya, 2018; Morton, 2010; Harman, 2018, 2009).

The interactions and interdependence of technologies and social change reflect the growing complexities in innovation ecosystems characterized by social, organizational and cultural shifts that facilitate the formation of the knowledge-based economy (Russell & Smorodinskaya, 2018). Acknowledging these relationships and problematizing them draw attention to those ideas and pathways that emerge to manage the negative outcomes. Stressing on relational agency helps in recognizing how and in what ways networks bind actors on one hand, while encouraging non-anthropocentrism by focusing on planetary ecologies on the other (Heikkurinen et al., 2021; Morton, 2010; Harman, 2018, 2009). The coordination of information within such complex networks require a new class of intuitional technologies (Allen, et al., 2020). Organizing associated with innovation is complex as it could entail integration of new technologies in daily life that challenge the existing semantic stance (Steffen, 2010) or they could involve aesthetic or functional ideas that introduce new meanings into social systems by linking emerging trends with current technologies (Cova and Svanfeldt, 1993).

2.4 The technology potential

The conceptual sophistication of the word technology, and how it had been understood through its relationship with science and industry, over time, has come to represent a combination of 'science of the arts' and 'applied science' (Schatzberg, 2006). The combination has led to a fusion of meanings that tend to reduce the

entire idea of industrial arts to invention, and invention to applied science, resulting in deterministic discourses that categorize technological change as the inevitable consequence of scientific discovery (Schatzberg, 2006). Technology, through its ability to intervene between scales, and thereby navigate complexities of planetary science as well as the mundane (Agar, 2019). This opens up possibilities for it to be extended beyond an actors' category into an analytical one. It means that while paying attention to the richness of technology as an actor's category, it is also possible to sharpen thinking with technology as an analytical category (Agar, 2019; Callon, 1987). It helps in incorporating the paradox inherent in technological advances as an important element in understanding transitions.

A convenient place to start is with Beck's (1992) 'world risk society', an idea that describes how the very technology, science, and industrialism responsible for the progress of late modern society might be putting it at risk as well. Embedded in this idea is the acknowledgement of progress, the risks inherent in such progress, and the realization that we are entangled in this in ways we do not fully understand or control (Latour, 2003). The first step would be identifying the narratives that highlight such risks because talking about them creates opportunities for new ways of thinking. This is a process of reproblematization of the past through the imagination of a future that is threatening, as well as a reevaluation of norms and imperatives that guided past decisions to develop alternative perspectives on capitalism, law, consumerism, and science (Beck, 2015). Such a framing enables technology, science, and industrialism to remain relevant during transitions (Beck, 2015). Retaining relevance is important as they are integral in organizing the complex assemblage of networks of unexpected associations between heterogeneous elements, each of which is an active node that is no longer just a compliant intermediary (Latour, 2003). The notion of externality that has always been somewhat problematic (Callon, 1998b), gets resolved in such assemblages.

2.4.1 Technology enables complex assemblages

Assemblages as Tsing (2015) describes, are open-ended communities or commons that imply narratives of progress while incorporating the precarity, vulnerability, indeterminacy, and unpredictability inherent in them. Therefore, technologies become entangled with those narratives, for instance, the Internet is the fabric into which lives get woven (Castells, 2016). Language itself could be considered as an external device incorporated into the most intimate of the human self (Clark & Chalmers, 1998), a form of social communication technology that humans have collectively constructed for instructing imagination (Dor, 2017). This framing could be observed in the figure of cyborg, an entity that in embodying what are

traditionally human and non-human elements, creates an ontological unity. A cyborg is quite appropriate for understanding the experience of being human in a technological culture (Verbeek, 2008b). Therefore, technology can be seen as being constitutive for humanity, but technologies neither become embodied entirely nor in transparent ways (Stiegler, 1998).

In modern societies, machines are seen as instruments that serve to accelerate time. However, digital technologies through real time interactions show how waiting and slowness are produced and distributed in synch with advances in convenience and speed, mimicking uneven social and political geographies (Volmar & Stine, 2012). When a triggering factor, in this case, lack of speed, is also an outcome, the environment goes into a spiral from bad to worse. Breaking out of the vicious cycle of functional stupidity (Alvesson & Spicer, 2012) is possible by taking advantage of the suspension of social rules and behaviors triggered during a new stage of technological development (Nenonen & Storbacka, 2021, 2020; Stiegler, 2019). This is becoming visible in digital social networks. A recent report captures how teen users have developed a number of strategies to make themselves seen, heard, and valued online. The users appear to counter the prevalence of ignorance inside social media and gaming companies that abdicate responsibility by strategically choosing what they prefer to not know about their users and thus failing to protect the health and well-being of minors. Progress in modern societies have meant a continuous process of automatization, beginning with skills of manual workers to the current systems of knowledge through digital retention (Stiegler, 2019). It is in this current digital transformation where information is stored and retained through an artificial means of automated categorization that the need for human choice gains significance and along with it the opportunity to create innovative organizational forms (Stiegler, 2019).

Taking a historical perspective on such organization, the human metasystem transition (HMST) theory describes how information mediums act as platforms for organization of controls, and energy systems as engines for stabilization of control organization, and new control systems emerge and stabilize when a new information medium evolves and acquires stable access to an energy system (Last, 2015a). The organization of bands or tribes were stabilized through the coordination of language and hunting, followed by kingdoms through writing and agriculture, and nation-states through printing press and industrial economies (Last, 2015a, b). The HMST is based on the understanding of the emergence of higher control organization through the stabilization of feedback between emergent information-energy systems. It posits that the phenomena of energy and information appear to fundamentally influence human system and builds on previously established processes, allowing higher controls to stabilize new

organization and complexity. The rise of the Internet and associated digital technologies like Internet of Things (IoT) and Artificial Intelligence (AI) is now signaling a new form of organization often characterized as the Information Society (IS) (Last, 2017; Morrar et al., 2017; Floridi, 2019, 2014; Rifkin, 2014).

The building blocks of this Information Society rest on increased processing power and higher transmission and storage capacities for building increasingly integrated and versatile information technology (IT) solutions resulting in growth in complexity (Hanseth & Ciborra, 2007). The complexity is characterized by an increase in the number and heterogeneity of included components, relations, and their dynamic and unexpected interactions in IT solutions. It has drawn researchers' attention to novel coping mechanisms like architectures, modularity or standards, including the adoption of a more holistic, socio-technical and evolutionary approach that puts the growth in the combined social and technical complexity at the center of an empirical scrutiny (Hanseth & Lyytinen, 2016). This socio-technical assemblage has resulted in information infrastructures (II) that are composed of other infrastructures, platforms, application and IT capabilities, where recursion forms the organizing principle implying that such IIs return 'onto' themselves by being composed of similar elements (Hanseth & Lyytinen, 2016; Lee et al., 2006). This is the case socially as well, where IIs are recursively organized in that they are both outcomes and conditions of design action and involve both rule-following and rule-shaping activities (Hanseth & Lyytinen, 2016). Therefore, the control of such II is distributed and episodic and the result of negotiation and shared agreements. Distributed forms of control depart from traditional approaches with a single entity assuming control, instead, here the forms of control are episodic where groups come together according to capabilities, interest, needs shared across multiple communities in myriad and unexpected ways (Hanseth & Lyytinen, 2016). The distributed forms exhibit unbounded openness with no clear boundaries between those who may design and those who may not, and where new components can be added and integrated in unexpected ways and contexts (Hanseth & Lyytinen, 2016), signifying a continued assemblage in practice and the Internet is a manifestation of such design practices. The recursive organizing inherent in the Internet, is able to integrate contingency, which forms the basis of machine intelligence, and it is precisely the contingency that enables this intelligence to evolve.

However, to be able to comprehend the role of the Internet, it is necessary to focus on the material as well as discursive (Graham & Dutton, 2019) and the discursive elements are in many ways rooted in the post-World War II understanding of cybernetics, or control of social systems involving humans and technology (Wiener, 1954, 1948; Simon, 1947). Cybernetics, derived from the ancient Greek

kubernetike, meaning the art of steering, captures how the relationship between communication and decision-making is essential for designing particular systems of organizational governance (Vallée, 2009). The Internet as an information medium is distinct from an automatic feedback machine that performs homogeneous repetitive work. The epistemology of the Internet, as described by Hanseth and Lyytinen (2016) makes it a recursive machine which is capable of integrating contingency and provides much broader contexts to understand the application of cybernetics. The notion of recursivity suggests an epistemological break from a mechanical worldview and in that signals a shift away from discussions relevant to such worldview. The emergence of the decentralized Internet as a new class of institutional technology, often referred to as the blockchain is the latest manifestation of this shift.

Digital transformation characterized by the rise of the Internet, and now blockchain has resulted in the metaphor of organizations to shift from the initial organizations as computers, to organizations as networks to organizations as a network of computers connected peer-to-peer (Vergne, 2020). It brings forward the view how everything is entwined. The assemblage distracts from taking actions conducive to these connections, and focusing on what exactly a particular technology enables as well as disables, is a pragmatic starting point (Vergne, 2020). Doing so invites new ways of conceptualizing and understanding organizations, through an expanded view of cybernetics. From a perspective of cybernetics steeped in mechanisms of command and control that privileges a form of technological globalization that is exclusively focused on homogeneity and replicability, towards one that embraces the earth as a whole cybernetic system (Hui, 2017). This involves thinking coherently to transcend divisions and conflicts to reconsider the economic system through a process that is not limited to adaptation but active modification for the purpose of making things better (Nenonen & Storbacka, 2021, 2020; Stiegler, 2018a, b).

2.4.2 Technology to shape information-energy combinations

To ensure basic material needs of billions of people, there needs to be a re-think in terms of the current organizations of production, distribution, and consumption assemblages, and technology is a key element in these new configurations of energy and information (Vita et al., 2021; Millward-Hopkins et al., 2020; Shove, 2020). Complexity brings the integrated relationship of ideas and practices that hold the contemporary human society and the global economic networks together into clear focus. Complexity clarifies the problems inherent in technological knowledge as a master narrative of innovation that is singularly growth-focused

along with the related socio-technical imaginaries (Strand et al., 2018). These imaginaries influence the current assemblage of systems, as science, technology and socio-ecological systems are co-produced (Elish & Boyd, 2018; Jasanoff, 2004). While these discourses are important in identifying and engaging with the uncertainties that technologies usher in, turning these uncertainties into resources would enable new ways of organizing and new organizational forms (Perez, 2010).

Economic history offer insights into technological interactions through the work of Cherrier and Saidi's (2020) history of collaborations between engineers and economists at Stanford, Kay and King's (2020) account on economics borrowing and applying practical problem-solving approaches from engineers, Mirowski 's (2002) description of 'cyborg science' that emerged out of the alliances during the Second World War as a mechanized rational-choice model that takes methodological individualism for granted, and Roth's (2002) presentation of 'The Economist as Engineer' on market design, to name a few. The idea of eclecticism at the core of technology have offered opportunities for imagining a diversity of combinations that have contributed enormously to the productivity of firms, through innovation. This entanglement with technology makes it possible to draw upon what Baldwin (2018) refers to as 'technical recipes' to refer to the various combinations characterizing the complexity that cannot be reduced to concise, universal propositions. These combinations that are able to satisfy several objectives under a range of circumstances, echo the ideas that have questioned the equilibrium approach in economics in different ways (for eg. Ostrom, 2005; Simon, 1991; Kirman, 1989; Schumpeter, 1954; Polanyi, 1951; Hayek, 1948, 1945; Veblen, 1898). In this sense, technology is a useful concept for describing a set of practices that humans use to sustain life, express values, desires, and dreams, shape culture, and transform the material world. It becomes part of the assemblage through the networks, and a tool for organizing, implying coordination of information and energy that is at the heart of life and living.

Transition narratives of human history include energy given the nature of its socio-technical entanglement (Byrne et al., 2009; Spreng, 1993). The socio-technical transitions literature contributes towards an understanding of the multi-dimensional and complex shifts necessary towards sustainable energy systems (Sorman & Giampietro, 2013; Coenen et al., 2012; Markard et al., 2012; Geels and Schot, 2010; Geels et al., 2008). In addition, a body of work within the 'thermodynamic context' (Fritsch., 2021; Turchin & Nefedov, 2009) focuses on the loss of society's ability to cooperate and act for goals collectively. It looks at the modern quest for efficiency and speed which has resulted in unprecedented levels of complexity through elaborate global system of extraction, production, transportation, manufacturing, and retailing. These narrative strands are insights

into historical energy systems and their coordination mechanisms where activities reveal the connections between energy, time, and information (Cederlöf, 2021). For instance, the best way to save energy in transportation is slow down speed limits or slow down industrial processes, and is related to how maximum thermodynamic efficiency can only be approached by performing processes infinitely slowly (Spreng, 1993). This is where applied research and engineering do the job of making processes and equipment more productive and efficient by bringing another element to the combination of energy and time, and that is knowledge (Spreng, 1993). Knowledge contributes through information combinations that makes it possible to improve the performance of activities but this is not restricted to information that contribute to inventions alone. It consists of information combinations that contribute to the knowledge of the future, consisting of a complex interaction of elements that are political, cultural, and environmental.

The information combinations embody future imaginaries, that offer possibilities of becoming, and in the case of business networks, opportunities for market shaping (Nenonen & Storbacka, 2021, 2020). However, the political, cultural, and environmental elements that interact to enable particular combinations need to recombine for accommodating these imaginaries. For instance, the interactions increasingly visible through the narrative dynamics accompanying the development of Bitcoin, an application on the blockchain, reveal the tensions between the existing and emerging combinations. Bitcoin, framed as a technological innovation to respond to the 2008 financial crisis brings forward many of the principles and assumptions of the dominant political economy (De Filippi & Loveluck, 2016; Kostakis & Giotitsas, 2014). An important one is that of energy that powers this dominant system, and the other is that of speed of transactions. Discussions on the rising energy consumption trends of crypto currencies, led by Bitcoin, reveal the critiques of such consumption and the consequences of enabling transactions based on current energy infrastructures (de Vries, 2020; Krause & Tolaymat, 2018; Truby, 2018). Renewable energy cannot solve the issue of sustainability if one considers the lifecycle of crypto currency mining machines along with the unreliability of renewable energy sources (de Vries, 2019). While these are valid, they also take existing networks of production and consumption for granted, without considering assumptions that offer opportunities for alternative assemblages that could enable a deeper transition trajectory. These assemblages are visible in ideas related to democratic and redistributive economies, regenerating environment instead of merely commodifying it, and facilitating international alliances without imposing any particular sets of values (Howson, 2021). The transition to sustainable energy systems presents such opportunities in transforming organizational models that

are designed to support a society with fossil fuels at its core (Giuliani, 2018). Technological devices and objects augment knowledge and activities, by fostering better ways of thinking in countless combinatorial possibilities through network building. Technology, in this sense, becomes key for market shaping (Kaartemo & Nyström, 2021; Nenonen & Storbacka, 2021, 2020).

2.4.3 Technology for business networks transitions to sustainable energy systems

Business network literature has noted the role of technology in accelerating market change and how technological infrastructure influence actors' activities (Nenonen & Storbacka, 2021, 2020), yet this role remains understudied (Kaartemo & Nyström, 2021). This has constrained perspectives that could lend pragmatic approaches to understanding the role of technology in market environments characterized by complex, dynamic, non-linear elements interacting on multiple levels (Kaartemo & Nyström, 2021; Möller et al., 2020). Even while acknowledging markets as malleable ecosystems constantly in the state of becoming (Humphreys & Carpenter, 2018) and how firms use technologies for developing new value propositions to change socio-technical structures (Svahn et al., 2017), there is little or no attention paid towards the activities and the consequences of their interactions (Voola et al., 2022; Kaartemo & Nyström, 2021; Sharma, 2020). In addition to obscuring various aspects that emerge from linkages between technology and innovation (Kaartemo & Nyström, 2021), it also limits exposure to the realities of challenges related to sustainability (Voola et al., 2022; Sharma, 2020). As technology is interwoven into narratives of information and energy flows that underpin the sociotechnical systems to which business networks belong (Moezzi et al., 2017; Spring & Araujo, 2017; Hermwille, 2016; Longhurst et al., 2016; Sorman & Giampietro, 2013), market shaping remains constrained within existing imaginaries.

Market shaping, in this context, would require a radically different way of thinking about technology. This is not easy as the reality of experience in everyday life is actively and perpetually constructed through the establishment of routinized social order that rests on common-sense knowledge, and any violation of this order can be potentially terrifying (Berger & Luchman, 1966). One way of dealing with such transition could be praxis, understood as purposive actions in the world (Stones, 2009). Praxis stands in relation to knowledge, and this automatically implicates others, as knowledge is never complete, and always fragmentary and evolving, and rather than being a limitation, this gives knowledge the potential for bringing about radical transformation across society (Castoriadis, 1987). Praxis in aligning with knowledge allows a particular framing of desire, something that is

core to the human experience and an unconscious force for making connections (Deleuze & Guattari, 1987). Technologies enable these subjective desires to emerge and interact and serve as toolkits for telling stories about how relationships assemble and fall apart (Law, 2009), thus facilitate the higher-level learning where actors learn as a network (Storbacka & Nenonen, 2015).

For instance, taking a network perspective, circular economy (CE) can be understood better by embracing the reality of the inherent instability of products and acknowledging the physical and institutional effort required for stabilizing them (Spring & Araujo, 2017). Highlighting products as qualified and constitutive of a distributive network, instead of being defined by the producer opens up opportunities for innovative network reconfigurations (Spring & Araujo, 2017). However, the complexity is far more than the current system is able to handle, and it is this realization through critiques or framing of problems that the system creates contingencies. Such contingencies are central to the system, as they enrich it with information to be able to develop as a network by making choices where technology is used for disabling certain elements while enabling others (Vergne, 2020). From a strategic perspective this could be framed within coopetition that combines two opposing concepts: collaboration and competition (Dubois & Fredriksson, 2008; Bengtsson & Kock, 2000). Coopetition strategy becomes a means for addressing context specific challenges by enabling cooperation in promoting certain mechanisms while competing others out. This would guide network activities towards innovative organizing for capturing and circulating distributed value embedded in these interactions (Narayan & Tidström, 2020a).

Here, as a new class of institutional technology, blockchain or distributed ledger technologies (DLTs), offer opportunities for coordination of information and incentives through contracts, transactions, resource attributes, ownership, knowledge, and governance. This is made possible through an infrastructure consisting of applications such as decentralized digital currencies, digital assets through token economies, digital identities, and smart contracts (Allen et al., 2020b; Abadi and Brunnermeier, 2018; Beck et al., 2018; De Filippi, 2016; Narayanan et al., 2016). These applications enable innovations through decentralized finance, decentralized digital platforms, and decentralized autonomous organizations (Böhme et al., 2015). Focusing on contexts and their specific challenges, the innovation activities reimagine societal interactions and urge for an abundance of creative solutions by capturing the distributed value embedded in these interactions in the form of information (Narayan & Tidström, 2019b; Narayan & Tidström, 2020a). In contrast to the one size fits all dominant organizational models (Trump et al., 2018) that discourage alternative ideas through centralized mechanisms while profiting from the capture of the

interactions, as Zuboff (2019) has noted, these applications offer the potential for innovations through a diversity of organizational forms. The characteristics of recursivity and contingency and associated technological applications that are able to match a variety of value propositions through multiple coordination mechanisms, makes the blockchain an ideal environment for innovative organizing. Market shaping for transitions to sustainable energy systems would entail embracing such innovative organizing by leveraging these applications for dynamic combinations of information and energy.

2.5 The role of narratives

Innovations for transitioning towards sustainable energy systems necessitate the design of interaction processes to acknowledge the wider relationships and networks implicated in the process. For this, the design process requires a lens that recognizes that the world cannot be divided into categories of 'nature' and 'society' and consists of a series of negotiations between multiplicity of forces, with humans being one of them (Harman, 2018, 2009). The diverse stories embedded in the theoretical perspectives of innovation, complexity, and technology through their interactions offer such a lens, however, all design is, consciously or unconsciously, a form of persuasive communication, with products and service design offering arguments for how people should live (Stegall, 2006). To be relevant for new ways of living, the persuasion shifts towards a more speculative stance. For business networks to reorient and redesign interaction processes for embracing a speculative stance, there needs to be different kind of persuasive device. Narratives as powerful persuasive devices are often leveraged to give meaning and purpose for the practice of strategy in organizations, and offer opportunities for enabling and constraining activities (Fenton & Langley, 2011). In that sense, narratives can help in highlighting aspects that embody the dynamic and holistic accounts of complexity of human-nature connectedness in innovation processes to select activities that enable these connections to flourish through sustainable energy choices.

2.5.1 Narratives as persuasive devices – the becoming

Narrative devices have gained relevance in the conceptual toolboxes in economics (Shiller, 2017), and signal their roles in orientating behaviors and choices in economically relevant settings (Bénabou et al., 2018). This is evident in the growing awareness of the relationship between the formation and consolidation of folk economic beliefs (Boyer & Petersen 2018). There is now growing awareness related to the social salience of certain fictional narratives and how these

relationships have probably been underestimated by the current research agenda of behavioral economics (Acerbi & Sacco 2018). For instance, narratives reveal how those in positions of authority use strategic ignorance to deny knowledge they are expected to share (Bakken & Wiik, 2018; McGoey, 2007). These have included descriptions of actors' explanations and justifications of ignoring data they themselves have produced, facilitated, and enabled through contextual conditions that have resulted in the propagation of dysfunction of systems upheld collectively (Essén et al., 2021). Narratives propagated through scientific fields and experts are used as legitimation instruments for political decisions which are recursively used for justification of research and innovation policies that strengthen these fields of expertise (Strand et al., 2018). These narratives then become part of sociotechnical imaginaries embodying the creative aspects of the collective imaginations social life and order, that are reflected in the design and fulfilment of science and technology experiments (Strand et al., 2018; Pfotenhauer & Jasanoff, 2017; Jasanoff, 2004). As these experiments take shape through innovations, narratives capture the transition processes involving complex interactions of consumer practices, policies, cultural meanings, infrastructures, and business models (Bergman, 2017; Moezzi et al., 2017; Hermwille, 2016).

However, narratives are not linear, the linearity is the outcome of the performance of the narrative, in its telling. Narratives are vehicles for stories and they come afterwards to add plot and coherence to the storyline (Boje, 2001, 2011 a, b; Yolles, 2007). Within the context of building coherence and unfolding temporality, narratives enable thoughts relating to contingencies, as well as counterfactuals and possibilities (Morgan & Wise, 2017). They are instrumental in linking different modes of thoughts or systematic philosophies and the practice of every day actions (Czarniawska, 2011; Gare, 2000). In situations relating to lack of semantic harmony, conflicts and paradigm wars develop (Fink & Yolles, 2012; Chari et al., 2009; Kuhn, 1970) and in such conditions narratives allow important interplays through what Boje (2011b, p.14) refers to as Collective Storytelling Dynamics (CSD) that capture the differences and complexities. Narratives in being constitutive of social life could be seen as mediating connections that facilitate the complex and evolving discourses and their relatedness to sustainability. They could, therefore, be understood as forms of communication that allow diverse communities of discourses to compare, contrast, and debate structures of information by sharing ontologies.

Sharing ontologies through narratives facilitates interoperability by exploring the relational aspects of the information embedded in them, while illuminating the potential for value nested in such relationships. The narrative process is framed as an autonomous assemblage of systems that arise through knowledge interactions

by those involved in the unstructured, incomplete, incoherent stories (Rantakari & Vaara, 2017; Boje, 2008, 2011a, b). These localized stories are never isolated as they are in a multiplicity of relations, and there is a need for paying attention to the various kinds of history of multiplicities that are in and around storytelling organization and organizing (Boje, 2021). The stories are not limited to humans, objects tell stories too, and in embodying diverse discourses, draw attention to the dynamics of storytelling through interactions between matter, energy, and information, implicating a diverse network of systems (Boje, 2021). Within this conceptualization, every story or reflection is from a particular relational perspective, that is, a perspective need not be reduced to a fragment of the whole, rather it could be understood as a conceptualization of the whole from that perspective. In understanding networks as a process of discovering what Deleuze (1993) refers to as 'the fold' where the relativism does not refer to the relativeness of what is true but the truth about particular relationships (Linstead & Thanem, 2007). This introduces possibilities for ongoing innovative and creative recombination of action.

Within the human realm of action or 'doing' as noted by Castoriadis (1987), there is a certain relationship between action and knowledge. Action that Castoriadis (1987) refers to as praxis, draws upon knowledge that is fragmentary and provisional, and is characterized by its ability to take others into consideration and recognize their autonomy. Nenonen and Storbacka's (2020) proposal for market shaping or supporting could be understood as such a practice. The fragmentary and provisional nature of knowledge along with the autonomous aim of praxis fosters creativity and possibilities for transition, and in doing so makes the process of transition inclusive – pertaining to all levels and spheres of life. This resonates with the idea of innovation processes where organization is affected through imaginative combinations that introduce transformations at all levels and spheres of life (Bucher, 2019). Such imaginative combinations are made possible through shared ontologies of the diverse communities of discourse, with digital technologies playing a critical role in sensemaking (Narayan, 2020). In the contexts of organizations, discourses are constituted of and peppered with narratives that are often articulated through fragmented stories without clear beginning and end, and serve as multifaceted means of sensemaking and sense-giving (Rantakari & Vaara, 2017; Boje, 2008, 2011a). When diverse communities of discourse assemble, bringing along their versions of anticipated imaginaries, the sensemaking process needs to accommodate the diverse stories.

2.5.2 Implications for sense making in business networks

The organizational configuration of the global socio-economic energetic systems of mobility, housing, clothing, and food (Cederlöf, 2021; Geels, 2020, 2011; Debizet et al., 2016; Grin et al., 2010) are held together by narratives woven through the interactions of consumer practices, policies, cultural meanings, infrastructures, and business models (Bergman, 2017; Moezzi et al., 2017; Hermwille, 2016). However, these interactions are rooted in a fundamental desire for progress (Latour, 2013, 2005, 2004; Law, 2009; Stiegler, 2019, 2013) that resonate across space and time. Taking this perspective offers the possibility for making sense together, and in doing so frees business networks from seeking coherence for sensemaking. Making sense through resonance invites speculative actions that interact with knowledge actively (Castoriadis, 1987). Given that knowledge of the future is a matter of speculation and it is precisely the lack of foreknowledge that is the source of innovativeness (Beckert, 2013; Buchanan & Vanberg, 1994) this resonance becomes an important catalyst for sensemaking within business networks.

Interactions, by their very nature, draw attention to the relationships between different elements. The stories that these relationships reveal help in understanding the constraints and enablers for developing coordination mechanisms for imagining change as a system (Nenonen & Storbacka, 2020). This system, representing diverse stories helps in orchestrating relations between heterogeneous entities. They transform into knowledge objects through imaginaries and narratives embodying the collective expectations, their explicit claims and implied framings, and possibilities for diverse actors and entities to shape and be shaped, and question socio-technical futures, for innovative organizing (Konrad & Böhle, 2019).

2.5.3 The narrative of resonance through digital objects for business networks transition to sustainability

The transition, from seeking coherence towards seeking resonance, creates an element of, what Morton (2010) describes as, sympathy that unite actors, and alliances form not for succession but emergence. These kinds of encounters awaken dormant connections and present innovative revival strategies for imagining pathways towards anticipating optimistic futures (Gare, 2000). Assemblages that invite diverse forms of knowledge and multidisciplinary perspectives are conducive to such encounters. In fact, assemblages within economic systems have led to distributed achievements, emerging from relationships and associations between human and non-human entities within

business environments (Tsing, 2015). The use of ecosystem and its growing prominence in an increasingly networked society, offers clues about this mechanism.

The term ecosystems commonly conveys an understanding of ecological and human systems as Self-Organizing Holarchic Open (SOHO) systems (Kay et al., 1999). From an organizational perspective, it highlights the importance of understanding the entanglement and indeterminism inherent in the assemblage of these systems (Dyck & Greidanus, 2017). This understanding guides the forms of governance where a set of distinct yet interdependent organizations are able to coordinate for addressing multilateral dependencies based on diverse types of complementarities (Jacobides et al., 2018). As these governance forms need to evolve continuously to accommodate the growing diversity inherent in the process, technology becomes an important element in this assemblage. Technology, as a coordinating mechanism is also an extension of what it means to be human, as is evident in the use of the term cyborg (Haraway, 2013; Verbeek, 2008b) depicting the hybridity of technological and natural forms. This is similar to how a spider and its web, form a co-evolving relationship to access food, water, and even build security mechanisms. Embracing this hybridity creates a form of resonance with the perspectives underlying the evolution of the current socio-technical configurations (Strand et al., 2018). These perspectives are driven by a fundamental human need to address the issues and challenges that are a consequences of existing system configurations (Stiegler, 2019; Callon, 2007b). Embracing this hybridity clarifies relationships and interactions between the socio-technical elements and their evolution over time and space. This helps in identifying the difficult and complex stories related to climate change, degradation of ecosystems, wasted and unclean water, waste production and disposal, poverty and inequality (Lewis, 2020; Scott, 2021, 2020; Potts, 2019; Moran & Kanemoto 2017; Ivanova et al., 2016; Wiedmann et al., 2015; Kanemoto et al. 2014; Lazonick & Mazzucato, 2013; Lenzen et al., 2012a & b).

This is possible precisely because technology is an important analytical category for understanding human history and beyond (Agar, 2019). Through meanings that establish it as industrial arts, applied science, and technique (Schatzberg, 2018), it is woven into the very fabric of storytelling agendas (Castells, 2016). Technology belongs in modes that transcends its instrumentality, efficiency or materiality, as it is enfolded through time, space, and actions (Verbeek, 2008a; Latour & Venn, 2002) through these stories. The stories help in identifying the contexts through entangled elements of energy and information that make possible the various human practices of production and consumption. This highlights the role of information and the imaginative ways in which technologies

are deployed for the purpose of acquiring and distributing energy implicated in human systems of production and consumption (Last, 2015a). The development and growth of the information technologies is taking this understanding to a new semantic level through the creation of informational objects.

Informational objects constitute the context or the milieu, and here it is important to grasp the specific nature of information as a digital object to make connections apparent (Hui, 2012). The Latin root of the word 'data', derives from things given, to describe how in the modern age of computing, this givenness acquires meaning (Hui, 2012). In addition to the condition of the appearance of the world that gives rise to a new interpretation of the relation between human beings and things, the givenness, within a reality of transmittable and storable computer information, undergoes a material transformation (Hui, 2012). The significance is not just in the processing of data that is understood as digital, but that by operating with data, the system is able to establish connections and form a network that extends across platforms and databases, which is then amplified through social networking (Hui, 2012). Organizing technologies weaned on inductive learning demonstrate the transition from storing and retrieving static database towards those involved in arrangements that lend themselves to manipulation (Hui, 2019).

The organizational processes through which this reality emerges reveals the role of information in establishing order to the universe's natural tendency towards entropy (Hidalgo, 2015; Floridi, 2009). Attributing this role to information bestows it with clear ethical possibilities and therefore intent – information that establishes order within a certain context is selected and that which does not, is set aside but not discarded, to be selected within another appropriate context. This progress in ideas enables the development of planetary sensibility where innovation as a process creates matters of concern (Callon, 2007b) only to be turned into opportunities for further innovation. In this conceptualization, the idea of waste is just another opportunity for innovation. It resonates with natural processes, where anything that is left over during or after a process, gets transformed, implying a recursivity or a spiral, where every loop is different as the process moves along. In according this primacy of movement through process, as opposed to substance (Chia, 1999), the narrative embraces ontological realism while rejecting epistemological realism in favor of assemblages. The assemblages imply open-ended explorations (Linstead & Thanem, 2007) for ongoing innovative recombination of action. In doing so, organizing becomes synonymous with change (Linstead & Thanem, 2007) and conducive for market shaping (Nenonen & Storbacka, 2021, 2020).

The Fig 8 below is an illustration of this theorizing process where the understanding of transition from global to planetary perspectives is created through the idea of commons for wider representation of innovation to enable ecosystem orchestration, complexity to learn as a system through energy-information flows, and technology to enable the continuous context specific combinatorial organizing process.

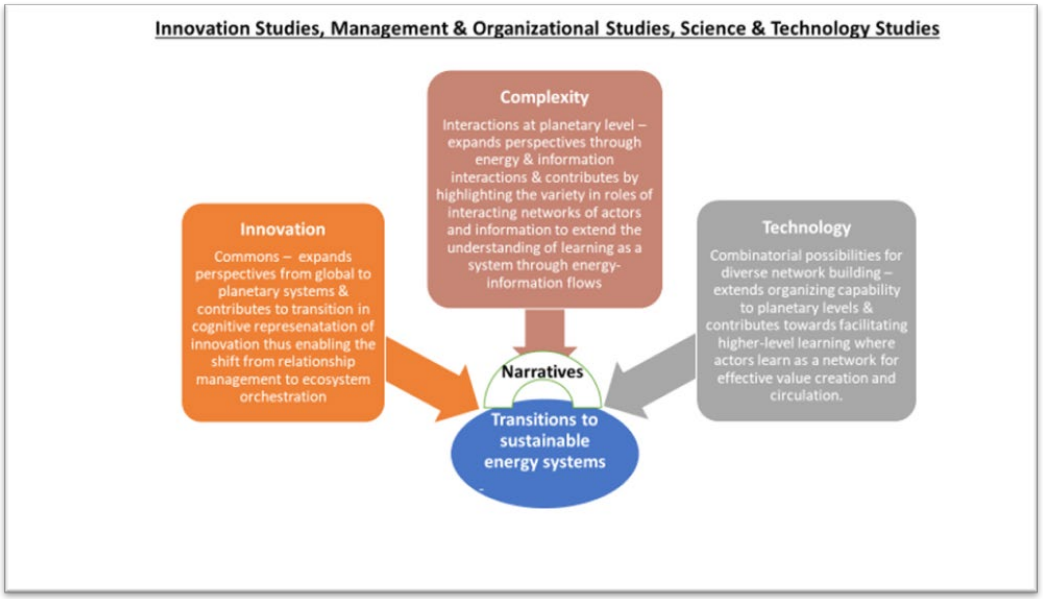


Figure 8. Theorizing for innovative organizing

3 METHODOLOGY

3.1 Research ontology and epistemology

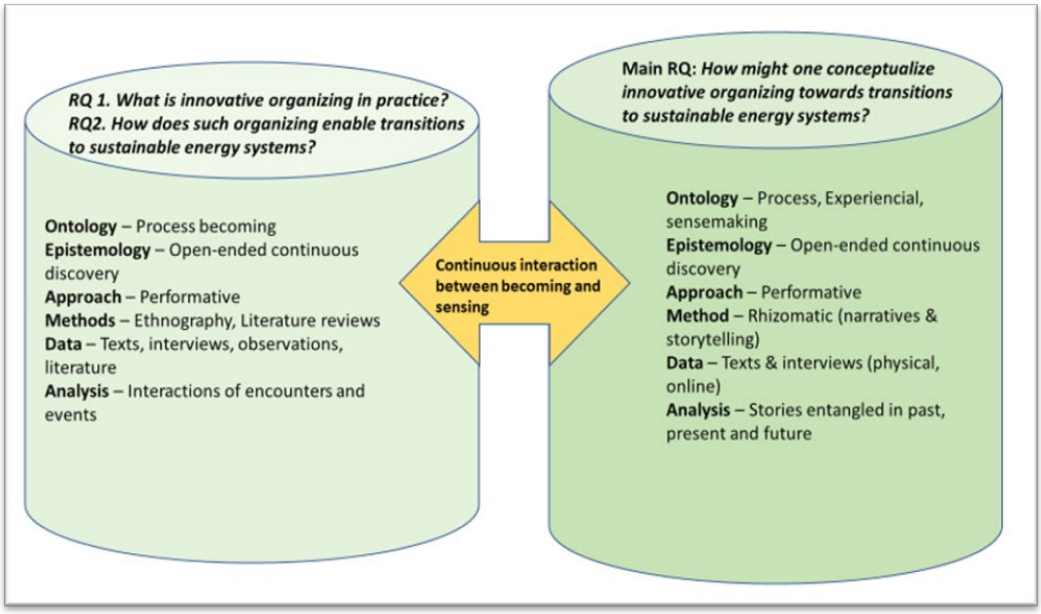


Figure 9. The philosophical underpinnings and methodological choices

The objective of this section is to draw attention to the philosophical underpinnings and the methodological choices in conducting this research process, the fig 7 above captures the process. This research engages with reality through an ontology of becoming emphasized by process philosophers that include, among others, Heraclitus, Henri Bergson, William James, Robert Cooper, John Shotter and Robert Chia (Nayak, 2008). The justification for a process ontology lies in the aim of this research, which is to articulate the change and transformation that underpins market shaping through innovative organizing for transitions towards sustainable energy systems. This is distinct from representing the truth of such processes, and therefore renders the social paradigms realized by Burrell and Morgan (1979) unnecessary and redundant (Deetz, 1996). The core issue with Burrell and Morgan's (1979) classification, as far as this research process is concerned, is its grounding in a philosophy of science that is based in the representational view of language and through that a subject-object dualism (Deetz, 1996). In speaking on behalf of other marginalized paradigms, Burrell and Morgan (1979) retain the definitional authority of functionalism and that might explain the ready acceptance of their grid into management science (Deetz, 1996). However, as the philosophical distinction of subjectivity and objectivity has become increasingly problematic, any attempt to classify new research on the

subjective-objective dimension of Burrell and Morgan (1979) limits the potential of such research and distorts understanding (Deetz, 1996).

A process ontology, on the other hand, breaks with representations to return to the true nature of things where the dualisms are not outcomes but a method of division for allowing representations to indicate tendencies or 'becomings' that reveal differences in kind (Nayak, 2008). This process of becoming is the key to understanding and overcoming the mechanistic view of machines based on linear causality, and provides a new way to understand human consciousness and experience (Hui, 2020). It dissolves the facile distinctions between nature and technology by drawing on cybernetics, to mobilize two key elements, feedback and information (Hui,2020, 2017). This enables inclusivity of human and non-human elements. It considers the behavior of all beings, animate (living) and inanimate (lifeless), and nature and society, to create a connection between different orders of magnitude, macro and micro, mind and body (Hui, 2020). This ontological realm reveals the limitations of mechanistic views already visible in the critiques by Niklas Luhmann and Ludwig von Bertalanffy, of industrialism which inherited the dualistic tendency of early modern thought (Hui, 2020). The duality creates silos, where one side views machines as tools for controlling nature, while the other sees any human intervention in the pristine natural environment as problematic.

While it is true that modern machines are all cybernetic in that they employ circular causality as their principle of operation, however, in doing so, they also assimilate certain behaviors of organisms. That does not make them deterministic but opens up opportunities for innovation and experimentation (Hui, 2020). Similarly, Darwinian ideas of adaptation, and adoption are given primacy in ecological framings, but human beings in addition to adaptation and adoption also actively innovate with tools and change their environment (Hui, 2020). For transitions in business networks, this is precisely the point that both Möller et al (2020) and Nenonen and Storbacka (2021, 2020) recognize and articulate while urging for change. They pave the path for innovative organizing and in doing so render Burrell and Morgan's (1979) grid a relic of the mechanistic era.

The epistemology here is pluralist, and relies on a different kind of truth, one that is not a faithful reflection of a static world of beings but a process of continuous learning. As any kind of learning, including learning during sensemaking involves an engagement with assemblages with embodied issues and defined singularities, implying an interaction between human knowledge and the open-ended evolution of the world (DeLanda, 2000). The open-endedness contains the structure of the world with its diverse actualizations, combinatorial potentialities, and the possibilities of amalgamating new structures out of heterogenous components

(DeLanda, 2000). The openness of the world is not achieved by making the world dependent on human interpretation. Instead of this form of anthropocentrism, this epistemology transforms the world into a creative, complex, and problematized arena of becoming (DeLanda, 2000). In allowing for a perspective where the world is enriched by a multiplicity of non-human agencies this openness introduces a new paradigm where learning and innovation are at the heart of organizing.

Process ontology, in that sense, embraces non-linearity and multitude, and enables an understanding of organization as being synonymous with change but in conceptualizing this process of becoming, it remains inclusive (Linstead & Thanem, 2007). Therefore, process ontology is not limited to reactive change where organizations accommodate and reduce effects of change that result from the multiplicity of interactions (Linstead & Thanem, 2007). In fact, it is about provoking and shaping change. As process ontology takes along all forms of organizing it helps in creating a conceptual frame for sensemaking and actions related to transitioning towards sustainable energy systems, in what could be described as a 'rhizomatic' model (Chia, 1999) of organizing. The main research question, explored through a rhizomatic method, indicates a performative approach. The rhizomatic method became necessary as the explorations into the phenomenon of transition guided the articles, which in turn influenced further explorations. The sections below offer a description of the approach, justification of the method and how the approach fits in with the method.

3.2 The research approach

The performative approach in this research process is intentional. The intent is to express rather than communicate, in the sense described by Deleuze and Guattari (Massumi, 2002). This qualification is necessary because both concepts are closely bound together. There is a strategic intent to this, and it has to do with linking the subject's expression causally to its content, but pointing out that the nature of the link has changed (Boje, 2021). For instance, in the first book chapter, the expression of circular economy links to innovation, yet in the very linking the way innovation is framed, changes (Narayan & Tidström, 2019a). It is an important aspect because it illuminates the diversity of system assemblages and how even though the relationships remain, the meanings change. For instance, in transitioning towards sustainable energy systems, the validity of the idea of innovation being important for economic growth remains, only the relationships with the idea of economy and growth changes in unexpected ways. As a word, 'degrowth' becomes a semantic signifier for exploring the conceptual practice of

growth through a constant creation of difference (see Asara et al., 2015; Kallis, 2013; Sorman & Giampietro, 2013). Concepts like renting instead of owing, or pay per use, initially seen as circular economy business models, in practice demands radical change. Here, borrowing from Cusset's (2008) epigraph before French Theory's preface, theory itself could be understood as a conceptual practice, and must be judged in terms of other practices with which it interacts. Therefore, the research approach follows a performative paradigm where the reference to knowledge is viewed as knowledge-in-becoming, a constant creation of difference through the researcher's entanglement with the both the research phenomenon and the wider world. This is explained in the section below.

3.2.1 Research methods

Rhizomes are dynamic weed formations, in contrast to the arboreal and hierarchical tree structure, that involve spontaneous, unpredictable, and distant connections between heterogenous elements (Linstead & Thanem, 2007; Blaug, 1999; Chia, 1999). Rhizomes extend into what can be understood as the interior vitality of the planet as well as its interconnecting exteriors. The rhizomatic methods incorporates an active and creative response to the specific experiences which remain in conversation with the lived reality and changes along with it. The rhizomatic method is consistent with Jackson's (2017) approach of thinking without method (Jackson, 2017, p. 666). The idea behind this strategy is to enable free exploration afforded by rhizomatic approach. Thinking without method frees qualitative inquiry from the two forms of epistemological imperatives, of knowledge production and the conventional dependency on procedural method (Jackson, 2017). This gives prominence to relations that are external to the traditional framings and boundaries and allows for the mobilization of a variety of actors (Jackson, 2017). This also establishes that even when these relationships are outside they are not separate, there is no duality implied in making the distinction between inside and outside. To be on the outside of method does not imply an exteriority that takes on its own form, rather the objective of being outside of method is to instigate the new (Jackson, 2017), which is what the published articles do. As Chia (1999) has indicated, typologies, taxonomies, and classifications schemas might be convenient but they are ultimately reductionist methods for abstracting, fixing, and labeling what is intrinsically a changing, fluxing, and transforming social reality. They might serve the purpose of identifying different types of organizational change processes but they do not get at the heart of the phenomenon of change itself (Chia, 1999). As change is at the core of this research, a rhizomatic method is best suited for the purpose.

3.2.2 Rhizomes embody desire and movement

It has been observed that even though it is quite common to refer to change and transformation, and their profound effects on modern life, there has been little progress in 'thinking movement' (Chia, 1999, p. 209). In fact, instincts favour the fixed and static, and the separate and the self-contained, through taxonomies, hierarchies, systems, and structures (Chia, 1999). These represent a distinct vocabulary of institutionalized thought geared towards making flux, movement, change, and transformation subordinated to stasis and equilibrium (Chia, 1999). Therefore, in embracing a process ontology, this research turns against Method (Barthes, 1986, p. 319). As Barthes reminds us that research 'must constitute a critique' (1986, p. 319) that is required to also turn against Method, incorporating the relevance of what he means, through the considered use of a proper noun.

Paying heed to Barthes' (1986) advice on methods within the context that the researcher explores, presents the opportunity for imagining alternative ways for future potentialities through a desire for the future. Desire is crucial because it becomes a motivational force. Desire responds to the formal organizational arrangements that seek to repress and eradicate desire by differentiating itself through organizing for change (Linstead & Thanem, 2007). However, theorizing what is yet to exist can be challenging. Hence, the methodological challenge is to generate critical knowledge for the future with data sourced from the present. In acknowledging this, Gümüsay and Reinecke (2021) have suggested that management scholars should leverage the methodological and theoretical toolkits available to co-create the future and actively contribute to societal organization through these toolkits. Management scholarship as empirical social science uses methodological tools based on data sourced from observed events and engagement with the future is most commonly done through predictive analysis, but Gümüsay and Reinecke (2021) asks for caution. To avoid being subjected to profitable but dystopian futures, owing to dominance of prediction products (Zuboff, 2019; Savage & Burrows, 2007), they urge instead, for researchers to articulate desirable futures. Given the uncertainty that is characteristic of the future, imagination plays an important role in imposing order on both thoughts and actions (Loasby, 2011). Imagination helps in creating new visions of the future that offer new prospects for shaping the world (Nenonen & Storbacka, 2020) and needs to be strengthened through theory (Gümüsay & Reinecke, 2021). The imaginative framing itself, in such an endeavor, evolves through a process of becoming as it encounters existing theoretical perspectives and reimagines them to accommodate the interactive milieu comprising of human and non-human elements. It is through this process that the idea of business networks' transitioning towards sustainable energy systems is explored.

3.2.3 Rhizomatic explorations

The explorations are through narratives. Narratives constitute social life and mediate connections, and in doing so, they allow diverse communities to compare, contrast, and debate structures of information by sharing ontologies (Boje, 2021). Sharing ontologies through narratives facilitates interoperability by exploring the relational aspects of the information embedded in them, while illuminating the potential for value nested in such relationships. In the context of this research, energy acquired centrality as it emerged as an important theme that weaves its way through all narrative assemblages, be it economic, social, ecological, or political. Given that all human activities are performed through continuous and simultaneous interactions at individual, group, and societal levels, what constitutes as sustainable is indicative of constant processes of coordinating and organizing. This requires energy use to be understood as moments where human practice and forms of energy coalesce (Sorman & Giampietro, 2013). Therefore, making energy explicit while studying social processes requires it to be conceptualized not only through its discrete material properties but also through its continuous thermodynamic qualities (Cederlöf, 2021). This is because, to be able to express what energy can do, one needs to capture its effects and how it can or cannot enter into composition with other effects. These expressions are manifested through decisions related to the organization of information that incorporate both stability and change at multiple levels of interaction. The circular economy is a way of thinking that disrupts the established norms of interactions.

Therefore, explorations into circular economy offered a logical exploration path and the article, 'Circular economy inspired imaginaries for sustainable innovations' (Narayan & Tidström, 2019a) enabled this process. It encouraged explorations of global supply chains and business and financial networks, and media and science communication, also led to connections that helped in understanding that the environment being described resembled that of commons. This was an important step and helped in thinking about innovation as an activity that is intrinsically open. Therefore, such explorations do not start with a stable subject and follow the subject's intending on and with the world, as one always enters in the middle of things (Vagle & Hofsess, 2016; Deleuze & Guattari, 1987/1980). The subject is both constructed and constructing; an agent and acted upon, therefore, what is available for the subject is a manifestation of the social and is made possible by that subject's intending. This ensures that the intended-ness is not lost while being brought into being by the embodied subjects (Vagle & Hofsess, 2016). The results of such a process of exploration is a notion of destabilized intentionality. The threads of meaning represented by intentional stories are not conceived as clear lines of connections between the subjects and

objects but as rhizomes with shifting connections among things and the connections cannot be traced to specific origins or destinations, instead these stories contribute to a narrative of becoming.

The articles became the catalysts for the rhizomatic journey and also mirrors to enable the process to become recursive. The interviews, literature reviews, and the other data that contributed to the articles offered initial maps that enabled the linking of energy practices through food, clothing, shelter, and mobility. This exploration did not follow any set method, just a rhizomatic path where one article led to several others, followed by some tweets, that in turn led to some YouTube videos and blogs, where a reference to a book or article led to archival data and so on. The exploration also included immersive environments, where the researcher would be part of various communities of practice. This was, in a way, influenced by the methods used in the articles, where a significant part of the data collection was done simply by lurking about and listening and interacting. This is consistent with Østern et al's (2021) description of the researcher's position, as one of material- discursive entanglement, where the researcher becomes a conduit and not an obstacle, and emphasizes researcher sensing as well as thinking. This is a more effective way to gather insights as interviews alert people and they tend to expect a certain structure and subsequently, like to follow one. This leaves actors, including ideas and objects, outside that framing, without a voice (Jackson, 2017) and leads to the outside/inside duality. It might seem that without a structure, things can quickly devolve into chaos and irrelevance, but this was not the case. The reason was to do with being aware of connections and relationships. This, the researcher found was an acquired skill, that helps in making explicit the entanglements and differences through other texts, objects (pictures, videos, firms etc.), personal experiences, or other data. Barad (2014, 2011, p. 445) refers to this analytic technique as 'diffractive'.

The implied open-endedness with the capacity to generate multiple contingencies and therefore conclusions from such research data, can pose a problem in terms of generating the evidence for practical use. This is where the idea of assemblages played an important role. Relations between bodies, thoughts, social formations, and other materialities need not be defined by form, substance, subjectivity, or any fixed attributes, but simply by their emergent capacities to affect or be affected (Deleuze, 1988). To create these affective arrangements these relationships come together in assemblages, that are fluctuating, unstable, yet productive constellations that generate the capacity to act (Deleuze, 1998). Creating a narrative by making connections with the diversity of stories helped embrace the idea of assemblage. It enabled the researcher to remain true to the reality of the open-endedness of relationships but also offer tangible opportunities for action,

through the articles. The articles offer answers to RQ 1. What is innovative organizing in practice? & RQ2. How does such organizing enable transitions to sustainable energy systems? Adopting this process enabled the research to dismantle widely held inner beliefs yet doing so also helped in creating a pragmatic reality without the artificial duality of offering a representation of one. This enabled the process to remain exploratory and open ended.

As Chia (1999) has noted, research has become defined by typologies, taxonomies, and classification schemas that it is easier to just try and fit data into them to create a representation of reality. As the objective was not to offer a representation of reality but provoke thinking about what this reality could be, illustrated by the main research question – How might one conceptualize innovative organizing towards transitions to sustainable energy systems? – looking outside the methods to focus on connections and relationships seemed appropriate. These connections and relationships between actors, comprising of people, objects, or ideas offer a far richer version of reality. For instance, the documentary 'Inside Job' that was about the 2008 financial crisis offered insights into the global financial networks, and how they are linked to important policy makers, star academics, celebrities, firms, business networks, industrial ecosystems, and of course families and friends. However, following the stories and the connections, also revealed how thinking from outside the system to address and challenge the pathology of the inner domain resulted in the rise of Bitcoin and an entire system of assemblage.

The stories describe opportunities for reclaiming and restoring the Internet to its original role of unleashing the creativity of the human mind through infinite collaborative networks. While quite distinct, the stories exhibit a pattern in being united in their imagination and anticipation of the future. They highlight not just what is going wrong but what emerges after, by drawing on potential ideas related to innovation, complexity, and technology, embedded in dominant narratives. The Bitcoin stories, for instance, embody a particular story about markets being singularly conditioned by the means of exchange. These stories argue that money markets condition public expenditure and they can do this because the form of money used. This money, the stories claim, is created by radically disconnecting from productive capacity and basing its capabilities on ruthless externalization of costs of all kinds to serve a crude and simplistic metric of success. The stories of Bitcoin and other cryptocurrencies offer a form of value distinct from what is represented by money. The values are entangled with human activities and desires, and are presented as pure forms of information of input and output. In doing so, the stories pry open questions about energy implicated in such desires and force a confrontation with the consequences of not addressing the underlying assumptions that drive current energy use.

This is visible through assemblages that begin with a particular material connection and then starts collecting stories that contribute to the narrative about that material. Such interactions maintain or contest relationships continuously over time and space, implying change through a continuous process of becoming. Implicated in this assemblage is a pattern language, aligned through technologies. They transform the process, the experiences and practices, including those that experience and practice it. It reveals how the digitalization of everyday socio-economic activities involves representing, processing, storing, and communicating increasing amounts of matter, energy and information, and offer possibilities for imaginative organizing. The changes in relationships through the assemblages of artifacts such as phones, computers, codes, algorithms, laws, economic, social, and cultural theories and norms reveals how the agency for any change, is distributed, which means no single thing or person, or institution can solely claim to be leading the process. They unveil how the materialities of energy infrastructures can act not only to condition human action but also to catalyze it, prompting a human response or socioecological change.

This assemblage offered insights for alternative forms of organizing and resulted in the article, 'Blockchains for accelerating open innovation systems for sustainability transitions' (Narayan & Tidström, 2019b). These connections, that traverse across multiple levels, micro (personal, firm), meso (industry, community) and macro (nations, global networks), make it impossible, and in a way, naïve to situate any unit of analysis. Understanding these relationships and connections to arrive at a definite conclusion is not possible, as they are unpredictable, but in engaging with them, one can sense how they resonate. The continuous interactions online embody not just responses to events, but represent different contact points that appear to be scaffolding the transition to new forms of constantly evolving human contracts. These evolving contracts offer clues into behavioral dimensions that have so far, remained unidentified, or simply ignored. For instance, Kay and Mervyn (2020) have highlighted how the many characteristics of human reasoning, identified as biases and signs of human failure by behavioral economics could be telling alternative stories of adaptation that are beneficial to success. These behaviour ecologies comprise of lives people inhabit in real worlds, even if they could be misleading within the confines of the worlds created for the purposes of economic modelling. Organizing within this context is fraught with inherent ambiguity and to understand the interactions within this organization-in-creation, perceptions and methodologies need to engage with ideas related to indeterminacy and complementarity. The article 'Leveraging resource ecologies for sustainability transitions–a waste management case' (Narayan & Tidström, 2020b) made this tangible by illustrating how connections

present opportunities for building coalitions to solve problems created within the system.

The connections and relationships come alive through myriad stories and over time form a particular resonance that help in stringing together a narrative only to be led into other connections. The research process, in that sense, follows the four principles of rhizomes (Deleuze & Guattari, 1987) as illustrated in the Table 3 below.

Table 2. The principles of rhizome adapted from Deleuze and Guattari (1987).

Connection and heterogeneity (Through existing literature, critiques of existing literature. Frequently these discoveries and connections were culled from newsletters, Tweets, blogs, vlogs, seminars, YouTube videos, podcasts & news articles.)	• Ceaselessly establishes connections between heterogeneous elements • Transmission may proceed along transversal lines • Linkages may involve infection between unrelated traits • A wild, semiotic throng in which not everything can be linguistically coded
Multiplicity (Source diversity is key, people like to cite familiar research to adhere to disciplinary focus, but the differences can emerge in the ideas presented. This particularly true of the emerging research on energy where multiple voices are trying to make themselves heard, these include digital objects like bots. Tweet alerts have often been about subjects that were never intended for but in choosing to draw attention, the bots unwittingly lent voice to the 'others'.)	• A true multiplicity with neither subjects nor objects, constantly forming and breaking combinations • Differences are substantive and allowed to persist and co-exist • Identities and interests are fluid and never overcoded.
Asignifying rupture (This principle was not visible initially. It was in the breaks that came into the energy discussions, be it through food, mobility, shelter, or products and services. Initially they led right back to the duality of technology and ecology. This rupture was resolved from within the socio-technical and socio-economic encounters. Breaking with categorizations and adopting assemblage revealed the code for continuous organizing.)	• Breaks and cuts can occur anywhere, not only at joints • Components are arranged through segmentary "lines of flight" • Ruptures are resolved by beginning again on new lines or old ones • Encounters with other assemblages involve capturing code; a parallel evolution may re-stratify everything
Cartography or mapping (This involved the hundreds of research notes that tried to piece together the material that was being collected. It required a disciplined approach towards the material, in terms of exploring, collecting, writing reports and constantly updating them.)	• Oriented toward experiments in contact with the real • Constructs a map that is susceptible to constant modification and reworking • Open, interconnectable, nomadic, capable of maintaining multiple entryways and exits • Always a singular performance, a succession of singularities

The rhizomatic method suggests a sense of movement and ephemerality, with a generative impulse that is embedded in the creative and productive flows. These flows connect the points in the rhizome, and the continuously connecting lines grow, spread, and propagate perpetually in all directions, and it is this evolving nature that lends rhizomatic organizations the strength to survive and proliferate (Deleuze & Guattari, 1987). The rhizomatic method enabled the assemblage of fragmented narratives without clear beginnings and ends, unrestricted by linguistic constructions but including other forms of semiosis that offer a multifaceted means of sensemaking and sensegiving (Rantakari & Vaara, 2017; Boje, 2008). The continuous conceptual lines of flight offered an innovative way to visualize things as fluid, shape-shifting assemblages continually on the move in interacting with the world, rather than perceiving them as stable essences. The evolution of the rhizomatic exploration resulted in several research notes that used the evolving relationships to analyze the environments. The analysis then tried to locate the different relationships within the economic activities of extraction, production, distribution and exchange. This classification was inspired by the idea of product biography that is used to explore the relationships that constitute the story of a product in the article, 'Tokenizing coopetition in a blockchain for a transition to circular economy' (Narayan & Tidström, 2020a). The article acted as a catalyst for exploring the assemblage of relationships that it alludes to but could not elaborate further, given its defined scope.

The articles triggered exploratory journeys that enabled unrestricted encounters and engagements, and their framings allowed organization of the data and in making sense of these encounters. At other times these explorations led to the development of a new article. The article 'Leveraging Digital Intelligence for Community Well-Being' (Narayan, 2020), is one such example. The ideas that hold the article together emerged while exploring blockchain and how artificial intelligence is an important part of its assemblage. This exploration widened to include diverse stories of well-being, economic growth, degrowth, racial profiling, wealth, inequality, information systems, and much more. In thinking through these stories with the help of extensive research notes yielded more connections and further stories. These encounters meant continuously modifying research notes. As the stories proliferated and interacted, the relationships woven through the economic activities of extraction, production, distribution and exchange, contained within the existing energetic systems helped in framing the article. A sample of a research note can be accessed in the Appendices. The process explores the information-energy nexus captured through various narrative assemblages trying to make sense of the food system, and brings into focus the interactions between the systems and their relationships to draw attention to what it could potentially become.

3.2.4 The performative paradigm in rhizomes

During such research processes, what starts out as a search for something new morphs into something familiar, yet also new; a continuous process of discovery through connections. The performance, therefore, reflects what can be called post-phenomenology, distinct from early phenomenology. The focus in early phenomenology was on the 'essence' of the phenomena, whereas in post-phenomenology the interest is in chasing the different trajectories that phenomena can/might take, thus offering researchers the opportunity to experiment with entangled connections among seemingly disparate philosophies, theories, and methodologies (Vagle & Hofsess, 2016). In this research, the process starts with making commitments to the practices of reduction and bracketing to be able to describe the phenomenon in its pre-reflective phase through existing theory, but diverse stories disrupt this and the process meanders into unexpected trajectories revealing other facets of the phenomenon, that add to the description yet in doing so changes it. For instance, trying to understand what transitions to sustainable energy systems would mean, led to circular economy, as means for realizing the transition in practice. However, this exploration led to ideas that radically changed how innovation is understood and practiced.

A performative paradigm enables space for movement and freedom, experimentation and inclusion, that shake up notions about what research is and should be (Østern et al., 2021). The learning-becoming-knowing implied in the process is performative, and the performativity revolves around picking up narrative threads that help in expressing how desirable futures could be made possible. Here the performance is activated through social media listening tools (Reid & Duffy, 2018), but veers into interactions that blend the physical with the virtual. For instance, a Tweet about a radical new technology draws different kinds of responses, and one particular response is selected as it links to an article documenting the technology's systemic effects, which generates diverse responses thus allowing an assemblage of narratives where the past, present and future get simultaneously co-created. Or other instances where reference lists of academic articles result in connected papers through an entanglement with an experimental technological tool that uses 'smart citations '. Here simply typing the title of an article outputs a network graphic listing titles and abstracts of the most relevant prior and derivative research papers connected to the one typed into the search bar, while pulling out related citations, and offering contexts of citation, based on mentioning, supporting, and contrasting. These encounters with technologies encourages open interactions with wider knowledge networks that facilitate learning about concepts through a multitude of relationships. In doing so, this technological engagement enables the performance of an integrative review

approach (Snyder, 2019) to engage with the desire for combining perspectives, a key requirement for conducting this research.

A performative paradigm highlights the role of desire that stems from the need for making connections that enables a productive and creative flow (Deleuze & Parnet, 1987). The emphasis is not on the components and how they contribute to the development of the process, but the uniqueness of the relations among them. This rhizomatic performance develops continuously to enable multiplicity to grow or change so that unique new possibilities are continually created during the process (Deleuze & Guattari, 1987). Rhizomatic motion is ongoing, and cannot be defined in advance as it has no beginning or end but always a middle, a kind of milieu from which it grows and overspills (Deleuze & Guattari, 1987, p. 21). This approach implies a collective dimension, which is valuable in designing a research process where the objective is not limited to describing the experience of innovation processes towards transitioning towards sustainable energy systems, but also the activity of becoming.

3.2.5 The relevance of a performative paradigm to the research process

It is important to clarify that with a performative research paradigm the focus shifts from what a research phenomenon is to what it does (Østern et al., 2021). This requires methodological innovation and experimentation that implies a shift from being to becoming, an onto-epistemological shift that recognizes the inseparability of nature/culture and human/matter (Østern et al., 2021; Barad, 2003, 2007, 2014; De Landa, 2000; Deleuze & Guattari, 1987). The performative paradigm emerged through the research process itself and this is reflected in how the articles resonate with each other through their relatedness in exploring the transitions towards sustainable energy systems. It is this resonance that the main research question, functioning as a kind of knowledge apparatus (Østern et al., 2021; Barad, 2003, 2007) helps in sensing. The function of this knowledge apparatus is to make sense of what exactly resonates between the five published articles which showcase the performative aspect of 'learning/be(com)ing/ knowing' (Østern et al., 2021, p. 7). Circular economy offered the possibility for discovering the intricate ways that energy and information systems interact and work towards encouraging practices through what Boje (2021) refers to as retrospective storytelling.

For instance, the first, in the form of book chapter, 'Circular economy inspired imaginaries for sustainable innovations' (Narayan & Tidström, 2019a) draws upon the concept of imaginaries from STS (science and technology studies) to show how the ideas embedded in Circular Economy (CE) evoke existing values that enable

sustainable innovation processes. The findings indicated how in addition to models and best practices, sustainable innovations are deeply rooted in specific social, cultural, political and economic contexts and that those contexts shape how innovations could be understood as sustainable. The idea that emerges here is that models and best practices need not limit possibilities, instead they could offer continuing value through endless combinations that consider the needs of these various contexts. This led to the understanding of innovative organization of ideas, and in doing so revealed the relevance of tools in addressing the complexity to enable such innovative combinations.

The second book chapter, 'Blockchains for accelerating open innovation systems for sustainability transitions' (Narayan & Tidström, 2019b), addresses that by offering the possibility of blockchains for addressing the inherent complexity and interconnectedness of challenges related to sustainability. It presents the features of blockchains as enabling mechanisms for coordinating various combinations of skills, capabilities, and knowledge across open innovation networks, for contextualizing value creating potential of such combinations. Enabling combinations for values to emerge from both, sharing as well as capturing information, it presents a distributed and decentralized vision of organizing. The insights into the growing relevance of context specific and dynamic strategies of collaboration and competition led to the need for evolving an innovative framing for overcoming the limitations inherent in current organizational systems.

The third article, explores this possibility by deploying blockchain in the context of circular economy. The article, 'Tokenizing coopetition in a blockchain for a transition to circular economy' (Narayan & Tidström, 2020a) presents how a coopetition strategy could be operationalized and optimized using tokens in a blockchain to support a transition to circular models of value creation and appropriation. Using literature review as a method, the article offered that tokens could enable previously disconnected product ecosystems to converge and enable creativity and innovation required for circular business models. However, the success of such convergence would require the coopetition models to transition from the current stages of value creation and appropriation to being based on value creation and circulation. The findings revealed the need for identifying how such a transition could be understood within current organizational arrangements.

The fourth article, came together to highlight this through an explanation of the inner life of organization by actively engaging with the outside. The happenings occurred during the researcher's earlier occupation as a sustainability consultant and began to make sense during the research process. It led to a novel theoretical perspective that identified the role of social intelligence in reconfiguring and

redesigning current organizational systems. The article 'Leveraging resource ecologies for sustainability transitions–a waste management case' (Narayan & Tidström, 2020b), showcased a process through which organizations develop the ability to identify and integrate diverse groups of actors using social intelligence to build an ecology of resources to address challenges related to product waste. This organizational process acknowledges and assumes responsibility of business activities by embracing energetic efficiency in addressing its waste stream. The activities related to waste occur outside the core business but in engaging with the outside through the facilitation of waste management, the organization sets in motion unplanned activities that bring unexpected changes in its core activities. Social intelligence, in identifying and developing resource ecologies, also brings into focus the diverse values that exist yet remain unacknowledged in traditional systems of organizing.

The idea of social intelligence combined with growing interest in blockchain technologies led to the exploration of Artificial Intelligence (AI) and its significance in making diverse values transparent. Transparency would help in articulating and designing societal systems that foster well-being, by expanding on the concept of value and in doing so redefining growth in a knowledge society. The fifth and final article, 'Leveraging Digital Intelligence for Community Well-Being' (Narayan, 2020) offers this imaginary by situating the opportunities that AI offers for innovative social designs specific to communities and their understanding of well-being. The article offers that for improving community well-being using AI, the knowledge, insights, and impressions or analysis required a wider frame of reference, and containing AI within the dominant paradigm of technological innovation as a driver of economic growth, limits its potential.

The articles do not lend themselves to any form of coherence, yet they resonate with each other as a collective. Their potential did not lie in coherence but in resonance, and this forced the research process itself to become innovative, which meant performing the work to make this resonance become tangible. Understood from this perspective, the research process evolved towards a performative paradigm to make sense of itself, and the articles became the catalysts as well as mirrors of this process of evolution. Instead of representing reality, this research process, chose to engage with it. In the section below is the description of this engagement process.

3.2.6 The performative research process

The process of publishing the articles deepened engagements with the transition process. With each article, it became increasingly clear that thinking about

transition is intrinsically a creative process that intrudes and disrupts what is known. Thinking disrupts by unhinging the empirical, interior faculties of memory, recall, reminiscence, imagination. The faculties form an internal world, and converge and contribute to the common project of recognizing an object (Deleuze, 1994). This disruption from outside forces the emergence of new and unanticipated faculties that are unregulated by method, and according to Deleuze (1994) when this happens, instead of trying to understand, recognize, or resolve this force of thought, we create. This is visible through the articles, how circular economy or waste management changes the notion of what innovation could be, a creative process of network building (Narayan & Tidström, 2020b, Narayan & Tidström, 2019a). How blockchain and artificial intelligence leverages the innovation potential of a network and in doing so transforms the network (Narayan, 2020; Narayan & Tidström, 2020a; Narayan & Tidström, 2019a). This is consistent with market shaping (Nenonen & Storbacka, 2020, 2021). Thinking about transition, prompted an inquiry into the process through a guiding question "What is this a case of?" (Langley, 2021, p. 251). This was key to sensing the potentialities of innovation, complexity, and technology that resonate through the articles and informed the sensemaking process by situating the diverse stories of change and non-change, related to economic growth, climate change, energy, mobility, food, security, poverty, inequality, environmental collapse, chemical contamination, wars, and politics. The framings of the articles offered a basis for evaluating the ontological status of organization and theorizing organization in a way that at least matches the complexity of the interactions. This complexity is understood through the web of interactions that reveal the value framework of current energy-information nexus related to business networks through interwoven potentialities of innovation, complexity, and technology.

3.2.7 The empirical material

This research engages with reality through an ontology of becoming (Nayak, 2008) to articulate change and transformation that underpins organizing for transitions towards sustainable energy systems and this informs the epistemology which encourages open-ended explorations (De Landa, 2000). Within such a conceptualization, the empirical universe could be anything that resonates with transitions to sustainable energy systems. To manage the research process, the idea of energy was approached through circular economy and this became the initial empirical setting. Circular economy remained a key catalyst for creating the opportunity to interact and constantly build connections using rhizomatic explorations (Deleuze & Guattari, 1987). These explorations comprised academic as well as non-academic or grey literature, including articles, reports, white papers,

books, documentaries, films, and social media interactions through tweets, posts, blogs, podcasts, videos, curated newsletters, and actual interactions with people, objects, and spaces. The eclectic selection of empirical material matches the research philosophy and is appropriate for conducting a rhizomatic research process.

There is growing recognition of instances where incorporating literature beyond peer-reviewed academic journals seems appropriate (Adams et al., 2016; Sharma et al., 2015). The diversity and heterogeneity of material can make a variety of positive contributions to subsequent inquiry and practice (Adams et al., 2017). Digital media as an important conduit for a societal assemblage offer possibilities for capturing lived realities as well as how they interact with the formal descriptions, and in doing so, these dynamic interactive environments are creative spaces. Curated newsletters are increasingly common and some are curated by experts and academics who share and promote these newsletters while also inviting comments and dialogues. Examples of such curated newsletters are Tech Policy Watch coordinated by Marietje Schaake, the international policy director at Stanford University's Cyber Policy Center and international policy fellow at Stanford's Institute for Human-Centered Artificial Intelligence, Data & Society that researches topics related to AI and automation, the impact of technology on labor and health, and online disinformation, and Aeon, that offers articles and videos from experts, artists, academics, and practitioners on diverse subjects.

Others are curated by individuals who are just interested in discovering, documenting, and musing about diverse facets of knowing. For instance, Sentiers, that describes its objective as wanting to make sense in a world that is changing constantly, Brainpickings (now The Marginalian) an exploration of personal growth fueled by curiosity and lifelong learning across disciplines that figures out business growth as a byproduct as it expands and absorbs, and Workfutures, a research initiative that explores themes related to ecologies of work and anthropology of the future. Communities like Interintellect, that emulate the environment of salons for discussing literature, science, art, and philosophy. These resources are also in constant dialogue with academic literature, and the texts and ideas offer embedded links that often direct towards research that rarely show up in bibliometric reviews. In addition, these newsletters raise questions about assumptions that are often taken for granted in existing literature. This enabled the academic literature review to be integrative, by including reviews, critiques, and synthesis of representative literature on a particular topic in a way that allow for new perspectives and frameworks to emerge (Torraco, 2016). The review process was done in concert with non-academic literature, and this enabled the identification of a wider set of academic literature. A wider set of literature allowed

for the elements to be organized thematically and critically with the intention of taking existing ideas for catalyzing future research (Amis et al., 2020; Snyder, 2019).

Conventionally the role of news media in constructing collective perceptions of reality (Gamson et al., 1992; Tuchman, 1978) and normative and interpretive frameworks (Gans, 1979), make media accounts an optimal source material for examining dominant narratives. However, the interactive nature of social media present unique opportunities for more layered and nuanced interpretations of diverse stories, including those from news media, resulting in far more complex narratives. These narratives could be understood as digital artefacts (Hui, 2012) that embody the assemblage of systems of production and consumption visible in the diverse and fragmented stories of organization as well as disorganization and how both contribute to the transition process. (*Appendix 1 presents an example of the research process. Many such rhizomatic narratives were developed to make sense of the reality, the underlying relationships and the process of change*).

3.2.8 Scientific rigor

In exploring the issue of scientific rigor in qualitative research, Harley and Cornelissen (2020) challenge understandings of rigor that consider it as integral to templates or confining rigor to proper application of a template. Rigor should not reside in protocolized techniques or methods but in the process of researchers reasoning about their use of particular techniques and reporting such reflections (Harley & Cornelissen, 2020). Rigor, according to Harley and Cornelissen (2020), should demonstrate the applicability of two broad criteria – coherence of the argumentation and the process through which researchers arrive at what they regard as the best explanation for their findings.

Establishing coherence of argumentation refers to the consistence in ontological, epistemological, and methodological assumptions and how the theoretical claims line up with these assumptions. With regard to such coherence, this research has demonstrated a clear consistency with process ontology which aligns with an epistemology of becoming. With regard to the second criteria of maintaining logical coherence, this thesis offers explicit links that lead from data to theoretical presuppositions, to candidate theoretical frameworks, onto actual theoretical inferences. This is illustrated in the Fig 10 below.

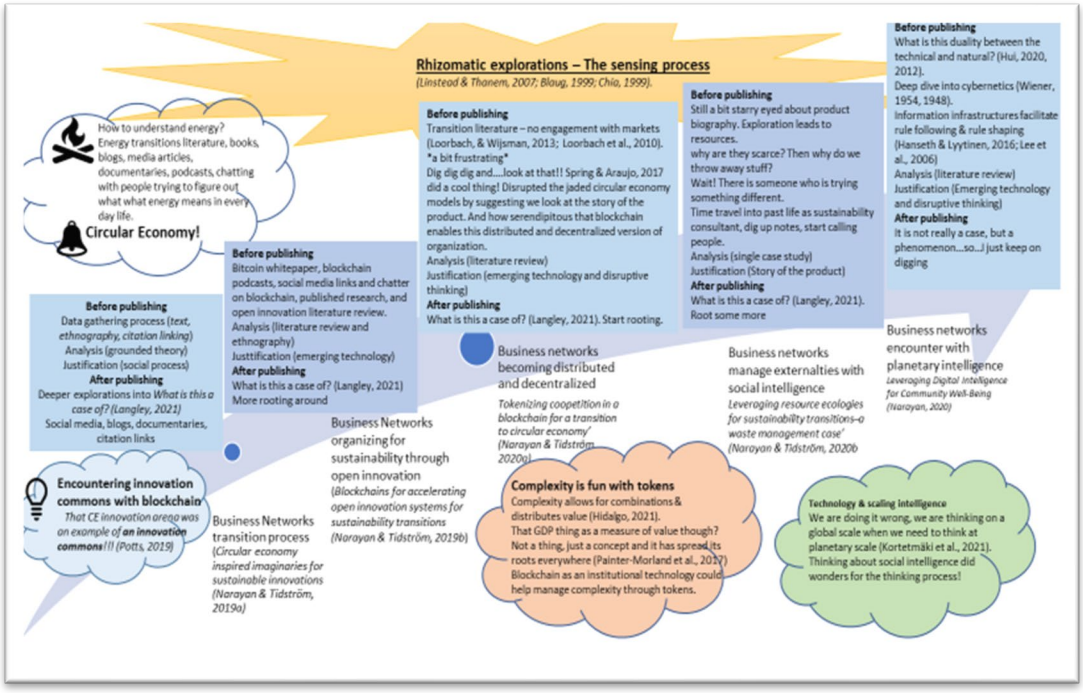


Figure 10. A narrative capture of a rhizomatic exploration of transitions

4 FINDINGS

The key findings of this research are illustrated in the Fig 11 and elaborated on below.

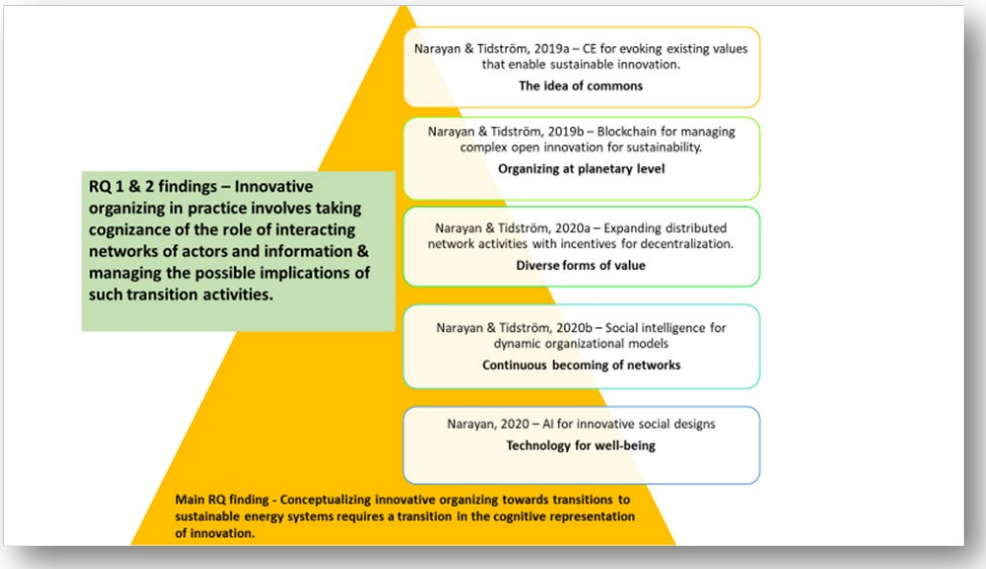


Figure 11. Findings related to main RQ addressed by the narrative framework created with theoretical perspectives on innovation, complexity, technology, and findings related to RQ 1 & 2 addressed by published articles.

Main RQ. How might one conceptualize innovative organizing towards transitions to sustainable energy systems?

4.1 A transition in the cognitive representation of innovation

The first objective of this thesis is to develop a sense of how organizations might think about sustainability through an expansion of relationships implicated in business networks to be able to imagine the necessary organizational elements. To achieve the first objective, this thesis draws upon theoretical perspectives on innovation, complexity, and technology, and captures how these interact to imagine possibilities for action. These interactions help in broadening the foundations of existing understanding of ecosystems and business fields (Adner & Kapoor, 2010; Möller & Svahn, 2009) to incorporate real-world phenomena

(Möller et al., 2020) for market shaping (Nenonen & Storbacka, 2021, 2020) through innovative organizing. By fulfilling this objective, the thesis offers a process for experiencing and accessing the diversity of knowledge through wider disciplinary engagements.

The interactions reveal the assemblages. The assemblage of systems draws attention to the interconnections that offers a comprehensive ontology of nonhierarchical complex material systems comprising of human as well as non-human elements, defined by their process of production within an energetic environment (Debizet et al., 2016; Morton, 2010; Smil, 2008). Becoming aware of such assemblages increases the possibilities for thinking about innovation as an open-ended process, but this is not in contrast with closed processes. The implication is in the transition from primary imagination towards secondary imagination, which during the process of transition, enables primary imagination to become free of its associations with vision and images (Weick, 2005). The associating principle in secondary imagination is to do with reordering, fusing and moving the associations with primary imagination around to form new experiences (Weick, 2005). The rhizomatic stories reveal the possibilities of coexistence where the consequences of activities whether closed or open loses significance as the assemblage makes it possible to manage both. The openness when understood from this perspective, is a default state, it does not have to be qualified, and distributes agency.

This performative element of assemblages is evident in Callon's (2016; 2007b) description of markets, and also in the idea of innovation commons (Potts, 2019; Potts & Hartley, 2015). The concept of assemblages highlights how the crucial ingredient for the emergence of innovation at any level of reality is the ability of elements to be productive through combinations at respective sublevels, that is at the level of the components of the structures in question (DeLanda, 2000). Given that not all components have the same level of productivity, the key ingredient for combinatorial richness, and therefore, for an essentially open future, is heterogeneity of components, and processes that allow these heterogenous elements to come together (DeLanda, 2000). Here, the function of anticipated imaginaries is to make space for such diversity.

It increases complexity but also offers potentiality for the emergence of possible ways of interacting, creating connections, and building and rebuilding relationships. This semiotic understanding is critical, as it offers an opportunity to device a common language for transition that has the ability to listen to and communicate with our environments. The possibilities for transition could take place through understanding the internal models of the world that are used to

make sense of human beings' place in nature, and how they can be changed by considering diverse stories to articulate new narratives. The diversity of stories help in articulating the interesting part about understanding these internal models, to enlist help for finding acceptable ways of changing them, implying coordination. Coordination brings forth the role of technology, and here again, engaging with technology requires letting go of the duality of technology and ecology by what Hui (2020, p.63) refers to as 'ecology of machines'. This brings another transition in the cognitive representation of innovation. It attempts to bring techno-diversity into the innovation mix. This changes the understanding of new technologies to that of new combinations of technologies, old or new depends on the needs of the context. What binds the assemblages is the onto-epistemology of process and becoming, making it possible to be, through becoming.

Coordination as a process is a conversational experience as it entails tailoring and arranging activities towards accomplishing objectives, that are often in dispute (Tsoukas et al., 2020; Cannon-Bowers et al., 1995; Boden, 1994; Locke & Latham, 1990; Weick, 1979). Therefore, coordinating for transitioning towards sustainable energy systems, for business networks, require conversational mechanisms that allows for innovative organizing through a continuous assemblage of diverse systems. This would entail extending and expanding perceptions through familiar concepts to consider the nested, layered, multimodal, transitional, and conditioned nature of business environments, their dynamics, phases, and processes of evolution, and the forces that constrict and enable such evolution (Möller et al., 2020). Therefore, the assemblages are expressed within familiar theoretical perspectives of innovation, complexity, and technology, through a narrative framework, to serve as a persuasion device for market shaping (Nenonen & Storbacka, 2021, 2020) towards sustainable energy systems.

RQ 1. What is innovative organizing in practice?

RQ2. How does such organizing enable transitions to sustainable energy systems?

4.2 Role of interacting networks of actors and information, and possible implications of such transitions

The second objective of this thesis is to offer a pragmatic approach for relationships to evolve, grow, and manifest themselves in unlikely ways. This entailed explorations into what could be innovative organizing in practice and how

does such organizing enable transitions to sustainable energy systems. It is achieved through the published articles.

The articles offer an opportunity to understand the transition process as activity and indicate in practice, how innovative organizing embodies the complexity inherent in the interactions and anticipations associated with such processes. The articles force a confrontation with how transition settings shape agency and subjectivity in relation to the purpose at hand, while also offering the potential to continuously redefine that purpose progressively. It is through these relationships that actors make claims about how the world is created and offer new combination opportunities for designing and building a better, healthier, and more resilient world. The combinations, embody distributed cognition, that offer the possibilities for organization of activities within particular contexts. The innovative organizational configurations reveal the cognitive frameworks and the underlying politics and ethics through the choices as well as the possibilities that are effectively boxed out. In doing so, the combinations offer an interesting way of exploring how economic, social, political, and environmental dimensions interact within particular contexts and how they influence interactions for transitions within business networks.

The book chapter, 'Circular economy inspired imaginaries for sustainable innovations' (Narayan & Tidström, 2019a) emerged out of observations of interactions where the idea of circular economy (CE) was evoked as an imaginary to draw the attention of Finnish businesses with concepts that are familiar within the context of their existing business activities. With the progress in the engagement process, the CE-inspired sociotechnical imaginaries prompt a collective process of making sense for negotiating collaborative paths towards understanding the meaning of sustainable innovations. While nested in values with relevance within the immediate network where the activities were located, the understanding expanded to include the wider environment the actors were embedded in. As this activity was specific to business networks, the theoretical framework of networks pictures (Möller & Halinen, 2017; Möller, 2010) would have been relevant. However, the data indicated that the ideas related to CE interact across wider networks representing an assemblage of systems, and the idea of socio-technical imaginaries (Pfotenhauer & Jasanoff, 2017) offered an expanded and an inclusive canvas for exploration. The imaginaries are tied to how actors begin to understand the socio-technical systems through their connection to the planet. In this context, this connection emerged from a very specific element of Finnish culture where being in nature is part of the Finnish identity. This illustrates how seemingly unrelated connections gain relevance by embodying desires that act as a motivational force, and responds by rearranging elements that

repress the process of organizing (Linstead & Thanem, 2007). During such a process diverse stories with competing agendas can suddenly find elements of familiarity (Boje, 2021; Morton, 2010). It also shows that the economic, social, and natural are invariably entangled through relationships in simple yet profound ways (Latour et al., 2018). In doing so addresses a gap in the framing of transition process within business networks, by expanding the idea of network pictures to include socio-technical imaginaries. The findings from this article reveal the importance of the idea of commons while offering a pragmatic way of innovative organizing by employing socio-technical imaginaries as an important transition tool. This finding brought forth the practical issue of coordinating the diversity implicit in such imaginaries, and explorations into open innovation and energy transitions led to emerging ideas of blockchain technology.

The book chapter, 'Blockchains for accelerating open innovation systems for sustainability transitions' (Narayan & Tidström, 2019b), explored how the features of blockchain could address the inherent complexity and interconnectedness of sustainability challenges. The focus here was on exploring practical ways in which activities related to innovative organizing could be coordinated. This foray into an emerging technological paradigm brings into clear focus the complexity of economic systems through the MLP framework to introduce the network implications of understanding innovations from the perspective of energy-information nexus. Innovation as an important driver of economic activity remains intrinsically an open and interactive landscape, as has been observed by Chesbrough (2003) and in business network literature (Rampersad et al., 2010; Möller & Svahn, 2009), yet there remains a distinction between open and closed innovation in literature (Huizingh, 2011). This anomaly between how innovation is in practice and the way it is framed in literature became clear in the knowledge tradition that the framework of blockchain is grounded in. The system of interactions that blockchain enables allows for shifts in organizing based on an evolutionary-institutional economic perspective for establishing institutional systems of governing interactions (Beck et al., 2018; Berg et al., 2018). Blockchain offers a pragmatic resolution to the complexity inherent in innovative organizing. The ideas related to blockchain leads towards expanding and extending the theory of innovation from Schumpeter, to ask a more fundamental question about why entrepreneurs discover these opportunities (Potts, 2019; Shane, 2000). Here, the idea of innovation commons combines Elinor Ostrom's governance of commons with Friedrich Hayek's ideas on distributed knowledge and information under uncertainty (Potts, 2019) to deal with the innovation question in a more fundamental manner. The commons perspective invites a wider range of human and non-human actors to account for their roles in the process and introduces complexities implicit in subjective experiences and the blockchain offers a

pragmatic and innovative approach for doing so. There is ontological coherence between innovation and markets and networks through Hayek's ideas on distributed knowledge and information under uncertainty (Hadjikhani & LaPlaca, 2013; Callon 2007b; Snehota & Håkansson, 1995). Yet, the commons framework is a useful one for being inclusive of human and non-human actors and acknowledging their ability to act. It is this inclusiveness that could enable business networks to expand from relationship management to ecosystems orchestration for shaping markets (Möller et al., 2020; Nenonen & Storbacka, 2021, 2020). Further, the inclusiveness highlights the importance of understanding and the relevance of distributed and decentralized organizing (Vergne, 2020) for managing the interactions through innovation, complexity and technology. The findings from this article suggest that the blockchain as a practical means for organizing such interactions encourages inclusiveness and in that enables innovative organizing at a planetary level.

Interactions at planetary levels draw attention to energy, as energy choices are integral to any process at individual, organizational, and societal levels (Vogel et al., 2021; Marchi et al., 2019; Sorman & Giampietro, 2013; Quinn & Dutton, 2005). Circular economy (CE) is a relevant context where changes in energy use is central to exploring sustainable economic activity. The article, 'Tokenizing coopetition in a blockchain for a transition to circular economy' (Narayan & Tidström, 2020a) uses the concept of product biographies to build a distributed understanding of the process. It draws attention to the inherent instability of products that need to be stabilized physically and institutionally (Spring & Araujo, 2017) to introduce the idea of tokens on the blockchain to encourage innovation during the process through coopetition. As a conceptual paper it looks at how the blockchain as a ledger could be used for encouraging innovative combination of information about the lifecycle of products by using tokens as incentives. In this conceptualization, the uncertainty inherent in the instable state of products (Spring & Araujo, 2017) is seen as a necessary condition for human intelligence, initiative, and imagination and the unpredictability of the products are key to knowledge and scientific progress, and innovation (Loasby, 2011). Coopetition as a strategy is relevant but not in the way its objective is expressed in terms of value creation and appropriation, but in value creation and circulation. In this conceptualization, value is created precisely because it is circulated rather than captured, as what is being circulated is information about the product at various stages of its evolution, and this information is critical for innovation. This is consistent with the view that knowledge is created through patterns that enable the imposing of order while envisaging new combinations in an evolutionary process that is driven by purpose embodying competing and complementary elements, which may or may not work (Loasby, 2011), yet valuable because of the information it contains. It turns

attention towards why markets can be civilizing forces by making the definition of goods at the heart of competition, and thus making political and moral reflection part of the process instead of externalizing them (Callon, 2016). The article offers a narrative of coopetition as a strategy to connect to the original idea of distributed knowledge at the core of business network thinking (Waluszewski et al., 2019; Hadjikhani & LaPlaca, 2013; Snehota & Håkansson, 1995). In doing so, the theorizing of coopetition within business networks is transformed into a motivational force for renewing and defending the theoretical foundation (Clegg et al., 2020). This draws attention to the reality that change is not what networks have but what networks are (Lowe & Rod, 2018). This makes networks in a continuous state of transitioning and therefore the ability to select and combine elements that help in resolving problems that arise as the process evolves. By highlighting the non-linear aspect of coopetition, the findings highlight its possibility of becoming a strategic tool for innovative organizing of information and energy interactions. In embodying ideas related to innovation, complexity, and technology, the findings show that coopetition instigates interactions for ecosystem orchestration (Möller et al., 2020) through assemblages enabled by blockchains, with tokens that identify diverse forms of value for market shaping (Nenonen & Storbacka, 2021, 2020).

Value is often located in things we tend to devalue, like waste. While capturing such value could be possible by constant coordination of practices and activities through energy-information interactions, there needs to be a model that can inspire pathways enabling a transition from global towards planetary thinking. The article 'Leveraging resource ecologies for sustainability transitions–a waste management case' (Narayan & Tidström, 2020b), is an example of an organization that is on such a transition journey. While the transition journey is about improving the product itself to remain competitive, it is simultaneously developing the ability to identify and integrate diverse groups of actors using social intelligence for accessing an ecology of resources for innovative solutions to address the waste generated by its business activities. The focus of the article is pointedly on the orchestration of resource ecologies for reclassifying waste into wealth, making the product itself is at the heart of innovation and competition (Callon, 2016). The activities related to this orchestration become effective narrative devices for transforming actors' relationship with the concept of waste. As the findings show, these activities are strategic to the business through an acknowledgement of the past and the present to create imaginaries of the future through a collective negotiation process. The important part of the findings is how firms can engage with such complexity through continuous project building that organize actors thematically and spatially by forming nets within a network to resolve issues, a form of decentralized and distributed organizing. To avoid

complexity organizing sometimes resorts to artificial separation of activities that are in reality interdependent, resulting in the failure of the relations evolve over time and space. The main contribution of this study is the use of social intelligence for sensing this interdependence through the interconnectedness of resource ecologies that offer the means for embracing uncertainty and emergence during transitions. In highlighting the interconnectedness, this study illustrates how the scope of firm activities could be expanded by embracing a continuous process of becoming. In doing so, the study pries open the blackbox of network interactions (Guercini et al., 2014). The findings indicate that transitions to sustainability demand innovative organizing that embodies process and change to orchestrate ecosystems (Möller et al., 2020) for continuous market shaping (Nenonen & Storbacka, 2021, 2020). Business networks need to be understood as being a state of continuous process of becoming during which social intelligence develops and evolves for such orchestration and shaping.

As networks expand, this social intelligence acquires complexity. The complexity inherent in this process of becoming brings into clear focus the integrated relationships of ideas and practices that hold contemporary society and economic networks together. Technologies like artificial intelligence (AI) offer the potentiality of organizing knowledge about these ideas and practices. In this sense it becomes a key element in the reconfigurations of energy and information (Vita et al., 2021; Millward-Hopkins et al., 2020; Shove, 2020) implicated through the assemblages of organizations of production, distribution, and consumption. The stories we tell ourselves about the world are a description of the world as we understand it, and if we want to change the world, we need to change the story first. The article 'Leveraging Digital Intelligence for Community Well-Being' (Narayan, 2020) looks at the growing influence of artificial intelligence (AI) and the opportunity it offers, for challenging those stories that limit progress and privilege those that encourage innovative social designs specific to communities and their understanding of well-being. This article challenges the current paradigm of technological innovation as a driver of economic growth as limiting the potential of such a technology's ability in improving community well-being. In presenting AI's potential for contributing to well-being, the article brings out the limiting prospects of economic growth as an indicator of prosperity and opens up possibilities for communities to explore other forms of growth that might be relevant to their specific contexts. The findings of this article offers an understanding of how a singular frame of reference that facilitate stories of globalization by connecting potential of new technologies to economic growth alone limits the possibilities for leveraging such technologies for pursuing planetary well-being goals. Engaging with how communities understand well-

being could offer businesses opportunities for building network collectives geared towards new innovations that contribute to and enable such well-being to thrive.

The Fig 12 is a snapshot of the research agenda, that includes findings and how these findings contribute to business networks understanding of market shaping through innovative organizing for transitioning to sustainable energy systems.

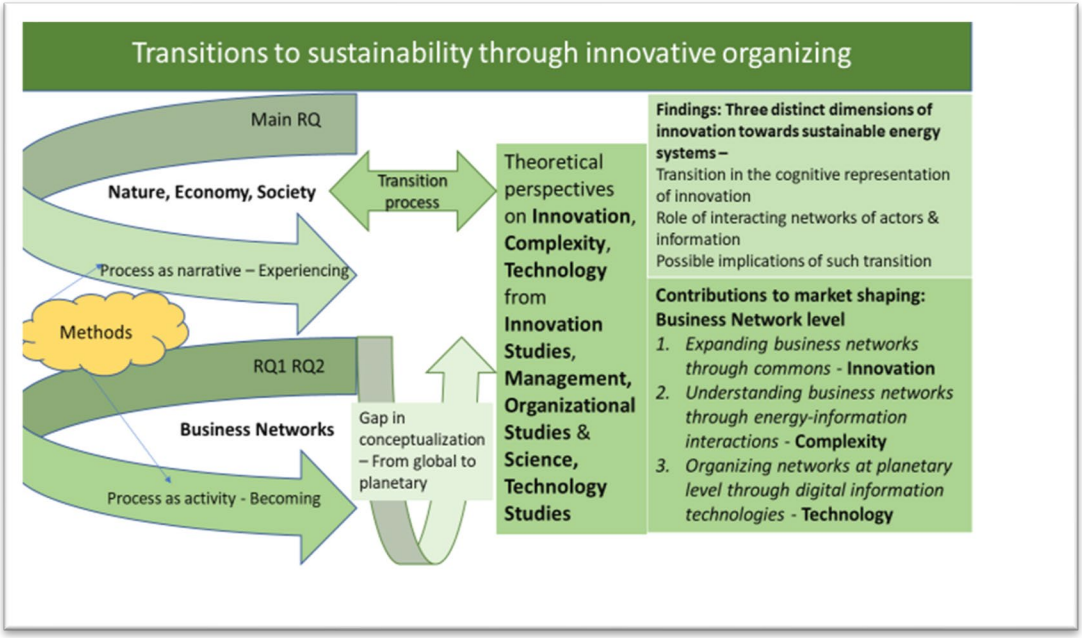


Figure 12. The agenda for transitioning to sustainable energy systems

5 DISCUSSIONS AND CONCLUSIONS

In presenting any research a big picture of the object of research is implicitly invoked to give identity and meaning to what is being presented. In this case, the big picture remains incomprehensible as there are no precise coordinates that can accurately define the planetary level crisis we are facing today. Yet, the reality of what we are encountering remains because reality exists whether we are aware of it or not (Harman, 2018, 2009; Morton, 2010). A consequence of this is the induction of a certain amount of humility, a literal coming down to Earth for engaging with the idea of interdependence and imagine a form of democratization (Latour et al., 2018) to enable the processes of transitions required for expanding our awareness of reality.

One always enters in the middle of things where the threads of meaning in intentional stories offer possibilities for pursuing unintended connections (Vagle & Hofsess, 2016; Deleuze & Guattari, 1987/1980) resulting in fragmented narratives with multifaceted means of sensemaking and sensegiving (Rantakari & Vaara, 2017; Boje, 2008). These explorations are often dismissed frequently as noise, or externalities (Callon, 1998b), but experiences such as these enable simple abstractions to emerge and contribute towards creating new semantic levels where one is able to be precise (Dijkstra, 1972). Energy presents an entry into understanding the interdependence (Smil, 2021, 2008) through an interaction of choices (Sorman & Giampietro, 2013), at individual (Quinn & Dutton, 2005), organizational (Marchi et al., 2019) and societal (Vogel et al., 2021) levels. As one becomes aware of this reality, the focus shifts from globalization of business activities and its attendant problems towards a complex interaction between levels that is planetary in scale with an additional dimension of a distinct non-human centric approach. The idea of ecosystem orchestration (Möller et al., 2020) takes on a new meaning. During this shift the conceptualization of integration undergoes a cognitive turn in which intentional work becomes rooted in the idea of humans as embedded and codependent with microbes, the climate, and technologically emergent communities.

Galvanizing this interactive action and participation inclusive of non-human agents enables us to transcend the modernist framework while grounding us in life-sustaining existence (Latour et al., 2018). Energy, that sustains all life, therefore, offers a point of entry, first through the possibilities of transitions by transforming networked organizational models designed to support a society with fossil fuels at its core (Giuliani, 2018). This expands rhizome-like to reveal the complex ways in which networked organizations harness the affordances provided by innovation and technology for building relationships by privileging those

stories that sustain them. Finally, the same affordances could be leveraged for reorienting these networks by privileging stories that contribute to transitioning towards sustainable energy infrastructures for zero-waste and lower consumption (Smil, 2021). The ecosystem orchestration in this sense becomes contingent on specific choices that priviledge these infrastructures, made possible through innovative organizing that contribute to market shaping (Nenonen & Storbacka, 2021, 2020). The transition stories are captured through the articles included in the thesis and in that sense transform into artifacts of innovation themselves, thus bringing in the element of performativity to the larger research process. They also act as bridging mechanisms for engaging with the idea of interdependence that is at the heart of this project.

To incorporate this interdependence, shifting focus to multiple actors or objects is useful as in their concreteness they compete and collaborate with one another to create more complex objects while retaining their own emergent qualities (Latour et al., 2018). The reality of actors or objects are not determined by their accessibility for a knowing subject but measured by the associations, therefore requires interdisciplinary perspectives and tools that facilitate the understanding between human and non-human agents (Latour et al., 2018). This thesis has attempted to approach the reality of the planetary crisis through such interdisciplinarity with the help of theoretical perspectives of innovation, complexity, and technology and using narratives to make sense of their interactions.

The objective is that of offering a pragmatic approach where the focus is not on accuracy in describing the reality but more on how existing realities can intervene and bring about change. By turning the focus away from the representational dimension of reality to a pragmatic one, this approach embraced the economic and business realities while making transparent its practical implications. As a continuous process, this cannot be framed but can be described, therefore it is what the thesis does. It offers a description of reality by weaving together existing knowledge that offers a narrative of possibilities, and the articles are specific examples of such possibilities. In doing so the thesis enacts or performs an innovation process to understand its contribution to transition mechanisms and shows how business networks could expand perspectives for addressing the planetary crisis through innovative organizing. Indeed, the articles included in this thesis are stories about such organizing and part of the process of organization of ideas that lead towards discovering three distinct dimensions of innovation towards sustainable energy systems – the transition in the cognitive representation of innovation, role of interacting networks of actors and information in such transitions, and the possible implications of such transition.

The means for answering the main research question emerged through the various exploratory threads that were triggered as the activities related to these stories progressed, enabling an understanding of innovative organizing.

5.1 Imaginaries for innovative organizing

The democratization of perspectives through socio-technical imaginaries makes interdependence visible across a range of phenomena, taking innovations for transitions to sustainable energy systems into the realm of what Potts (2019) has described as commons. The existence of such imaginaries correspond to network pictures in business networks (Möller & Halinen, 2017; Möller, 2010) and open innovation (Chesbrough, 2003) could be understood as the coordination of the different network elements visible through this picturing within business networks. However, the nature of the planetary crisis requires this picturing to extend to the commons, where the diversity of socio-technical imaginaries demand that innovation remain open-ended with no center or edge, making networks infinite and never able to fully account for their meanings and effects. Understood from this perspective, the idea of progress need not be seen as contested, but non-linear that embraces the diversity of experience. This is why imagination becomes the ultimate source of progress (Loasby, 2011). Imagination, in this context also becomes a shaping or modifying force (Weick, 2005) with the ability to impact cognitive and mental models through anticipation of change from within structures (Nenonen & Storbacka, 2020) for innovative organizing.

As innovative organizing is fueled by imaginaries, it embraces complexity. While it combines elements essential to a particular context, it does not externalize unnecessary ones, rather, it allows for new networks to address these externalities. Innovative organizing, understood from this perspective, challenges the descriptive analysis of the current system of globalized economic networks that offer predictions of growth that undermine the entangled social, economic, and ecological systems. In fact, such organizing treats moments of crisis as critical junctures for imagining alternatives (Gümüsay & Reinecke, 2021), even as they interrupt established market systems into movement by challenging deeply-rooted mental models through activities that promise stability (Nenonen & Storbacka, 2020). They help in progressing beyond critiques of globalization to draw upon those elements that made coordination on such a scale possible in the first place, and imagine alternatives by conceptualizing reality in a way that is capable of acknowledging the coexistence of all objects, even those that are yet to arrive (Stiegler, 2018a; Morton, 2010). Organizing, in this context, would entail a rational response through ideas and activities that enable such collective representation,

and changes how the meaning of a network is accessed, through another network, making it a moving target.

5.1.1 The CE as a socio-technical imaginary – Becoming aware of interdependence

Circular economy is a tangible framework that acts as a rational and collective response through ideas and activities. As a regenerative system that offers the potential to minimize resource input and waste, emission, and energy by slowing, narrowing and closing, material and energy loops (Geissdoerfer et al., 2017), CE is uniquely situated at the intersection of innovation and technology, that allows energy to become an explicit and integral aspect of the various combinations of innovation and technology. These combinations occur through forms of organizing driven by imaginaries that consider subjective understanding of innovation and technology. The crux of the CE approach depends on the recognition that organizational capabilities through distribution of knowledge is at the heart of organizing, and that large-scale cooperation is possible by appealing to familiar ideas and cultural moorings. The research arena illustrated how concepts as objects have the ability to flow across boundaries and in embodying this nomadic quality, they allow for an instruction of imagination (see Dor, 2017). The idea of CE draws one in with the promise of paths leading towards sustainable resource use, and in the process turns the focus towards the possibilities of exploring individual capacity for contributing to decisions about how to do it. The turn towards exploring individual capacity is significant as this capacity embodies the idea of distributed knowledge and cognition. This is owing to the fact that no single individual, object, organization, group, or community can comprise of all there is to know, which makes them intrinsically interdependent, and therefore implicating relationships.

The reality of interdependence that activities related to CE reveal requires the research perspective to broaden (Möller et al., 2020). Socio-technical imaginaries inspired by CE could strengthen network pictures (Möller & Halinen, 2017; Möller, 2010) by enabling a form of democratization that creates the means for becoming aware of and engaging with this interdependence. Sociotechnical imaginaries highlight the shared meanings and values attached to the practical implementation of CE models as such imaginaries have material outcomes in terms of influencing behaviour and narratives as well as feelings of individual and collective identities where the natural world also gets representation during the innovation processes (Narayan & Tidström, 2019a). Embracing imaginaries nudges business network thinking into the realm of constant state of becoming (Lowe & Rod, 2018) as these networks evolve through encounters with diverse stories.

5.1.2 Stories of becoming

The world-scale issues, understood from the perspective of energy use, result from the accelerating flow of people, goods, resources, ideas, and play out on individual, societal, and planetary levels. The CE can help in identifying the ecosystem of ideas and practices underlying the current networks of production and consumption systems. The descriptions of these flows also indicate the ideas, relationships, and activities that allow for successful organization of these networks. Interdependence requires new ways of understanding interactions because the entangled elements of economic, social, and ecological crisis forces a confrontation with the idea that no one entity can claim to be in possession of truth (Harman, 2018; Latour et al., 2018). This problem has been framed, within economics, as the sheer impossibility of accumulating all relevant knowledge of any circumstance as such knowledge is dispersed in bits of incomplete and frequently contradictory forms in the ways in which individuals possess (Hayek, 1945). It is therefore, not the mere allocation of resources, and here Hayek (1945, p. 520) clearly states about the 'givenness' of resources – "...if 'given' is taken to mean given to a single mind which deliberately solves the problem set by these "data." – but how to secure the best use of resources, or utilization of knowledge not given to any single entity in totality. From the perspective of firms, business networks offer an appropriate entry for beginning such an exploration of interdependence, as in taking the relationship view, this field of research has argued that resources and their utilization are never completely given and the central question needs to be about how resource utilization changes and develops (Snehota & Håkansson, 1995). Drawing parallels with this school of economic thought, Snehota and Håkansson, (1995) have urged that the attention must be on the dynamics, on the changes in the resource utilization, rather than on the statics, highlighting a network of interdependent relationships.

The network view of interdependent relationships is, therefore, built on similar theoretical approaches that have addressed different yet related issues (Snehota & Håkansson, 1995), while evolving over time and place (Hadjikhani & LaPlaca, 2013). The evolution reveals how relationships contributed towards the growth of knowledge about businesses and the networks they create, through collaborations between various human actors (Möller & Halinen, 2018). This transitional leap enabled better understanding of business networks during an era of globalization, however, addressing the planetary crisis requires a weaving together of a particular kind of narrative that incorporates the stories of those objects that are emerging through the interactions that globalization has enabled. These stories encourage us to pay attention to what we pay attention to, and changes how things are remembered and evidence is integrated for decision making. Here, undertaking

market-shaping strategies (Nenonen & Storbacka, 2020), requires paying attention to market objects. Objects, for instance, reveal the changes affected by such market-shaping strategies, in the patterns of human activity within a given metabolic regime, a contextual combination of information and energy. Social intelligence that lends the ability to identify and integrate diverse groups of actors to create resources ecologies for addressing problems emerging through markets activities (Narayan & Tidström, 2020b), become key for such combinations. The interconnectedness of resource ecologies and the interactions resulting in joint actions can often have different rewards and benefits for the diverse range of actors implicated in such networks, and this form of social intelligence offers managers options to experiment with transitional pathways that match the objectives of diverse network actors and provide unique resource combinations for building competitive advantage (Narayan & Tidström, 2020b). In addition, open and transparent activities in introducing uncertainty and emergence, enable ideas to spread through different layers of the society through connecting, sharing and developing resources, helping build awareness, change behaviours and attitudes.

However, these activities are located within the current metabolic regime represented through the entangled relationships of everyday existence in the form of transport, housing, agri-food system through investments, behavioral patterns, vested interests, favorable subsidies, infrastructure, and regulations (Cillo et al., 2019; Unruh, 2000). Without addressing the networks established through this energetic regime, such activities lead to rebound effects, as Levänen et al (2021) have argued when discussing CE. Therefore, CE or related activities call for innovative organizing that is able to cope with the variety of contextual combinations of energy and information, where change is not what a network has but what it is, by embodying the diversity of stories of becoming (Lowe & Rod, 2018).

5.1.3 The technology of coordination for becoming

Innovative organizing requires technology for navigating the complexity inherent through change and stability in these phenomena, to draw out entrepreneurial experiments in institutional forms, for harnessing new possibilities for coordination (Allen et al., 2020a) across multiple dimensions of time and space. Research on business networks has captured coordination through change and stability and the ability to endure long relationships through interactions in resource adaptations (Andersen et al., 2020). With the research focus turning towards the different kinds of changes in interactions, and subsequent changes in perspectives on stability and change, the need for different research methodologies

equipped with epistemological perspectives for handling the multiple temporalities inherent in these explorations (Andersen et al., 2020) are becoming pronounced. As the focus expands to include wider planetary interactions, these methodologies and perspectives become even more critical, and drawing on technology for practices related to transmission, stabilization, and transformation of information and knowledge through intergenerational processes of education and culture (Stiegler, 2018a, b) gain relevance. Technology reminds us of the rational human response to making life better, and in that offers hope for the future. The pathologies of the current systems of organizational networks need not be externalized, instead they could offer valuable information for transforming these into possibilities for innovation (Callon, 1998a). However, how does one prevent this performance from being reduced to a mere act of what Mirowski and Nik-Khah (2008) describe as 'social engineering', but embrace a collective consciousness? In this context, innovative organizing requires the ability to initiate a multi-scaled and complexly developed set of related strategies and technics to acknowledge the planetary crisis where possibilities for continuous establishment and reconfiguration of networks revolve around the idea of value as contributory rather than extractive.

The Internet offered this possibility but the existing network configurations have allowed it to be increasingly leveraged for concentrating market power (Khan & Vaheesan, 2017), and carry forward normative justification of markets into settings that appear like markets but operate more like control infrastructures (Viljoen et al., 2021). Vergne (2020) has suggested decentralizing through dispersion of coordinated communications within organizations as well as distributing through dispersion of organizational decision-making to avoid the pitfalls of dystopia created by dominant platform oligopolies and regulations at the level of data for better social outcomes. Blockchain enables forms of organizing that are both decentralized and distributed (Vergne, 2020) and presents opportunities for creating open innovation networks capable of engaging with planetary level challenges (Narayan & Tidström, 2019b) that require a higher order form of coordination of information and knowledge about information and knowledge (Allen & Potts, 2016). The notion of distribution builds network resiliency, such networks are optimized for efficiency but to be resilient to external shocks and decentralized builds a notion of freedom from centralized control (Vergne, 2020). In a setting that combines these two features, the information and knowledge about the various facets of the planetary crisis could be addressed through subjective interactions with information and knowledge (Narayan & Tidström, 2019b).

Features and mechanisms of the blockchain that support decentralization and distribution makes the existence of this setting viable as they allow creative combinations that match subjective needs with available resources (Narayan & Tidström, 2019b). The features enable new mechanisms for coordinating various combinations of skills, capabilities, and knowledge across open innovation networks, and contextualize the value creating potential of such combinations. A distributed and decentralized vision of organizing can leverage blockchains for addressing the inherent complexity and interconnectedness of challenges related to sustainability (Narayan & Tidström, 2019b). A vision that CE embodies as is evident in the socio-technical imaginaries as it emerges through the stories of practice (Narayan & Tidström, 2019a) but gets misplaced in implementation as the logics of the dominant and centralized energy regime create boundaries through entrenched investments, behavioral patterns, vested interests, favorable subsidies, infrastructure, and regulations (Cillo et al., 2019; Unruh, 2000).

This presents a far deeper issue, one that requires a transition in how we understand products (Spring & Araujo, 2017). In drawing attention to the inherent instability of products, physically and institutionally, Spring and Araujo (2017) have urged for an approach that captures the process of stabilization through product biographies. With multiple product biographies unfolding and revealing value creation potentialities, the existing networks will require reconfiguring to reflect the decentralization of the product. Instead of one central authoritative understanding, the product can then be understood through the various contexts by revealing information about its entire lifecycle. Turning the focus on the product makes it possible to visualize the webs of connections that enable its existence and this distributed information opens up spaces for innovative entrepreneurial opportunities at every transition point within the product's lifecycle (Narayan & Tidström, 2020a). Existing knowledge on coopetition related to how firms cooperate and compete simultaneously to create and capture value (Tidström & Rajala, 2016) offer a familiar framework to draw on for creating a bridge between what exists and the imagined future (Narayan & Tidström, 2020a; Narayan & Tidström, 2019a). From an organizational perspective, blockchain is best understood as an institutional or social technology for coordination made possible through tokens representing a wide variety of assets. As a bridging strategy, coopetition deployed on a blockchain helps realize the cyclical continuity that CE proposes, through tokens that help manage the value creation and appropriation associated with coopetition for creating CE ecosystems.

However, in interacting with the concept of value within the context of CE, coopetition models would need to transition from the current stages of value creation and appropriation to value creation and circulation. Doing so would bring

into focus what Hultman et al (2021) have described as the process through which products come into being. Including wider networks implicated in such products reveal how products are stabilized within an energy regime through entrenched investments, behavioral patterns, vested interests, favorable subsidies, infrastructure, and regulations (Cillo et al., 2019; Unruh, 2000). For instance, coopetition is such a mechanism that in combination with applications made possible through blockchain offers the potential for experimenting with diverse energy regimes that incorporate the rich ecologies of planetary life. The diversity of energy would enable new forms of investment, discover and acknowledge diverse behaviour, accommodate different interests that would subsidize them if required, through network configurations.

This form of decentralized and distributed organizing brings about a change in the cognitive representation of innovation, from relationships to a process of relations (Callon, 2017; Cochoy et al., 2016). A process of relations builds on what is known, giving due consideration to the intentional work that we do as humans, in addition, this work relates to the other systems we are co-dependent on, for instance the natural system, as well as the technologically enabled communities that globalization has created. It offers possibilities for developing a sense of becoming humans in continuous relationships with learning with our evolving environments. This includes digital ones, and leveraging digital intelligence for our well-being requires that we understand how the current paradigm of technological innovation as a driver of economic growth alone, limits its potential (Narayan, 2020). The knowledge, insights, impressions or analysis required for paying attention to well-being points to a larger frame of reference and the idea of commons is a good place to begin this process. A commons perspective directs attention towards those elements that are often externalized during organizational processes. Making these elements visible, changes how they are viewed and later integrated within these processes through networks.

Paying attention to something amplifies that context, thus affecting how we see and remember things that eventually inform our decision-making process (Narayan, 2020). For instance, the world of information is increasingly mediated by digital technologies with growing dependence on search-based AI, controlled by a selected group of firms with discrete understanding of the world, which they use to refer to real world objects without concerning themselves with the underlying ideas and thinking that describe them (Narayan, 2020). In facilitating the creation of data of information and resources, digital technologies like AI, could be far more effective when process of relations become part of the creative process (Narayan, 2020). However, it is important to consider that intelligence is retained in individual memories that are collectively held as knowledge,

transmitted across generations to stabilize conditions of human life (Stiegler, 2018b). These conditions that emerge as a struggle against the entropic effects of human behaviour, threaten all life not just human, and in that becomes a planetary crisis (Stiegler, 2018b) requiring an assemblage that is representative of all life, and technology becomes part of this assemblage by helping in building these process of relationships.

The objective, therefore, is offering a pragmatic approach where the role of business networks is not to be accurate ways of depicting what is, but what it could become. In turning the focus away from the representational dimension to a pragmatic one, this approach remains respectful of the network perspective while making transparent its practical implications. The network perspective in its entanglement with technology, science and industrialism is integral in understanding how the assemblage of a network of unexpected associations between heterogeneous elements, each of which is an active node that is no longer just a compliant intermediary (Latour, 2003) rejects the notion of externality (Callon, 1998b) and turns it into an innovation. However, if these innovations have so far contributed to progress in human living conditions in ways that are now threatening those conditions (Stiegler, 2018b) then this network perspective requires broadening (Möller et al., 2020) and active shaping (Nenonen & Storbacka, 2020), a form of innovation in itself. This process of innovation begins with visualizing networks as things or objects that offer other entities, in addition to humans, possibilities for relating their stories to account for their role in the being and becoming of these innovative networks. Technologies as part of this assemblage facilitate the decentralized and distributed form of organizing in rich and context-sensitive informational environments that reveal how entities embody information and energy, for imagining processes of innovative reconfigurations to transition to sustainable energy systems.

5.1.4 Consequences of planetary realism for business networks

Perceiving the interior vitality of the planet as well as its interconnecting exteriors, requires imagination to try on different kinds of realities, predict possible futures, experience other viewpoints. This understanding draws in a complex transdisciplinary project that links philosophy, sociology, anthropology, art, literature, politics, music, history, and the sciences. The rhizomatic method that this thesis applies accesses transdisciplinarity from within the disciplinary boundaries it is committed to and the promiscuity is possible because everything flows together on a planetary scale. The purpose of indulging in disciplinary promiscuity is to introduce more questions through unknown variables, than can

possibly be answered, while giving rise to potentiality and the emergence of possible ways of interacting, creating connections, and building and rebuilding relationships. This has consequences for how we can approach what is real, especially when it involves a process of transition, a liminal state where the past, present and the future come together in surprising and unexpected ways, and a thing, or object, in this case, business networks, is always more, excessive, and beyond their perceived qualities. This makes what is real, hard to grasp, and has to be approached indirectly (Harman, 2018) and this thesis has tried to conceptualize innovative organizing as a process to describe the possibilities.

The possibilities always exist for innovative combinations, but it is precisely in these combinations involving decisions related to what we think matters, dictate our choices. The transdisciplinary agenda is useful for making sense of this, it enables an interruption in one way of seeing through which another way of seeing opens up, what Stiegler (2018) refers to as a conversion of gaze. The process of conversion is critical and thinking in rhizomes help. Rhizomatic explorations reveal the function of desire which is directed towards structuring action by subjecting humans to the symbolic systems that are meaningful to them. This is exactly what Sitra does in invoking symbols that are meaningful to Finnish businesses, but the moment members of the business community encounter the activities associated with these symbols, they have to dissolve the concept of community and engage with the collective (Narayan & Tidström, 2019a). A similar function of desire structures the current economic system, and has given rise to cooperative mechanisms driving the structures referred to as innovation systems (Godin, 2010a; Freeman, 1987; Nelson, 1993), that have an important social and economic change in the twentieth century. However, as this desire has collapsed into drive, understood as profits for business networks, they have transformed into networks of remote action made possible with delocalized production units meant to form and remotely control massive markets through automated interconnected financial markets (Stiegler, 2019).

These processes of automated decision making in connecting with drive-based automatisms that control consumer markets, first through mass media and now through the data economy is contributing towards creating a hyper-industrialized society (Viljoen et al., 2021; Stiegler, 2019). The specific kind of management strategies that have aided and abetted these processes have led to what Alvesson and Spicer (2012, 1194–20) have described as a form of functional stupidity. Yet these new technologies also interrupt and suspend social rules and behaviors that underpin the success of these drive-based control systems, thereby destroying those social systems (Stiegler, 2019). This presents an opportunity, and firms have the possibility to use this crisis to shape their environments by focusing on building

appropriate network configurations by paying attention to specific needs that have been ignored or emerge during such periods (Nenonen & Storbacka, 2020). As this implies imagining change as a system (Nenonen & Storbacka, 2020) the energy system that dominates modes of production and consumption through entanglement with social structures is a relevant place to pay attention (Floyd et al., 2020). The CE in explicitly referencing energy systems (Martin, 2020), offers a tangible arena for business networks to imagine change as a system through innovation processes. Imagining this change and operationalizing the innovation processes effectively integrates technology into culture through imaginaries, making it possible to account for and become aware of both the realities, ones that are core to business activities and those that are external to them. Imaginaries flatten the understanding of reality through inclusiveness that can be accessed in existing ideas of the commons, where technologies are deployed for leveraging and combining context specific needs. The astute observation by a manager reflecting on the packaging company's recycling journey captures this managerial reality of orchestrating, 'Our business is to produce or manufacture the packaging material and recycling is not our business, but it is our business to make recycling work' (Narayan & Tidström, 2020b, p. 887).

Flattening reality has consequences, for instance, apart from being uncertain due to the introduction of diverse actors thus increasing complexity, it challenges dominant power structures. This need not be surprising, as new forms of organizations are quite consistent in forcing new realities to take shape by challenging powerful actors by deploying new technologies and the creation of Bitcoin is the latest example that is actively taking on the centralized platform model (Vergne, 2020). However, this centralized platform has been stabilized through a single energy source with its own assemblages and this is clearly visible through the CE. The CE reveal the assemblages that constitute business networks through activities that demand a constant influx of low-entropy energy and matter to remain productive, and the consequent value embodied in a product (Cederlöf, 2021; Narayan & Tidström, 2020a). This is primarily why the energy intensity of Bitcoin and other cryptocurrencies have evoked a critical discussion as the consumption and the consequences of enabling transactions based on current energy infrastructures creates additional stresses on our already fragile environment (de Vries, 2020; Krause & Tolaymat, 2018; Truby, 2018). Mere transitioning to renewable energy does not resolve this issue (de Vries, 2020) as is increasingly becoming clear in CE models as well (Levänen et al., 2021).

The system boundaries that enable organizational activities to stabilize with the help of energy begin to represent cultural artefacts or products that sustain certain worldviews (Cederlof & Hornborg, 2021). These boundaries and the related

worldviews obscure the energy implicated in the material relations and the socially uneven flows that is embodied in these artifacts (Cederlof & Hornborg, 2021). Uncovering this information in the relations and flows through product biographies could offer possibilities for innovative organizational models for transitions through applications on the blockchain by incorporating contextual, localized and decentralized interactions between energy and information (Narayan & Tidström, 2020a). The information rich environments push for a cognitive reconfiguration of society that turns human connectivity into a process of semiotic emergence guided by semiotic scaffolding, that makes it viable to change as a system. Information understood as a digital object is contingent as an object of knowledge, and its value lies within modes of interactions and reveals itself according to the different modes of functionalities, thus going beyond the idea of cybernetic 'control' (Hui, 2020, 2012). This puts such information beyond any single point of control, as on its own it has no value, it is only in the interactions that opportunities for discovering and developing unexpected value propositions emerge. For business networks this could be explored by discovering value in diverse forms of organizing, as the possibilities of value creation emerge in these information rich contexts. By leveraging contextual intelligence, blockchains applications enable innovative organizational forms to address information and incentive problems within contexts through a diversity of contracts, transactions, resource attributes, ownership, knowledge, and governance (Narayan & Tidström, 2019b; Narayan & Tidström, 2020a).

However, value creation is a complex relationship building process where new ideas have to consider existing perceptions of value while simultaneously building a coalition for creating new network combinations to realize undiscovered value (Narayan, 2020). For business networks this is a simultaneous process involving an internal way of being, while extending and exceeding outwards. As these dynamic interplays are shaped by social, economic, political, cultural, and psychological processes where the general societal discourses maintain the need for economic growth as the cornerstones of success, this influences how well-being is understood (Narayan, 2020). Here, technologies like AI offer tools for businesses to shape these interplays where the entanglement of economic, social and environmental well-being becomes explicit. Expanding the network perspective, in this context, is an expansion of knowledge, and activities associated with such growth involve severing some connections and forging others (Potts, 2001). From what it is, the focus shifts towards what would it like to be, and in that organizing as a process is a constant creation of identity and sometimes certain connections and relationships serve as a reminder of what motivates this movement (Bakken & Hernes, 2006), somewhat akin to toxic relationships. Here, the concept of degrowth (Kerschner et al., 2018; Kallis, 2013; Kallis et al., 2012) is

valuable mainly because it forces a reckoning with choices in what needs to degrow. These choices embody decisions that reflect contextual combinations of energy and information and are inherently ethical, and technologies are not mere instruments but purposeful in making the combinations and further coordination between these combinations happen.

5.1.5 A future network of commons

The business network approach through its empirical pictures of interdependent actors, exchange of specific and heterogenous exchange of resources, whose value remains unknown unless understood through interactions, offer important insights into efficiency and innovation of firms as well as the business landscape (Waluszewski et al., 2019). This approach pertains to a community whose specific interest remains within activities related to business. In doing so, it embodies features of networks that do not operate in common interest, and do not provide same opportunities for all those related to it, and therefore non-transparent and have no intrinsic fairness (Waluszewski et al., 2019). The question then is, how can this be addressed, and the thesis offers that by turning the attention of networks towards changes required for transitioning towards sustainable energy systems, to help navigate from the concept of community towards a collective understood as commons. The activities related to transitioning from community towards a commons could create an understanding of the aspects of the interactive process an innovation itself, as it implies changing as a system. Changing as a system, whether understood as families, groups, organizations, institutions, markets, technologies or ecologies, makes complexity inherent within and amongst these categories, making them multi-level, coevolutionary mass of interconnected learning entities within which pending and actual innovation is a permanent feature (Allen, 2015). Here desire transforms into a motivational force where theorizing itself is geared towards integrating contradictory evidence, not merely for critique but for renewing foundations and defending the foundations (Clegg et al., 2020) in this case, that of network perspective.

Negotiating this change requires an approach for unpacking the narratives that dominate and therefore sustain and reproduce the same problems, and telling of new stories that articulate possibilities for creating new system states offer the opportunity to break out of this narrative cycle. In addition, process thought encourages a diversity of perspectives when considering change; it could be understood as a state of being where paradoxes are allowed to coexist while navigating a shift from one paradigm towards another, similar to how science evolves – through the resolution of contradictions. Transdisciplinarity in this

context, is valuable for understanding and representing what Waluszewski et al (2019) describe as the role of interactivity and overall challenges such as globalization, climate change and environmental threats. This is what the thesis does by offering a narrative that captures the interactions between innovation, complexity, and technology for imagining transition pathways.

5.2 Contribution – Theoretical and methodological

Interdisciplinarity is at the heart of this thesis, therefore its main theoretical contribution is a creative combination of frameworks as tools for exploring complex issues related to sustainability. The combination is strategic, as interdisciplinarity enables an understanding of diverse contexts and thereby create empathy for diversity as well as the flexibility in exploring what innovative organizing for transitions could be. The theoretical encounters offered a set of conceptual tools for reassessing the ontological status of business networks in an environment of rapid socio-technical and environmental change and attendant complexity. Specifically, this relates to the possibilities for imagining a diversity of interactions through the discovery of innovative information combinations in the emerging digital information infrastructures. This presents a radically new perspective of innovative organizing for market shaping where technology is presented as a distinct and creative human response to contemporary challenges by acknowledging and assimilating them to addressing these challenges. Technology in this sense becomes a bridging mechanism for managing the continuously growing complexity of business networks, and a critical element of innovative organizing. In addition to creating an intellectual background for imagining what such innovative organizing could be, the theoretical tools also offer how such organizing could be made possible by expanding and renewing existing theoretical perspectives.

The book chapter, Circular economy inspired imaginaries for sustainable innovations' (Narayan & Tidström, 2019a) borrows the concept of imaginaries from STS (science and technology studies) to show how Circular Economy (CE) could become a catalyst for evoking existing values for enabling sustainable innovation. Imaginaries in STS are predominantly used to critique power discourses but, in this context, it was used to show how an intermediary that is also a quasi-state actor can use imaginaries constructively to create a narrative of change.

The second book chapter 'Blockchains for accelerating open innovation systems for sustainability transitions' (Narayan & Tidström, 2019b), was another

interdisciplinary endeavour that brought together literature on open innovation and transitions studies to build a bridge with the emerging literature on blockchain rooted in institutional and evolutionary economic theories, to explore the possibility of blockchains for addressing the inherent complexity and interconnectedness of challenges related to sustainability and how the features of blockchains could enable new coordination mechanisms for coordinating a distributed and decentralized vision of organizing.

The third article, 'Tokenizing coopetition in a blockchain for a transition to circular economy' (Narayan & Tidström, 2020a) combined strategy, circular economy, transition studies, business networks, blockchains and token economy to present a framework for operationalizing coopetition on a blockchain with token as an incentive for value creation and circulation. In addition to the creative combination of literature, the main contribution of this article was in the area of coopetition strategy where it showed that to facilitate such a model, the current stages of value creation and appropriation need to shift towards value creation and circulation.

The fourth article, 'Leveraging resource ecologies for sustainability transitions–a waste management case' (Narayan & Tidström, 2020b), introduced the role social intelligence in reconfiguring and redesigning current organizational systems to incorporate energetic efficiency. The idea of resource ecology is developed by problematizing the sustainability challenge from an energy transition perspective, drawn from science and technology studies (STS). The framing of sustainability from STS allowed for the development of a wider ecosystem perspective to capture the growing network of resource ties. This framing becomes useful for articulating how organizations develop the ability to identify and integrate diverse groups of actors to build an ecology of resources to address such inefficiency.

The fifth article, 'Leveraging Digital Intelligence for Community Well-Being' (Narayan, 2020) combined organizational studies, sustainability, transition studies, information systems, artificial intelligence, degrowth economics, and well-being literatures to investigate the potential for artificial intelligence (AI). Well-being is tied to an individual's cognitive and affective assessment of life, which considers the emotional reactions to events based on how satisfaction and fulfillment are discerned. This makes well-being dynamic, with subjective, social, and psychological dimensions, along with a state of being where human needs are met and one can act meaningfully. This highlights a relational element underlying social and community well-being. Taking a relational view helps in understanding how the subjective aspects of local life is not limited to the individual, but extends to ways in which people feel well together. This means, in addition to economic

value, technologies like AI offer potentialities for innovative social designs specific to communities and their understanding of well-being.

To show how the different articles resonate with each other, the research process delved into innovation studies, science and technology studies, management and organizational studies, to develop a narrative for making sense of the transition process. Drawing attention to the potentiality of innovation, complexity, and technology, addresses the limitation in understanding how technology interacts in shaping markets and innovation (Kaartemo & Nyström, 2021) and how change and process is subjective, and substances are not fixed entities (Lowe & Rod, 2018). The theoretical combinations become key to sensing the environment (Möller et al., 2020) for the purpose of shaping markets (Nenonen & Storbacka, 2021, 2020) required for transitioning towards sustainable energy systems.

The process of combining theoretical perspectives that leads to the theoretical contribution, also allows this thesis to make a methodological contribution through the introduction of the rhizome, a spontaneous and unpredictable means of making distant connections between heterogeneous elements. Rhizomes in embodying non-linearity and spontaneity are helpful devices for studying complex and interactive environments as they enable inclusion of neglected views and voices. Rhizomes pry open black boxes through their underlying connections and the interactions to create empathy for their process of becoming and in doing so offer appropriate tools for transformation and change.

5.3 Managerial implication

The most critical implication for managers, is the radical transformation of the managerial role. The kind of onto-epistemological turn that this thesis suggests has the possibility to impact how managers understand their environments. The interactions between innovation, complexity, and technology offer new imaginaries that could potentially usher in new ideas and forms of organizations and organizing. Such models will offer new insights into how and where value emerges as innovation processes evolve. The decentralization and distribution of firm activities that is inherent to this kind of transition process will require managers to reimagine work, as this work will depend on managerial creativity. There is an artificial duality that managers need time to reflect on, this duality is often reflected in narratives related to work and life, or personal and professional, when these elements are intricately linked. This was visible as managers during the workshops began engaging with circular economy. There was a realization that the work they do and the lives they value are intricately connected, and this

realization enabled them to value cooperative methods for circular economy models.

A similar process unfolded in the context of waste management as well, where managers, in order to develop social intelligence traversed across work and life boundaries to enable the organizational elements to coalesce into decentralized and distributed activities for managing waste. Individual entities matter as they embody the interactions that contribute to making them matter, and entities evolve through continuing interactions. This means that managerial practice needs to be based on assumptions that describe a systemic and processual view of organizing, and can be done by adopting an ecosystem perspective to broaden levels of analysis and emphasize interdependence. In doing so managers can develop abilities for seeing beyond organizational boundaries and perceive multiple tiers of stakeholders (human and non-human), activities, and social structures that impact their interactions.

Technology, in this context, becomes a managerial response to resolve the duality of inside and outside, personal and professional, work and life. This is evident from how information technologies are becoming key to decentralization and distribution of power and responsibility, for managing complexity. Here, the managerial need for control needs radical transformation, as does the managerial understanding of value. Digital technologies make it possible to, emphasize and deemphasize control depending on the context. Contextual focus enables the identification of the configurations that contribute to the creation of diverse forms of value. In this context, managerial learning is vital in reorienting as well as expanding traditional notions of control and value. The learning process needs to go beyond the dualities and embrace the process of living where the social, economic, and ecology is inextricably linked and the managerial role is identifying the contexts for interventions. This means the act of living, that include organization of economic life, will inevitably throw up challenges, which offer opportunities for innovative organization.

Innovative organizing, for managers, would require identifying and acknowledging the limits of current models and transforming them. Responses to crisis cannot be aimed at reinforcing an existing system. Such responses remain inadequate and become incompatible with the natural world, while consistently deepening inequality, and exacerbating conflicts, leading to fragility that creates conditions for another version of the crisis. For managers, the idea of risk, rooted in the loss of the business environment and what exists, often frame ideas and attitudes related to resilience and adaptation. This can create a bias towards preserving the very system instrumental in contributing to the factors that fuel fear

in the first place. Resilience and adaptation within such framings blind managers to the opportunities for shaping markets or joining forces to support such shaping. Each article, in some way suggests how managers could think about devising ways for understanding and designing strategies that leverage resilience and adaptation effectively to contribute to shaping markets or supporting such endeavors.

5.4 Limitations of the research

While this research process offers theoretical and methodological contributions and managerial implications by highlighting an alternative way of understanding networks, through a process of sensing the world as an interconnected whole, it also has a number of limitations. For instance, the key transition element in such sensing is to acknowledge the limitations of linear causality and embrace the complex mechanisms of feedback. In that sense, this research process itself, much like any unfolding process, is incomplete therefore inadequate because it is a process of continuous becoming. In that, this is really a work-in-progress.

This is especially true for a research project that aims to study change and transitions. Change is uncertain and transitions are complex processes, and what is presented in this thesis is just a tiny slice of the whole transition apparatus. For instance, both the empirical articles are specific to distinct geographical, social, cultural, and economic contexts. While the findings can be generalized and extrapolated across contexts, to some extent, the methods and aims will vary as contexts change. This is a clear limitation.

Further, the research's engagement with emerging technologies, and the imaginaries presented are speculative. Even though the speculation and imagination do not emerge out of nothing, in that, they are grounded in reality. However, there is always a possibility for failure of imagination when the organizing process veers into the territory of being fanciful (Weick, 2005). This possibility has not been addressed in the thesis. As the process of interactions grow the distinction between imagination and fancy will become clearer and offer opportunities for further reflections.

5.5 Suggestions for future research and conclusions

Technology is an important area for future research, as is law. They are important areas and the two are increasingly getting entwined especially as digital currencies and blockchain technologies start gaining prominence and becoming ubiquitous for addressing challenges related to the transitions to sustainable energy systems.

Such challenges are increasingly being framed and addressed through what are referred to as digital autonomous organizations (DAOs). In this context, it would be important and interesting to study how and if existing legal frameworks could contribute to the growing number of DAOs. As DAOs are community led, with evolving consensus mechanisms, they could offer new and innovative ways of organizing for shaping markets to address challenges related to transitioning to sustainable energy systems.

For business networks, these legal and organizational dimensions will become important as decentralized and distributed networks become increasingly common, and these networks adopt unique legal mechanisms to match their needs. Transdisciplinarity is key for building such a perspective as it helps in adding rich and novel insights to the highly complex global concerns, beginning with climate change and sustainability. It also extends into areas concerning science, technology, social problems and policy, education, and the arts, areas that are acknowledged implicitly, but remain underexplored, and offer interesting research pathways to explore.

References

Abadi, J., & Brunnermeier, M. (2018). Blockchain economics (No. w25407). National Bureau of Economic Research. Accessed July 24, 2019 from: https://scholar.princeton.edu/markus/publications/blockchain-economics.

Adams, R. J., Smart, P., & Huff, A. S. (2017). Shades of grey: guidelines for working with the grey literature in systematic reviews for management and organizational studies. International Journal of Management Reviews, 19(4), 432-454.

Adams, R., Jeanrenaud, S., Bessant, J., Denyer, D., & Overy, P. (2016). Sustainability-oriented innovation: A systematic review. International Journal of Management Reviews, 18 (2), 180-205.

Acemoglu, D., & Robinson, J. (2009). Foundations of societal inequality. Science, 326(5953), 678-679.

Acerbi, A., & Sacco, P. L. (2018). Folk-economic beliefs as 'evidential fiction': Putting the economic public discourse back on track. Behavioral and Brain Sciences,41, e159.

Adams, V., Murphy, M., & Clarke, A. E. (2009). Anticipation: Technoscience, life, affect, temporality. Subjectivity, 28(1), 246-265.

Adner, R. (2006). Match your innovation strategy to your innovation ecosystem. Harvard business review, 84(4), 98.

Agar, J. (2019). What is technology? Technology: critical history of a concept, by Eric Schatzberg, Chicago and London, University of Chicago Press, 2018, 352 pp., $27.45 (paperback), ISBN: 978-0-226-58383-9. Annals of Science, 1-6.

Ahl, A., Yarime, M., Goto, M., Chopra, S. S., Kumar, N. M., Tanakã, K., & Sagawa, D. (2020). Exploring blockchain for the energy transition: Opportunities and challenges based on a case study in Japan. Renewable and Sustainable Energy Reviews, 117, 109488.

Ahuja, G. (2000). Collaboration networks, structural holes, and innovation: A longitudinal study. Administrative science quarterly, 45(3), 425-455.

Alexander, S., & Floyd, J. (2018). Carbon civilisation and the energy descent future: Life beyond this brief anomaly. Simplicity Institute Publishing.

Aligica, P. D., & Tarko, V. (2012). Polycentricity: from Polanyi to Ostrom, and beyond. Governance, 25(2), 237-262.

Allen, D. W., Berg, C., Markey-Towler, B., Novak, M., & Potts, J. (2020a). Blockchain and the evolution of institutional technologies: Implications for innovation policy. Research Policy, 49(1), 103865.

Allen, D. W., Berg, C., Lane, A. M., & Potts, J. (2020b). Cryptodemocracy and its institutional possibilities. The Review of Austrian Economics, 33(3), 363-374.

Allen, S., Cunliffe, A. L., & Easterby-Smith, M. (2019). Understanding sustainability through the lens of ecocentric radical-reflexivity: Implications for management education. Journal of Business Ethics, 154(3), 781-795.

Allen, D., & Potts, J. (2016). How innovation commons contribute to discovering and developing new technologies. International Journal of the Commons, 10(2).

Allen, P. M. (2015). Evolution: complexity, uncertainty and innovation. In The evolution of economic and innovation systems (pp. 145-170). Springer, Cham.

Alvesson, M., & Spicer, A. (2012). A Stupidity-Based theory of organizations. Journal of management studies, 49(7), 1194-1220.

Alvesson, M. (1993). The play of metaphors. In John Hassard & Martin Parker (Eds.), Postmodernism and organizations. London: Sage.

Amin, A., & Cohendet, P. (1999). Learning and adaptation in decentralised business networks. Environment and Planning D: Society and Space, 17(1), 87-104.

Amis, J. M., Mair, J., & Munir, K. A. (2020). The organizational reproduction of inequality. Academy of Management Annals, 14(1), 195-230.

Andersen, P. H., Medlin, C. J., & Törnroos, J. Å. (2020). Re-appraising interaction and process for industrial network research: The future plunging mirror hall metaphor. Industrial Marketing Management, 91, 627-638.

Andersen, P. H., & Medlin, C. J. (2016). Transient commitments and dynamic business networking. Industrial Marketing Management, 58, 11-19.

Anderson, B. (2010). Preemption, precaution, preparedness: Anticipatory action and future geographies. Progress in Human geography, 34(6), 777-798.

Antonelli, C. (2017). Endogenous innovation: the creative response. Economics of Innovation and New Technology, 26(8), 689-718.

Antonelli, C. (2009). The economics of innovation: from the classical legacies to the economics of complexity. Economics of Innovation and New Technology, 18(7), 611-646.

Araujo, L., & Easton, G. (2012). Temporality in business networks: The role of narratives and management technologies. Industrial Marketing Management, 41(2), 312-318.

Araujo, L., Finch, J., & Kjellberg, H. (Eds.). (2010). Reconnecting marketing to markets. Oxford University Press.

Araujo, L. (2007). Markets, market-making and marketing. Marketing theory, 7(3), 211-226.

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

Arrow, K. J. (1971). The economic implications of learning by doing. In Readings in the Theory of Growth (pp. 131-149). Palgrave Macmillan, London.

Arrow, K. (1962). "Economics of Welfare and the Allocation of Resources for Invention," The Rate and Direction of Inventive Activity ed. R.R. Nelson Princeton: Princeton University Press.

Arthur, W. B. (2021). Foundations of complexity economics. Nature Reviews Physics, 1-10.

Arthur, W. B. (2014). Complexity and the Economy. Oxford University Press.

Arthur, W. B. (1999). Complexity and the economy. science, 284(5411), 107-109.

Asara, V., Otero, I., Demaria, F., & Corbera, E. (2015). Socially sustainable degrowth as a social–ecological transformation: repoliticizing sustainability. Sustainability Science, 10(3), 375-384.

Atkinson, A. B. (2015). Inequality: What can be done?. Harvard University Press.

Audebrand, L. K. (2010). Sustainability in strategic management education: The quest for new root metaphors. Academy of Management Learning & Education, 9(3), 413-428.

Augenstein, K., & Palzkill, A. (2016). The dilemma of incumbents in sustainability transitions: a narrative approach. Administrative Sciences, 6(1), 1.

Axelsson, B. (1992). Corporate Strategy Models and Networks - Diverging Perspectives. In B. Axelsson and G. Easton (eds.), Industrial Networks: A New View of Reality. Routledge. pp. 184-204.

Bakken, T., & Wiik, E. L. (2018). Ignorance and organization studies. Organization Studies, 39(8), 1109-1120.

Bakken, T., & Hernes, T. (2006). Organizing is both a verb and a noun: Weick meets Whitehead. Organization studies, 27(11), 1599-1616.

Bale, C. S., Varga, L., & Foxon, T. J. (2015). Energy and complexity: New ways forward. Applied Energy, 138, 150-159.

Baldwin, C. Y. (2018). Design rules, volume 2: how technology shapes organizations. Harvard Business School Research Paper Series, 19-042.

Banerjee, S. B., & Bonnefous, A. M. (2011). Stakeholder management and sustainability strategies in the French nuclear industry. Business strategy and the environment, 20(2), 124-140.

Bansal, P., & Song, H. C. (2017). Similar but not the same: Differentiating corporate sustainability from corporate responsibility. Academy of Management Annals, 11(1), 105-149.

Bansal, P., & Gao, J. (2006). Building the future by looking to the past: Examining research published on organizations and environment. Organization & environment, 19(4), 458-478.

Barad, K. (2014). Diffracting diffraction: cutting together-apart. Parallax 20(3): 168–187. DOI: 10.1080/13534645.2014.927623.

Barad, K (2011) Erasers and erasures: Pinch's unfortunate 'uncertainty principle'. Social Studies of Science 41(3): 443–454.

Barad, K. (2007). Meeting the Universe Halfway. Quantum Physics and the Entanglement of Matter and Meaning. Durham and London: Duke University Press.

Barad, K. (2003). Posthumanist performativity: toward an understanding of how matter comes to matter. Signs: Journal of Women in Culture and Society 28(3): 801–831. DOI: 10.1086/345321.

Barad, K (1996) Meeting the universe halfway: Realism and social constructivism without contradiction. In Nelson, LH, Nelson, J (eds) Feminism, Science and the Philosophy of Science. Dordrecht: Kluwer, pp. 161–194.

Barnard, C. I. (1968). The functions of the executive (Vol. 11). Harvard university press.

Barthes, R. (1986) The rustle of language. Oxford, Blackwell.

Beer, D. (2018). The data gaze: Capitalism, power and perception. Sage.

Beer, S. (1989). The viable system model. Viable Systems Model, Wiley, Chicester.

Beck, R., Müller-Bloch, C., & King, J. L. (2018). Governance in the blockchain economy: A framework and research agenda. Journal of the Association for Information Systems, 19(10), 1.

Beck, U. (2015). Emancipatory catastrophism: What does it mean to climate change and risk society?. Current Sociology, 63(1), 75-88.

Beck, U. (1992). From industrial society to the risk society: Questions of survival, social structure and ecological enlightenment. Theory, culture & society, 9(1), 97-123.

Beckert, J. (2021). The firm as an engine of imagination: Organizational prospection and the making of economic futures. *Organization Theory*, *2*(2), 26317877211005773.

Beckert, J. (2013). Capitalism as a system of expectations: Toward a sociological microfoundation of political economy. Politics & Society, 41(3), 323-350.

Beinhocker, E. D. (2020). Toward a New Ontological Framework for the Economic Good. Global Perspectives, 1(1).

Beinhocker, E. D. (2006). The origin of wealth: Evolution, complexity, and the radical remaking of economics. Harvard Business Press.

Bénabou, R., Falk, A., & Tirole, J. (2018). Narratives, imperatives, and moral reasoning. IZA Discussion Paper 11665, Bonn.

Bencherki, N., & Cooren, F. (2011). Having to be: The possessive constitution of organization. Human relations, 64(12), 1579-1607.

Bengtsson, M., & Kock, S. (2000). ”Coopetition” in business Networks—to cooperate and compete simultaneously. Industrial marketing management, 29(5), 411-426.

Benkler, Y., Faris, R., Roberts, H., & Zuckerman, E. (2017). Study: Breitbart-led right-wing media ecosystem altered broader media agenda. cjr.org. Retrieved from https://www.cjr.org/analysis/breitbart-media-trump-harvard-study.php.

Berg, C., Markey-Towler, B., Novak, M., & Potts, J. (2018). Blockchains evolving: Institutional and evolutionary economics perspectives. SSRN Electron. J, 3160428.

Bergek, A., Jacobsson, S., Carlsson, B., Lindmark, S., & Rickne, A. (2008). Analyzing the functional dynamics of technological innovation systems: A scheme of analysis. Research policy, 37(3), 407-429.

Berger, P. L. and T. Luchman (1966), Social Construction of Reality, New York: Doubleday.

Bergman, N. (2017). Stories of the future: Personal mobility innovation in the United Kingdom. Energy research & social science, 31, 184-193.

Berkers, E., & Geels, F. W. (2011). System innovation through stepwise reconfiguration: the case of technological transitions in Dutch greenhouse horticulture (1930–1980). Technology Analysis & Strategic Management, 23(3), 227-247.

Bessant, J., Alexander, A., Tsekouras, G., Rush, H., & Lamming, R. (2012). Developing innovation capability through learning networks. Journal of economic geography, 12(5), 1087-1112.

Bhidé, A. (2020). Making economics more useful: how technological eclecticism could help. Applied Economics, 52(26), 2862-2881.

Birch, K. (2020). Technoscience rent: Toward a theory of rentiership for technoscientific capitalism. Science, Technology, & Human Values, 45(1), 3-33.

Birch, K., Chiappetta, M., & Artyushina, A. (2020). The problem of innovation in technoscientific capitalism: data rentiership and the policy implications of turning personal digital data into a private asset. Policy Studies, 1-20.

Birch, E. L. (2017). Inclusion and innovation: The many forms of stakeholder engagement in habitat III. Cityscape, 19(2), 45-52.

Blackburn, S., & Pelling, M. (2018). The political impacts of adaptation actions: Social contracts, a research agenda. Wiley Interdisciplinary Reviews: Climate Change, 9(6), e549.

Blaug, R. (1999). The tyranny of the visible: Problems in the evaluation of anti-institutional radicalism. Organization, 6(1), 33-56.

Boden, D. (1994) The business of talk: Organizations in action. Cambridge: Polity Press.

Boje, D. M. (2021). Storytelling and Cybersemiotics. In Introduction to Cybersemiotics: A Transdisciplinary Perspective (pp. 421-443). Springer, Cham.

Boje, D.M., & Lundholt, M. W. (2018). Understanding organizational narrative-counter-narratives dynamics. Communication & Language at Work, 5(1), 18-29.

Boje, D. M., & Henderson, T. L. (Eds.). (2014). Being quantum: Ontological storytelling in the age of antenarrative. Cambridge Scholars Publishing.

Boje, D. M. (2011a). Storytelling and the Future of Organizations. London: Routledge.

Boje, D.M. (2011b) 'Introduction to agential antenarratives that shape the future of organizations', in Boje, D.M. (Ed.): 2011 Storytelling and the Future of Organizations. An Antenarrative Handbook, pp.1–19, Routledge, New York.

Boje, D. M. (2008). Storytelling Organizations. London: Sage.

Boje, D.M. (2001) Narrative Methods for Organizational and Communication Research, Sage, London, available at http://cbae.nmsu.edu/,dboje/papers/narrative_methods_intro.htm Accessed June 12, 2019.

Botta, A., Caverzasi, E., Russo, A., Gallegati, M., & Stiglitz, J. E. (2019). Inequality and finance in a rent economy. Journal of Economic Behavior & Organization.

Boyer, P., & Petersen, M. B. (2018). Folk-economic beliefs: An evolutionary cognitive model. Behavioral and Brain Sciences,41, e158.

Böhme, R., Christin, N., Edelman, B., & Moore, T. (2015). Bitcoin: Economics, technology, and governance. Journal of economic Perspectives, 29(2), 213-38.

Brimhall, K. C. (2019). Inclusion Is Important… But How Do I Include? Examining the Effects of Leader Engagement on Inclusion, Innovation, Job Satisfaction, and Perceived Quality of Care in a Diverse Nonprofit Health Care Organization. Nonprofit and Voluntary Sector Quarterly, 48(4), 716-737.

Brimhall, K. C., & Mor Barak, M. E. (2018). The critical role of workplace inclusion in fostering innovation, job satisfaction, and quality of care in a diverse human

service organization. Human Service Organizations: Management, Leadership & Governance, 42(5), 474-492.

Broadstock, D. C., Managi, S., Matousek, R., & Tzeremes, N. G. (2019). Does doing "good" always translate into doing "well"? An eco-efficiency perspective. Business Strategy and the Environment, 28(6), 1199-1217.

Brockway, P. E., Sorrell, S., Semieniuk, G., Heun, M. K., & Court, V. (2021). Energy efficiency and economy-wide rebound effects: A review of the evidence and its implications. Renewable and Sustainable Energy Reviews, 110781.

Buchanan, J. M., & Vanberg, V. J. (1994). The market as a creative process. The philosophy of economics: an anthology, 2, 315-335.

Bucher, J. (2019). The Overlooked Roots of Innovations: Exploring the Relevance of Imagination on Innovation Using Science Fiction. In Responsible, Sustainable, and Globally Aware Management in the Fourth Industrial Revolution (pp. 55-75). IGI Global.

Burrell, G., & Morgan, G. (1979). Sociological paradigms and organisational analysis: Elements of the sociology of corporate life. London, UK: Routledge.

Busch, J., Foxon, T. J., & Taylor, P. G. (2018). Designing industrial strategy for a low carbon transformation. Environmental Innovation and Societal Transitions, 29, 114-125.

Byrne, J., Martinez, C., & Ruggero, C. (2009). Relocating energy in the social commons: Ideas for a sustainable energy utility. Bulletin of Science, Technology & Society, 29(2), 81-94.

Byrne, J., & Yun, S. J. (1999). Efficient global warming: Contradictions in liberal democratic responses to global environmental problems. Bulletin of Science, Technology & Society, 19(6), 493-500.

Cannon-Bowers, J. A., Tannenbaum, S. I., Salas, E., & Volpe, C. E. (1995). Defining competencies and establishing team training requirements. Team effectiveness and decision making in organizations, 333, 380.

Callon, M. (2017). Markets, marketization and innovation. In The Elgar companion to innovation and knowledge creation. Edward Elgar Publishing.

Callon, M. (2016). Revisiting marketization: from interface-markets to market-agencements. Consumption Markets & Culture, 19(1), 17-37.

Callon, M. (2009). Civilizing markets: Carbon trading between in vitro and in vivo experiments. Accounting, organizations and society, 34(3-4), 535-548.

Callon, M. (2007a) "What Does It Mean to Say that Economics Is Performative?," in D. MacKenzie, F. Muniesa, and L. Siu (eds.), Do Economists Make Markets? On the Performativity of Economics. Princeton: Princeton University Press.

Callon, M. (2007b). An essay on the growing contribution of economic markets to the proliferation of the social. Theory, Culture & Society, 24(7-8), 139-163.

Callon, M. (2004). The role of hybrid communities and socio-technical arrangements in the participatory design. Journal of the center for information studies, 5(3), 3-10.

Callon, M. (1998a). An essay on framing and overflowing: economic externalities revisited by sociology. The Sociological Review, 46(1_suppl), 244-269.

Callon, M. (1998b). "Introduction: the Embeddedness of Economic Markets in Economics," in M. Callon (ed.), The Laws of the Markets. Oxford: Blackwell; Keele: The Sociological Review.

Cantwell, J. (2005). Innovation and competitiveness. The Oxford handbook of innovation, 543-567.

Carroll, G. R. (1998) Ecological Models of Organizations. Ballinger, Cambridge, MA (1988).

Callon, M. (1987). Society in the making: the study of technology as a tool for sociological analysis. The social construction of technological systems: New directions in the sociology and history of technology, 83-103.

Campbell, T. (2010). Justice (3rd ed.). Basingstoke, England: Palgrave Macmillan.

Castells, M. (2016). 75. Networks of Outrage and Hope: Social Movements in the Internet Age. In Democracy (pp. 433-435). Columbia University Press.

Castoriadis, C. (1987). The Imaginary Constitution of Society, translated by Kathleen Blamey. Cambridge, Mass.: MIT Press.

Cederlöf, G., & Hornborg, A. (2021). System boundaries as epistemological and ethnographic problems: Assessing energy technology and socio-environmental impact. Journal of Political Ecology, 28(1), 111-123.

Cederlöf, G. (2021). Out of steam: Energy, materiality, and political ecology. Progress in Human Geography, 45(1), 70-87.

Chakrabarti, R., Henneberg, S.C. and Ivens, B.S. (2020), "Open sustainability: conceptualization and considerations", Industrial Marketing Management, Vol. 89, pp. 528-534.

Chari, V. V., Kehoe, P. J., & McGrattan, E. R. (2009). New Keynesian models: not yet useful for policy analysis. American Economic Journal: Macroeconomics, 1(1), 242-66.

Cherrier, B., & Saïdi, A. (2020). A century of economics and engineering at Stanford. History of Political Economy, 52(S1), 85-111.

Chesbrough, H. W. (2003). Open innovation: The new imperative for creating and profiting from technology. Harvard Business Press.

Chia, R. (1999). A 'rhizomic'model of organizational change and transformation: Perspective from a metaphysics of change. British journal of management, 10(3), 209-227.

Chouinard, Y., Ellison, J., & Ridgeway, R. (2011). The sustainable economy. Harvard Business Review, 89(10), 52-62.

Cillo, V., Petruzzelli, A. M., Ardito, L., & Del Giudice, M. (2019). Understanding sustainable innovation: A systematic literature review. Corporate Social Responsibility and Environmental Management, 26(5), 1012-1025.

Cinner, J. E., Barnes, M. L., Gurney, G. G., Lockie, S., & Rojas, C. (2021). Markets and the crowding out of conservation-relevant behavior. Conservation Biology, 35(3), 816-823.

Clapp, J., & Purugganan, J. (2020). Contextualizing corporate control in the agrifood and extractive sectors. Globalizations, 17(7), 1265-1275.

Clapp, J. (2019). The rise of financial investment and common ownership in global agrifood firms. Review of International Political Economy, 26(4), 604-629.

Clark, A., & Chalmers, D. (1998). The extended mind. analysis, 58(1), 7-19.

Clegg, S., Cunha, M. P. E., & Berti, M. (2020). Research movements and theorizing dynamics in management and organization studies. Academy of Management Review, (ja).

Cloutier, C., & Langley, A. (2020). What makes a process theoretical contribution? Organization Theory, 1(1), https://doi.org/10.1177/2631787720902473.

Cochoy, F., Trompette, P., & Araujo, L. (2016), "From market agencements to market agencing: an introduction", Consumption Markets & Culture, Vol. 19 No. 1, pp. 3-16.

Cochoy, F. (1998). Another discipline for the market economy: marketing as a performative knowledge and know-how for capitalism. The Sociological Review, 46(1_suppl), 194-221.

Coe, N. M., Dicken, P., & Hess, M. (2008). Global production networks: realizing the potential. Journal of economic geography, 8(3), 271-295.

Coenen, L., Benneworth, P., & Truffer, B. (2012). Toward a spatial perspective on sustainability transitions. Research policy, 41(6), 968-979.

Colander, D., & Kupers, R. (2016). Complexity and the art of public policy: Solving society's problems from the bottom up. Princeton University Press.

Cole, D. R. (2013). Lost in data space: Using nomadic analysis to perform social science. Deleuze and research methodologies, 219-237.

Collins, R. (1981). On the microfoundations of macrosociology. American journal of sociology, 86(5), 984-1014.

Contractor, F. J., & Lorange, P. (2002). The growth of alliances in the knowledge-based economy. International Business Review, 11(4), 485-502.

Conley, J. M., Lambright, C. S., Evans, N., Strynar, M. J., McCord, J., McIntyre, B. S., ... & Gray Jr, L. E. (2019). Adverse maternal, fetal, and postnatal effects of hexafluoropropylene oxide dimer acid (GenX) from oral gestational exposure in Sprague-Dawley rats. Environmental health perspectives, 127(3), 037008.

Cornelissen, J., Höllerer, M. A., & Seidl, D. (2021). What theory is and can be: Forms of theorizing in organizational scholarship. Organization Theory, 2(3), 26317877211020328.

Cornelissen, J. P., Oswick, C., Christensen, L. T., & Phillips, N. (2008). Metaphor in organizational research: An introduction, synthesis, and implications for research. Organization Studies, 29(1), 7-22.

Cova, B., Pardo, C., Salle, R., & Spencer, R. (2015). Normal vs spectacular science: The IMP Group and BtoB marketing. Industrial Marketing Management, 49, 80-83.

Cova, B., & Svanfeldt, C. (1993). Societal innovations and the postmodern aestheticization of everyday life. International Journal of Research in Marketing, 10(3), 297-310.

Currie, W. L., & Lagoarde-Segot, T. (2017). Financialization and information technology: themes, issues and critical debates–part I. Journal of Information Technology, 32, 211-217.

Cusset, F. (2008). French theory: how Foucault, Derrida, Deleuze, & Co. transformed the intellectual life of the United States. U of Minnesota Press.

Cyert, R. M., & March, J. G. (1963). A behavioral theory of the firm (Vol. 2, No. 4, pp. 169-187).

Czarniawska, B. (2011). Narrating organization studies. Narrative Inquiry, 21(2), 337-344.

Daft, R. L. (1978). A dual-core model of organizational innovation. Academy of management journal, 21(2), 193-210.

D'Alisa, G., & Kallis, G. (2020). Degrowth and the State. Ecological economics, 169, 106486.

Davenport, T. H. (1994). Managing in the new world of process. Public Productivity & Management Review, 133-147.

Dean, T. J., Brown, R. L., & Bamford, C. E. (1998). Differences in large and small firm responses to environmental context: Strategic implications from a comparative analysis of business formations. Strategic management journal, 19(8), 709-728.

Debizet, G., Tabourdeau, A., Gauthier, C., & Menanteau, P. (2016). Spatial processes in urban energy transitions: considering an assemblage of Socio-Energetic Nodes. *Journal of cleaner production*, *134*, 330-341.

Deetz, S. (1996). Crossroads—Describing differences in approaches to organization science: Rethinking Burrell and Morgan and their legacy. Organization science, 7(2), 191-207.

Deleuze, G. (1988). Spinoza: Practical Philosophy. San Francisco, CA: City Lights.

Deleuze, G. (1994). Difference and repetition. Columbia University Press.

Deleuze, G., & Guattari, F. (1991). What is philosophy? Columbia University Press.

Deleuze, G. (1993). The fold: Leibniz and the Baroque. University of Minnesota Press.

Deleuze, G., & Guattari, F. (1987). A thousand plateaus: Capitalism and schizophrenia (B. Massumi, Trans.). Minneapolis: University of Minnesota Press. (Original work published 1980)

Deleuze, G., & Parnet, C. (1987). Dialogues (trans. H Tomlinson and B Habberjam). New York: Columbia University Press.

De Angelis, R., & Ianulardo, G. (2020). Circular Economy as Fictional Expectation to Overcome Societal Addictions. Where Do We Stand?. Philosophy of Management, 1-21.

De Filippi, P. (2016). The interplay between decentralization and privacy: the case of blockchain technologies. Journal of Peer Production, Issue, (7).

De Filippi, P., & Loveluck, B. (2016). The invisible politics of bitcoin: governance crisis of a decentralized infrastructure. Internet policy review, 5(4).

DesJardine, M., & Bansal, P. (2019). One step forward, two steps back: How negative external evaluations can shorten organizational time horizons. Organization Science, 30(4), 761-780.

De Landa, M. (2000) 'Deleuze and the Open-ended Becoming of the World', pp. 1–10 in www.brown.edu/Departments/Watson_Institute/programs/gs/VirtualY2K/DeLanda.html.

DeLanda, M. (2016). Assemblage theory. Edinburgh University Press.

de Vries, A. (2020). Bitcoin's energy consumption is underestimated: A market dynamics approach. Energy Research & Social Science, 70, 101721.

de Vries, A. (2019). Renewable energy will not solve bitcoin's sustainability problem. Joule, 3(4), 893-898.

Dewald, U., & Truffer, B. (2011). Market Formation in Technological Innovation Systems—Diffusion of Photovoltaic Applications in Germany. Industry & Innovation, 18(3), 285–300. https://doi.org/10.1080/13662716.2011.561028.

Diaz Riuz, C. (2012). Theories of markets: Insights from marketing and the sociology of markets. The Marketing Review, 12(1).
https://doi.org/10.1362/146934712x13286274424316

Dijkstra, E. W. (1972). The humble programmer. Communications of the ACM, 15(10), 859–866

Di Silvestre, M. L., Favuzza, S., Sanseverino, E. R., & Zizzo, G. (2018). How Decarbonization, Digitalization and Decentralization are changing key power infrastructures. Renewable and Sustainable Energy Reviews, 93, 483-498.

Dodgson, M., Hughes, A., Foster, J., & Metcalfe, S. (2011). Systems thinking, market failure, and the development of innovation policy: The case of Australia. Research Policy, 40(9), 1145-1156.

Donaldson, T. (2021). How Values Ground Value Creation: The practical inference framework. Organization Theory, 2(4), 26317877211036712.

Dor, D. (2017). From experience to imagination: Language and its evolution as a social communication technology. Journal of Neurolinguistics, 43, 107-119.

Dosi, G. (2013). Innovation, evolution, and economics: where we are and where we should go. Fagerberg et al.(eds), 111-133.

Dosi, G., & Marengo, L. (2007). Perspective—on the evolutionary and behavioral theories of organizations: a tentative roadmap. Organization Science, 18(3), 491-502.

Dosi, G., & Orsenigo, L. (1988). Coordination and transformation: an overview of structures, behaviours and change in evolutionary environments. Technical change and economic theory, 13-37.

Dosi, G. (1982). Technological paradigms and technological trajectories: a suggested interpretation of the determinants and directions of technical change. Research policy, 11(3), 147-162.

Dougherty, D., & Dunne, D. D. (2011). Organizing ecologies of complex innovation. Organization Science, 22(5), 1214-1223.

Dougherty, D. (1992). Interpretive barriers to successful product innovation in large firms. Organization science, 3(2), 179-202.

Drucker, P. 2006. Innovation and Entrepreneurship. Collins, New York.

Dubois, A and P Fredriksson (2008). Cooperating and competing in supply networks: Making sense of a triadic sourcing strategy. Journal of Purchasing and Supply Management, 14(3), 170–179.

Dubois, A., & Araujo, L. (2006). The relationship between technical and organisational interfaces in product development. The IMP Journal, 1(1), 28-51.

Dunbar, R. (1992). Neocortex size as a constraint on group size in primates. Journal of Human Evolution, 22, 469–493.

Dyck, B., & Greidanus, N. S. (2017). Quantum sustainable organizing theory: A study of organization theory as if matter mattered. Journal of Management Inquiry, 26(1), 32-46.

Dyer, J. H., & Singh, H. (1998). The relational view: Cooperative strategy and sources of interorganizational competitive advantage. Academy of management review, 23(4), 660-679.

Easterlin, R. A. (2015). Happiness and economic growth–the evidence. In Global handbook of quality of life (pp. 283-299). Springer, Dordrecht.

Edler, J., & Fagerberg, J. (2017). Innovation policy: what, why, and how. Oxford Review of Economic Policy, 33(1), 2-23.

Edwards, M. G., Alcaraz, J. M., & Cornell, S. E. (2021). Management education and earth system science: Transformation as if planetary boundaries mattered. Business & society, 60(1), 26-56.

Elish, M. C., & Boyd, D. (2018). Situating methods in the magic of Big Data and AI. Communication monographs, 85(1), 57-80.

EMF (Ellen MacArthur Foundation). (2015). Towards a circular economy: Business rational for an accelerated transition. http://www.ellenmacarthurfoundation.org/business/reports Accessed December 14, 2016.

Epstein, G. A., & Jayadev, A. (2005). The rise of rentier incomes in OECD countries: financialization, central bank policy and labor solidarity. Financialization and the world economy, 39, 46-74.

Essén, A., Knudsen, M., & Alvesson, M. (2021). Explaining Ignoring–Working with Information that Nobody Uses. Organization Studies, 0170840621998720.

Fagerberg, J. (2018). Mobilizing innovation for sustainability transitions: A comment on transformative innovation policy. Research Policy, 47(9), 1568-1576.

Fagerberg, J. (2007). A guide to Schumpeter. Confluence: Interdisciplinary Communications, 2008, 20-22.

Fagerberg, J., & Verspagen, B. (2002). Technology-gaps, innovation-diffusion and transformation: an evolutionary interpretation. Research policy, 31(8-9), 1291-1304.

Fagerberg, J. (1994). Technology and international differences in growth rates. Journal of economic Literature, 32(3), 1147-1175.

Featherstone, M. (2020). Stiegler's ecological thought: The politics of knowledge in the anthropocene. Educational Philosophy and Theory, 52(4), 409-419.

Fenton, C., & Langley, A. (2011). Strategy as practice and the narrative turn. Organization studies, 32(9), 1171-1196.

Feola, G. (2020). Capitalism in sustainability transitions research: Time for a critical turn?. Environmental Innovation and Societal Transitions, 35, 241-250.

Ferraro, F., Etzion, D., & Gehman, J. (2015). Tackling grand challenges pragmatically: Robust action revisited. Organization Studies, 36(3), 363-390.

Ferraro, F., Pfeffer, J., & Sutton, R. I. (2005). Economics language and assumptions: How theories can become self-fulfilling. Academy of Management review, 30(1), 8-24.

Finke, T., Gilchrist, A., & Mouzas, S. (2016). Why companies fail to respond to climate change: Collective inaction as an outcome of barriers to interaction. Industrial Marketing Management, 58, 94-101.

Fink, G., & Yolles, M. (2012). Narratives, paradigms and change–the issue of relevance. European Journal of Cross-Cultural Competence and Management, 2(3-4), 191-208.

Fjeldstad, Ø. D., Snow, C. C., Miles, R. E., & Lettl, C. (2012). The architecture of collaboration. Strategic management journal, 33(6), 734-750.

Flammang, J. A. (2009). The taste for civilization: Food, politics, and civil society. University of Illinois Press.

Floridi, L. (2019). The green and the blue: naïve ideas to improve politics in a mature information society. In The 2018 yearbook of the digital ethics lab (pp. 183-221). Springer, Cham.

Floridi, L. (2014). The fourth revolution: How the infosphere is reshaping human reality. OUP Oxford.

Floridi, L. (2009). The information society and its philosophy: Introduction to the special issue on "the Philosophy of Information, its Nature, and future developments". The Information Society, 25(3), 153-158.

Floyd, J., Alexander, S., Lenzen, M., Moriarty, P., Palmer, G., Chandra-Shekeran, S., ... & Keyßer, L. (2020). Energy descent as a post-carbon transition scenario: How 'knowledge humility'reshapes energy futures for post-normal times. Futures, 122, 102565.

Folke, C., Biggs, R., Norström, A. V., Reyers, B., & Rockström, J. (2016). Social-ecological resilience and biosphere-based sustainability science. Ecology and Society, 21(3).

Follet, M. P. (1949). Freedom and Co-ordination: Lectures in Business Organization, edited and with introduction by Lionel Urwick. London: Management Publications Trust

Ford, D., Mattsson, L. G., & Snehota, I. (2017). Management in the interactive business world. In No Business is an Island. Emerald Publishing Limited.

Ford, D., & Mouzas, S. (2008). Is there any hope? The idea of strategy in business networks. Australasian Marketing Journal, 16(1), 64-78.

Ford, D., Gadde, L. E., Håkansson, H., Snehota, I., & Waluszewski, A. (2008, September). Analysing business interaction. In 24th IMP Conference, Uppsala (pp. 1-37).

Ford, D. & Håkansson H. (2006). IMP: Some Things Done, Much More to Do. European Journal of Marketing. 40(3-4), pp. 248-258.

Foxon, T. J., Köhler, J., Michie, J., & Oughton, C. (2013). Towards a new complexity economics for sustainability. Cambridge journal of economics, 37(1), 187-208.

Frambach, R. T., Barkema, H. G., Nooteboom, B., & Wedel, M. (1998). Adoption of a service innovation in the business market: an empirical test of supply-side variables. Journal of business research, 41(2), 161-174.

Franz, M., Schlitz, N., & Schumacher, K. P. (2018). Globalization and the water-energy-food nexus–Using the global production networks approach to analyze society-environment relations. *Environmental Science & Policy*, *90*, 201-212.

Freeman, C., & Soete, L. (2009). Developing science, technology and innovation indicators: What we can learn from the past. Research policy, 38(4), 583-589.

Freeman, C. (2002). Continental, national and sub-national innovation systems—complementarity and economic growth. Research policy, 31(2), 191-211.

Freeman, C., & Soete, L. (1997). The economics of industrial innovation. Psychology Press.

Freeman, C. & Perez, C. (1989). Structural crises of adjustment: business cycles and investment behaviour. In: Dosi, G. (ed.), Technical Change and Economic Theory. London: Frances Pinter. pp. 39–66.

Freeman, C. (1987). Technology, Policy, and Economic Performance: Lessons from Japan. Frances Pinter, London.

Freeman, C. (1979). The determinants of innovation: Market demand, technology, and the response to social problems. Futures, 11(3), 206-215.

Freeman, C. (1974). The Economics of Industrial Innovation. (1st ed.), Penguin, Harmondsworth.

Frenken, K. (2017). A complexity-theoretic perspective on innovation policy. Complexity, Innovation and Policy, 3(1), 35-47.

Fritsch, F., Emmett, J., Friedman, E., Kranjc, R., Manski, S., Zargham, M., & Bauwens, M. (2021). Challenges and Approaches to Scaling the Global Commons. Frontiers in Blockchain, 4, 9.

Fuentes, C. (2014). Green materialities: Marketing and the socio-material construction of green products. Business Strategy and the Environment, 23(2), 105-116.

Funk, R. J., & Hirschman, D. (2014). Derivatives and deregulation: Financial innovation and the demise of Glass–Steagall. Administrative science quarterly, 59(4), 669-704.

Gadde, L. E., Huemer, L., & Håkansson, H. (2003). Strategizing in industrial networks. Industrial marketing management, 32(5), 357-364.

Gamson, W. A., Croteau, D., Hoynes, W., & Sasson, T. (1992). Media images and the social construction of reality. Annual review of sociology, 18(1), 373-393.

Gans, H. (1979). Deciding what's news: A study of CBS Evening News, NBC Nightly News, Newsweek, and Time. New York, NY: Random House.

Gare, A. (2000). Philosophy, civilization, and the global ecological crisis: The challenge of process metaphysics to scientific materialism. Philosophy Today, 44(3), 283-294.

Garud, R., Berends, H., & Tuertscher, P. (2018). Qualitative approaches for studying innovation as process. In R. Mir & S. Jain (Eds.), Routledge Companion to Qualitative Research in Organization Studies (pp. 226–247). NY: Routledge.

Garud, R., Gehman, J., & Giuliani, A. P. (2014). Contextualizing entrepreneurial innovation: A narrative perspective. *Research Policy*, *43*(7), 1177-1188.

Garud, R., & Karnøe, P. (2003). Bricolage versus breakthrough: distributed and embedded agency in technology entrepreneurship. Research policy, 32(2), 277-300.

Garrett, T. J., Grasselli, M., & Keen, S. (2020). Past world economic production constrains current energy demands: Persistent scaling with implications for economic growth and climate change mitigation. Plos one, 15(8), e0237672.

Gao, J., & Bansal, P. (2013). Instrumental and integrative logics in business sustainability. Journal of Business Ethics, 112(2), 241-255.

Geels, F. W. (2020). Micro-foundations of the multi-level perspective on socio-technical transitions: Developing a multi-dimensional model of agency through crossovers between social constructivism, evolutionary economics and neo-institutional theory. Technological Forecasting and Social Change, 152, 119894.

Geels, F. W. (2019). Socio-technical transitions to sustainability: a review of criticisms and elaborations of the Multi-Level Perspective. Current Opinion in Environmental Sustainability, 39, 187-201.

Geels, F. W. (2011). The multi-level perspective on sustainability transitions: Responses to seven criticisms. Environmental innovation and societal transitions, 1(1), 24-40.

Geels, F. W. (2010). Ontologies, socio-technical transitions (to sustainability), and the multi-level perspective. Research policy, 39(4), 495-510.

Geels, F. W., Hekkert, M. P., & Jacobsson, S. (2008). The dynamics of sustainable innovation journeys.

Geels, F. W., & Schot, J. (2007). Typology of sociotechnical transition pathways. Research policy, 36(3), 399-417.

Geels, F. W. (2004). From sectoral systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory. Research Policy, 33(6–7), 897–920. https://doi.org/10.1016/j.respol.2004.01.015

Geels, F. W., Elzen, B., & Green, K. (2004). General introduction: system innovation and transitions to sustainability. System innovation and the transition to sustainability, 1-16.

Geels, F. W. (2002). Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. Research policy, 31(8-9), 1257-1274.

Gehl, K. M., & Porter, M. E. (2020). The politics industry: How political innovation can break partisan gridlock and save our democracy. Harvard Business Press.

Gehman, J., Etzion, D., & Ferraro, F. (2022). Robust action: Advancing a distinctive approach to grand challenges. In *Organizing for societal grand challenges*. Emerald Publishing Limited.

Geiger, S., Harrison, D., Kjellberg, H., & Mallard, A. (Eds.). (2014). Concerned markets: Economic ordering for multiple values. Edward Elgar Publishing.

Geissdoerfer, M., Savaget, P., Bocken, N. M., & Hultink, E. J. (2017). The Circular Economy–A new sustainability paradigm?. Journal of cleaner production, 143, 757-768.

Georgescu-Roegen, N. (1971). The Entropy Law and the Economic Process, Cambridge, MA, Harvard University Press.

Gereffi, G., Humphrey, J., & Sturgeon, T. (2005). The governance of global value chains. Review of international political economy, 12(1), 78-104.

Ghoshal, S. (2005). Bad management theories are destroying good management practices. Academy of Management learning & education, 4(1), 75-91.

Ghoshal, S., & Moran, P. (1996). Bad for practice: A critique of the transaction cost theory. Academy of management Review, 21(1), 13-47.

Gilson, L. L., & Goldberg, C. B. (2015). Editors' comment: so, what is a conceptual paper?. Group & Organization Management, 40(2), 127-130.

Giuliani, E. (2018). Regulating global capitalism amid rampant corporate wrongdoing—Reply to "Three frames for innovation policy". Research Policy, 47(9), 1577-1582.

Gnyawali, D. R., & Madhavan, R. (2001). Cooperative networks and competitive dynamics: A structural embeddedness perspective. Academy of Management review, 26(3), 431-445.

Godenhjelm, S., & Johanson, J. E. (2018). The effect of stakeholder inclusion on public sector project innovation. International Review of Administrative Sciences, 84(1), 42-62.

Godin, B. (2010a). National innovation system: a note on the origins of a concept, Project on the Intellectual History of Innovation, Montreal, Quebec.

Godin, B. (2010b). Meddle not with them that are given to change": Innovation as evil. Project on the Intellectual History of Innovation, paper, 6.

Graham, M., & Dutton, W. H. (Eds.). (2019). Society and the internet: How networks of information and communication are changing our lives. Oxford University Press.

Grandjean, P., Heilmann, C., Weihe, P., Nielsen, F., Mogensen, U. B., Timmermann, A., & Budtz-Jørgensen, E. (2017). Estimated exposures to perfluorinated compounds in infancy predict attenuated vaccine antibody concentrations at age 5-years. Journal of immunotoxicology, 14(1), 188-195.

Grin, J., Rotmans, J., & Schot, J. (2010). Transitions to sustainable development: new directions in the study of long-term transformative change. Routledge.

Grubb, M., Hourcade, J. C., & Neuhoff, K. (2015). The Three Domains structure of energy-climate transitions. Technological Forecasting and Social Change, 98, 290-302.

Guattari, F. (2000). The Three Ecologies. London and New Brunswick, NJ: The Athlone Press.

Guercini, S., La Rocca, A., Runfola, A., & Snehota, I. (2014). Interaction behaviors in business relationships and heuristics: Issues for management and research agenda. Industrial Marketing Management, 43(6), 929-937.

Gümüsay, A. A., & Reinecke, J. (2021). Researching for desirable futures: From real utopias to imagining alternatives. Journal of Management Studies.

Guinea, O., & Erixon, F. (2019, January). Standing up for competition: Market concentration, regulation and Europe's quest for a new industrial policy. European Center for International Political Economy, ECIPE Occasional Paper. https://ecipe.org/publications/standing-up-for-competition/

Gupta, A. K., Tesluk, P. E., & Taylor, M. S. (2007). Innovation at and across multiple levels of analysis. Organization science, 18(6), 885-897.

Hadjikhani, A., & LaPlaca, P. (2013). Development of B2B marketing theory. Industrial Marketing Management, 42(3), 294-305.

Hahn, T., Pinkse, J., Preuss, L., & Figge, F. (2015). Tensions in corporate sustainability: Towards an integrative framework. Journal of Business Ethics, 127(2), 297-316.

Hahn, T., Preuss, L., Pinkse, J., & Figge, F. (2014). Cognitive frames in corporate sustainability: Managerial sensemaking with paradoxical and business case frames. Academy of management review, 39(4), 463-487.

Hajer, M. A. (1995). The Politics of Environmental Discourse: Ecological Modernisation and the Policy Process Clarendon Press, Oxford.

Håkansson, H. and Prenkert, F. (2004) 'Exploring the Exchange Concept in Marketing', in H. Håkansson, D. Harrison and A. Waluszewski (eds) Rethinking Marketing. Developing a New Understanding of Markets, pp. 75–94. Chichester: John Wiley.

Halinen, A., Medlin, C. J., & Törnroos, J. Å. (2012). Time and process in business network research. Industrial Marketing Management, 41(2), 215-223.

Hallin, A., Karrbom-Gustavsson, T., & Dobers, P. (2021). Transition towards and of sustainability—Understanding sustainability as performative. Business Strategy and the Environment, 30(4), 1948-1957.

Hannan, M. T., & Freeman, J. (1989). Organizational ecology. Harvard university press.

Hanseth, O., & Lyytinen, K. (2016). Design theory for dynamic complexity in information infrastructures: the case of building internet. In Enacting Research Methods in Information Systems (pp. 104-142). Palgrave Macmillan, Cham.

Hanseth, O. (2010). From systems and tools to networks and infrastructures-from design to cultivation: Towards a design theory of information infrastructures. In Industrial informatics design, use and innovation: Perspectives and services (pp. 122-156). IGI Global.

Hanseth, O., & Ciborra, C. (Eds.). (2007). Risk, complexity and ICT. Edward Elgar Publishing.

Haraway, D. (2013). Simians, cyborgs, and women: The reinvention of nature. Routledge.

Harley, B., & Cornelissen, J. (2020). Rigor with or without templates? The pursuit of methodological rigor in qualitative research. Organizational Research Methods, 1094428120937786.

Harman, G. (2018). Object-oriented ontology: A new theory of everything. Penguin UK.

Harman, G. (2009). Prince of networks: Bruno Latour and metaphysics. re. press.

Hasegawa, T., Havlík, P., Frank, S., Palazzo, A., & Valin, H. (2019). Tackling food consumption inequality to fight hunger without pressuring the environment. Nature Sustainability, 2(9), 826-833.

Hart, S. L. (2010). Capitalism at the crossroads: Next generation business strategies for a post-crisis world. FT Press.

Hart, S. L., & Milstein, M. B. (1999). Global sustainability and the creative destruction of industries. MIT Sloan Management Review, 41(1), 23.

Hausmann, R., & Rodrik, D. (2003). Economic development as self-discovery. Journal of development Economics, 72(2), 603-633.

Hayek, F. A. (1948). Free enterprise and competitive order. Individualism and economic order, 107-18.

Hayek, F. A. (1945). The use of knowledge in society. The American economic review, 35(4), 519-530.

Håkansson, H., & Snehota, I. (Eds.). (2017). No business is an island: Making sense of the interactive business world. Emerald Group Publishing.

Håkansson, H. (2014). Corporate Technological Behaviour (Routledge Revivals): Co-operation and Networks. Routledge.

Håkansson, H. (2006). Business relationships and networks: consequences for economic policy. The Antitrust Bulletin, 51(1), 143-163.

Håkansson, H., & Waluszewski, A. (Eds.). (2007). Knowledge and innovation in business and industry: The importance of using others (Vol. 5). Routledge.

Håkansson, H., & Lundgren, A. (2006) Industrial Networks and Technological Innovation. Möller, K. E., & Wilson, D.T. (Eds.), Business Marketing: An Interaction and Network Perspective, Kluwer, Boston.

Håkansson, H., & Waluszewski, A. (2002). Path dependence: restricting or facilitating technical development? Journal of Business Research, 55(7), 561-570.

Håkansson, H., & Johanson, J. (1993). The network as a governance structure: interfirm cooperation beyond markets and hierarchies. Grabher, G. (Ed.), The embedded firm: On the socio-economics of industrial networks, Routledge, London, pp. 35-51.

Håkansson, H., & Johanson, J. (1992). A model of industrial networks. Axelsson, B., & Easton, G. (Eds.), Industrial networks: A new view of reality, Routledge, New York, pp. 28-34

Håkansson, H. (1987). Product development in networks. Technological development: A network approach, Croom Helm, London, pp. 84–127.

Håkansson, H. (Ed.). (1982). International marketing and purchasing of industrial goods: An interaction approach (Vol. 389). Chichester: Wiley.

Harwick, C. (2020). Inside and Outside Perspectives on Institutions: An Economic Theory of the Noble Lie. Journal of Contextual Economics, Forthcoming.

Heath, C., & Staudenmayer, N. (2000). Coordination neglect: How lay theories of organizing complicate coordination in organizations. Research in organizational behavior, 22, 153-191.

Heikkurinen, P., Clegg, S., Pinnington, A. H., Nicolopoulou, K., & Alcaraz, J. M. (2021). Managing the Anthropocene: Relational agency and power to respect planetary boundaries. Organization & Environment, 34(2), 267-286.

Heisenberg, W. K. (1958) Physics and philosophy. New York: Harper & Row.

Hekkert, M. P., Suurs, R. A. A., Negro, S. O., Kuhlmann, S., & Smits, R. E. H. M. (2007). Functions of innovation systems: A new approach for analysing technological change. Technological Forecasting and Social Change, 74(4), 413–432. https://doi.org/10.1016/j.techfore.2006.03.002

Hemment, D. (2018). Trust in invisible agents. Leonardo, 51(5), 450-450.

Henderson, J., Dicken, P., Hess, M., Coe, N., & Yeung, H. W. C. (2002). Global production networks and the analysis of economic development. Review of international political economy, 9(3), 436-464.

Hendrickson, M., Howard, P. H., Constance, D. (1 November 2017). Power, food and agriculture: Implications for farmers, consumers and communities. https://doi.org/10.2139/ssrn.3066005.

Henneberg, S. C., Naudé, P., & Mouzas, S. (2010). Sense-making and management in business networks—Some observations, considerations, and a research agenda. Industrial Marketing Management, 39(3), 355-360.

Hermwille, L. (2016). The role of narratives in socio-technical transitions—Fukushima and the energy regimes of Japan, Germany, and the United Kingdom. Energy Research & Social Science, 11, 237-246.

Hidalgo, C. A. (2021). Economic complexity theory and applications. Nature Reviews Physics, 1-22.

Hidalgo, C. (2015). Why information grows: The evolution of order, from atoms to economies. Basic Books.

Hidalgo, C.A., Klinger, B., Barabasi, A.L., & Hausmann, R. (2007). The product space and its consequences for economic growth. Science 317: 482–487.

Holttinen, H. (2014). Contextualizing value propositions: Examining how consumers experience value propositions in their practices. Australasian Marketing Journal (AMJ), 22(2), 103-110.

Howard, P. H. (2021). Concentration and power in the food system: Who controls what we eat?. Bloomsbury Publishing.

Howard, P. H. (2015). Intellectual property and consolidation in the seed industry. Crop Science, 55(6), 2489-2495.

Howarth, C., & Monasterolo, I. (2016). Understanding barriers to decision making in the UK energy-food-water nexus: The added value of interdisciplinary approaches. Environmental Science & Policy, 61, 53-60.

Howson, P. (2021). Distributed degrowth technology: Challenges for blockchain beyond the green economy. Ecological Economics, 184, 107020.

Hui, Y. (2020). Machine and ecology. Angelaki, 25(4), 54-66.

Hui, Y. (2019). Recursivity and Contingency, London and New York: Rowman & Littlefield.

Hui, Y. (2017). On cosmotechnics: For a renewed relation between technology and nature in the anthropocene. Techne: Research in philosophy and technology, 21(2/3), 319-341.

Hui, Y. (2012). What is a digital object? Metaphilosophy, 43(4), 380-395.Huizingh, E. K. (2011). Open innovation: State of the art and future perspectives. Technovation, 31(1), 2-9.

Hultman, J., Corvellec, H., Jerneck, A., Arvidsson, S., Ekroos, J., Gustafsson, C., ... & Wahlberg, N. (2021). A resourcification manifesto: Understanding the social process of resources becoming resources. Research Policy, 50(9), 104297.

Humphreys, A., & Carpenter, G. S. (2018). Status games: Market driving through social influence in the US wine industry. Journal of Marketing, 82(5), 141-159.

Hussain, N., Rigoni, U., & Cavezzali, E. (2018). Does it pay to be sustainable? Looking inside the black box of the relationship between sustainability performance and financial performance. Corporate Social Responsibility and Environmental Management, 25(6), 1198-1211.

Hyysalo, S., Juntunen, J. K., & Martiskainen, M. (2018). Energy Internet forums as acceleration phase transition intermediaries. Research Policy, 47(5), 872–885. https://doi.org/10.1016/j.respol.2018.02.012

Isham, A., Mair, S., & Jackson T. (2020). Wellbeing and productivity: a review of the literature. CUSP working paper no 22. Guildford: University of Surrey. Retrieved from: Online at: www.cusp.ac.uk/powering-productivity. Accessed January 5, 2020.

Ivanova, D., Stadler, K., Steen-Olsen, K., Wood, R., Vita, G., Tukker, A. and Hertwich, E.G. (2016). Environmental impact assessment of household consumption. Journal of Industrial Ecology, 20(3), pp.526-536.

Jacobides, M. G., Cennamo, C., & Gawer, A. (2018). Towards a theory of ecosystems. Strategic Management Journal, 39(8), 2255-2276.

Jackson, A. Y. (2017). Thinking without method. Qualitative Inquiry, 23(9), 666-674.

Jackson, T., & Senker, P. (2011). Prosperity without growth: Economics for a finite planet. Energy & Environment, 22(7), 1013-1016.

Jänicke, M. (1985). Preventive Environmental Policy as Ecological Modernisation and Structural Policy. IIUG Discussion Paper 85-2, Berlin.

Jasanoff, S. (2004). The idiom of co-production. States of knowledge: The co-production of science and social order, 1, 12.

Jensen, R. (2007). The digital provide: Information (technology), market performance, and welfare in the South Indian fisheries sector. The quarterly journal of economics, 122(3), 879-924.

Johannessen, J. A. (2013). Innovation: a systemic perspective–developing a systemic innovation theory. Kybernetes.

Kaartemo, V., Nenonen, S., & Windahl, C. (2020). Institutional work by market-shaping public actors. *Journal of Service Theory and Practice*.

Kaartemo, V., & Nyström, A. G. (2021). Emerging technology as a platform for market shaping and innovation. Journal of Business Research, 124, 458-468.

Kallis, G. (2013). Societal metabolism, working hours and degrowth: a comment on Sorman and Giampietro. Journal of cleaner production, 38, 94-98.

Kallis, G., Kerschner, C., & Martinez-Alier, J. (2012). The economics of degrowth. Ecological economics, 84, 172-180.

Kanemoto, K., Moran, D., Lenzen, M., & Geschke, A. (2014). International trade undermines national emission reduction targets: New evidence from air pollution. Global Environmental Change, 24, 52-59.

Kanter, R. M. (1994). Collaborative advantage. Harvard business review, 72(4), 96-108.

Karnøe, P. (1996). The social process of competence building. International Journal of Technology Management, 11 (7/8) (1996), pp. 770-789.

Kauffman, L. H. (2017). A concise approach to eigenform and reflexivity. Kybernetes.

Kay, J., & King, M. (2020). Radical uncertainty: Decision-making beyond the numbers. WW Norton & Company.

Kay, J. J., Regier, H. A., Boyle, M., & Francis, G. (1999). An ecosystem approach for sustainability: addressing the challenge of complexity. Futures, 31(7), 721-742.

Kemp, R. (2011). Ten themes for eco-innovation policies in Europe. SAPI EN. S. Surveys and Perspectives Integrating Environment and Society, (4.2).

Kent, R. E. (2000). The information flow foundation for conceptual knowledge organization. Advances in Knowledge Organization, 7, 111-117.

Kerschner, C., Wächter, P., Nierling, L., & Ehlers, M. H. (2018). Degrowth and Technology: Towards feasible, viable, appropriate and convivial imaginaries. Journal of cleaner production, 197, 1619-1636.

Kinsley, S. (2012). Futures in the making: practices to anticipate 'ubiquitous computing'. Environment and Planning A, 44(7), 1554-1569.

Kish, K., & Quilley, S. (2017). Wicked dilemmas of scale and complexity in the politics of degrowth. Ecological Economics, 142, 306-317.

Kirman, A. (1989). The intrinsic limits of modern economic theory: the emperor has no clothes. The Economic Journal, 99(395), 126-139.

Kitschelt, H. (1991). Industrial governance structures, innovation strategies, and the case of Japan: sectoral or cross-national comparative analysis? International Organization, 453-493.

Köhler, J., Geels, F. W., Kern, F., Markard, J., Onsongo, E., Wieczorek, A., ... & Wells, P. (2019). An agenda for sustainability transitions research: State of the art and future directions. Environmental innovation and societal transitions, 31, 1-32.

Koivunen, N., & Rehn, A. (2009). Creativity and the Contemporary Economy. Malmo, Sweden: Copenhagen Business School Press.

Konietzko, J., Bocken, N., & Hultink, E. J. (2020). Circular ecosystem innovation: An initial set of principles. Journal of Cleaner Production, 253, 119942.

Konrad, K., & Böhle, K. (2019). Socio-technical futures and the governance of innovation processes—An introduction to the special issue. Futures, 109, 101-107.

Kornberger, M., & Mantere, S. (2020). Thought experiments and philosophy in organizational research. Organization Theory, 1(3), 2631787720942524.

Kortetmäki, T., Puurtinen, M., Salo, M., Aro, R., Baumeister, S., Duflot, R., ... & Kotiaho, J. S. (2021). Planetary well-being. Humanit Soc Sci Commun, 8, 258. https://doi.org/10.1057/s41599-021-00899-3

Kostakis, V., & Giotitsas, C. (2014). The (A) political economy of bitcoin. tripleC: Communication, Capitalism & Critique. Open Access Journal for a Global Sustainable Information Society, 12(2), 431-440.

Krause, M. J., & Tolaymat, T. (2018). Quantification of energy and carbon costs for mining cryptocurrencies. Nature Sustainability, 1(11), 711-718.

Krippner, G. R. (2011). Capitalizing on crisis: The political origins of the rise of finance. Harvard University Press.

Kuhn, T. S. (1970). The structure of scientific revolutions. Chicago: University of Chicago Press.

Küpers, W. M. (2013). Embodied transformative metaphors and narratives in organisational life-worlds of change. Journal of Organizational Change Management.

La Rocca, A., & Snehota, I. (2014). Relating in business networks: Innovation in practice. Industrial Marketing Management, 43(3), 441-447.

Lachman, D. A. (2013). A survey and review of approaches to study transitions. Energy Policy, 58, 269-276.

Lacoste, S. (2016). Sustainable value co-creation in business networks. Industrial Marketing Management, 52, 151-162.

Landrum, N. E., & Ohsowski, B. (2018). Identifying worldviews on corporate sustainability: A content analysis of corporate sustainability reports. Business Strategy and the Environment, 27(1), 128-151.

Langley, A. (2021). What is "this" a case of? Generative theorizing for disruptive times. Journal of Management Inquiry, 30(3), 251-258.

Larsson, M. (2018). Circular business models: Developing a sustainable future. Cham: Springer International Publishing.

Last, C. (2015a). Human metasystem transition (HMST) theory. Journal of Ethics and Emerging Technologies, 25(1), 1-16.

Last, C. (2015b). Information-energy metasystem model. Kybernetes.

Latour, B. (2013). An inquiry into modes of existence. Harvard University Press.

Latour, B., Harman, G., & Erdélyi, P. (2011). The Prince and the Wolf: Latour and Harman at the LSE: The Latour and Harman at the LSE. John Hunt Publishing.

Latour, B. (2005). Reassembling the Social: An Introduction to Actor network theory. Oxford: Oxford University Press.

Latour, B. (2004). Politics of nature. Harvard University Press.

Latour, B. (2003). Is re-modernization occurring-and if so, how to prove it? A commentary on Ulrich Beck. Theory, culture & society, 20(2), 35-48.

Latour, B., & Venn, C. (2002). Morality and technology. Theory, culture & society, 19(5-6), 247-260.

Latour, B. (1987). Science in action: How to follow scientists and engineers through society. Harvard university press.

Latour, B. (1986). The powers of association. In J. Law (Ed.), Power, action and belief. A new sociology of knowledge? (Vol. 32) (pp. 264–280). London, Boston and Henley: Routledge & Kegan Paul.

Law, J. (2009). Actor network theory and material semiotics. The new Blackwell companion to social theory, 3, 141-158.

Lazonick, W., & Mazzucato, M. (2013). The risk-reward nexus in the innovation-inequality relationship: who takes the risks? Who gets the rewards?. Industrial and Corporate Change, 22(4), 1093-1128.

Lazonick, W. (2012). The financialization of the US corporation: What has been lost, and how it can be regained. Seattle UL Rev., 36, 857.

Lazonick, W. (2003). The theory of the market economy and the social foundations of innovative enterprise. Economic and Industrial democracy, 24(1), 9-44.

Lee, C., Dourish, P. and Mark, G. (2006). The Human Infrastructure of the Cyberinfrastructure, Proceedings of CSCW'06 (Banf, Canada); New York: ACM Press, 483–492.

Lenhart, A., & Owens, K. (2021). The Unseen Teen: The Challenges of Building Healthy Tech for Young People. Data & Society. Accessed June 5, 2021 https://datasociety.net/wp-content/uploads/2021/05/The-Unseen-Teen-.pdf

Lenzen, M., Moran, D., Kanemoto, K., Foran, B., Lobefaro, L. and Geschke, A. (2012a). International trade drives biodiversity threats in developing nations. Nature, 486(7401), p.109.

Lenzen, M., Kanemoto, K., Moran, D. & Geschke, A. (2012b). Mapping the structure of the world economy. Environmental science & technology, 46(15), pp.8374-8381.

Leone, P. V., Mantere, S., & Faraj, S. (2021). Open theorizing in management and organization studies. Academy of Management Review, (ja).

Levänen, J., Uusitalo, V., Härri, A., Kareinen, E., & Linnanen, L. (2021). Innovative recycling or extended use? Comparing the global warming potential of different ownership and end-of-life scenarios for textiles. Environmental Research Letters, 16(5), 054069.

Levitt, T. (1962). Innovation in Marketing: New Perspectives for Profit and Growth. McGraw-Hill, New York.

Lewin, P. (2016). Plan-coordination: Who needs it?. The Review of Austrian Economics, 29(3), 299-313.

Lewis, P. (2021). The innovation systems approach: an Austrian and Ostromian perspective. The Review of Austrian Economics, 34(1), 97-114.

Lewis, P. (2020). Developing Technician Skills for Innovative Industries: Theory, Evidence from the UK Life Sciences Industry, and Policy Implications. British Journal of Industrial Relations.

Lewis, P., & Dold, M. (2020). James Buchanan on the nature of choice: ontology, artifactual man and the constitutional moment in political economy. Cambridge Journal of Economics, 44(5), 1159-1179.

Lewis, S. L., & Maslin, M. A. (2015). Defining the anthropocene. Nature, 519(7542), 171-180.

Linstead, S., & Thanem, T. (2007). Multiplicity, virtuality and organization: The contribution of Gilles Deleuze. Organization Studies, 28(10), 1483-1501.

Loasby, B. J. (2011). Uncertainty and imagination, illusion and order: Shackleian connections. Cambridge Journal of Economics, 35(4), 771-783.

Loasby, B. J. (2007). The ubiquity of organization. Organization Studies, 28(11), 1729-1759.

Loasby, B. J. (2005). Making connections. Econ Journal Watch, 2(1), 56.

Loasby, B. J. (2004). 'Hayek's theory of the mind'. In Koppl, R. (Ed.), Evolutionary Psychology and Economic Theory: Advances in Austrian Economics, Volume 7. Oxford: Elsevier, 101–34

Loasby, B. J. (2001a). Cognition, imagination and institutions in demand creation. In Escaping Satiation (pp. 13-27). Springer, Berlin, Heidelberg.

Loasby, B. J. (2001b). Time, knowledge and evolutionary dynamics: why connections matter. Journal of Evolutionary Economics, 11(4), 393-412.

Locke, E. A., & Latham, G. P. (1990). A theory of goal setting & task performance. Prentice-Hall, Inc.

Longhurst, N., Avelino, F., Wittmayer, J., Weaver, P., Dumitru, A., Hielscher, Hielscher S., Cipolla, C., Afonso, R., Kunze, I., & Morten, Elle. (2016) Experimenting with alternative economies: four emergent counter-narratives of urban economic development. Current opinion in environmental sustainability, 22, 69-74.

Looker, C., Luster, M. I., Calafat, A. M., Johnson, V. J., Burleson, G. R., Burleson, F. G., & Fletcher, T. (2014). Influenza vaccine response in adults exposed to perfluorooctanoate and perfluorooctanesulfonate. toxicological sciences, 138(1), 76-88.

Loorbach, D., & Wijsman, K. (2013). Business transition management: exploring a new role for business in sustainability transitions. Journal of cleaner production, 45, 20-28.

Loorbach, D., van Bakel, J. C., Whiteman, G., & Rotmans, J. (2010). Business strategies for transitions towards sustainable systems. Business strategy and the environment, 19(2), 133-146.

Lowe, S., & Rod, M. (2018). Business network becoming: Figurations of time, change and process. Industrial Marketing Management, 68, 156-164.

Luhman, J. T., & Boje, D. M. (2001). What is complexity science? A possible answer from narrative research. Emergence, A Journal of Complexity Issues in Organizations and Management, 3(1), 158-168.

Luhmann, N. (1995). Social systems. Stanford University Press.

Luhmann, N. (1990). The cognitive program of constructivism and a reality that remains unknown. In Krohn, W et al. (eds) Selforganization (pp. 64-85). Springer, Dordrecht.

Lundvall, B. Å. (Ed.). (2010). National systems of innovation: Toward a theory of innovation and interactive learning (Vol. 2). Anthem press.

Lundvall, B. Ä., & Johnson, B. (1994). The learning economy. Journal of industry studies, 1(2), 23-42.

Lusch, R. F., & Nambisan, S. (2015). Service innovation. MIS quarterly, 39(1), 155-176.

Lyon, D. (2014). Surveillance, Snowden, and big data: Capacities, consequences, critique. Big data & society, 1(2), 2053951714541861.

Makkonen, H., Aarikka-Stenroos, L., & Olkkonen, R. (2012). Narrative approach in business network process research—Implications for theory and methodology. Industrial Marketing Management, 41(2), 287-299.

Mancarella, P. (2014). MES (multi-energy systems): An overview of concepts and evaluation models. Energy, 65, 1-17.

March, J. G., & Simon, H. A. (1958). Organizations. John Wiley & Sons. New York.

Marchi, B., Zanoni, S., Zavanella, L. E., & Jaber, M. Y. (2019). Supply chain models with greenhouse gases emissions, energy usage, imperfect process under different coordination decisions. International Journal of Production Economics, 211, 145-153.

Markard, J., Raven, R., & Truffer, B. (2012). Sustainability transitions: An emerging field of research and its prospects. Research policy, 41(6), 955-967.

Marshall, A. P., & O'Neill, D. W. (2018). The Bristol Pound: A tool for localisation?. Ecological Economics, 146, 273-281.

Martin, M. (2020). Industrial symbiosis networks: application of the circular economy for resource efficiency. In Handbook of the Circular Economy. Edward Elgar Publishing.

Massumi, B. (Ed.). (2002). A shock to thought: Expression after Deleuze and Guattari. Psychology Press.

May, T. (2003). When is a Deleuzian becoming?. Continental Philosophy Review, 36(2), 139-153.

Mazzucato, M. (2018). Mission-oriented innovation policies: challenges and opportunities. Industrial and Corporate Change, 27(5), 803-815.

Mazzucato, M., & Robinson, D. K. (2018). Co-creating and directing Innovation Ecosystems? NASA's changing approach to public-private partnerships in low-earth orbit. Technological Forecasting and Social Change, 136, 166-177.

McGoey, L. (2007). On the will to ignorance in bureaucracy. Economy and Society, 36(2), 212-235.

Meadows, D. H., Meadows, D. L., Randers, J., & Behrens, W. W. (1972). The limits to growth. New York, 102(1972), 27.

Medlin, C. J., & Saren, M. (2012). Interaction: Coherence to a future. In M.S. Glynn, A.G. Woodside (Eds.), Business-to-Business Marketing Management: Strategies, Cases, and Solutions. Emerald Group Publishing Limited. 18, 173-188.

Metcalfe, J. S. (2005). Systems failure and the case for innovation policy. In Innovation policy in a knowledge-based economy (pp. 47-74). Springer, Berlin, Heidelberg.

Millward-Hopkins, J., Steinberger, J. K., Rao, N. D., & Oswald, Y. (2020). Providing decent living with minimum energy: A global scenario. Global Environmental Change, 65, 102168.

Mirowski, P., & Nik-Khah, E. (2017). The knowledge we have lost in information: the history of information in modern economics. Oxford University Press.

Mirowski, P. (2010). Inherent vice: Minsky, Markomata, and the tendency of markets to undermine themselves. Journal of Institutional Economics, 6(4), 415-443.

Mirowski, P., & Nik-Khah, E. (2008). Command performance: Exploring what STS thinks it takes to build a market. Living in a material world: Economic sociology meets science and technology studies, 89-128.

Mirowski, P. (2007). Markets come to bits: Evolution, computation and markomata in economic science. Journal of Economic Behavior & Organization, 63(2), 209-242.

Mirowski, P. (2002). Machine dreams: Economics becomes a cyborg science. Cambridge University Press.

Mirowski, P. (1991). More heat than light: economics as social physics, physics as nature's economics. Cambridge University Press.

Moezzi, M., Janda, K. B., & Rotmann, S. (2017). Using stories, narratives, and storytelling in energy and climate change research. Energy Research & Social Science, 31, 1-10.

Mollick, E., & Robb, A. (2016). Democratizing innovation and capital access: The role of crowdfunding. California management review, 58(2), 72-87.

Möller, K., Nenonen, S., & Storbacka, K. (2020). Networks, ecosystems, fields, market systems? Making sense of the business environment. Industrial Marketing Management, 90, 380-399.

Möller, K., & Halinen, A. (2018). IMP thinking and IMM: Co-creating value for business marketing. Industrial Marketing Management, 69, 18-31.

Möller, K., & Halinen, A. (2017). Managing business and innovation networks—From strategic nets to business fields and ecosystems. Industrial Marketing Management, 67, 5-22.

Möller, K. (2013). Theory map of business marketing: Relationships and networks perspectives. Industrial Marketing Management, 42(3), 324-335.

Möller, K. (2010). Sense-making and agenda construction in emerging business networks—How to direct radical innovation. Industrial Marketing Management, 39(3), 361-371.

Möller, K., & Svahn, S. (2009). How to influence the birth of new business fields—Network perspective. Industrial Marketing Management, 38(4), 450-458.

Möller, K., Pels, J., & Saren, M. (2009). The marketing theory or theories into marketing? Plurality of research traditions and paradigms. The SAGE handbook of marketing theory, 151.

Möller, K., Rajala, A., & Svahn, S. (2005). Strategic business nets—their type and management. Journal of Business research, 58(9), 1274-1284.

Monteiro, E., & Hanseth, O. (1996). Social shaping of information infrastructure: on being specific about the technology. In Information technology and changes in organizational work (pp. 325-343). Springer, Boston, MA.

Moore, J. F. (1993). Predators and prey: a new ecology of competition. Harvard business review, 71(3), 75-86.

Moradi, A., & Vagnoni, E. (2018). A multi-level perspective analysis of urban mobility system dynamics: What are the future transition pathways?. Technological Forecasting and Social Change, 126, 231-243.

Moran, D. & Kanemoto, K. (2017). Identifying species threat hotspots from global supply chains. Nature Ecology & Evolution, 1(1), p.0023.

Moran, P., & Ghoshal, S. (1999). Markets, firms, and the process of economic development. Academy of management Review, 24(3), 390-412.

Morgan, M. S., & Wise, M. N. (2017). Narrative science and narrative knowing. Introduction to special issue on narrative science. Studies in History and Philosophy of Science Part A, 62, 1-5.

Morgan, G. (1980). Paradigms, metaphors, and puzzle solving in organization theory. Administrative science quarterly, 605-622.

Mor Barak, M. E., Lizano, E. L., Kim, A., Duan, L., Rhee, M. K., Hsiao, H. Y., & Brimhall, K. C. (2016). The promise of diversity management for climate of inclusion: A state-of-the-art review and meta-analysis. Human Service Organizations: Management, Leadership & Governance, 40(4), 305-333.

Morton, T. (2010). Thinking ecology: The mesh, the strange stranger, and the beautiful soul. Collapse, 6, 265-293.

Morrar, R., Arman, H., & Mousa, S. (2017). The fourth industrial revolution (Industry 4.0): A social innovation perspective. Technology Innovation Management Review, 7(11), 12-20.

Morrissey, J. E., Mirosa, M., & Abbott, M. (2014). Identifying transition capacity for agri-food regimes: application of the multi-level perspective for strategic mapping. Journal of Environmental Policy & Planning, 16(2), 281-301.

Motesharrei, S., Rivas, J., & Kalnay, E. (2014). Human and nature dynamics (HANDY): Modeling inequality and use of resources in the collapse or sustainability of societies. Ecological Economics, 101, 90-102.

Mouzas, S. (2006). Marketing Action in Networks. European Journal of Marketing. 40(11-12), pp. 1271-1291.

Narayan, R. (2020). Leveraging Digital Intelligence for Community Well-Being. International Journal of Community Well-Being, 3(4), 539-558.

Narayan, R., & Tidström, A. (2020a). Tokenizing coopetition in a blockchain for a transition to circular economy. Journal of Cleaner Production, 121437.

Narayan, R., & Tidström, A. (2020b). Leveraging resource ecologies for sustainability transitions–a waste management case. Journal of Business & Industrial Marketing.

Narayan, R., & Tidström, A. (2019a). Circular economy inspired imaginaries for sustainable innovations. In Innovation for Sustainability (pp. 393-413). Palgrave Macmillan, Cham.

Narayan, R., & Tidström, A. (2019b). Blockchains for Accelerating Open Innovation Systems for Sustainability Transitions. Blockchain Economics: Implications of Distributed Ledgers: Markets, Communications Networks, and Algorithmic Reality.

Narayanan, A., Bonneau, J., Felten, E., Miller, A., & Goldfeder, S. (2016). Bitcoin and cryptocurrency technologies: a comprehensive introduction. Princeton University Press.

Nayak, A. (2008). On the way to theory: A processual approach. Organization Studies, 29(2), 173-190.

Nelson, R. (2013). Reflections on the study of innovation and on those who study it. Innovation studies: evolution and future challenges. Oxford University Press, Oxford, 187-193.

Nelson, R. R. (2011). The Moon and the Ghetto revisited. Science and Public Policy, 38(9), 681-690.

Nelson, R. R. (2008). Bounded rationality, cognitive maps, and trial and error learning. Journal of Economic Behavior & Organization, 67(1), 78-89.

Nelson, R. R. (2005). Technology, institutions, and economic growth. Harvard University Press.

Nelson, R., & Winter, S. G. (2002) 'Evolutionary theorizing in economics', Journal of Economic Perspectives 16: 23-46.

Nelson, R. R. (Ed.). (1993). National innovation systems: a comparative analysis. Oxford University Press on Demand.

Nelson, R.R., & Winter, S. G. (1982). An Evolutionary Theory of Economic Change. Bellknap Press, Cambridge, MA.

Nelson, R. R. (1977). The moon and the ghetto. New York: Norton.

Nenonen, S., & Storbacka, K. (2021). Market-shaping: navigating multiple theoretical perspectives. AMS Review, 1-18.

Nenonen, S., & Storbacka, K. (2020). Don't adapt, shape! Use the crisis to shape your minimum viable system–And the wider market. Industrial Marketing Management, 88, 265-271.

Nonaka, I., Chia, R., Holt, R., & Peltokorpi, V. (2014). Wisdom, management and organization. Management Learning, 45(4), 365-376.

North, D. C. (1999). Dealing with a non-ergodic world: Institutional economics, property rights, and the global environment. Duke Environmental Law & Policy Forum., 10, 1.

Öberg, C. (2019). The role of business networks for innovation. Journal of Innovation & Knowledge, 4(2), 124-128.

Oh, D. S., Phillips, F., Park, S., & Lee, E. (2016). Innovation ecosystems: A critical examination. Technovation, 54, 1-6.

Olsen, P. I. (2013). IMP theory in light of process-and system theories. IMP Journal, 7 (3) (2013), pp. 159-170.

Olsen, P. I., & Håkansson, H. (2017). The roles of deals and business networks in innovation processes. IMP Journal.

Olsen, P. I., Prenkert, F., Hoholm, T., & Harrison, D. (2014). The dynamics of networked power in a concentrated business network. Journal of Business Research, 67(12), 2579-2589.

Østern, T. P., Jusslin, S., Nødtvedt Knudsen, K., Maapalo, P., & Bjørkøy, I. (2021). A performative paradigm for post-qualitative inquiry. Qualitative Research, 14687941211027444.

Ostrom, E. (2005). Understanding institutional diversity Princeton University press. New Jersey, 393-432.

Painter-Morland, M., Demuijnck, G., & Ornati, S. (2017). Sustainable development and well-being: A philosophical challenge. Journal of Business Ethics, 146(2), 295-311.

Pasmore, W., Winby, S., Mohrman, S. A., & Vanasse, R. (2019). Reflections: sociotechnical systems design and organization change. Journal of Change Management, 19(2), 67-85.

Penrose, E. (1959). The theory of the growth of the firm Blackwell. London, UK.

Penttilä, K., Ravald, A., Dahl, J., & Björk, P. (2020). Managerial sensemaking in a transforming business ecosystem: Conditioning forces, moderating frames, and strategizing options. Industrial Marketing Management, 91, 209-222.

Papachristos, G., & Adamides, E. (2016). A retroductive systems-based methodology for socio-technical transitions research. Technological forecasting and social change, 108, 1-14.

Papachristos, G., Sofianos, A., & Adamides, E. (2013). System interactions in socio-technical transitions: Extending the multi-level perspective. Environmental Innovation and Societal Transitions, 7, 53-69.

Perez, C. (2010). Technological revolutions and techno-economic paradigms. Cambridge journal of economics, 34(1), 185-202.

Perez, C. (2002). Technological Revolutions and Financial Capital. Cheltenham: Edward Elgar.

Pfeffer, J. (2005). Why do bad management theories persist? A comment on Ghoshal. Academy of Management Learning & Education, 4(1), 96-100.

Pfotenhauer, S., & Jasanoff, S. (2017). Panacea or diagnosis? Imaginaries of innovation and the 'MIT model'in three political cultures. Social Studies of Science, 47(6), 783-810.

Philippe, D., & Bansal, P. (2013). Embedding environmental actions in time and space: the evolution of sustainability narratives. In Academy of Management Proceedings (Vol. 2013, No. 1, p. 14098). Briarcliff Manor, NY 10510: Academy of Management.

Piketty, T. (2014). Capital in the Twenty-First Century: a multidimensional approach to the history of capital and social classes. The British journal of sociology, 65(4), 736-747.

Polanyi, M. (1951). The Logic of Liberty. Chicago, IL: University of Chicago Press.

Polanyi, K. ([1944] 2001). The Great Transformation: the political and economic origins of our Time. Beacon Press

Potts, J. (2019). Innovation commons: The origin of economic growth. Oxford University Press.

Potts, J. (2018). Governing the innovation commons. Journal of Institutional Economics, 14(6), 1025-1047.

Potts, J. (2015). Behavioral innovation economics. Handbook for Behavioral Economics, Routledge: London.

Potts, J., & Hartley, J. (2015). How the social economy produces innovation. Review of Social Economy, 73(3), 263-282.

Potts, J. (2001). Knowledge and markets. Journal of Evolutionary economics, 11(4), 413-431.

Potts, J. (2000). The New Evolutionary Microeconomics: Complexity, Competence and Adaptive Behaviour, Edward Elgar, Cheltenham.

Prahalad, C. K., & Prahalad, C. K. (2005). The Fortune at the Bottom of the Pyramid. Wharton School Pub.

Preiser, R., Biggs, R., De Vos, A., & Folke, C. (2018). Social-ecological systems as complex adaptive systems. Ecology and Society, 23(4).

Prendeville, S., Cherim, E., & Bocken, N. (2018). Circular cities: Mapping six cities in transition. Environmental innovation and societal transitions, 26, 171-194.

Prenkert, F. (2017). Understanding business networks from a mixed network and system ontology position: A review of the research field. IMP Journal.

Purchase, S., Kum, C., & Olaru, D. (2016). Paths, events and resource use: New developments in understanding innovation processes. Industrial Marketing Management, 58, 123-136.

Quinn, R. W., & Dutton, J. E. (2005). Coordination as energy-in-conversation. Academy of management review, 30(1), 36-57.

Raab, J., Mannak, R. S., & Cambré, B. (2015). Combining structure, governance, and context: A configurational approach to network effectiveness. Journal of public administration research and theory, 25(2), 479-511.

Ramos, C., Roseira, C., Brito, C., Henneberg, S. C., & Naudé, P. (2013). Business service networks and their process of emergence: The case of the Health Cluster Portugal. Industrial Marketing Management, 42(6), 950-968.

Rampersad, G., Quester, P., & Troshani, I. (2010). Managing innovation networks: Exploratory evidence from ICT, biotechnology and nanotechnology networks. Industrial marketing management, 39(5), 793-805.

Rantakari, A., & Vaara, E. (2017). Narratives and processuality. The Sage handbook of process organization studies, 271-285.

Rappaport, B. (2010). Using the elements of rhythm, flow, and tone to create a more effective and persuasive acoustic experience in legal writing. Legal Writing: J. Legal Writing Inst., 16, 65.

Raworth, K. (2017). Doughnut economics: seven ways to think like a 21st-century economist. Chelsea Green Publishing.

Reid, E., & Duffy, K. (2018). A netnographic sensibility: Developing the netnographic/social listening boundaries. Journal of Marketing Management, 34(3-4), 263-286.

Rifkin, J. (2014). The zero marginal cost society: The internet of things, the collaborative commons, and the eclipse of capitalism. St. Martin's Press.

Rikap, C. (2020). Amazon: A story of accumulation through intellectual rentiership and predation. Competition & Change, 1024529420932418.

Rip, A. (2012). The context of innovation journeys. Creativity and innovation management, 21(2), 158-170.

Rip, A., & Kemp, R. (1998). Technological change. Human choice and climate change, 2(2), 327-399.

Ritala, P., & Almpanopoulou, A. (2017). In defense of 'eco'in innovation ecosystem. Technovation, 60, 39-42.

Ritala, P., Kraus, S., & Bouncken, R. B. (2016). Introduction to coopetition and innovation: contemporary topics and future research opportunities. International Journal of Technology Management, 71(1-2), 1-9.

Ritter, T., Wilkinson, I. F., & Johnston, W. J. (2004). Managing in complex business networks. Industrial marketing management, 33(3), 175-183.

Robert, V., Yoguel, G., & Lerena, O. (2017). The ontology of complexity and the neo-Schumpeterian evolutionary theory of economic change. Journal of Evolutionary Economics, 27(4), 761-793.

Romer, P. M. (1990). Endogenous technological change. Journal of political Economy, 98(5, Part 2), S71-S102.

Røpke, I. (2016). Complementary system perspectives in ecological macroeconomics—The example of transition investments during the crisis. Ecological Economics, 121, 237-245.

Rosile, G. A., Boje, D. M., Herder, R. A., & Sanchez, M. (2021). The Coalition of Immokalee Workers uses ensemble storytelling processes to overcome enslavement in corporate supply chains. Business & Society, 60(2), 376-414.

Roth, S., & Valentinov, V. (2020). East of nature. Accounting for the environments of social sciences. Ecological Economics, 176, 106734.

Roth, A. E. (2002). The economist as engineer: Game theory, experimentation, and computation as tools for design economics. Econometrica, 70(4), 1341-1378.

Rosenbaum, E. (2021). Mental models and institutional inertia. Journal of Institutional Economics, 1-18.

Russell, M. G., & Smorodinskaya, N. V. (2018). Leveraging complexity for ecosystemic innovation. Technological Forecasting and Social Change, 136, 114-131.

Sabatini, A., O'Toole, T., & Gregori, G. (2021). Integrating sustainability in business network initiation: the case of an Italian pasta maker. Journal of Business & Industrial Marketing.

Sachs, J. D., Schmidt-Traub, G., Mazzucato, M., Messner, D., Nakicenovic, N., &

Rockström, J. (2019). Six transformations to achieve the sustainable development goals. Nature Sustainability, 2(9), 805-814.

Sarasini, S., & Linder, M. (2018). Integrating a business model perspective into transition theory: The example of new mobility services. Environmental innovation and societal transitions, 27, 16-31.

Sarker, A., & Blomquist, W. (2019). Addressing misperceptions of governing the commons. Journal of Institutional Economics, 15(2), 281-301.

Savage, M., & Burrows, R. (2007). The coming crisis of empirical sociology. Sociology, 41(5), 885-899.

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

Schatzberg, E. (2018). Technology: critical history of a concept. University of Chicago Press.

Schatzberg, E. (2006). "Technik" Comes to America: Changing Meanings of" Technology" before 1930. Technology and culture, 47(3), 486-512.

Schroeder, A., Ziaee Bigdeli, A., Galera Zarco, C., & Baines, T. (2019). Capturing the benefits of industry 4.0: a business network perspective. Production Planning & Control, 30(16), 1305-1321.

Shiller, R. J. (2017). Narrative economics. American Economic Review,107, 967–1004.

Schmidt, L., Mialon, M., Kearns, C., & Crosbie, E. (2020). Transnational corporations, obesity and planetary health. The Lancet Planetary Health, 4(7), e266-e267.

Schoonhoven, C. B., Eisenhardt, K. M., & Lyman, K. (1990). Speeding products to market: Waiting time to first product introduction in new firms. Administrative Science Quarterly, 177-207.

Schot, J., & Steinmueller, W. E. (2018). Three frames for innovation policy: R&D, systems of innovation and transformative change. Research Policy, 47(9), 1554-1567.

Schumpeter, J.A. (1976). Capitalism, Socialism and Democracy [1942], London: Allen & Unwin.

Schumpeter, J. (1954). History of Economic Analysis. London: Allen & Unwin.

Schumpeter, J. A. (1947). The creative response in economic history. The journal of economic history, 7(2), 149-159.

Schumpeter, J. A. (1939). Business Cycles: A Theoretical, Historical, and Statistical Analysis of the Capitalist Process (p. 87). New York and London: McGraw-Hill.

Schot, J. (1998). The usefulness of evolutionary models for explaining innovation. The case of the Netherlands in the nineteenth century. History and Technology, an International Journal, 14(3), 173-200.

Scott, J. C. (2021). Further Reflections on Seeing Like a State. Polity, 53(3), 507-514.

Scott, J. C. (2020). Seeing like a state: How certain schemes to improve the human condition have failed. Yale University Press.

Seebode, D., Jeanrenaud, S., & Bessant, J. (2012). Managing innovation for sustainability. R&D Management, 42(3), 195-206.

Sekulova, F., Kallis, G., Rodríguez-Labajos, B., & Schneider, F. (2013). Degrowth: from theory to practice. Journal of cleaner Production, 38, 1-6.

Shackle, G. 1982. Imagination and the Nature of Choice. Edinburgh University Press, Edinburgh, Scotland.

Shand, H. & Wetter, K. J. (2019). Plate Tech-Tonics: Mapping Corporate Power in Big Food. ETC Group. At: https://etcgroup.org/sites/www.etcgroup.org/files/files/etc_platetechtonics_a4_nov2019_web.pdf

Shane, S. (2000). Prior knowledge and the discovery of entrepreneurial opportunities. Organization science, 11(4), 448-469.

Sharma, A. (2020). Sustainability research in business-to-business markets: An agenda for inquiry. Industrial Marketing Management, 88, 323-329.

Sharma, T., Choudhury, M., Kaur, B., Naidoo, B., Garner, S., Littlejohns, P., &

Staniszewska, S. (2015). Evidence informed decision making: the use of "colloquial evidence" at nice. International journal of technology assessment in health care, 31(3), 138-146.

Sharma, S., & Hart, S. L. (2014). Beyond "saddle bag" sustainability for business education. Organization & Environment, 27(1), 10-15.

Shore, L. M., Randel, A. E., Chung, B. G., Dean, M. A., Holcombe Ehrhart, K., & Singh, G. (2011). Inclusion and diversity in work groups: A review and model for future research. Journal of management, 37(4), 1262-1289.

Shove, E. (2020). Time to rethink energy research. Nature Energy, 1-3.

Shove, E. (2018). What is wrong with energy efficiency?. Building Research & Information, 46(7), 779-789.

Shove, E., & Walker, G. (2014). What is energy for? Social practice and energy demand. Theory, culture & society, 31(5), 41-58.

Shove, E., & Pantzar, M. (2005). Consumers, producers and practices: Understanding the invention and reinvention of Nordic walking. Journal of consumer culture, 5(1), 43-64.

Shrivastava, P., & Guimarães-Costa, N. (2017). Achieving environmental sustainability: The case for multi-layered collaboration across disciplines and players. Technological Forecasting and Social Change, 116, 340-346.

Shrivastava, P., & Hart, S. (1995). Creating sustainable corporations. Business strategy and the environment, 4(3), 154-165.

Simon, H. A. (1991). Organizations and markets. Journal of economic perspectives, 5(2), 25-44.

Simon, H. (1947/1997). Administrative behavior: A study of decision-making processes in administrative organization, 4th ed. New York and London: Macmillan.

Smil, V. (2021). Grand Transitions: How the Modern World Was Made. Oxford University Press.

Smil, V. (2008) Energy in Nature and Society: General Energetics of Complex Systems. Cambridge, MA: MIT Press.

Smith, A., Voß, J. P., & Grin, J. (2010). Innovation studies and sustainability transitions: The allure of the multi-level perspective and its challenges. Research policy, 39(4), 435-448.

Smith, K. (2000). Innovation as a systemic phenomenon: rethinking the role of policy. Enterprise and innovation management studies, 1(1), 73-102.

Snehota, I., & Håkansson, H. (1995). Developing relationships in business networks. London: Routledge.

Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. Journal of business research, 104, 333-339.

Sorman, A. H., & Giampietro, M. (2013). The energetic metabolism of societies and the degrowth paradigm: analyzing biophysical constraints and realities. Journal of Cleaner Production, 38, 80-93.

Spaargaren, G., & Mol, A. P. (1992). Sociology, environment, and modernity: Ecological modernization as a theory of social change. Society & natural resources, 5(4), 323-344.

Spekman, R. E., Isabella, L. A., MacAvoy, T. C., Isabella, L. A., & MacAvoy, T. C. (2000). Alliance competence: Maximizing the value of your partnerships (pp. 40-43). New York: Wiley.

Spreng, D. (1993). Possibilities for substitution between energy, time and information. Energy policy, 21(1), 13-23.

Spring, M., & Araujo, L. (2017). Product biographies in servitization and the circular economy. Industrial Marketing Management, 60, 126-137.

Steffen, D. (2010) “Design semantics of innovation”. S. Vihma (Ed.), Design Semiotics In Use, Publication Series A100, Aalto University School of Art and Design, Helsinki. pp. 82-110.

Stegall, N. (2006). Designing for sustainability: A philosophy for ecologically intentional design. Design issues, 22(2), 56-63.

Steward, F. (2012). Transformative innovation policy to meet the challenge of climate change: sociotechnical networks aligned with consumption and end-use as

new transition arenas for a low-carbon society or green economy. Technology Analysis & Strategic Management, 24(4), 331-343.

Stiegler, B. (2019). For a neganthropology of automatic society. In Pringle, T., Koch, G., &

Stiegler, B. Machine. Minneapolis and London: University of Minnesota Press,

Stiegler, B. (2018a). The Neganthropocene. (D. Ross, Ed. & Trans.). Open Humanities Press. http://www.openhumanitiespress.org/books

Stiegler, B. (2018b). Artificial stupidity and artificial intelligence in the anthropocene. Lecture delivered on 23 November 2018 at the Institute of Ereignis, Shanghai.

Stiegler, B. (2013). What makes life worth living: On pharmacology. John Wiley & Sons.

Stiegler, B. (1998). Technics and time: The fault of Epimetheus (Vol. 1). Stanford University Press.

Stiglitz, J. E. (2012). The price of inequality: How today's divided society endangers our future. WW Norton & Company.

Stirling, A. (2011). Pluralising progress: From integrative transitions to transformative diversity. Environmental Innovation and Societal Transitions, 1(1), 82-88.

Stones R (2009) Theories of social action. In: Turner B (ed.) The New Blackwell Companion to Social Theory. London: Blackwell, pp. 83–105.

Storbacka, K., & Nenonen, S. (2015). Learning with the market: Facilitating market innovation. Industrial Marketing Management, 44, 73-82.

Stout, L. A. (2012). The shareholder value myth: How putting shareholders first harms investors, corporations, and the public. Berrett-Koehler Publishers.

Strand, R., Saltelli, A., Giampietro, M., Rommetveit, K., & Funtowicz, S. (2018). New narratives for innovation. Journal of Cleaner Production, 197, 1849-1853.

Strathern, M. (1997). 'Improving ratings': audit in the British University system. European review, 5(3), 305-321.

Svahn, F., Mathiassen, L., & Lindgren, R. (2017). Embracing digital innovation in incumbent firms: How Volvo cars managed competing concerns. MIS Q., 41(1), 239-253.

Thacker, S., Adshead, D., Fay, M., Hallegatte, S., Harvey, M., Meller, H., ... & Hall, J. W. (2019). Infrastructure for sustainable development. Nature Sustainability, 2(4), 324-331.

The MIT 21st Century Manifesto Working Group (1999). What do we really want? A manifesto for the organizations of the 21st Century. MIT Initiative on Inventing the Organizations of the 21st Century, Discussion Paper http://ccs.mit.edu/21c/

Thapaliya, D., Hanson, B. M., Kates, A., Klostermann, C. A., Nair, R., Wardyn, S. E., & Smith, T. C. (2015). Zoonotic Diseases of Swine: Food-borne and Occupational Aspects of Infection. In Zoonoses-Infections Affecting Humans and Animals (pp. 23-68). Springer, Dordrecht.

Tidström, A., & Rajala, A. (2016). Coopetition strategy as interrelated praxis and practices on multiple levels. Industrial Marketing Management, 58, 35-44.

Tirole, J. (2020). Digital dystopia. 13th Digital Economics Conference, Toulouse School of Economics. Accessed November 25, 2020 https://www.tse-fr.eu/sites/default/files/TSE/images/conference/Digital_conf_2020/tirole_digital_dystopia_080120.pdf

Torraco, R. J. (2016). Writing integrative literature reviews: Using the past and present to explore the future. Human resource development review, 15(4), 404-428.

Tripsas, M. (1997). Unraveling the process of creative destruction: Complementary assets and incumbent survival in the typesetter industry. Strategic management journal, 18(S1), 119-142.

Truby, J. (2018). Decarbonizing Bitcoin: Law and policy choices for reducing the energy consumption of Blockchain technologies and digital currencies. Energy research & social science, 44, 399-410.

Trump, B. D., Florin, M. V., Matthews, H. S., Sicker, D., & Linkov, I. (2018). Governing the use of blockchain and distributed ledger technologies: not one-size-fits-all. IEEE Engineering Management Review, 46(3), 56-62.

Tsing, A. L. (2015). The mushroom at the end of the world: On the possibility of life in capitalist ruins. Princeton University Press.

Tsoukas, H., Patriotta, G., Sutcliffe, K. M., & Maitlis, S. (2020). On the way to Ithaka [1]: Commemorating the 50th Anniversary of the Publication of Karl E. Weick's The Social Psychology of Organizing. Journal of Management Studies, 57(7), 1315-1330.

Tsoukas, H. (2017). Don't simplify, complexify: From disjunctive to conjunctive theorizing in organization and management studies. Journal of management studies, 54(2), 132-153.

Tsoukas, H., & Hatch, M. J. (2001). Complex thinking, complex practice: The case for a narrative approach to organizational complexity. Human relations, 54(8), 979-1013.

Tuchman, G. (1978). Making news: A study in the construction of reality. New York, NY: Free Press.

Tushman, M., & Anderson, P. (2004). Managing strategic innovation and change: A collection of readings. Oxford University Press, USA.

Tura, N., Keränen, J., & Patala, S. (2019). The darker side of sustainability: Tensions from sustainable business practices in business networks. Industrial Marketing Management, 77, 221-231.

Turchin, P., & Nefedov, S. A. (2009). Secular cycles. Princeton University Press.

Unruh, G. C. (2000). Understanding carbon lock-in. Energy policy, 28(12), 817-830.

Urry, J. (2005). The complexity turn. Theory, culture & society, 22(5), 1-14.

Utterback, J. M. (1971). The process of technological innovation within the firm. Academy of management Journal, 14(1), 75-88.

Vagle, M. D., & Hofsess, B. A. (2016). Entangling a post-reflexivity through post-intentional phenomenology. Qualitative Inquiry, 22(5), 334-344.

Valentinov, V., Roth, S., & Pies, I. (2021). Social goals in the theory of the firm: a systems theory view. Administration & Society, 53(2), 273-304.

Valentinov, V., & Pérez-Valls, M. (2020). A conception of moral wayfinding for business managers: The obligation for a sustainable corporation. Journal of Cleaner Production, 124771.

Vallée, R. (2009). History of Cybernetics. Systems Science And Cybernetics, 3, 22-33.

Vandeventer, J. S., & Lloveras, J. (2021). Organizing degrowth: The ontological politics of enacting degrowth in OMS. Organization, 28(3), 358-379.

Van der Borgh, M., Cloodt, M., & Romme, A. G. L. (2012). Value creation by knowledge-based ecosystems: evidence from a field study. R&D Management, 42(2), 150-169.

Van de Ven, A. H. (2017). The innovation journey: you can't control it, but you can learn to maneuver it. Innovation, 19(1), 39-42.

Van de Ven, A. H. (1986). Central problems in the management of innovation. Management science, 32(5), 590-607.

van Fenema, P. C., & Keers, B. B. (2020). Rediscovering strategic content in 'strong process' research on business network innovation. Industrial Marketing Management, 91, 639-656.

Veal, G., & Mouzas, S. (2010). Learning to collaborate: a study of business networks. Journal of Business & Industrial Marketing.

Veblen, T. (1898). Why is economics not an evolutionary science?. The quarterly journal of economics, 12(4), 373-397.

Verbeek, P. P. (2008a). Morality in design: Design ethics and the morality of technological artifacts. In Philosophy and design (pp. 91-103). Springer, Dordrecht.

Verbeek, P. P. (2008b). Cyborg intentionality: Rethinking the phenomenology of human–technology relations. Phenomenology and the Cognitive Sciences, 7(3), 387-395.

Vergne, J. P. (2020). Decentralized vs. distributed organization: Blockchain, machine learning and the future of the digital platform. Organization Theory, 1(4), 2631787720977052.

Viljoen, S., Goldenfein, J., & McGuigan, L. (2021). Design choices: Mechanism design and platform capitalism. Big Data & Society, 8(2), 20539517211034312.

Vita, G., Rao, N. D., Usubiaga-Liaño, A., Min, J., & Wood, R. (2021). Durable Goods Drive Two-Thirds of Global Households' Final Energy Footprints. Environmental Science & Technology.

Vogel, J., Steinberger, J. K., O'Neill, D. W., Lamb, W. F., & Krishnakumar, J. (2021). Socio-economic conditions for satisfying human needs at low energy use: an international analysis of social provisioning. Global Environmental Change, 102287.

von Hippel, F. A. (2020). The chemical age: How chemists fought famine and disease, killed millions, and changed our relationship with the earth. University of Chicago Press.

von Hippel, E. (2009). Democratizing innovation: the evolving phenomenon of user innovation. International Journal of Innovation Science.

von Hippel, E., 2005. Democratizing innovation. Cambridge, MA: MIT Press

Voola, R., Bandyopadhyay, C., Voola, A., Ray, S., & Carlson, J. (2022). B2B marketing scholarship and the UN sustainable development goals (SDGs): A systematic literature review. Industrial Marketing Management, 101, 12-32.

Voshmgir, S., & Zargham, M. (2020). Foundations of Cryptoeconomic Systems. Cryptoeconomics Working Paper Series, Vienna University of Economics, no. 1. 2019.

Volmar, A., & Stine, K. (eds.) (2021). Media Infrastructures and the Politics of Digital Time: Essays on Hardwired Temporalities. Amsterdam: Amsterdam University Press. https://library.oapen.org/handle/20.500.12657/50573

Voss, D. (2013). Deleuze's Rethinking of the Notion of Sense. Deleuze Studies, 7(1), 1-25.

Wagner, R. E. (2019). Economic Theory and the Social Question: Some Dialectics Regarding the Work-Dependency Relationship. Journal of Contextual Economics (JCE)–Schmollers Jahrbuch, 139(2–4), 407-420.

Walter, A., Ritter, T., & Gemünden, H. G. (2001). Value creation in buyer–seller relationships: Theoretical considerations and empirical results from a supplier's perspective. Industrial marketing management, 30(4), 365-377.

Waluszewski, A., Snehota, I., & La Rocca, A. (2019). What remains to be discovered? Manifesto for researching the interactive business world. Journal of Business & Industrial Marketing.

Wasieleski, D., Waddock, S., Fort, T., & Guimarães-Costa, N. (2021). Natural sciences, management theory, and system transformation for sustainability. Business & Society, 60(1), 7-25.

Wang, X. (2020). Blockchain chicken farm: and other stories of tech in China's countryside. FSG Originals.

Wanvik, T. I., & Haarstad, H. (2021). Populism, instability, and rupture in sustainability transformations. Annals of the American Association of Geographers, 1-16.

Wasieleski, D., Waddock, S., Fort, T., & Guimarães-Costa, N. (2021). Natural sciences, management theory, and system transformation for sustainability. Business & Society, 60(1), 7-25.

Watson, T. J. (2012). Making organisational ethnography. Journal of Organizational Ethnography.

Weber, K. M., & Truffer, B. (2017). Moving innovation systems research to the next level: towards an integrative agenda. Oxford Review of Economic Policy, 33(1), 101-121.

Weber, K. M., & Rohracher, H. (2012). Legitimizing research, technology and innovation policies for transformative change: Combining insights from innovation systems and multi-level perspective in a comprehensive 'failures' framework. Research Policy, 41(6), 1037-1047.

Weick, K. E. (2005). Organizing and failures of imagination. International public management journal, 8(3), 425-438.

Weick, K. E. (1989). Theory construction as disciplined imagination. Academy of management review, 14(4), 516-531.

Weick, K. E. (1979). The Social Psychology of Organizing, 2nd edition. Reading, MA: Addison-Westley.

Weigt-Rohrbeck, J., & Linneberg, M. S. (2019). Democratizing innovation processes: personal initiative in bottom-up eco-innovation. European Journal of Innovation Management.

Welch, C., & Wilkinson, I. (2002). Idea logics and network theory in business marketing. Journal of Business-to-Business Marketing, 9(3), 27-48.

West, S., Haider, L. J., Stålhammar, S., & Woroniecki, S. (2020). A relational turn for sustainability science? Relational thinking, leverage points and transformations. Ecosystems and People, 16(1), 304-325.

Whiteman, G., Walker, B., & Perego, P. (2013). Planetary boundaries: Ecological foundations for corporate sustainability. Journal of management studies, 50(2), 307-336.

Wiedmann, T.O., Schandl, H., Lenzen, M., Moran, D., Suh, S., West, J., & Kanemoto, K. (2015). The material footprint of nations. Proceedings of the National Academy of Sciences, 112(20), pp.6271-6276.

Wiener, N. (1954), The Human Use of Human Beings Cybernetics and Society, New York: Avon Books

Wiener, N. (1948). Cybernetics: Control and communication in the animal and the machine. Cambridge, MA: MIT Press.

Williamson, O. E. (1985) The economic institutions of capitalism. New York: Free Press.

Wilkinson, I., & Young, L. (2002). On cooperating: firms, relations and networks. Journal of business research, 55(2), 123-132.

Wilkinson, I. (2001). A History of Network and Channels Thinking in Marketing in the 20th Century. Australasian Marketing Journal, 9(2), 23–52.

Wittneben, B. B., Okereke, C., Banerjee, S. B., & Levy, D. L. (2012). Climate change and the emergence of new organizational landscapes. Organization Studies, 33(11), 1431-1450.

Wootton, D. (2018). Power, Pleasure, and Profit: Insatiable Appetities from Machiavelli to Madison. Harvard University Press.

Wright, E. O. (2010). Envisioning real utopias. Verso.

Yolles, M., & Fink, G. (2015). A general theory of generic modelling and paradigm shifts: part 1–the fundamentals. Kybernetes.

Yolles, M. (2007). The dynamics of narrative and antenarrative and their relation to story. Journal of Organizational Change Management.

Zuboff, S. (2019). Surveillance capitalism and the challenge of collective action. In New labor forum (Vol. 28, No. 1, pp. 10-29). Sage CA: Los Angeles, CA: SAGE Publications.

Appendices

Appendix 1

Research note

The description of this process appears as a linear description here but the actual process of sensemaking emerged rather haphazardly. The Fig. 3, from a UK government report provides an overview of the actors and flows that make up the global food system. The report where the diagram appears, explores the pressures on the global food system to identify what kinds of decisions policy makers need to make for ensuring that a rising global population can be fed in a fair and sustainable manner.

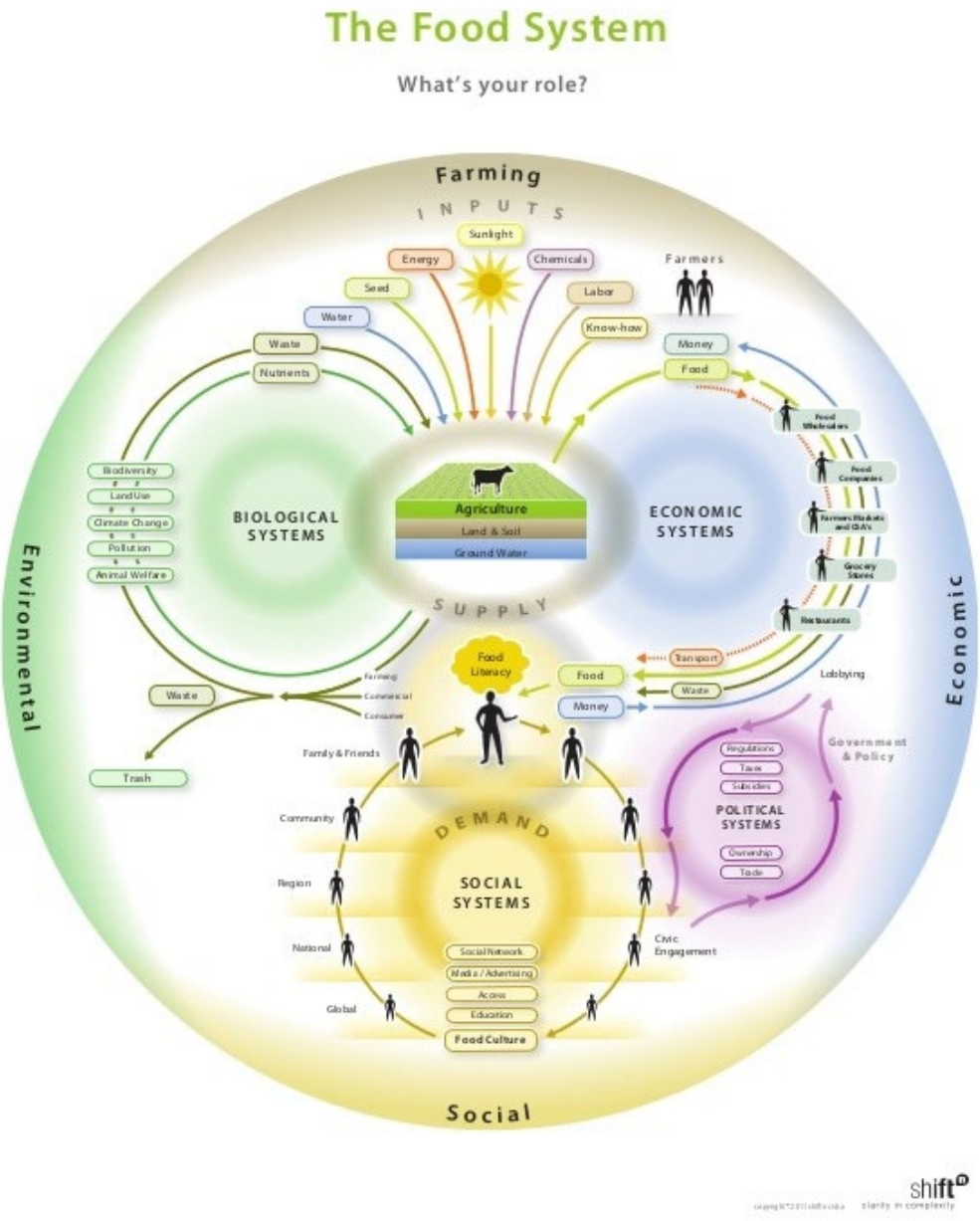


Figure 13. Future of Food and Farming project, UK Government Office for Science (2011). Source: *https://www.gov.uk/government/publications/future-of-food-and-farming*

The organizational map in the above Fig. appeared unexpectedly during a YouTube video presentation on the practice of permaculture as a multidimensional approach to resolving matters related to food security, health, reviving local produce, lowering input costs, and building resilience. The deep dive into permaculture began as an interaction with a researcher studying it as a Cuban community response to economic sanctions and also of communities in Detroit, both ravaged by inability to access food. Cuba was unable to import food and the slow death of the automobile industry in Detroit owing to the business imperative to relocate to cheaper locations, raised unemployment and devastated entire communities. But in both instances, communities organized and transformed empty lots into food gardens. The effect of activities in pursuit of 'quality' in one environment, that results in seemingly unrelated events where political, economic, social, and environmental entangle. This helped in visualizing the diverse interactions that sustain the food ecosystem, and subsequently contextualizing as well as de-contextualizing the various issues that cropped up while exploring transition stories in food systems. For instance, Hendrickson et al (2017) as rural sociologists, discuss issues relating to corporate consolidation of food production, processing, and distribution in the United States (US) that has resulted in making food less affordable for many Americans. The story about the inability of the citizens in one of the richest countries in the world to access a basic level of subsistence, brought to mind Nelson's (1977) "The Moon and the Ghetto", and social, cultural, economic, and political aspects that interact at individual, social groups, states, national, and global levels. This included reflections on industrialized food production and structures of modern economies, and the intricate relationships through which they have contributed towards fragmenting families, alienating senses from the natural world, and robbing society of its capacity to shape manners, ethics, and sociability (Flammang, 2009). Or how many of these decisions relate to structures that are a result of centralized policies and plans implemented globally without any practical knowledge or recognition of local customs, cultures, or natural ecologies, except the rationale of economic growth driving them (Scott, 2021, 2020).

In pursuing the narrative of growth and concentration of economic power, Hendrickson et al (2017) documents such consolidation and train focus on how key decisions about the US food system are in the hands of few large companies (production and distribution), giving them opportunities to influence policymakers, direct food and industry research, and impact media coverage. This outsize influence gives a handful of corporations enormous power to impact decisions about what food is produced, how, where, and by whom, including who gets to eat what, globally (Howard, 2021; Shand & Wetter, 2019).

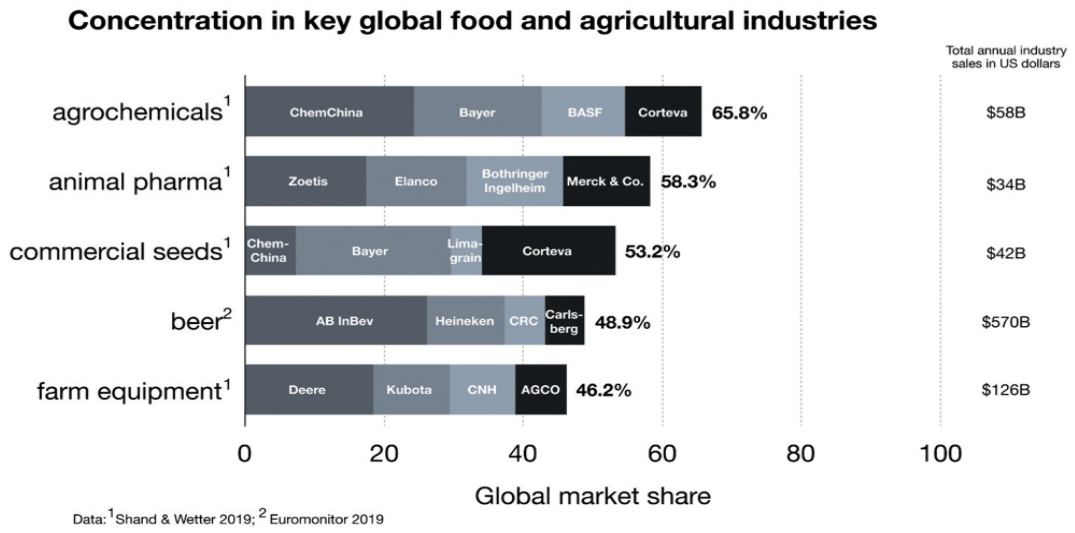


Figure 14. Shand, H. & Wetter, K. J. (2019). Plate Tech-Tonics: Mapping Corporate Power in Big Food. ETC Group: https://etcgroup.org/sites/www.etcgroup.org/files/files/etc_platetechtonics_a4_nov2019_web.pdf

The Lancet Commission of obesity has called for a reframed understanding of obesity, undernutrition, and climate change, as interconnected global crises with common societal drivers, and drawn attention to transnational food and beverage companies are creating health and environmental challenges in low- and middle-income countries (Schmidt et al., 2020). This narrative of power also appears in Howard's, (2015) documentation of consolidation and its impact on skewed intellectual property rights towards a handful of corporations that often use their power to block criticism of practices that harm others, as well as new and innovative ideas and practices, opened up other dimensions of global ecological and food security issues. The Fig. 15, is an example of one company (Monsanto, now owned by Bayer) but to get a sense of how seed companies are organized this is a good resource: https://philhoward.net/2018/12/31/global-seed-industry-changes-since-2013/).

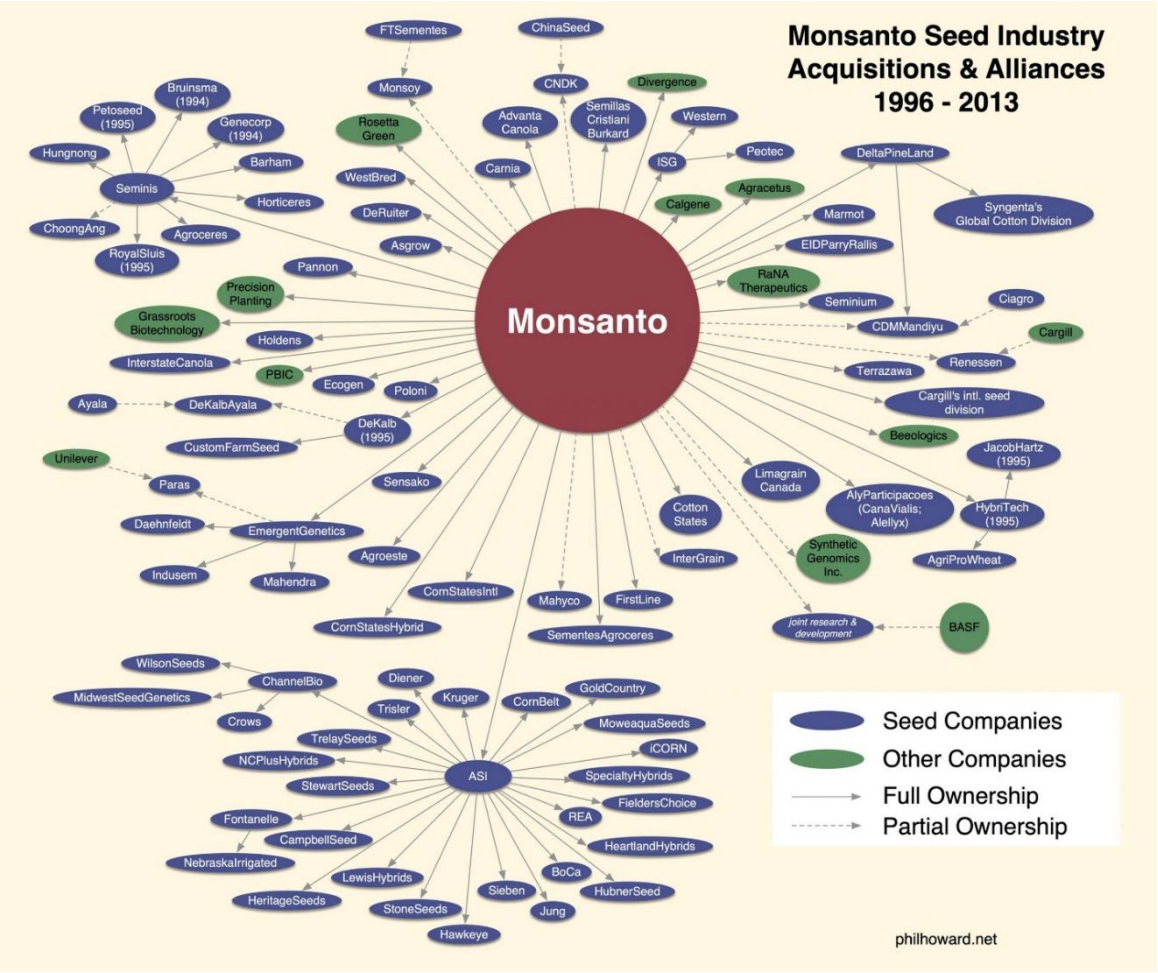


Figure 15. Source: https://philhoward.net/2018/12/31/global-seed-industry-changes-since-2013/

These narratives of concentration of power can also be witnessed through other non-academic mechanisms. One such example was the popular image that the organization Oxfam released as part of its report on the top 10 corporations that control the global food system in 2014 (see Fig. 16 below). The image generated a lot of attention online and prompted discussions related to food systems, and their relation to the current state of social, environmental, and economic health.

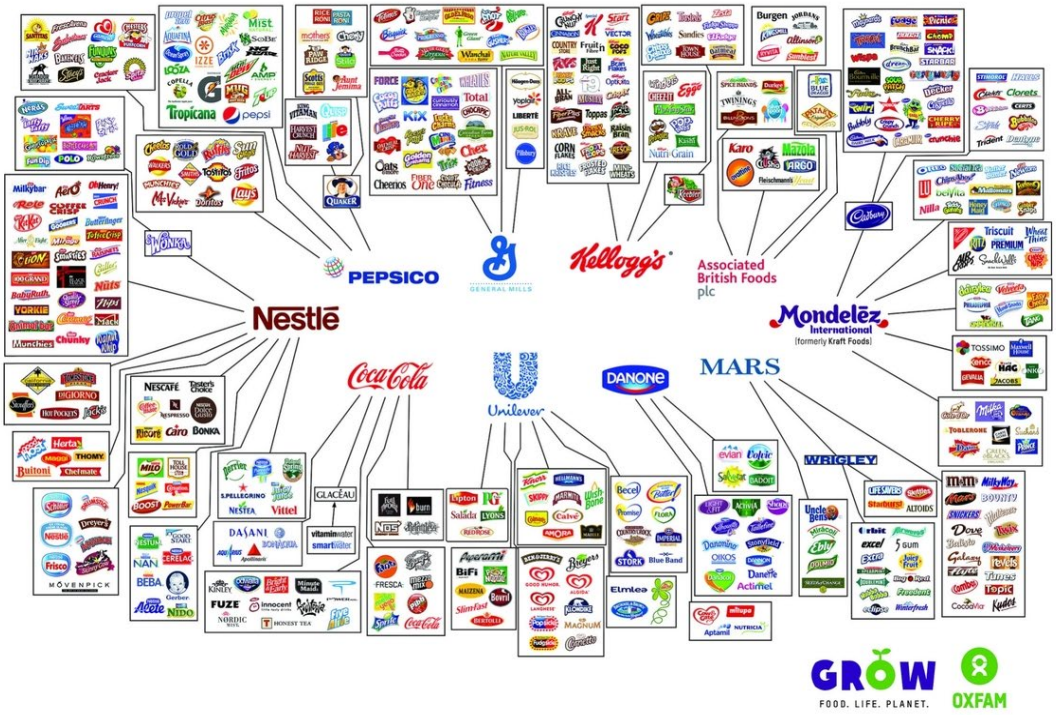


Figure 16. Source: https://s3.amazonaws.com/oxfam-us/www/static/media/resized/Behind-the-brands-illusion-of-choice-graphic-2048x1351_1220x763.jpg

These structured as well as unstructured materials attain significance through the production of information, that become catalysts for controversies. The meta-framework represented by the Fig. 3 is a sensemaking apparatus that tries to visualize the various relationships and contextualize the diverse knowledge frameworks. These information frameworks offered by various actors ranging from academia to public organizations emerge to draw attention to the organizational structures and the relationships, both of which serve as important microcosms of practices.

They are useful for telling stories of a certain kind, offering some sort of identity to them as well as supporting different activities that incorporate learning or problem-solving mechanisms. In doing so, they also order and arrange things by making claims about 'best practices', what matters, and how we know things. Wang's (2020) Blockchain Chicken Farm, for instance, brings a diversity of dimensions in its descriptions of a digitized rural world related to innovation, connectivity, and collaboration, to reveal the interconnections through globalization, technology, agriculture, and commerce. Its descriptions of

industrialized pork farming reveals a logic of innovation focused on driving demand, thereby increasing transmission of diseases, also reflected in studies (see Thapaliya et al., 2015). The continuous emergence of diseases drive implementation of new technologies like AI, which bring down cost, driving availability and demand, as people begin to believe that pork is a necessary part of their diet. These technologies are expensive because observed from another dimension, the stories of AI replacing humans hide those that articulate how AI still needs humans to be useful to humans. Therefore, deploying these technologies make sense only with high volumes that encourage industrialization of farming and push smaller farmers out. However, it is in the very identification of these challenges that proposals targeting the under-nourished while reducing over consumption, food waste, agriculture intensification, and other environmental impacts, offer the possibilities for change in response to the current assemblage (Hasegawa et al., 2019). This evidence was visible in the way food ecosystem is visualized by the UK policy makers as illustrated in Fig 13, and serves as a reminder that even though Scott's (2021, 2020) critique on centralized policies and plans are valid, possibilities for transition are very much alive and thriving.

The assemblages target particular networks, and make claims about their expertise, contributions, and knowledge, and in doing so they invite others to engage with them. For instance, the interest generated through the Oxfam report prompted these companies to make changes and offer commitments related to climate change, land-use, fair price, among others, by inviting every day individuals to offer ideas and solutions.

CHAPTER 24: CIRCULAR ECONOMY INSPIRED IMAGINARIES FOR SUSTAINABLE INNOVATIONS

Rumy Narayan
Doctoral researcher
School of Management
University of Vaasa
Email: rumy.narayan@uwasa.fi

Annika Tidström
Professor
School of Management
University of Vaasa
Email: annika.tidstrom@uwasa.fi

Introduction

The Circular Economy (CE) has attracted a lot of attention in policy and business, where it is viewed as an important approach for achieving sustainable development. The CE-concept has its roots in historical, economic, and ecological fields, which highlights its relevance to sustainable business (Murray et al., 2017). Geissdoerfer et al., (2017: 759) have defined CE as: 'as a regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops.'

CE, therefore, provides impetus for a new economic system with multiple opportunities for innovation (Korhonen et al., 2018; Geissdoerfer et al., 2017; Bocken et al., 2016; Ghisellini et al., 2016; Brennan et al., 2015). Innovations hold the keys to sustainable development and sustainable innovation implies 'a collective commitment of care for the future through responsible stewardship of science and innovation in the present' (Owen et al., 2013). Innovation consequently involves complex interactions between organizations, technologies, and industry sectors (Rip, 2012; Van de Ven et al., 2008; Abernathy and Clark, 1985).

As a critical dimension of policy making, innovation draws attention to the imaginations that are associated with it, in terms of unanticipated risks, uncertainties, ambiguities, social fragility and so on (Pfotenhauer and Jasanoff, 2017; Jasanoff, 2006; Sturken et al., 2004; Beck, 1992). However, there is also a performative function associated to these imaginations that explore how innovations are realised

through ‘sociology of expectations’ (Pfotenhauer and Jasanoff, 2017). Imaginaries capture and influence ideas, symbols, and feelings. In doing so, imaginaries help in producing a shared sense of belonging to guide the collective understanding of our world (Jasanoff and Kim, 2009). They contribute to the emergence of new social and technological configurations for future-oriented businesses with promises of innovation opportunities that do not exist except in the imaginaries of involved actors (Borup et al., 2006).

Jasanoff and Kim (2009:120) have defined such sociotechnical imaginaries as “collectively imagined forms of social life and social order reflected in the design and fulfilment of nation-specific scientific and/or technological projects”. They are frequently used to elucidate the “hidden social dimensions of energy systems,” as they represent important “cultural resources that shape social responses to innovation” (Jasanoff and Kim, 2013, pp. 189-190). The CE with its focus on reformulating our relationship with materials and goods (Stahel, 2016) through innovations embodies certain sociotechnical imaginaries.

Sociotechnical imaginaries define and shape the understanding of innovations from diverse perspectives and play an important role in mobilizing the required resources. Sociotechnical imaginaries, therefore, are descriptions of futures that are attainable and offer prescriptive means through which such futures could be attained (Jasanoff and Kim, 2009). Sociotechnical imaginaries are visions that involve the creation of shared sociotechnical futures through innovations. Such imaginaries provide ‘a thread of continuity and stability by extending existing frames of reference from the past into the future, thus mitigating the unknown through what is known and taming the disruptive quality of innovation through what is imaginable and permissible in a given social, political, and historical context’ (Pfotenhauer and Jasanoff, 2017:788).

For sustainable innovation, the frame expands from traditional objectives such as economic growth, to those related to societal needs related to reducing inequality, and promoting sustainable production and consumption systems. Merli et al., (2018) have recently urged for research on CE to focus on societal changes required for global transition paths towards sustainable production and consumption systems. However, these new framings do not replace the existing ones, rather, framings compete with one another for the imagination of various stakeholders (Schot and Steinmueller, 2016).

The challenge is to figure out the kind of actions that could direct innovations for tackling such system wide transformations. Here public organizations play an important role (Mazzucato, 2015; 2016). These organizations act as intermediaries for facilitating the collective creation of imaginaries for innovations. Further, public organisations need to steer and evaluate dynamic change, and encourage

an experimental process of innovative change (Edmondson et al., 2018; Schot and Steinmueller, 2016; Mazzucato, 2013).

The aim of this chapter is to explore how CE inspired sociotechnical imaginaries, through collaboration and values, facilitate sustainable innovation. The empirical part of the chapter is based on a qualitative case study of Sitra, the Finnish innovation agency, and how it inspires imaginaries for sustainable innovation through CE. The CE is emerging as a socio-economic paradigm that could open ways for innovative and sustainable means of production and consumption; studies into the social implication of this remain insufficient (Merli et al., 2018). This chapter sheds new light on how CE, in addition to implying a particular mode of production and consumption, could also prioritize societal elements that enable sustainable innovation.

Below we present a review of sustainable innovations, imaginaries and intermediaries. Thereafter, the methodology is described, followed by a presentation and discussions of findings of the empirical study. The chapter ends with some conclusions including implications for theory and practice.

Literature Review

Sustainable innovations

While innovation is widely recognised as essential for addressing complex sustainability related issues, the current innovation frames and approaches may not be suitable for solving these issues (Adams et al., 2016; Boons and Leudeke-Freund, 2013; Soete, 2013). For instance, innovation in consumer products might have directed our societies towards "a long-term conspicuous consumption path of innovation" that destroys the value of the product forcing consumers to buy more frequently (Soete, 2012:9). For the desired transformative change, the focus of innovation needs to shift towards achievement of system-wide transformation from mere optimisation of existing systems related to products and processes (Adams et al., 2016; OECD, 2015).

Sustainability-oriented innovations require intentional changes in firms' philosophy and values (Adams et al., 2016). This implies systemic innovations aimed at transforming existing societal relationships, interactions between firms, user behaviours and lifestyles, institutional orientations, and business objectives (Adams et al., 2016; Draper, 2013). Sustainable innovations should ultimately be able to address the economic challenges associated with deregulated markets and skewed incentive structures leading to recurring financial and economic turbulence (Jackson, 2016; Sachs, 2015). Moreover, sustainable innovation should consider societal issues related to inferior quality of work and life, and high levels of inequality (Piketty and Zucman, 2014; Stiglitz, 2012; Banerjee and Duflo, 2011; Sen, 2001). Sustainable innovation initiatives should also address environmental problems that are endangering our natural systems (Jackson, 2016; Steffen et al., 2009; Meadows et al., 1972).

Firms play a central role for sustainable innovations, as they are a part of both the problem and the solution; they reinforce the current economic paradigm, thus they may influence positive change towards sustainability (Adams et al., 2016). In practice, innovations in domains like new business models replacing products with services that offer alternatives indicate that the focus should extend beyond the technology, to include how innovations are used, who they involve, and how they affect behaviour change (Geels, 2004). By extending the frame to include sustainability, the complexity multiplies, and to facilitate the transition process, creating imaginaries becomes an effective tool.

Sociotechnical imaginaries

Originally defined by Jasanoff and Kim (2009) as 'collectively imagined forms of social life and social order reflected in the design and fulfilment of nation-specific scientific and/or technological projects', sociotechnical imaginaries emphasize action and performance along with materialization through technology. This involves developing capabilities for envisioning future scenarios that enable a shared understanding of the social and technical aspects of innovation and their implicated futures. These futures entail new configurations of technologies, markets, user practices, policies, and cultural discourses implying new sociotechnical imaginaries.

CE is related to sociotechnical imaginaries as it draws on an inheritance from fields like industrial ecology (Bocken et al., 2016; Clift and Druckman, 2015; Gregson et al., 2015), 'cradle-to-cradle' design (McDonough and Braungart, 2010), and 'natural capitalism' (Lovins et al., 1999), offering new ways of imagining our sociotechnical systems. In these 'sociotechnical imaginaries' the concept of waste would become redundant (MacArthur, 2013) through long lasting design, maintenance, repair, reuse, remanufacturing, refurbishing and recycling (Bocken et al., 2016). For instance, by offering a novel perspective on waste and resource management and a new cognitive unit and discursive space for debate, CE enables the alignment of decisions and actions on technologies and appropriate organisational structures to support them (Bocken et al., 2017; Blomsma and Brennan, 2017). The transformation in practices like design and reuse, with the objective of keeping materials in circulation through a series of systemic feedback loops (Hobson, 2016; Stahel, 2016; Bocken et al., 2014; MacArthur, 2013) creates a powerful incentive for attracting businesses towards CE.

The core idea of CE is driven by a vision of future opportunities for building profitable businesses through innovations that highlight resource efficiency; implying an economic and environmental focus (Murray et al., 2017; Ghisellini et al., 2016; Preston, 2012). Such innovations impact how we think about life, as how we make things dictates how we work, what we buy, and how we conduct our lives (Preston, 2012). In discussing CE models, there is a fundamental change in how the future is imagined. However, recent studies have also indicated that so far action on CE is largely limited to recycling and cleaner production (Merli et al., 2018), and reuse faces cognitive barriers (Ranta et al., 2017). In CE contexts, enabling sociotechnical imaginaries could offer a way forward, as unlike

narratives, they are explanatory and used for justification purposes. They could offer hypothetical futures and the resources and capabilities needed to make them concrete.

As sociotechnical imaginaries are intricately entwined with how institutions and economic activities are organised and structured, they influence the ways in which people think they ought to be organised and structured (Anderson, 2006; Taylor, 2004). Firms are embedded in a certain culture and environment that shapes their symbols, norms, and meanings and it is pragmatic to connect with them from within "the direct practice of social life" (Dewey, 1925, as cited by Scherer and Palazzo, 2007, in Alfred and Adam, 2009). For firms sustainability matters mainly because of the growing societal expectation that they must use resources and materials responsibly and wisely, reduce pollution and toxins in production and consumption processes, and address issues related to climate change (Ehrenfeld, 1999; Alfred and Adam, 2009).

Sociotechnical imaginaries could describe possible futures that incorporate these while prescribing how to attain them. Such imaginaries exert substantial influence on contemporary politics and shape discourses that determine economic, technical and social trajectories (Jasanoff, 2006). The concept of sociotechnical imaginaries is used to understand how national science and technology (S&T) projects evolve over time. Policies on S&T have been described as arenas for capturing the role of culture and practices that enable the creation and stabilisation of particular imaginaries that influence future pathways (Jasanoff and Kim, 2009). For instance, leasing as a CE business model would entail new ways of imagining ownership and lifestyles while developing capabilities for services, supporting technologies, lasting design, and existing policy frameworks that are currently attuned towards linear models. This is similar to sustainable innovation process arenas that are systemic and complex, involving interactions between diverse groups of actors – producers, users, entrepreneurs, early adopters, idea generators, policy makers, and financiers. It also brings into focus the importance of intermediaries.

Transition Intermediaries

Transition intermediaries are actors that facilitate coordination processes during complex transition processes involving industry, policy makers, research organisations, and other stakeholders (van Lente et al., 2003). Intermediaries could take various organisational forms, for instance, intermediaries that facilitate transitions to renewable energy have often been government agencies and organisations, NGOs (non-governmental organisations), public utilities and consultancies, including private energy service companies (ESCs) (Backhaus, 2010). Intermediaries understand the implied changes in sociotechnical systems, characterised by shifts in infrastructures, actor groups, technologies and contexts of application (Moss, 2009; van Lente et al., 2003).

Intermediary organisations intercede within existing systems of production and consumption to create and encourage competing debates and narratives while influencing underlying social interests during transition processes (Hamann and April, 2013; Hodson and Marvin, 2010; Seitanidi and Lindgreen, 2010). As sustainability transition processes have gained momentum, the roles played by intermediaries that aid these processes have come into focus (Kivimaa et al., 2017; Kivimaa, 2014). Intermediaries play an important role in the selection of the kinds of innovations that are given prominence, the way they are framed, and the process through which they are finally embedded within society.

The interconnectedness of sustainability issues demand innovations to be conceptualized through sociotechnical imaginaries that leverage the societal dynamics to create a link with what is desirable, with the help of intermediaries.

Methodology

The empirical study is based on qualitative single case study research, which was considered as most appropriate as the aim was to get rich and in-depth information about a previously unexplored phenomenon (Eisenhardt, 1989). The chosen case is Sitra, the Finnish Innovation Fund, an independent public foundation, which operates directly under the supervision of the Finnish Parliament. It was purposefully selected, as it is a key organisation that is building an understanding of current societal transitions and facilitating the ways and means of generating discussions and debates on pathways for such transition processes. Sustainability is an integral part of its agenda and it has identified CE as a key approach for inspiring sustainable innovations.

The applied research methods were interviews and written documents. In total, seven semi-structured interviews have been carried out in June and September 2017. The average length of an interview was 35-40 minutes. The informants were considered as most appropriate as they have important and influential roles related to Sitra's CE initiative. The written material was collected from various sessions during the World Circular Economy Forum (WCEF) hosted by Sitra in June 2017, this included presentations as well as panel discussions.

This study used the grounded theory approach (Jørgensen, 2001; Strauss and Corbin, 1994), as at its core, it involved studying a social process. This approach helped in identifying how the CE creates sociotechnical imaginaries or visions for hypothetical futures that could enable pathways for sustainable innovation.

Findings

There are two main findings from this study. The first relates to the role of sociotechnical imaginaries in prompting a collective process of meaning making for negotiating collaborative paths for

sustainable innovation. The second finding is related to the importance of sociotechnical imaginaries in leveraging national shared culture to develop visions for sustainable innovations.

Imaginaries for collective meaning making

Our findings indicate that Sitra's initiatives related to CE-inspired sociotechnical imaginaries for businesses of the future act as an incentive for firms to get involved. Initially, they revolve around activities that appear possible within the existing system of production and consumption. Models around recycling, repair, and maintenance are strong drivers as firms are able to visualize solutions within their current operations. However, during the workshops organised by Sitra, it became evident that while exploring practical pathways for operationalising these models, actors encounter the challenges underlying such models. These challenges include activities such as new logistics design, identifying new partners, reorienting firm objectives and designing innovative consumer engagement initiatives. In recognising these challenges, the actors begin focusing on the specific values attached to collaboration and sharing. For instance, both collaboration and sharing enable firms to distribute risks and responsibilities, scale up activities like logistics, material use, design, training, and make them economically viable. Thus, CE models allow for a shared understanding of contexts highlighting the values that shape future imaginaries.

The imaginaries inspired by CE are comprised of loops where the consumption and production processes result in little or no waste. During a CE conference organised by Sitra, we observed a gradual progress in understanding the application of imaginaries, as actors expanded their understanding of CE models through increased levels of interaction with these imaginaries. The pathways for the transition to CE models of repair, refurbish, recycle, renting, sharing, borrowing, and redesigning, trigger imaginaries that have wider implications. These implications are related to a deeper engagement with needs through a combination of products and services, which calls for meaningful relationships with the customer. Developing such relationships require proximity and our findings indicate that relating the CE models to the core social and cultural values of the participants enables this proximity. For instance, the participants' shared understanding of trust and collaboration along with an identification with societal values, within their common social and cultural contexts made it easier to build connections. Our findings show that the values strengthen the ties between actors and enable them to negotiate pathways for production and consumption systems through innovations that seek to address the economic, social, and environmental dimensions.

At the Sitra conference, we observed how CE models enable firms to visualise waste as a resource, and in trying to make sense of the practical implications of such visualisation, firms invoke not just the material and organisational resources that need to be deployed, but also imaginative resources. Imaginative resources are the ideas and thoughts that are invoked by the actors trying to make the transition from the current linear system towards a circular one. The imaginative resources help in

relating the goals, priorities, benefits, and risks to the firms, as well as the societal frameworks they are embedded in.

Pursuing the operational aspects of CE models result in deeper understanding of the underlying issues that constrain sustainability pathways, for instance, existing societal relationships, business objectives, behaviours and lifestyles, and institutional set ups. They also trigger a collective process of imagining change. These imaginaries are able to expand the values associated with collaboration and sharing to transparency and trust. It became evident that while collaboration and sharing are important for operationalising CE models, transparency and trust form the basis of building those values. In operationalising CE visions, the opportunities for business and innovations become linked to certain societal values. For instance, developing sustainable packaging through collaboration distributes the cost of development and builds scale, but it also forces firms to confront their existing principles regarding opening up parts of their business processes to outsiders. We observed how these realisations led to further discussions on the importance of values like trust and transparency in Finnish society.

Sitra brings together a wide range of stakeholders from and diffuses the ideas related to CE in order to encourage interactions for a rich social construction of what it means for different people. In practice this happened by engaging actors in workshops and at a conference. The CE pathways are co-produced during the interactions. The interactions resulted in creating specific relationships to issues and the meanings attached to them, to build an understanding of the kinds of innovations that are acceptable. Environmental issues, for instance, resonate because of the ways in which various actors describe their relationship with nature – as an important common resource, a source for various economic activities and enriching social experiences involving family and friends. The focus then shifts to the kind of innovations that would incorporate these objectives without privileging one over the other. Through this process, the interrelatedness of the environmental, economic and social elements becomes evident.

Imaginaries rooted in culture

The interviews with Sitra and interactions with other actors during the conference indicated that in Finland, there appears to be a strong identification with innovations and a certain pride in technological prowess. This coupled with a deep cultural tradition of making and fixing things, makes CE emotionally and intellectually engaging and practically appealing. Such culturally specific imaginaries of innovation become productive means of engagement, as they resonate with the ideas underlying CE.

Through CE, Sitra is inspiring collective sociotechnical imaginaries through a shared national culture of building world-class organisations, exploring entrepreneurial opportunities, leading to new job

creation and skill development. The idea of a national first mover advantage acts as a key motivating factor. The appeal of acquiring a knowledge-based competitive advantage is strong and actors believe that CE models could, through opportunities for sustainable innovations, enable that. There is a shared understanding that these experiences would serve as learning guides for future transition processes. The understanding and the consequent identification of innovation opportunities are within a certain cultural context. Here innovations are seen as a collectively imagined sociotechnical progress for Finnish society while acknowledging the problems they are expected to solve. We find that Sitra is employing CE to inspire a culturally constructed understanding of sustainability.

Sitra employed CE to create an experience of innovation processes, and what they can mean to diverse groups of people by invoking a shared national culture. Initially, by creating a set of imaginaries to generate engagement processes, followed by the creation of CE platforms for sustainable food, forest-based loops, technical loops, transport logistics, and a platform for common action for facilitating system-wide transition processes.

The key findings of the empirical study are illustrated in Figure 24.1.

INSERT FIGURE 24.1 HERE

Discussion

For CE, sociotechnical imaginaries offer an approach that enable processes of continuous engagement between the dynamics of innovations within their social and cultural contexts. Innovations are increasingly coming under the purview of practitioners, with diverse groups of actors engaging in doing, implementing, or fostering them (Pfotenhauer and Jasanoff, 2017). As CE gains relevance, the sociotechnical imaginaries associated with it open up pathways for exploring related innovations while engaging with the social and cultural meanings attached to them. Businesses and policy makers often view elements of innovation as something that can be identified and standardised across markets but in practice, many of these elements need to be pegged to particular contexts and sociotechnical imaginaries offers the means for doing so. For academics and researchers, they offer new ways of understanding innovation processes and capturing the connections and interrelatedness of such processes, to see what works and what does not, and why.

Existing studies on CE are mainly focused on resource management and environmental practices, while those intending to re-shape the socio-economic paradigm are rare. When linking CE to the broader aspect of sustainability there is often a failure to fully recognise the implications from social science perspectives (Merli et al., 2018; Murray et al., 2017). Our findings indicate that the sociotechnical imaginaries connected to CE can leverage national shared culture and play an important role in facilitating pathways for sustainable innovation opportunities. Imagination as ‘an organised

field of social practices' (Jassanof and Kim, 2009:122) plays an important role in creating social order. In this case, the national shared culture of making and fixing things and deriving pride from national innovation and technological projects provide the social cues for creating sociotechnical imaginaries for CE, and in doing so open up possibilities for sustainable innovation. These findings gain relevance because they add a new and interesting dimension to research on CE and its implications of sustainable innovation.

From the perspective of firms and policy makers, driving sustainable consumption and production is considered an essential strategy for achieving CE (Bilitewski, 2012) and the related activities are frequently connected to waste management (Pauliuk, 2018; Sakai et al., 2017). However, there is a need for strategies that can transform the upstream process of production and consumption (Bocken et al., 2017b). Invoking sociotechnical imaginaries through CE is one such strategy that lets actors devise their own understanding of how practices related to production and consumption could evolve, and what they imply.

The complexities inherent in sustainability challenges are difficult to address within our often-disconnected worlds of business and consumers, on one hand, and governmental policy and economic advice on the other (Grubb et al., 2014). We find that invoking sociotechnical imaginaries through CE acts as a bridging mechanism between various actors. The dominant perspectives on CE offer pathways that present a positive correlation between economic potential and sustainability goals, in terms of pursuing economic growth by focusing on environmental issues and resource scarcity (Merli et al., 2018). Our findings show how these pathways are driven by existing realities of the actors involved. They relate to economic growth powered by innovations as an important driver for action. The CE offers tangible ways in visualising these realities by addressing costs related to resource scarcity and product waste. Highlighting the economic potential generates interest and encourages participation in exploring ideas on CE, as do the standardised tools and methods that guide the transition process towards mitigating environmental impact (Merli et al., 2018). However, supporting CE models like repair, reuse and renting, implies shifts in sociotechnical imaginaries relating to use, practices, traditions, identity, behaviour, and relationships. These imaginaries add a third vital pillar (the other two being economic and environmental) to CE oriented innovations, and that is the social dimension. Our findings illustrate how sociotechnical imaginaries inspired by CE unveil the practical pathways for businesses to embark on sustainability journeys through innovations.

Social imaginaries are informed by people's understanding of their social existence, in terms of how they interact with each other; what goes on between them in order to fit existing norms and develop new ones to meet changing expectations (Jasanoff, 2015; Taylor, 2004). We explore how CE inspired imaginaries are constructed through shared cultural values that are effective in drawing attention to what is meaningful and important, within a certain community of people, for creating the connections

and collaborations needed for change. This change is characterised by a shift in the ways of doing things (practices) within existing norms. However, the shift is not easy, as the incumbent system's deep entrenchment makes it resistant to change (Unruh, 2000). The evidence for this can be observed, for instance, in the lack of studies that investigate how firms may integrate CE principles into their business practices (Merli et al., 2018; Manninen et al., 2018), or the continuing focus on 'traditional' cleaner production business practices (Merli et al., 2018). Therefore, studies highlighting social interactions are important. Our study contributes here by showing that sociotechnical imaginaries offered by CE shape the ideas that help in realising sustainable innovation.

Innovations characterise business transitions to sustainability and CE presents opportunities for such innovations by offering perspectives on waste and resource management through cognitive and discursive spaces for debate, for aligning decisions and actions on technologies and organisational structures (Bocken et al., 2017; Blomsma and Brennan, 2017). However, the findings of our study show that sustainable innovation cannot be captured in models, or best practices alone. Such innovations are deeply rooted in specific social, cultural, political and economic contexts.

Conclusion

The main conclusion of this chapter is that CE has the ability for triggering imaginaries resulting in actions that could facilitate sustainable innovation processes. From a theoretical perspective, this leads to an understanding of the social engagements necessary for operationalising CE models in order to make them sustainable.

For managers, engaging with sociotechnical imaginaries could reveal the shared meanings and values attached to the practical implementation of CE models, thus highlighting the significance of social elements of CE. For instance, collaborating with diverse actors highlight the relevance of both cultural values and social practices for facilitating sustainable innovation processes. Sociotechnical imaginaries have material outcomes in terms of influencing behaviour and narratives as well as feelings of individual and collective identities. Therefore, they could be useful tools for practitioners and policy makers who often find it difficult to qualify what sustainability entails. They can also influence the development of policy and institutions, and concepts like CE help policymakers to initiate diverse actors to interact with each other. Letting such sociotechnical imaginaries emerge through processes of societal interactions could enable the intentional changes required to orient innovations towards sustainability. Therefore, the role of intermediaries that create spaces for building collective purpose and collaboration opportunities is important.

An avenue for future research could be to explore the capabilities of intermediaries in different sustainable innovation contexts. There is also a need for more research exploring the possibility of building a model for creating imaginaries that enable innovations to move from the traditional technical focus to one of changing behaviours. In this context, it would also be interesting to explore

the idea of storytelling as a method of system building for sustainable innovation. The strategic value of storytelling for sustainable innovation lies in their ability to build connections between people, ideas, and activities for transformational change.

References

Abernathy, William J., and Kim B. Clark. "Innovation: Mapping the winds of creative destruction." *Research policy* 14, no. 1 (1985): 3-22.

Adams, Richard, Sally Jeanrenaud, John Bessant, David Denyer, and Patrick Overy. "Sustainability-oriented innovation: a systematic review." *International Journal of Management Reviews* 18, no. 2 (2016): 180-205.

Alfred, A. Marcus, and R. Fremeth Adam. "Green management matters regardless." *The Academy of Management Perspectives* 23, no. 3 (2009): 17-26.

Anderson, Benedict. "Imagined communities (New ed.)." New York & London: Verso (2006).

Backhaus, Julia. "Intermediaries as innovating actors in the transition to a sustainable energy system." *Central European Journal of Public Policy* 4, no. 1 (2010): 86-108.

Banerjee, Abhijit V., and Esther Duflo. “Poor economics: A radical rethinking of the way to fight global poverty.” Public Affairs (2011).

Beck, Ulrich. “Risk society: Towards a new modernity.” Vol. 17. Sage (1992).

Bilitewski, Bernd. "The circular economy and its risks." *Waste management* 32, no. 1 (2012): 1.

Blomsma, Fenna, and Geraldine Brennan. "The emergence of circular economy: A new framing around prolonging resource productivity." *Journal of Industrial Ecology* 21, no. 3 (2017): 603-614.

Bocken, Nancy MP, Elsa A. Olivetti, Jonathan M. Cullen, José Potting, and Reid Lifset. "Taking the circularity to the next level: a special issue on the circular economy." *Journal of Industrial Ecology* 21, no. 3 (2017): 476-482.

Bocken, Nancy MP, Paavo Ritala, and Pontus Huotari. "The circular economy: exploring the introduction of the concept among S&P 500 firms." *Journal of Industrial Ecology* 21, no. 3 (2017b): 487-490.

Bocken, Nancy MP, Ingrid de Pauw, Conny Bakker, and Bram van der Grinten. "Product design and business model strategies for a circular economy." *Journal of Industrial and Production Engineering* 33, no. 5 (2016): 308-320.

Bocken, Nancy MP, Samuel W. Short, P. Rana, and Steve Evans. "A literature and practice review to develop sustainable business model archetypes." *Journal of cleaner production* 65 (2014): 42-56.

Boons, Frank, and Florian Lüdeke-Freund. "Business models for sustainable innovation: state-of-the-art and steps towards a research agenda." *Journal of Cleaner Production* 45 (2013): 9-19.

Borup, Mads, Nik Brown, Kornelia Konrad, and Harro Van Lente. "The sociology of expectations in science and technology." *Technology analysis & strategic management* 18, no. 3-4 (2006): 285-298.

Brennan, Geraldine, Mike Tennant, and Fenna Blomsma. "Business and production solutions: closing loops and the circular economy." (2015): 219-239.

Clift, Roland, and Angela Druckman, eds. “Taking stock of industrial ecology.” Springer (2015).

Dewey, John, and Jo Ann Boydston. "Experience and Nature. The Later Works. The Collected Works of John Dewey, 1882–1953." (1925).

Draper, Stephanie. "Creating the big shift: System innovation for sustainability." London: Forum for the Future (2013).

Eisenhardt, Kathleen M. "Building theories from case study research." *Academy of management review* 14, no. 4 (1989): 532-550.

Ehrenfeld, John R. "Cultural structure and the challenge of sustainability." *K. Sexton, AA Marcus, KW Easter & TD Burkhardt, Better environmental decisions: Strategies for governments, businesses and communities* (1999): 223-244.

Geels, Frank W. "From sectoral systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory." *Research policy* 33, no. 6-7 (2004): 897-920.

Geissdoerfer, Martin, Paulo Savaget, Nancy MP Bocken, and Erik Jan Hultink. "The Circular Economy–A new sustainability paradigm?." *Journal of Cleaner Production* 143 (2017): 757-768.

Ghisellini, Patrizia, Catia Cialani, and Sergio Ulgiati. "A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems." *Journal of Cleaner Production* 114 (2016): 11-32.

Gregson, Nicky, Mike Crang, Sara Fuller, and Helen Holmes. "Interrogating the circular economy: the moral economy of resource recovery in the EU." *Economy and Society* 44, no. 2 (2015): 218-243.

Grubb, Michael, Jean-Charles Hourcade, and Karsten Neuhoff. “Planetary economics.” London: Routledge (2014).

Hamann, Ralph, and Kurt April. "On the role and capabilities of collaborative intermediary organisations in urban sustainability transitions." *Journal of Cleaner Production* 50 (2013): 12-21.

Hobson, Kersty. "Closing the loop or squaring the circle? Locating generative spaces for the circular economy." *Progress in Human Geography* 40, no. 1 (2016): 88-104.

Hodson, Mike, and Simon Marvin. "Can cities shape socio-technical transitions and how would we know if they were?." *Research policy* 39, no. 4 (2010): 477-485.

Jackson, Tim. “Prosperity without growth: foundations for the economy of tomorrow.” Taylor & Francis (2016).

Jasanoff, Sheila. "Technology as a site and object of politics." In *The Oxford handbook of contextual political analysis* (2006).

Jasanoff, Sheila, and Sang-Hyun Kim. "Containing the atom: Sociotechnical imaginaries and nuclear power in the United States and South Korea." *Minerva* 47, no. 2 (2009): 119.

Jasanoff, Sheila. “Designs on nature: Science and democracy in Europe and the United States.” Princeton University Press (2011).

Jasanoff, Sheila, and Sang-Hyun Kim. "Sociotechnical imaginaries and national energy policies." *Science as culture*22, no. 2 (2013): 189-196.

Jasanoff, Sheila. "Future imperfect: Science, technology, and the imaginations of modernity." *Dreamscapes of modernity: Sociotechnical imaginaries and the fabrication of power* (2015): 1-47.

Jørgensen, U. "Grounded theory: Methodology and theory construction." *International encyclopedia of the social & behavioral sciences* 1 (2001): 6396-6399.

Kivimaa, Paula, Wouter Boon, Sampsa Hyysalo, and Laurens Klerkx. "Towards a Typology of Intermediaries in Transitions: a Systematic Review." (2017).

Kivimaa, Paula. "Government-affiliated intermediary organisations as actors in system-level transitions." *Research policy* 43, no. 8 (2014): 1370-1380.

Korhonen, Jouni, Cali Nuur, Andreas Feldmann, and Seyoum Eshetu Birkie. "Circular economy as an essentially contested concept." *Journal of Cleaner Production* 175 (2018): 544-552.

Lovins, Amory B., L. Hunter Lovins, and Paul Hawken. "A road map for natural capitalism." (1999).

MacArthur, Ellen. "Towards the circular economy." *Journal of Industrial Ecology* (2013): 23-44.

Manninen, Kaisa, Sirkka Koskela, Riina Antikainen, Nancy Bocken, Helena Dahlbo, and Anna Aminoff. "Do circular economy business models capture intended environmental value propositions?." *Journal of Cleaner Production* 171 (2018): 413-422.

Mazzucato, Mariana. "From market fixing to market-creating: a new framework for innovation policy." *Industry and Innovation*23, no. 2 (2016): 140-156.

Mazzucato, Mariana. "Innovation systems: from fixing market failures to creating markets." *Revista do Serviço Público* 66, no. 4 (2015): 627.

Mazzucato, Mariana. "Financing innovation: creative destruction vs. destructive creation." *Industrial and Corporate Change* 22, no. 4 (2013): 851-867.

McDonough, William, and Michael Braungart. “Cradle to cradle: Remaking the way we make things.” North point press (2010).

Meadows, Donella H., Dennis L. Meadows, Jorgen Randers, and William W. Behrens. "The limits to growth." *New York* 102 (1972): 27.

Merli, Roberto, Michele Preziosi, and Alessia Acampora. "How do scholars approach the circular economy? A systematic literature review." *Journal of Cleaner Production* (2017).

Moss, Timothy. "Intermediaries and the governance of sociotechnical networks in transition." *Environment and Planning A* 41, no. 6 (2009): 1480-1495.

Murray, Alan, Keith Skene, and Kathryn Haynes. "The circular economy: an interdisciplinary exploration of the concept and application in a global context." *Journal of Business Ethics*140, no. 3 (2017): 369-380.

Rogge, Karoline S. "OECD (2015) System innovation: synthesis report." *Environmental Innovation and Societal Transitions* (2016).

Owen, Richard, John Bessant, and Maggy Heintz, eds. "Responsible innovation: Managing the responsible emergence of science and innovation in society." John Wiley & Sons (2013).

Pauliuk, Stefan. "Critical appraisal of the circular economy standard BS 8001: 2017 and a dashboard of quantitative system indicators for its implementation in organizations." *Resources, Conservation and Recycling* 129 (2018): 81-92.

Pfotenhauer, Sebastian, and Sheila Jasanoff. "Panacea or diagnosis? Imaginaries of innovation and the 'MIT model'in three political cultures." *Social studies of science* 47, no. 6 (2017): 783-810.

Piketty, Thomas, and Gabriel Zucman. "Capital is back: Wealth-income ratios in rich countries 1700–2010." *The Quarterly Journal of Economics* 129, no. 3 (2014): 1255-1310.

Preston, Felix. "A Global Redesign?: Shaping the Circular Economy." London: Chatham House (2012).

Ranta, Valtteri, Leena Aarikka-Stenroos, Paavo Ritala, and Saku J. Mäkinen. "Exploring institutional drivers and barriers of the circular economy: a cross-regional comparison of China, the US, and Europe." *Resources, Conservation and Recycling* (2017).

Rip, Arie. "The context of innovation journeys." *Creativity and innovation management* 21, no. 2 (2012): 158-170.

Sachs, Jeffrey D. "The age of sustainable development." Columbia University Press (2015).

Sakai, Shin-ichi, Junya Yano, Yasuhiro Hirai, Misuzu Asari, Ritsuki Yanagawa, Takeshi Matsuda, Hideto Yoshida et al. "Waste prevention for sustainable resource and waste management." *Journal of Material Cycles and Waste Management* 19, no. 4 (2017): 1295-1313.

Scherer, Andreas Georg, and Guido Palazzo. "Toward a political conception of corporate responsibility: Business and society seen from a Habermasian perspective." *Academy of management review* 32, no. 4 (2007): 1096-1120.

Schot, Johan, and Ed Steinmueller. "Framing innovation policy for transformative change: Innovation policy 3.0." *SPRU Science Policy Research Unit, University of Sussex: Brighton, UK* (2016).

Seitanidi, Maria May, and Adam Lindgreen. "Cross-sector social interactions." *Journal of Business Ethics* 94 (2010): 1-7.

Sen, Amartya. "K., 1999, Development as freedom." (2001).

Soete, Luc. "Is innovation always good." *Fagerberg et al.(eds)*(2013): 134-144.

Soete, Luc. "Maastricht reflections on innovation: Tans lecture 2011." (2012).

Stahel, Walter R. "The circular economy." *Nature News* 531, no. 7595 (2016): 435.

Steffen, Will, Katherine Richardson, Johan Rockström, Sarah E. Cornell, Ingo Fetzer, Elena M. Bennett, Reinette Biggs et al. "Planetary boundaries: Guiding human development on a changing planet." *Science* 347, no. 6223 (2015): 1259855.

Stiglitz, Joseph E. "The price of inequality: How today's divided society endangers our future." WW Norton & Company (2012).

Strauss, Anselm, and Juliet Corbin. "Grounded theory methodology." *Handbook of qualitative research* 17 (1994): 273-285.

Sturken, Marita, Douglas Thomas, and Sandra Ball-Rokeach, eds. "Technological visions: The hopes and fears that shape new technologies." Temple University Press (2004).

Taylor, Charles. "Modern social imaginaries." Duke University Press (2004).

Unruh, Gregory C. "Understanding carbon lock-in." *Energy policy* 28, no. 12 (2000): 817-830.

Van de Ven, Andrew H., Douglas Polley, and Raghu Garud. "The innovation journey." Oxford University Press, USA (2008).

van Lente, Harro, Marko Hekkert, Ruud Smits, and Bas van Waveren. "Roles of systemic intermediaries in transition processes." *International journal of Innovation management* 7, no. 03 (2003): 247-279.

Chapter X

Blockchains for Accelerating Open Innovation Systems for Sustainability Transitions

Rumy Narayan And Annika Tidström

Abstract

Challenges related to climate change, inequality, environmental degradation, and resource scarcity threaten our ability to sustain ourselves while ensuring an equal and prosperous future. The inherent complexity and interconnectedness of these challenges demand a rethinking of our traditional approach towards organizing our production and consumption systems. Transitions towards sustainability require systemic changes, implying a wide network of actors coordinating for new forms of organizing. This chapter proposes that blockchains could offer opportunities for such organizing by leveraging the various combinations of skills, capabilities, and knowledge across open innovation networks to facilitate transitions. The characteristics of open innovation networks and their significance to blockchains are discussed, and their relevance in sustainability transitions. Democratizing access to knowledge and coding trust and consensus through smart contracts make new and innovative economic spaces and opportunities possible. Firms

may have to rethink traditional modes of organizing to seize the multiple opportunities that blockchains enabled open innovation systems present.

1.1 Introduction

Blockchain technologies offer opportunities to reinvent various categories of monetary markets, financial services, payments, and economics in addition to a highly effective model for organizing activities that could enable possibilities for reconfiguration across industries, including most areas of human activity [Swan, 2015]. Such possibilities could potentially help facilitate transitions to sustainability, for instance, through new forms of peer-production and decentralized infrastructures supporting applications such as shared economies, finance, cloud databases, and mesh networks.

Based on existing research, this chapter explores how blockchains could enable networks for open innovation. We focus on the characteristics of these open innovation networks and their contribution to sustainability transitions. By developing an understanding of the key characteristics and their relatedness to the ideas driving blockchains, this chapter addresses the relevance of such characteristics in open innovation processes guiding sustainability transitions. It proposes that blockchain technologies could play an important role in harnessing open innovation markets by radically reorganizing our production and consumption systems through decentralization; and thus enable transitions towards sustainable systems.

Sustainability transitions gain importance as societies globally face significant long-term challenges related to climate change, population, resource scarcity, food security and pollution. In addition, deepening inequality and slowing economic growth have further exposed the need for a reconsideration of the traditional models of production and consumption towards more sustainable ones. [Blok et al., 2015]. However, there are strong path-dependencies and lock-ins within the current system that resist change [Markard et al., 2012; Ahman and Nilsson, 2008; Unruh, 2000].

Established technologies are socialized through user behaviour, practices and lifestyles, aided by complimentary technologies that maintain the business models, value chains, organizational and institutional structures and regulations [Rip and Kemp, 1998]. The transition to electric vehicles where the internal combustion engine is giving way to battery technologies is not limited to the energy source but includes the sociotechnical system that supports them. The established alliances within current sociotechnical systems lean towards incremental rather than radical changes thus limiting capabilities for addressing sustainability challenges [Markard et al., 2012; Frantzeskaki and Loorbach, 2010; Dosi, 1982]. This has highlighted the need for ways and means of promoting and governing a fundamental transformation of sociotechnical systems towards sustainable modes of production and consumption.

An emerging body of literature on transitions to sustainable sociotechnical systems is contributing towards understanding the complex and multi-dimensional shifts that are necessary for societies and economies to adapt to sustainable models of production and consumption, encompassing areas like energy, transport, housing, and food [Coenen et al., 2012].

This transition process is defined by innovations that are systemic and are characterized by shifts towards sociotechnical configurations involving new technologies along with corresponding changes in markets, user practices, policy and cultural discourses, and governing institutions [Markard et al., 2012; Geels and Schot, 2010; Geels et al., 2008].

In the context of firms, this translates into navigating beyond product and process innovations towards a more systemic level of innovation that include products, services, and technologies along with new business and organizational models [Xavier et al., 2017; Adams et al., 2016; Montalvo, 2014; Boons et al., 2013], involving a wider stakeholder engagement. It is increasingly evident that such radical transitions requiring systems level innovations involving a diverse set of actors demand enabling tools for effective and efficient coordination.

There is now a growing consensus that the ideas, policies, and narratives that have traditionally defined and governed firm

competitiveness are changing and this changing landscape calls for collaborative innovation systems, as the issues are complex and interrelated [Loorbach and Wijsman, 2013]. Sustainability transitions therefore imply systemic changes requiring open innovation systems comprised of diverse actors such as businesses, research organisations, universities and governments.

Innovation is a multi-dimensional process characterized by changes in product, production process, markets, supplies/inputs, and organization [Schumpeter, 1934]. Innovation in the context of transition to sustainability needs to extend beyond economic potential to include societal changes that result from such innovation activities and the consequences for environmental and social sustainability, thus broadening both the problem framing as well as the analytical perspectives [Jacobsson and Bergek, 2011; Smith et al., 2010]. In drawing attention to the co-evolution of technology along with social networks and institutions, the innovation systems literature conceptualizes innovation as a process driven by multiple actors (Geels, 2010). Innovation conceptualized in this form, from the perspective of the firm, corresponds to the idea of open innovation.

It is important to note that in practice, openness is implicit in innovation processes, however, innovation literature makes a distinction between open and closed innovation [Huizingh, 2011]. Chesbrough [2003] used the term 'open innovation' as an umbrella construct that connected and integrated a range of activities, and in doing so enabled scholars and practitioners to visualize the design of innovation strategies in an increasingly networked and interconnected world [Huizingh, 2011].

Studies on open innovation offer deep insights into how firms negotiate environmental uncertainty and the complexities of innovation and knowledge recombination, and diffusion through increased organizational permeability initiated by interactions with a wide range of actors [Felin and Zenger, 2014]. This notion of innovation that encompasses diverse sets of actors has resulted in a range of alternatives ranging from contests and tournaments, to alliances and joint ventures, and corporate venture capital, licensing, open source platforms, and even participation in various development communities [Felin and Zenger, 2014]. Increase in such external linkages demonstrates improved

innovation outcomes and better financial performance [Leiponen and Helfat, 2010; Love et al., 2014]. Additionally, firms that repurpose their focus towards mitigating negative social and environmental impacts by moving beyond just optimizing individual performances could fundamentally restructure existing systems and encourage a rethink within wider networks [Loorbach and Wijsman, 2013].

Described as a 'new paradigm for organizing activity with less friction and more efficiency', blockchains offer global scope and scale for disintermediated transactions and automated resource allocation of physical as well as human assets [Swan, 2015]. We propose that firms that reorient themselves towards sustainable transition markets stand to gain by taking advantage of opportunities and blockchain technologies offer such firms the ability to do so. Blockchain technologies may offer alternate ways of 'spontaneous' organizing along with the governance properties of commons [Allen and Potts, 2016a&b; Davidson, et al., 2016] in open innovation processes directed towards solving issues related to sustainability.

More importantly, by enabling secure, end-to-end, and computationally validated transfer of value (this can be money, assets, or contractual agreements), it creates a new form of 'algorithmic trust' [Swan, and De Filippi, 2017], thus offering new opportunities for open innovation collaborative platforms aimed at resolving sustainability related challenges.

1.2 Open Innovation Networks for Sustainability

Transitions towards sustainable production and consumption systems require involvement of a variety of disciplines and approaches [Grin et al., 2010; Reid et al., 2010] including new business models and advanced management approaches incorporating new ways of determining business performance and success [Loorbach and Wijsman, 2013]. This means making intentional changes to the underlying philosophy and values that drive the current system; and to imagine this possibility while operating within the constraints of the incumbent system can be a

daunting task [Kemp et al., 1998; Geels, 2002; Garud and Gehman, 2012; Adams et al., 2016; Bollier, 2016].

However, open innovation arenas could enable such transition processes. Technology and innovation management studies present why open innovation systems may explain how firms leverage their capabilities and appropriate value more effectively, [Gassmann et al., 2010]. Some firms have internalized the idea that the value of business models that incorporate and encourage a continuous interaction of ideas within wider networks is far greater than those that do not [Chesbrough, 2003; Chesbrough and Appleyard, 2007; Gassmann et al., 2010]. Chesbrough [2003] described this shift from a predominantly closed system to an open one as a 'paradigm shift' (in the sense of Kuhn, 1962).Industrial marketing literature has identified the various actors in such innovation processes; comprised of firms, research organisations, universities and governments, it offers insights into how these complex innovation networks should be managed [Rampersad et al., 2010]. The dynamics of such innovation processes, that include not only market introduction and social embedding, but also the extent to which existing technological capabilities and market linkages need to be changed, have been discussed as well [Abernathy and Clark, 1985; Deuten et al., 1997; Van de Ven et al., 1999; Rip and Schot, 2002; Rip, 2012].

There have been efforts [Moore et al., 2014; Seyfang and Haxeltine, 2012] to provide an understanding of innovation processes for sustainability by reflecting on the normative orientations of such processes along with social and political aspects of knowledge production and technology development. This has contributed to innovation studies by connecting innovation theory with science and technology studies (STS); resulting in the examination of interactions within socio-technical transitions [Smith, et al., 2010].

Successful open-innovation efforts require a shared initiative, a pool of incentivized individuals and the organization of individual efforts. Blockchains, by allowing untrusted networks of participants to agree on shared states for decentralized and transactional data securely without any central control or supervisor [Tasca and Tessone, 2017] facilitates new modes of transactions. It offers a layer of societal mobilization by making activities for open innovation possible through

software protocols and provides an opportunity to understand its role in the socio-technical transition process towards sustainability.

1.3 Blockchain Technologies

The potential of blockchain technologies for initiating practices that go beyond payment reconciliation systems towards a value-creating paradigm implying societal benefits has been discussed widely [Böhme et al., 2015; Swan, 2015; Davidson et al., 2016; Walport, 2016; Kewell et al., 2017]. Blockchain technologies hold the promise of managing the contracts and records that define our economic, political, and social systems, through digitally engineered trust. Blockchains are open and distributed ledgers capable of recording transactions between two parties in a verifiable and permanent manner [Swan, 2015; Iansiti and Lakhani, 2017].

The potential of the blockchain can be gauged by its ability to embed contracts in digital codes that are stored in transparent and shared databases, protected from deletion, tampering, and revision. This would enable the identification, validation, storage, and sharing of all agreements, processes, tasks, and payments, thus making intermediary roles played by brokers, lawyers, and bankers, redundant.

Smart contracts on the blockchain are both defined as well as executed by the code automatically, making them autonomous, self-sufficient and decentralized [Swan, 2015]. Autonomy means that upon initiation of the contract, the initiating agent can cease any engagement with the contract, self-sufficiency offers such contracts to raise funds and allocate resources for specific activities, and decentralization means they are not dependent on any single centralized entity but distributed and self-executed across network nodes [Swan, 2015; Beck et al., 2016; Beck et al., 2017].

The true potential of the blockchain can be realized when individuals, organizations, machines, and algorithms begin freely interacting and transacting with one another with very little friction [Iansiti and Lakhani, 2017]. This is already evident from the financial industry's willingness to leverage blockchains for cost reductions and

increased efficiencies in several business processes involving networks of global transactions in goods, services, and legal contracts. Blockchains enable real-time settlements, which reduce operational costs, its immutability reduces the risk of fraud and the use of smart contracts eliminates operational errors [Tasca and Tessone, 2017].

This could have deeper implications for the structure and operation of society as current established power relationships and hierarchies could easily lose their effectiveness [Swan, 2015]. Blockchain-led innovations will have transformational effects on our social, economic, and political systems and in doing so, they could potentially create new foundational infrastructures for these systems [Swan, 2015; Iansiti and Lakhani, 2017].

Firms, within this context, could cease to be stable entities and morph into dynamic networks that will coalesce into temporary enterprises by pooling knowledge residing in millions of nodes to complete tasks and projects, or to solve problems, with limited or no centralized control. The protocols will enable cooperation, and along with smart contracts, make new economic spaces possible.

1.4 Blockchain Powered Open Innovation Platforms for Sustainability Transitions

The call for a redesign of our economic institutions within which human activities are conducted, with the right incentives for creating societal and environmental resilience, is a long standing one [Arrow et al., 1995]. Blockchains present the potential for developing the tools for creating such incentives at multiple levels through smart contracts, decentralization, and consensus [Swan, 2015].

The boundary spanning and dynamic nature of blockchains resonates with the core characteristics of open innovation. The idea of open innovation is synonymous with rapid technological change, where the challenge is to create openness to possibilities and options, and success depends on the re-combinations of these options and contribution from diverse actors [Chesbrough, 2003; Chesbrough and Appleyard, 2007]. Within this frame of reference, open innovation networks geared

towards sustainability transitions would necessitate an extension of technological capabilities and market linkages that result in ecological, economic and social values in addition to economic value. This implies reframing innovation for addressing wider challenges linked to sustainable and inclusive growth that spans beyond the boundaries of the firm.

An open innovation model incorporating economic, social and environmental aspects while engaging with diverse actors would have a distributive characteristic. The interconnectedness of the challenge amplifies the importance of all entities on the platform, thus eliminating any hierarchy in the interactions.

Firms in transition could use blockchain powered open innovation platforms for testing new ideas and models for sustainability. Such platforms would create opportunities for enacting complex interactions allowing technology to shape the development process and vice versa. This could enable problem solving not through adaption but through mobilizing collective intelligence and resources for radical new solutions, which is the core purpose of open innovation, the potential of which has remained under exploited so far [Gassmann et al., 2010].

Take the example of the open innovation platforms evolving around Circular Economy (CE), a framework that presents the potential for businesses to conceptualize economic activity along with environmental and social wellbeing in a sustainable manner [Geissdoerfer et al., 2017]. As a global partner of the Ellen Macarthur Foundation[i], a CE platform, Nike initially developed a sustainable material index in a bid to understand and manage the impact of its material consumption. Subsequently, it offered this information as a freely downloadable application, as users (designers and producers) increase their consumption of sustainable materials, the actual impact will be greater, and in addition, as more actors make the transition, the cost of these materials will fall, creating an important incentive for making the transition.

Now imagine this playing out on a blockchain and the range of product ideas and business models increase exponentially. The sustainable material index could be like an InterPlanetary File System (*IPFS is a global and always accessible filesystem that can be drawn*

upon for resolving any issues related to the Internet) for anyone wanting to work with sustainable materials. Through smart contracts, Nike could license its proprietary technology or even offer consulting services for business processes and strategies. This could create an avenue for revenue generation that it can leverage to justify cutting back on selling more products and contributing more effectively to a larger sustainability goal, that of bringing down the level of consumption in our societies. Nike, in this context, morphs into a key knowledge provider in the network, from a mere product company. Opendesk[ii] is another example of an online market place that hosts independent furniture designs while connecting customers to local makers, as an alternative to mass manufacturing and shipping; it claims to build a distributed and ethical supply chain through a global maker network.

Such models are possible for sustainable food, energy, mobility, and other consumer products leveraging the enormous volumes of data generated every day. This data includes historical records, messages, videos, GPS signals, and transactions, in addition to health records, land registry, education and employment. Organisations draw insights from the collection and analysis of data to optimize decision-making, personalize services and predict future trends. Ecco[iii], the Danish shoe brand is collecting data from customers in stores to explore the possibility for delivering affordable handmade bespoke shoes, for example. Further, advances in artificial intelligence (AI) is making it easier to draw relevance from disparate data sources and blockchains are becoming increasingly effective in addressing concerns related to privacy [Zyskind et al., 2015].

Being tamperproof and transparent generates trust and open up opportunities for collaborations, and decentralization of governance make blockchains effective in storing, protecting, and sharing data effectively. The ability to decentralize governance means that open innovation networks can emerge to solve issues at the micro levels while drawing resources from other parts of the network at very low costs.

As a new and evolving technology, blockchain itself is an interesting case study providing insights into the governance of innovation commons. Discovering complementary uses of new technologies reduces transaction costs and while the immediate gains

from new technologies or ideas might not be visible, innovation commons hold the promise of reaping the economic benefits of the continuous information exchange and coordination. [Allen, 2017]. Therefore, blockchain is a natural ally and could be a powerful driver for open innovation platforms for sustainability transitions.

1.5 Conclusion

Blockchain technologies facilitate a new paradigm by creating decentralized currencies, smart contracts or self-executing digital contracts, and creation of intelligent assets, while enabling participatory and decentralized governance systems [Wright and De Filippi, 2015]. Blockchains have the potential for revolutionizing how we think about innovation and enable the deployment of open innovation platforms for transitions towards sustainability.

Such innovation platforms could also, influence the governance norms of the blockchain. Lessing [1999] identifies law, social norms, markets, and architecture (for example, code) as the elements that influence behaviour and norms, and calls for a larger ecosystem approach for influencing individuals, and open innovation platforms for sustainability transitions could provide such an ecosystem. Open innovation platforms could help understand and shape the blockchain governance structures and the blockchain in turn could enable these platforms to flourish.

To manage complex transition processes, we need to rethink firms as dynamic networks with various combinations of skills and knowledge capabilities. Open innovation platforms could help pool the abundance of skills, knowledge, and capabilities for powerful problem solving capacity. Open innovation networks offer creative solutions as such platforms would attract diverse groups of problem solvers and diverse groups have been known to outperform groups of high-ability problem solvers [Hong and Page, 2004]. Blockchains can provide the right tools for capturing the full potential of such open innovation platforms, but it also has the potential for affecting a far more radical change in the very way we think about our economic systems.

In playing the role of a coordination mechanism, blockchain brings down all costs and barriers related to intermediations, and in doing that, it puts an end to scarcity as the driving logic of our economic system and replaces it with abundance [Swan, 2017]. Open innovation networks facilitate the process of bringing together valuable assets and knowledge that organisations can use and learn from and blockchain helps create a financial model for doing this. As digital, decentralized, and distributed ledgers, blockchains have the ability to store data structured by rules and validated through consensus. Through this, blockchains derive the ability to confirm identities, status, and authority thus mapping the economic and social interactions that underpin our societal networks. Opportunities emerge within these interactions and financial models could surface from unlimited combination of such opportunities.

Blockchains also guides us in conceptualizing change as a process of becoming as it shifts the focus from entities towards connections and relationships, resulting in radical changes in our traditional belief systems. The network of connections increases possibilities for creating value far more than what strategic moves alone might have provided. In the process of becoming, entities are able to explore multiple possibilities through the network of connections and leverage the same connections for making those possibilities work. There is a continuous process of pursuing possibilities and maintaining a certain level of stability as the possibilities are acted on.

Firms are commonly understood, in organizational theory, as entities that are continuously adapting to the changing environment; this perspective restricts possibilities that are activated when change is associated with becoming. The idea of becoming indicates that entities are in a state of continuous change by responding to connections with new ideas and other entities. [Nayak and Chia, 2011].

Sustainability is incredibly hard to define but such abstraction need not be problematic. Firms as part of open innovation networks powered by blockchains could continuously experiments with ideas and models for capturing opportunities in transitions to sustainability through introduction, testing and diffusion of new products, services and

processes. Operationalizing these processes on blockchains through smart contracts will bring down transaction costs (Davidson et al., 2018).

An open innovation process like this would also distribute the responsibilities and benefits associated with the product or service across the value chain and this in turn will create incentives for all stakeholders to be involved in the process. The Internet democratized information but the ability of blockchains to record events, verify facts, and enforce norms helps in organizing this information for value creation at each of these levels. Decentralized governance makes this effective.

Decentralized governance is still evolving and needs reframing to include not just the rules that govern blockchains-based networks and applications but also the rules that govern the infrastructure that these networks and application depend on. There is an endeavor to induce mechanisms for self-governance, along with bottom-up and multi-stakeholder governance and as this discussion develops and matures, it will provide valuable insights for governance of open innovation networks for sustainability transition governance on blockchains.

What is being proposed here will have deep implications how we conceptualize firms and this thought echoes often within the emerging scholarship on blockchains (see Davidson et al., 2018; Swan, 2017; Swan and De Filippi, 2017). It is increasingly evident that value resides at the nodes where information is understood, processed, validated, and exchanged. We conclude that blockchains could provide the dynamic organizational capability vital for organizations intent on capturing these values, through open innovation networks for addressing the complex and interrelated societal challenges to sustainability. To do this effectively, organizations will need to decentralize themselves while collaborating and sharing far beyond their traditional comfort zones.

1.6 References

Adams, R., Jeanrenaud, S., Bessant, J., Denyer, D., and Overy, P. (2016). Sustainability-oriented innovation: a systematic review. International Journal of Management Reviews, 18(2), 180-205.

Åhman, M., & Nilsson, L. J. (2008). Path dependency and the future of advanced vehicles and biofuels. Utilities Policy, 16(2), 80-89.

Allen, D. (2017). Blockchain Innovation Commons. Papers.ssrn.com. Retrieved 18 January 2018, from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2919170

Allen, D., and Potts, J. (2016a). How innovation commons contribute to discovering and developing new technologies. International Journal of the Commons, 10(2).

Allen, D., and Potts, J. (2016b). 'The origin of the entrepreneur and the role of the innovation commons', paper presented to 86th Annual Meeting of the Southern Economic Association Conference, Washington, D.C., 19-21 November 2016.

Arrow, K., Bolin, B., Costanza, R., Dasgupta, P., Folke, C., Holling, C.S., Jansson, B.O., Levin, S., Mäler, K.G., Perrings, C. and Pimentel, D. (1995). Economic growth, carrying capacity, and the environment. Ecological economics, 15(2), 91-95.

Beck R, and Müller-Bloch C (2017) Blockchain as radical innovation: a framework for engaging with distributed ledgers. In: Proceedings of the 50th Hawaii international conference on system sciences, Waikoloa Village.

Beck R, Czepluch JS, Lollike N, and Malone S (2016) Blockchain – the gateway to trust-free cryptographic transactions. In: Proceedings of the 24th European conference on information systems, Istanbul.

Blok, V., Long, T. B., Gaziulusoy, A. I., Ciliz, N., Lozano, R., Huisingh, D., Csutora, M., and Boks, C. (2015). From best practices to bridges for a more sustainable future: advances and challenges in the transition to global sustainable production and consumption: Introduction to the ERSCP stream of the Special volume. Journal of Cleaner Production, 108, 19-30.

Böhme, R., Christin, N., Edelman, B., and Moore, T. (2015). Bitcoin: Economics, technology, and governance. Journal of Economic Perspectives, 29(2), 213-38.

Bollier, D. (2016). Commoning as a transformative social paradigm. The Next System Project.

Boons, F., Montalvo, C., Quist, J., and Wagner, M. (2013). Sustainable innovation, business models and economic performance: an overview. Journal of Cleaner Production, 45, 1-8.

Chesbrough, H. (2003). Open Innovation: The New Imperative for Creating and Profiting from Technology. Harvard Business Press

Chesbrough, H. W., and Appleyard, M. M. (2007). Open innovation and strategy. California management review, 50(1), 57-76.

Coenen, L., Benneworth, P., and Truffer, B. (2012). Toward a spatial perspective on sustainability transitions. Research policy, 41(6), 968-979.

Davidson, S., De Filippi, P., & Potts, J. (2018). Blockchains and the economic institutions of capitalism. Journal of Institutional Economics, 1-20.

Davidson, S., De Filippi, P., and Potts, J. (2016). Disrupting governance: The new institutional economics of distributed ledger technology.

Dosi, G. (1982). Technological paradigms and technological trajectories: a suggested interpretation of the determinants and directions of technical change. Research policy, 11(3), 147-162.

Felin, T., and Zenger, T. R. (2014). Closed or open innovation? Problem solving and the governance choice. Research Policy, 43(5), 914-925.

Frantzeskaki, N., & Loorbach, D. (2010). Towards governing infrasystem transitions: reinforcing lock-in or facilitating change?. Technological Forecasting and Social Change, 77(8), 1292-1301.

Jasper Deuten, J., Rip, A., and Jelsma, J. (1997). Societal embedding and product creation management. Technology analysis & strategic management, 9(2), 131-148.

Garud, R., and Gehman, J. (2012). Metatheoretical perspectives on sustainability journeys: Evolutionary, relational and durational. Research Policy, 41(6), 980-995.

Gassmann, O., Enkel, E., and Chesbrough, H. (2010). The future of open innovation. R&d Management, 40(3), 213-221.

Geels, F. W. (2010). Ontologies, socio-technical transitions (to sustainability), and the multi-level perspective. Research policy, 39(4), 495-510.

Geels, F.W., and Schot, J., (2010). Part 1: The dynamics of sociotechnical transitions: a sociotechnical perspective. , In: Grin, J., Rotmans, J., Schot, J. (Eds.), Transitions to Sustainable Development: New Directions in the Study of Long Term Transformative Change. Routledge: London, pp. 11-104.

Geels, F. W., Hekkert, M. P., and Jacobsson, S. (2008). The micro-dynamics of sustainable innovation journeys. Technology Analysis and Strategic Management, 20(5), 521.

Geels, F. W. (2002). Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. Research policy, 31(8-9), 1257-1274.

Geissdoerfer, M., Savaget, P., Bocken, N. M., and Hultink, E. J. (2017). The Circular Economy–A new sustainability paradigm?. Journal of Cleaner Production, 143, 757-768.

Grin, J., Rotmans, J., and Schot, J. (2010). Transitions to sustainable development: new directions in the study of long-term transformative change. Routledge.

Hong, L., and Page, S. E. (2004). Groups of diverse problem solvers can outperform groups of high-ability problem solvers. Proceedings of the National Academy of Sciences of the United States of America, 101(46), 16385-16389.

Huizingh, E. K. (2011). Open innovation: State of the art and future perspectives. Technovation, 31(1), 2-9.

Iansiti, M., and Lakhani, K. R. (2017). The truth about blockchain. Harvard Business Review, 95(1), 118-127.

Jacobsson, S., and Bergek, A. (2011). Innovation system analyses and sustainability transitions: Contributions and suggestions for research. Environmental Innovation and Societal Transitions, 1(1), 41-57.

Kewell, B., Adams, R., and Parry, G. (2017). Blockchain for good?. Strategic Change, 26(5), 429-437.

Kuhn, T. S. (1962). The structure of scientific revolutions. Chicago: University of Chicago press.

Lessig, L. (1999). Code and Other Laws of Cyberspace. New York: Basic Books

Loorbach, D., and Wijsman, K. (2013). Business transition management: exploring a new role for business in sustainability transitions. Journal of cleaner production, 45, 20-28.

Love, J. H., Roper, S., and Vahter, P. (2014). Learning from openness: The dynamics of breadth in external innovation linkages. Strategic management journal, 35(11), 1703-1716.

Markard, J., Raven, R., and Truffer, B. (2012). Sustainability transitions: An emerging field of research and its prospects. Research policy, 41(6), 955-967.

Montalvo, C. (2014). Global innovation and production networks: new rationales and policy challenges. Can policy follow the dynamics of global innovation platforms?, 125.

Moore, M.L., Tjornbo, O., Enfors, E., Knapp, C., Hodbod, J., Baggio, J., Norström, A., Olsson, P. and Biggs, D. (2014). Studying the complexity of change: toward an analytical framework for understanding deliberate social-ecological transformations. Ecology and Society, 19(4).

Nayak, A., and Chia, R. (2011). Thinking becoming and emergence: process philosophy and organization studies. In Philosophy and organization theory (pp. 281-309). Emerald Group Publishing Limited.

Rampersad, G., Quester, P., and Troshani, I. (2010). Managing innovation networks: Exploratory evidence from ICT, biotechnology and nanotechnology networks. Industrial Marketing Management, 39(5), 793-805.

Reid, W. V., Chen, D., Goldfarb, L., Hackmann, H., Lee, Y. T., Mokhele, K., Ostrom, E., Raivio, K., Rockström, J., Schellnhuber, H.J., and Whyte, A. (2010). Earth system science for global sustainability: grand challenges. Science, 330(6006), 916-917.

Rip, A. (2012). The context of innovation journeys. Creativity and innovation management, 21(2), 158-170.

Rip, A., & Kemp, R. (1998). Technological change. Human choice and climate change, 2, 327-399.

Rip, A., and Schot, J. W. (2002). Identifying loci for influencing the dynamics of technological development. Shaping technology, guiding policy: Concepts, spaces and tools, 155-172.

Seyfang, G., and Haxeltine, A. (2012). Growing grassroots innovations: exploring the role of community-based initiatives in governing sustainable energy transitions. Environment and Planning C: Government and Policy, 30:381-400.

Schumpeter, J.A., 1934 (2008), The Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest and the Business Cycle, translated from the German by Redvers Opie, New Brunswick (U.S.A) and London (U.K.): Transaction Publishers.

Smith, A., Voß, J. P., and Grin, J. (2010). Innovation studies and sustainability transitions: The allure of the multi-level perspective and its challenges. Research policy, 39(4), 435-448.

Swan, M. (2017). Is technological unemployment real? An assessment and a plea for abundance economics. In Surviving the Machine Age (pp. 19-33). Palgrave Macmillan, Cham.

Swan, M. (2015). Blockchain: Blueprint for a new economy. " O'Reilly Media, Inc.".

Swan, M., and De Filippi, P. (2017). Toward a Philosophy of Blockchain.

Tasca, P., & Tessone, C.J. (2017). Taxonomy of Blockchain Technologies. Principles of Identification and Classification.

Unruh, G. C. (2000). Understanding carbon lock-in. Energy policy, 28(12), 817-830.

Van de Ven, A. H., Polley, D. E., Garud, R., and Venkataraman, S. (1999). The innovation journey Oxford University Press. New York.

Walport, M. (2016). Distributed Ledger Technology: Beyond Blockchain. UK Government Office for Science (p. 19). Tech. Rep.

Wright A., and DeFilippi P. (2015) Decentralized blockchain technology and the rise of lex cryptographia. Unpublished manuscript, Yeshiva University and Université Paris II. Retrieved 20 January 2018, from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2580664

Xavier, A. F., Naveiro, R. M., Aoussat, A., and Reyes, T. (2017). Systematic literature review of eco-innovation models: Opportunities and recommendations for future research. Journal of Cleaner Production, 149, 1278-1302.

Zyskind, G., & Nathan, O. (2015, May). Decentralizing privacy: Using blockchain to protect personal data. In Security and Privacy Workshops (SPW), 2015 IEEE (pp. 180-184). IEEE.

---

[i] https://www.ellenmacarthurfoundation.org/about

[ii] https://www.opendesk.cc

[iii] https://www.economist.com/science-and-technology/2018/05/22/shoemakers-bring-bespoke-footwear-to-the-high-street?cid1=cust/ddnew/email/n/n/20180522n/owned/n/n/ddnew/n/n/n/nap/Daily_Dispatch/email&etear=dailydispatc

h&utm_source=newsletter&utm_medium=email&utm_campaign=Daily_Dispatch&utm_term=20180522

Journal of Cleaner Production 263 (2020) 121437

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro

Tokenizing coopetition in a blockchain for a transition to circular economy

Rumy Narayan *, Annika Tidström

School of Management, Strategic Management, University of Vaasa, Tervahovi D303, Wolffintie 34, 65200, Vaasa, Finland

ARTICLE INFO

Article history:
Received 4 September 2019
Received in revised form
26 January 2020
Accepted 29 March 2020
Available online 2 April 2020

Handling Editor: Dr. Govindan Kannan

Keywords:
Sustainable
Circular economy
Coopetition
Blockchain
Token
Economy

ABSTRACT

The circular economy offers a way for businesses to conceptualize sustainable economic activity with a concern for environmental and societal well-being. Putting this concept into practice is a complex undertaking, given the current production and consumption systems, and necessitates strategies that enable competition and cooperation between various actors to generate and scale up the best ideas. Simultaneous competition and cooperation, or coopetition, is studied in strategy literature within the context of managing the complexity of business networks. Coopetition could offer valuable perspectives for firms transitioning to circular models. The purpose of this paper is to show how coopetition could be operationalized and optimized using tokens in a blockchain to support a transition to circular models of value creation and appropriation. The findings of our study indicate that tokens could enable previously disconnected product ecosystems to converge and unleash the waves of creativity and innovation required for circular business models. However, facilitating such convergence would require the coopetition models to transition from comprising the current stages of value creation and appropriation to being based on value creation and circulation.

1. Introduction

A growing global population, coupled with increasing economic activity, is accelerating resource use, societal imbalances, and environmental destruction (Bocken et al., 2014; Bocken and Antikainen, 2018). Competition for resources has resulted in calls to improve the productivity around the use of resources and consequently, focusing on productivity and the use of resources has become critical when managing sustainability issues (Boons et al., 2013; Mudgal et al., 2012; Dobbs et al., 2011). For businesses, it is important to consider that limitless exploitation of resources to stimulate economic activities is no longer feasible and linear supply-chain models demand rethinking (Bocken and Antikainen, 2018; Schulte, 2013; Rifkin, 2009).

The circular economy (CE) has emerged as an alternative approach intended to keep products, components, and materials in circulation while retaining their value (Bocken et al., 2017). Firms and organizations are currently exploring the CE as a model for conceptualizing the integration of sustainability into economic activities (Murray et al., 2017; Bocken et al., 2015). Research on the CE has focused on the origins of the concept (Frosch, 1992; Ehrenfeld and Gertler, 1997; Erkman, 1997; Preston, 2012), single case studies (Prendeville et al., 2014; Schnitzer and Ulgiati, 2007; Ramani et al., 2010). Implementation on the meso level - industrial parks (Chertow and Ehrenfeld, 2012; Conticelli and Tondelli, 2014); and on the macro level - cities, provinces, and nations (Su et al., 2013; Naustdalslid, 2014).

Lieder and Rashid (2016) note CE literature contains scant research on the management strategies that could help firms operationalize CE models. As firms explore the means of value creation at both the firm and the societal level in light of the promise of the CE, they need viable strategies to facilitate the transition. Firms able to move beyond optimizing individual performance through restructuring and to rethink existing systems and processes and that can then co-create sustainable marketplaces will gain a competitive advantage (Loorbach and Wijsman, 2013). This point relates to both collaborative and competitive, or coopetitive, activities. Bengtsson and Kock (2014: 182) define coopetition as "a paradoxical relationship between two or more actors simultaneously involved in cooperative and competitive interactions, regardless of whether their relationship is horizontal or vertical." Coopetition has been studied in the fields of strategic

* Corresponding author.
E-mail addresses: rumy.narayan@uva.fi (R. Narayan), annika.tidstrom@univaasa.fi (A. Tidström).

https://doi.org/10.1016/j.jclepro.2020.121437
0959-6526/

management and industrial marketing (e.g., Bengtsson and Kock, 2000; Dagnino and Padula, 2002; Dorn et al., 2016; Fernandez et al., 2019; Gnyawali and Park, 2011). One stream of coopetition research (Tidström and Rajala, 2016; Bengtsson and Kock, 2014; Ritala and Tidström, 2014; Bengtsson et al., 2010; Brandenburger and Nalebuff, 1995, 2011) focuses on value creation and appropriation.

For CE models, both the competition and the cooperation between actors are important and combining the underlying principles of the CE with a strategy of simultaneous cooperation and competition is worth exploring. Building CE ecosystems is complex, and Spring and Araujo (2017) concept of product biographies is a starting point for developing our idea. Spring and Araujo (2017) use product biographies to highlight the inherent instability of products, both physically and institutionally, and the managerial and institutional effort required to stabilize and process products for exchange or service value creation. They argue that within the CE context, there is an emphasis on products qualified by and constitutive of a distributed network. The perspective that visualizes a product as a distributed network instead of a single entity opens up spaces for innovative entrepreneurial opportunities at every transition point within the products' lifecycle. As multiple product biographies unfold, revealing potential value creation opportunities, the existing networks will require reconfiguring.

This reconfiguring could be understood as the decentralization of the product; instead of one central authoritative understanding, the product can then be understood within the various contexts by revealing information about its production and consumption lifecycle. These information contexts offer opportunities to develop a competitive advantage while employing cooperation for creating the value of the product. In redirecting the focus away from the product and toward its biography, the network of actors expands to include those that have not traditionally been directly part of firms' networks. Individuals and actors indirectly linked to the product's ecosystem become equally relevant sources, validators, custodians, and traders of information and knowledge related to the ecosystem. The opportunities for value creation and circulation through coopetition to operationalize CE models are nested in the aforementioned activities.

However, coordinating and incentivizing the activities that underpin coopetition presents a challenge for such complex processes. The complexity might have to be managed through decentralized and distributed systems that are secure, tamper proof, and can be tokenized. Such decentralization resonates with the underlying ideas of distributed ledger technology, often referred to as a blockchain. A blockchain creates a secure, robust, and transparent distributed ledger able to leverage resources within a global peer-to-peer network by building algorithmic trust through smart contracts, thus representing new market design opportunities (Catalini and Gans, 2016; Davidson et al., 2016). Apart from being an information and computational technology, as a software protocol based on cryptography, a blockchain is a digital information technology for distributed databases and is best understood if it is viewed as an institutional or social technology for coordination (Davidson et al., 2016; Swan, 2015).

Once validated, transactions in the blockchain become irreversible, verifiable, permanent, and secure, thus making the use of a blockchain well suited for financial transactions (Chen, 2018). This has resulted in the creation of digital currencies that have tokenized and decentralized money (Larios-Hernández, 2017). As the technology advances, the blockchain system will expand its potential by becoming capable of tokenizing and decentralizing other assets besides money (Tapscott and Tapscott, 2016). Tokenization in the blockchain is a process of converting the rights to an asset into a digital token, which facilitates the trading of those assets and permits micropayments. Tokens can represent a wide range of assets and can be transferred without any involvement of centralized entities and can be traded on digital currency exchanges without borders (Chen, 2018; Buterin, 2014). Tokens constitute innovations to the architecture of a platform (Henderson and Clark, 1990) that incentivize its growth, operations, and its security (Catalini, 2017).

In this conceptual paper, we show how coopetition focused on value creation and appropriation can enable firms seeking to transition toward sustainable systems to operationalize the CE within diverse networks. We propose that the strategy could be incentivized by tokenizing assets in a blockchain. The applied research methodology is based on a literature review of CE, coopetition, and blockchain research. This paper contributes to CE literature by enhancing the understanding of how and why coopetition as a strategy is pertinent to firms transitioning to CE models and how tokenization could facilitate such a strategy.

The structure of the paper is as follows: The next section discusses the research methodology. The following section elaborates on the key issues of the CE by reviewing the characteristics of the CE revealed by prior research and the challenges to its implementation. The following section presents coopetition strategy as a model for structuring interaction in networks of businesses, before we examine blockchain and tokenization and their relevance to coopetition. Next, the requirements of modern CE models and the coopetition strategy driven by tokenization on blockchain are combined into a theoretical framework before the key findings are discussed. The final section encompasses our conclusions, the study's managerial implications, and suggestions for future research.

2. Research methodology

A literature review is an appropriate research method through which to obtain an overview of the areas in which the research topic is embedded, and also serves to highlight areas requiring more research. There are several types of literature review; the most commonly used for business studies being the systematic review, the semi-systematic review, and the integrative review (Snyder, 2019). In this study, we used an integrative review, which is suitable when the aim is to synthesize literature on a topic in an integrative way in order to create novel frameworks and perspectives. Moreover, integrative reviews suit new and unexplored research topics (Torraco, 2005).

New conceptualizations and perspectives can arise by relating literature either through differentiation or integration (MacInnis, 2011). We used and blended literature on the CE, coopetition, and blockchain in order to develop a theoretical framework that illustrates opportunities for transitions to sustainability in coopetitive networks through the use of tokens. The logic behind our choice of literature can consequently be explained by first delving into the purpose of the CE, then into the approach that is coopetition, and finally into the method of tokens in blockchains. We chose the most relevant literature in all three areas highlighting the important aspects related to the particular topic. Another criterion for our choice of literature was the potential of combining it with the other perspectives in order to arrive at a relevant theoretical framework that could be explored further in future research.

In practice, on a more detailed level, the choice of literature was guided by a process of problematizing themes and in relation to these, combining findings of prior studies to meet the aim of the study. As far as the CE is concerned, we concentrated on the literature that captures the systems view of sustainability as it is related to a network perspective, which is a core theme of our study. Within the literature of business networks, we focused particularly on those studies related to coopetition and value creation and

appropriation within coopetition. The choice was motivated by indications in traditional business network research that networks featuring coopetitive interactions can involve various types of actors (not only business ones). Our focus on value creation and appropriation was motivated by the fact that from a strategic perspective, these activities constitute the core of coopetitive interaction. Moreover, we wanted to show how value appropriation, from a CE perspective, should be transformed into value circulation using a blockchain and the tokenization of product and service information, which also represents the final part of our literature review. In that section, we chose to focus on literature that elaborates on and explains the key features of blockchain, and our combination of literature shows how tokens as tools can be used for transitions to the CE through value creation and circulation in a context of coopetition.

3. From linear to coopetitive models for a circular economy

Problems like the ecological crisis, social inequalities, and political and economic instabilities are often articulated and thought of as discreet issues, but are actually interconnected (Lenzen et al., 2012a,b). There is evidence linking international trade to biodiversity threats in developing countries (Lenzen et al., 2012a,b), threats to entire species from global supply chains (Moran and Kanemoto, 2017; Wiedmann et al., 2015), and the international trading system undermining national emission targets (Kanemoto et al., 2014). The environmental impact of household consumption associated with the production and consumption of goods and services is evident (Ivanova et al., 2016), demanding a systematic approach to addressing the issue. Product and service biographies help conceptualize that impact as the products and services pass through the trading system. This perspective could also help firms visualize the CE beyond the predominant recycle-and-reuse models (Bocken et al., 2017; Murray et al., 2017) and open up spaces for regenerative local economic ecosystems through what Stahel (2016) describes as intelligent decentralization that offers opportunities for value creation and circulation.

3.1. The circular economy

Natural systems offer insights into the efficient management of resource cycles, making the concept of waste is redundant (Meadows et al., 2004). The ultimate aim of the CE is to redesign products or services from the perspective of minimal waste by allowing for easy repair or for the materials to be upgraded and reused, thus building value creation based on longevity and new forms of consumption (Schulte, 2013). MacArthur, 2014 define the CE as:

An industrial economy that is restorative by intention and design. It replaces the end-of-the-life concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse and return to the biosphere, and aims for the elimination of waste through the superior design of materials, products, systems and business models.

The interest in the CE has led to a significant number of publications, including case studies, reviews, and scientific reports (Andersen, 2007; Charonis, 2012; Preston, 2012; Prendeville et al., 2014; Bonviu, 2014; Gregson et al., 2015; Mac Arthur et al., 2015; Bocken et al., 2016; Bocken and Short, 2016). The CE models imply the adoption of cleaner production, increased producer and consumer responsibility and awareness, and the use of renewable materials and technologies while simultaneously adopting tools and policies that facilitate such use (Ghisellini et al., 2016).

Spring and Araujo (2017) illustrate how the CE perspective can be used to visualize products within a distributive network instead of the products being defined by the final producer, thus presenting entrepreneurial opportunities at various stages of the transition from specific materials and components to objects and vice versa. This view also distributes the responsibility for the final product through the entire value circle, making each entity a stakeholder in the process. This echoes the findings of Murray et al. (2017) describing the CE in the context of sustainable business, which link the CE to systems thinking and the need to consider businesses as part of a wider system of stakeholders.

The objective of the CE is to redesign the linear economic models to create a circular one where waste becomes a resource, thus enabling a more equitable solution to the linear system by prioritizing balance between the economic, environmental, and social aspects (Gregson et al., 2015; Haas et al., 2015; Ghisellini et al., 2016). This implies a complex set of networks (Lieder and Rashid, 2016; Bocken et al., 2017), requiring a wider network for designing the transition strategies. From the perspective of delivering more sustainable systems and solutions, a firm's innovation activities should be seen as dependent on the innovation activities of other firms (Aaldering et al., 2019). The literature on supply-chain management also recognizes such networks of organizations, because individual firms rarely possess the skills and resources to deliver a product's value proposition (Geissdoerfer et al., 2018). The configuration of such networks ranges from attributes like dynamic behavior, the diffusion of risks, trust, geographical dispersion and the like, to the characteristics of each organization in the network, to the product, and the type of collaboration. The collaboration aspect acquires additional relevance when sustainability is considered (see Geissdoerfer et al., 2018; Jagdev and Thoben, 2001; MacCarthy and Jayarathne, 2012). Geissdoerfer et al. (2018) have defined circular supply-chain management as the configuration and coordination of organizational functions within and across business units and organizations, implying a complex set of alignments.

The deployment of CE models and the incorporation of CE practices consequently require adjustments to current operations, realignments in supply-chain networks, and relationships based on cooperation, often with competitors (Preston, 2012). Here, a coopetition strategy to foster value creation and appropriation could make the transition to the CE both practical and attractive. Coopetition is thus a fruitful strategy to collectively build systems for sustainable innovation (Planko et al., 2016) and for transitions toward the CE.

3.2. Coopetition strategy

The evolution of networking approaches through a continuous interactive process is a focus of business network research, which being based on interdisciplinary contributions and insights (Cantù et al., 2013), makes it uniquely placed to provide rich perspectives on the various interactions, interdependencies, conflicts, and issues related to trust currently facing CE models and to capture their evolution.

The continuous evolution in business relationships illuminates a more relational rather than strictly transactional perspective on markets and provides a broad framework for understanding how firms could visualize business models that extend beyond the market to encompass other societal spaces and institutions. Business network research has intentionally focused on change and the continuity of change as the dominant logic and feature of business relationships. Cantù et al. (2013) described business relationships as processes of continuous adaptation in areas that include products, logistics, and administrative procedures.

The diversity of interactions and the subsequent adaptation fosters a seemingly endless organizational process that embraces

economic transactions as well as social exchanges; in this context, coopetition can spur innovation processes within networks (Park et al., 2014; Gnyawali and Park, 2011). Business network research highlights the cooperative and competitive aspects of business actors and the interaction between cooperation and competition as important characteristics of the heterogeneous business landscape (Ford and Håkansson, 2013).

The notion that organizations can compete in some activities while collaborating in others is an important requirement for network efficiency (Bengtsson et al., 2005) and value-creation strategy (Dahl et al., 2016). Coopetition can facilitate sustainable solutions and situations (Reniers et al., 2010). Implementing circular models to address complex and interconnected issues requires a balance between the competitiveness that lies at the heart of business strategy (Dagnino and Padula, 2002) and collaboration. Initiating such a transition requires a transdisciplinary understanding of the issues, and managing it means implementing a process that facilitates collaborative and interdependent networks between various stakeholders while simultaneously enabling competition over the best ideas.

The concept of value creation and appropriation remains at the heart of management research (Teece, 1986; Pitelis, 2009) and is important for research on networks and alliances (Pitelis, 2012; Dyer et al., 2008). From the economic perspective, value is what consumers are willing to pay for a product or service (Brandenburger and Stuart, 1996); following this logic, value creation embraces everything that adds value to any product or service, and value appropriation encompasses all activities that capture a portion of the created value.

The coopetitive perspective emerges from the recognition that value creation and appropriation take place within the realm of inter-firm dependence, which makes way for partially convergent interests whereby cooperation and competition occur simultaneously, giving rise to a novel form of strategic interdependence among firms (Dagnino and Padula, 2002). There is a stream of coopetition research that focuses on the simultaneous existence of value creation and appropriation (e.g., Ritala and Tidström, 2014; Ritala et al., 2014; Golnam et al., 2014; Ritala et al., 2013).

In coopetitive business relationships, the creation of value occurs through the integration of complementary and similar resources that are exchanged between firms to create greater value than each firm would have been able to create if acting alone (Bengtsson and Kock, 2000; Gnyawali and Park, 2009). In coopetitive business relationships, value creation is enhanced by competitive partners while heightening the joint understanding of business logic and technologies of the industry; this may facilitate knowledge sharing (Dussauge et al., 2000).

In comparison with value creation in coopetition, value appropriation is firm specific and may cause tensions in coopetition (Hamel, 1991; Tidström, 2009). According to Ritala and Tidström (2014), value appropriation may reduce the opportunity for other firms within the network to capture value (the zero-sum logic; Bengtsson et al., 2010; Ritala, 2009), and it may also not have an impact on other firms' abilities to capture the same or parallel value (the positive-sum logic; Choi et al., 2009; Ritala et al., 2009).

Coopetition research has highlighted relationships where actors manage value creation and appropriation within the same domain or in a shared market context, and while some studies claim that value creation takes place away from the customer and value appropriation occurs close to customers, others have illustrated that these are interconnected phenomena and evolve over time (Ritala and Tidström, 2014). This perspective injects firms with a certain level of strategic agility and becomes relevant for managing changes that are characteristic of transitions.

Digitalization (Reuter, 2016), specifically technologies like the *internet of things* and artificial intelligence that are powering industry 4.0 (see Ghoreishi and Happonen, 2019; Pagoropoulos et al., 2017; de Sousa Jabbour et al., 2018) and also 3D manufacturing (Despeisse et al., 2017) are becoming more relevant in transitions to the CE. This paper specifically focuses on the importance of the blockchain as a tool for creating, organizing, and managing new forms of CE networks. Thus, a blockchain becomes the tool that coordinates these technologies by offering security, privacy, and decentralization of data and information flow within networks.

4. Blockchain and tokens

Blockchain technology came into focus in 2008 with the emergence of Bitcoin. It has since expanded beyond cryptocurrency applications to a multitude of other commercial applications, including value and supply chains, business models, and market structures (Notheisen et al., 2017). A blockchain is a decentralized network that consists of economic agents who agree about the true state of shared data, such a network could support multiple types of transactions online and corresponding payments, exchanges of IPs, information, or any other type of digital asset (Catalini and Gans, 2016). Such agreements happen at regular intervals, resulting in digital marketplaces that are characterized by competition, lower entry barriers, and lower privacy risks, allowing actors to collaborate in making joint investments in shared infrastructures without assigning market power to a single entity (Notheisen et al., 2017; Catalini and Gans, 2016).

A blockchain is also a new way of coordinating economic activity because the underlying technology appears to possess the institutional aspects of market capitalism, such as property rights (ledger entry and private keys), exchange mechanisms (public keys and peer-to-peer networks), native money (crypto-tokens), and finance (initial coin offerings) (Davidson et al., 2016).

In the evolution of the original Blockchain, version 1.0 addressed cryptocurrency like Bitcoin to enable the transaction of digital property, Version 2.0 assisted complex transactions like the creation of new decentralized economies and financial instruments based on *smart contracts*, and 3.0 imagined the diffusion of this distributed ledger technology, powered by decentralized principles of governance and justice, across society (Elsden et al., 2018; Swan, 2015).

Despite its inability to meet the requirements of the current financial system and governments or to match the performance of existing payment networks, Bitcoin remains one of the largest applications using a blockchain as its design solves a particular problem: allowing a global network to securely transact and exchange value while sidestepping costly intermediaries (Catalini, 2017). The underlying technology is important in that it enables digital blockchain tokens to be used to raise funds and build ecosystems by co-opting complementors, early adopters, opinion leaders, and various other stakeholders.

Entrepreneurs have built new capabilities and have begun reshaping entrepreneurship and innovation using tokens powered by blockchain technology (Chen, 2018). The resulting digital marketplaces challenge the existing revenue models of incumbents and open opportunities for new approaches to data ownership and licensing, digital advertising, incentivizing product adoption, auctions, and reputation systems (Catalini and Gans, 2016).

As a decentralized ledger with protocols, a blockchain offers an unchangeable record of transactions by combining a distributed database. A ledger is an accounting tool that records economic information such as who owns what and the agreements, contracts, and definitions that capture the value of things, as well as all transactions of value. The value could include identity, property, contract, and their values, making ledgers a fundamental

instrument of modern market systems. Large central trust aggregators come at a cost along with distorted incentives (Davidson et al., 2016). A blockchain is a mechanism to prevent double-spending in the peer-to-peer electronic cash system. The database contains chronologically ordered and cryptographically interconnected blocks of transactions with a decentralized consensus mechanism and cryptographic security measures (Glaser, 2017). The combination of these elements hinders the spread of distorted or false information while moderating the friction among conflicting agents without requiring any centralized governing institution or authority (Notheisen et al., 2017).

Onik and Ahmed (2018) and Zareiyan and Korjani (2018) have discussed the possibilities that a blockchain could offer in future scenarios within industry 4.0 regimes. This could include industries based on digital enterprises with physical products at the center, with decentralized storage, augmented interfaces, and immutable crypto transactions at the end (Onik and Ahmed, 2018). Organizational models based on decentralized solutions for globalized manufacturing challenges by providing an ecosystem for manufacturers, designers, and consumers to interact efficiently without any restrictions (Zareiyan and Korjani, 2018). Information about the products and services is the guiding factor in developing such interactions and will also determine how supply-chain networks could be redesigned for closing the production and consumption loops. Westerkamp et al. (2018) offered a mechanism moving beyond the current supply-chain traceability using RFID and QR codes to track goods in the blockchain and documenting their creation, transformation, and exchange on a distributed ledger.

Emerging blockchain networks designed to improve supply-chain efficiency and transparency (Francisco and Swanson, 2018; Bocek et al., 2017; Hofmann et al., 2017) offer some examples of how tokens could be deployed to create networks (Westerkamp et al., 2018). Projects such as *Waltonchain* could offer insights into designing markets through coopetition utilizing tokens. The information on *Waltonchain* facilitates the visibility of products from the beginning to the end of the production process, by connecting single or multiple chains to its public *chain cluster* ecosystem, thereby enabling the transmission and integration of data value that could potentially be traded, exchanged, or even queried to enhance that data value. Another example is provided by Nike, which with various partners has built a database accessible to designers through the *Making* application, which intends to offer freely available information to those willing to use sustainable materials in designing their products. In doing so, Nike has distributed the responsibility for the choice of materials it uses while opening up unlimited collaboration options.

5. A framework for coopetition using tokens for building CE ecosystems

Openness is one of the key features of a blockchain that is designed to facilitate intra-organizational collaboration. While centralized organizations concentrate resources, distributed networks harness resources from masses of actors and in the process create open user-generated markets. In automating transactions, compliance, and trust and connecting actors, peer-to-peer blockchain systems make markets the primary mode of organization while reducing friction within economic networks (Davidson et al., 2016; Tapscott and Tapscott, 2016). Blockchain will have a considerable impact on our economic system, and economic systems are primarily about the things we value. The value embedded in the information about products and services is an important factor for organizing the production and consumption loops required for CE models. Information value depends on the use, purpose, and context of the information.

The first step towards designing the CE models would be to account for the value that is there in the system. Employing Spring and Araujo (2017) product biography, it is possible to securely represent the resources and exchanges in the economy in an information system, enabling the exchange, analysis, distribution, verification, and alteration of these resources and exchanges. It is critical that the information accounting layer remains true to the underlying resources and the exchanges taking place in the real economy. Currently, centralized actors and institutions maintain the connection by producing accounts and vouching for the information; a distributed ledger could associate any resource with a programmable asset, effectively turning it into a token.

Tokens can represent access rights to any kind of economic value or any kind of operation in a network that results in economic value. Converting the information embedded in product biographies into tokens opens up multiple opportunities for simultaneous cooperation and competition. A major challenge related to value creation and appropriation within coopetition is the issue of knowledge and the balance between sharing and securing knowledge (Solitander and Tidström, 2010). Tokenizing elements related to coopetition would facilitate both open and shared information and also information on the creators of information. Learning and innovation between the actors could be facilitated as valuable information would be available to all parties, and its use would be transparent.

By converting product information into openly available and accessible tokens in the blockchain, the central issue for creating value would be not information and knowledge as such but the ability to use the information. Firms would easily identify the origin of information and suitable cooperation partners to foster value creation. A critical success factor for coopetition is value appropriation, dividing the created value between the collaborating parties (Ritala and Tidström, 2014). A system of coopetition in the blockchain would facilitate the sharing and circulation of the created value as tokens show how each connected party is related to the aggregated information. Separation and/or integration are often considered as suitable strategies for managing coopetition and value creation and appropriation (e.g., Fernandez et al., 2014).

Tokens would facilitate a clear, transparent, and structured strategy for separating and/or integrating the elements related to cooperation and competition. Moreover, within a network of firms, it would be possible to create sub-networks and systems that would be based on differing principles related to the separation and integration. Coopetition could also facilitate transitions to CE-based business models particularly related to the products. Research has shown that business models based on coopetition can accelerate product development, generate a wider selection of products, and improve product quality (Velu, 2018). A framework for a token-based model of coopetition in transitions to the CE is illustrated in Fig. 1.

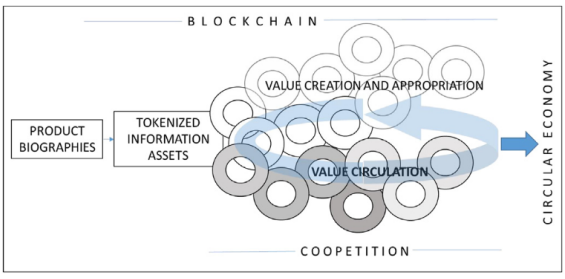


Fig. 1. Transitions to the CE using a tokenized model of coopetition.

It is apparent from Fig. 1 that tokenized information assets related to products can be beneficial for building an ecosystem of value creation and circulation through coopetition. The openness and opportunities provided by blockchain technology could support a network and ecosystem of the CE that continuously expands and grows.

6. Discussion

The CE has both a linguistic and descriptive meaning: linguistically, it is the opposite of linear, and descriptively, the CE refers to a continuous biogeochemical cycle and recycling (Murray et al., 2017). The CE is a continuous cycle of value creation and appropriation; however, the current CE models, while attempting to dematerialize economic growth, continue to rely on an economic model for which such growth is a necessity (Skene and Murray, 2017). There is a need for concepts that can inspire ideas for creating an effective bridge between the familiar and the emergent (Narayan and Tidström, 2019).

We suggest that coopetition is such a bridging strategy, that a blockchain helps realize the cyclical continuity that is inherent to the CE, and that tokens as applications in the blockchain help manage the value creation and appropriation associated with coopetition for creating CE ecosystems. The combination of cryptography and incentives in a blockchain allows participants in the network to query and verify the state of any transaction. The blockchain thus offers market participants the ability to lower the cost of auditing transaction information while allowing new marketplaces to emerge (Catalini and Gans, 2016). We find that this attribute could extend the network of actors beyond firms to include any individual or entity that is either directly or indirectly associated with the production and consumption processes in our economic system. We also find that there are certain features of a blockchain—its ability to be open and collaborative, iterative, and transparent, see Berg et al. (2018)—that resonate with those associated with CE models (see Leising et al., 2018; Murray et al., 2017; Preston, 2012).

For firms attempting to make the transition to CE models, the concept of product biographies would be a good starting point (Spring and Araujo, 2017) in that the concept highlights the nature, role, and identity of products. Setting this idea in the context of the CE further challenges the stability and identity of products as CE models advocate refurbishment, remanufacturing, dismantling, reuse, and recycling, as well as being open to new forms of valuation and exchange (Spring and Araujo, 2017). The product-biography perspective reveals new insights into a product's lifecycle in terms of its design, production, circulation, consumption or use, and disposal (Westerkamp et al., 2018). Each of these stages is supported through different networks that coordinate actors in the design, production, distribution, use, and disposal of the products (Spring and Araujo, 2017; Callon et al., 2002).

The abovementioned perspective is important because it distributes the responsibility for the product, instead of concentrating it on a single firm or actor, and in so doing makes the information relating to the contribution of value transparent, which encourages representative shares of the value created. However, managing the transition toward CE models requires the coordination of networks of actors. A decentralized ledger or blockchain could assist such coordination, and thus presents opportunities to form new types of contracts and organizations.

The shift, therefore, from a centralized system of creating consensus (using trust) to a distributed one (using blockchain technology) has the ability to transform the transactional dynamics of the modern economy. The combination of mathematical cryptography, open-source software, computer networks, and incentive mechanisms makes a blockchain a cryptographically secure and crypto-economically incentivized class of distributed ledger or a decentralized database (Swan, 2015; Davidson et al., 2016; Pilkington, 2016). Accordingly, blockchain technology becomes a natural fit for creating product biographies through the coordination of the networks of actors involved in the lifecycle of products. Every aspect of a product's lifecycle can be recorded, verified, stored, and ultimately traded, and tokens can facilitate each of these activities.

Tokens will allow individual actors to identify and define value independently and to build entire ecosystems around that value proposition through those tokens, and a strategy that combines simultaneous cooperation and competition could help actors create and appropriate value within these networks. As social interactions are embedded in these activities, we will see new forms of value emerging from such interactions that go beyond the existing forms of valued assets. This can enable actors to make the aspects of natural and social capital within individual contexts tangible.

Geissdoerfer et al. (2017) have articulated the challenges involved in defining the sustainability and its relationship with CE. Within the current paradigm of consumption and production, the relationship between sustainability and CE identified by Geissdoerfer et al. (2017) remains within core business networks. By turning the lens of inquiry toward product biographies (Spring and Araujo, 2017), the networks extend beyond firms to include societal actors who become involved at different stages of the evolution of the product. Those actors then contribute additional knowledge, dimensions, and skills that could be leveraged through coopetition to create dynamic CE models.

A current challenging issue within coopetition research is how coopetition should be managed. The literature suggests techniques for managing coopetition such as separation/integration, creating coopetition capability (Bengtsson et al., 2016), and managing tensions in coopetition (e.g., Tidström, 2014). By relying on value creation and value appropriation in coopetition, we present a novel approach for managing coopetition through the use of tokens in the blockchain. In addition, we propose that tokenizing the various activities relating to coopetition would enable a continuous process of value creation and circulation as tokens earned from one activity could be deployed for another, thus circulating the value.

The approach outlined above also facilitates the sharing of information, as well as defining its appropriate ownership which is central for the management of coopetition. Moreover, this approach encourages trust related to products within the cooperation. Prior research on coopetition has mainly addressed dyadic cooperation between competitors within different manufacturing industries (Czakon and Czernek, 2016; Gnyawali and Park, 2011) but the current study diverges in revealing how coopetition can benefit networks of various firms and related actors in their transitions to the CE.

7. Conclusion

The contribution of this conceptual study is twofold. First, it contributes to the research on transitions to CE models by introducing a strategy combining coopetition and a blockchain to direct the successful implementation of such a transition. Second, the study contributes to existing coopetition research by relating coopetition to CE models, particularly to the applications of blockchain relevant to a transition to the CE. The current research also illustrates how value creation and circulation is possible in such CE models. Thus far, coopetition research has focused on value creation and appropriation, incorporating a linear view of the value; our model presents a circular vision of value.

As far as managerial implications are concerned, our findings

suggest a need for managers and businesses to explore the options for more sustainable ways of working through the transitions to CE-based business models relying on coopetition. Competition may not be the most effective strategy to deliver competitive advantage, and the novel and productive way of doing CE-based business might well be to cooperate and compete simultaneously within a network system. Product biographies direct attention to the role of the various actors in product and service innovations and how the cost of such innovations is distributed, thereby highlighting the role of cooperation and competition for value creation and circulation. Managers might benefit from understanding and creating product and service biographies and combining digital tools to support organizing and network building to address sustainability challenges. Mapping the information related to the material and energy implicated in such biographies would be a good starting point. As those networks evolve, managerial input would focus on identifying and building collaborative networks for value creation. Product biographies distribute the responsibility for the product instead of concentrating on a single firm or actor and in doing so make transparent the information related to the contributions of value, consequently allowing the various actors to demand a representational share of the value created. By combining the secure recording of information with mechanisms for the coordination and transaction of such information, a blockchain could free up managerial resource to address the social interactions critical to network creation and consensus building that are required to promote CE business models.

A limitation of the current study is it being conceptual and based on a review of existing literature. An avenue for future research is therefore to explore our findings in an empirical study. This would include a deeper investigation of society's increasing reliance on data and how the value of data could be understood within various contexts. Further research would also be required to identify the organizational forms and strategies relevant for uncovering this nested value. Another theme for future research would be to thoroughly explore value circulation in the context of coopetitive business relationships. Coopetition research does incorporate studies on value creation and appropriation, but value circulation is a novel aspect of coopetition introduced in this paper; therefore, it would be important to explore how it can be managed and its implications for firm performance. Future research should also look at how different technologies complement each other to improve value creation and circulation and at the role of innovation in such distributed value systems.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

Rumy Narayan: Conceptualization, Writing - original draft, Writing - review & editing. **Annika Tidström:** Supervision, Writing - review & editing.

Acknowledgements

The corresponding author, Rumy Narayan was funded by the FINNISH CULTURAL FOUNDATION during the duration of the research for this article.

References

Aaldering, L., Leker, J., Song, C., 2019. Competition or collaboration? – analysis of technological knowledge ecosystem within the field of alternative powertrain systems: a patent-based approach. J. Clean. Prod. 212, 362–371.
Andersen, M.S., 2007. An introductory note on the environmental economics of the circular economy. Sustainability Science 2 (1), 133–140.
Bengtsson, M., Kock, S., 2000. "Coopetition" in business Networks—to cooperate and compete simultaneously. Ind. Market. Manag. 29 (5), 411–426.
Bengtsson, M., Kock, S., 2014. Coopetition—quo vadis? Past accomplishments and future challenges. Ind. Market. Manag. 43 (2), 180–188.
Bengtsson, M., Eriksson, J., Kock, S., 2005. The importance of competition and cooperation for the exploration of innovation opportunities. In: Managing Opportunity Development in Business Networks. Palgrave Macmillan, London, pp. 49–66.
Bengtsson, M., Eriksson, J., Wincent, J., 2010. Co-opetition dynamics–an outline for further inquiry. Compet. Rev.: An international business journal 20 (2), 194–214.
Bengtsson, M., Raza-Ullah, T., Vanyushyn, V., 2016. The coopetition paradox and tension: the moderating role of coopetition capability. Ind. Market. Manag. 53, 19–30.
Berg, C., Davidson, S., Potts, J., 2018. Institutional Discovery and Competition in the Evolution of Blockchain Technology. Available at: SSRN 3220072.
Bocek, T., Rodrigues, B.B., Strasser, T., Stiller, B., 2017. May. Blockchains everywhere-a use-case of blockchains in the pharma supply-chain. In: 2017 IFIP/IEEE Symposium on *Integrated Network and Service Management* (IM). IEEE, pp. 772–777.
Bocken, N.M., Antikainen, M., 2018. June. Circular business model experimentation: concept and approaches. In: International Conference on Sustainable Design and Manufacturing. Springer, Cham, pp. 239–250.
Bocken, N.M., Short, S.W., 2016. Towards a sufficiency-driven business model: experiences and opportunities. Environmental Innovation and Societal Transitions 18, 41–61.
Bocken, N.M., Short, S.W., Rana, P., Evans, S., 2014. A literature and practice review to develop sustainable business model archetypes. J. Clean. Prod. 65, 42–56.
Bocken, N.M.P., Rana, P., Short, S.W., 2015. Value mapping for sustainable business thinking. Journal of Industrial and Production Engineering 32 (1), 67–81.
Bocken, N.M., de Pauw, I., Bakker, C., van der Grinten, B., 2016. Product design and business model strategies for a circular economy. Journal of Industrial and Production Engineering 33 (5), 308–320.
Bocken, N.M., Olivetti, E.A., Cullen, J.M., Potting, J., Lifset, R., 2017. Taking the circularity to the next level: a special issue on the circular economy. J. Ind. Ecol. 21 (3), 476–482.
Bonviu, F., 2014. The European economy: from a linear to a circular economy. Rom. J. Eur. Aff. 14, 78.
Boons, F., Montalvo, C., Quist, J., Wagner, M., 2013. Sustainable innovation, business models and economic performance: an overview. J. Clean. Prod. 45, 1–8.
Brandenburger, A.M., Nalebuff, B.J., 1995. The Right Game: Use Game Theory to Shape Strategy, vol. 76. Harvard Business Review, Chicago, pp. 57–71.
Brandenburger, A.M., Nalebuff, B.J., 2011. Co-opetition. Crown business.
Brandenburger, A.M., Stuart Jr., H.W., 1996. Value-based business strategy. J. Econ. Manag. Strat. 5 (1), 5–24.
Buterin, V., 2014. A next-generation smart contract and decentralized application platform white paper.
Callon, M., Meadel, C., Rabeharisoa, V., 2002. The economy of qualities. Econ. Soc. 31 (2), 194–217.
Cantù, C., Corsaro, D., Fiocca, R., Tunisini, A., 2013. IMP studies: a bridge between tradition and innovation. Ind. Market. Manag. 42 (7), 1007–1016.
Catalini, C., 2017. How Blockchain Technology Will Impact the Digital Economy. University of Oxford Faculty of Law Blog, p. 24.
Catalini, C., Gans, J.S., 2016. Some Simple Economics of the Blockchain (No. W22952). National Bureau of Economic Research.
Charonis, G., 2012. October. Degrowth, steady state economics and the circular economy: three distinct yet increasingly converging alternative discourses to economic growth for achieving environmental sustainability and social equity. In: World Economic Association Sustainability Conference.
Chen, Y., 2018. Blockchain tokens and the potential democratization of entrepreneurship and innovation. Bus. Horiz. 61 (4), 567–575.
Chertow, M., Ehrenfeld, J., 2012. Organizing self-organizing systems: toward a theory of industrial symbiosis. J. Ind. Ecol. 16 (1), 13–27.
Choi, P., Garcia, R., Friedrich, C., 2009. The drivers for collective horizontal coopetition: a case study of screwcap initiatives in the international wine industry. Int. J. Strategic Bus. Alliances (IJSBA) 1 (3), 271–290.
Conticelli, E., Tondelli, S., 2014. Eco-industrial parks and sustainable spatial planning: a possible contradiction? Adm. Sci. 4 (3), 331–349.
Czakon, W., Czernek, K., 2016. The role of trust-building mechanisms in entering into network coopetition: the case of tourism networks in Poland. Ind. Market. Manag. 57, 64–74.
Dagnino, G.B., Padula, G., 2002. May. *Coopetition strategy: Towards a new kind of interfirm dynamics for value creation*. In: EURAM 2nd Annual Conference. Stockholm School of Entrepreneurship, Sweden, pp. 8–10.
Dahl, J., Kock, S., Henriksson, E.L.L., 2016. Strategising in coopetitive networks. In: Extending the Business Network Approach. Palgrave Macmillan, London, pp. 249–267.

Davidson, S., De Filippi, P., Potts, J., 2016. Economics of blockchain. Available at: SSRN 2744751.

de Sousa Jabbour, A.B.L., Jabbour, C.J.C., Godinho Filho, M., Roubaud, D., 2018. Industry 4.0 and the circular economy: a proposed research agenda and original roadmap for sustainable operations. Ann. Oper. Res. 270 (1–2), 273–286.

Despeisse, M., Baumers, M., Brown, P., Charnley, F., Ford, S.J., Garmulewicz, A., Knowles, S., Minshall, T.H.W., Mortara, L., Reed-Tsochas, F.P., Rowley, J., 2017. Unlocking value for a circular economy through 3D printing: a research agenda. Technol. Forecast. Soc. Change 115, 75–84.

Dobbs, R., Oppenheim, J., Thompson, F., Brinkman, M., Zornes, M., 2011. Resource Revolution: Meeting the World's Energy, Materials, Food, and Water Needs.

Dorn, S., Schweiger, B., Albers, S., 2016. Levels, phases and themes of coopetition: a systematic literature review and research agenda. Eur. Manag. J. 34, 484–500.

Dussauge, P., Garrette, B., Mitchell, W., 2000. Learning from competing partners: outcomes and durations of scale and link alliances in Europe, North America and Asia. Strat. Manag. J. 21 (2), 99–126.

Dyer, J.H., Singh, H., Kale, P., 2008. Splitting the pie: rent distribution in alliances and networks. Manag. Decis. Econ. 29 (2-3), 137–148.

Ehrenfeld, J., Gertler, N., 1997. Industrial ecology in practice: the evolution of interdependence at Kalundborg. J. Ind. Ecol. 1 (1), 67–79.

Elsden, C., Manohar, A., Briggs, J., Harding, M., Speed, C., Vines, J., 2018. April. Making sense of blockchain applications: a typology for HCI. In: Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems, pp. 1–14.

Erkman, S., 1997. Industrial ecology: an historical view. J. Clean. Prod. 5 (1–2), 1–10.

Fernandez, A.S., Le Roy, F., Gnyawali, D.R., 2014. Sources and management of tension in co-opetition case evidence from telecommunications satellites manufacturing in Europe. Ind. Market. Manag. 43 (2), 222–235.

Fernandez, A.S., Chiambaretto, P., Le Roy, F., Czakon, W. (Eds.), 2019. The Routledge Companion to Coopetition Strategies. Routledge, Abingdon.

Ford, D., Håkansson, H., 2013. Competition in business networks. Ind. Market. Manag. 42 (7), 1017–1024.

Francisco, K., Swanson, D., 2018. The supply chain has no clothes: technology adoption of blockchain for supply chain transparency. Logistics 2 (1), 2.

Frosch, R.A., 1992. Industrial ecology: a philosophical introduction. Proc. Natl. Acad. Sci. Unit. States Am. 89 (3), 800–803.

Geissdoerfer, M., Savaget, P., Bocken, N.M., Hultink, E.J., 2017. The Circular Economy–A new sustainability paradigm? J. Clean. Prod. 143, 757–768.

Geissdoerfer, M., Morioka, S.N., de Carvalho, M.M., Evans, S., 2018. Business models and supply chains for the circular economy. J. Clean. Prod. 190, 712–721.

Ghisellini, P., Cialani, C., Ulgiati, S., 2016. A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. J. Clean. Prod. 114, 11–32.

Ghoreishi, M., Happonen, A., 2019. Key enablers for deploying artificial intelligence for circular economy embracing sustainable product design: three case studies. In: The 13th International Engineering Research Conference. Eureca, p. 17, 2019.

Glaser, F., 2017. January. Pervasive decentralisation of digital infrastructures: a framework for blockchain enabled system and use case analysis. In: Proceedings of the 50th Hawaii International Conference on System Sciences.

Gnyawali, D.R., Park, B.J., 2009. Co-opetition and technological innovation in small and medium-sized enterprises: a multilevel conceptual model. J. Small Bus. Manag. 47 (3), 308–330.

Gnyawali, D.R., Park, B.J.R., 2011. Co-opetition between giants: collaboration with competitors for technological innovation. Res. Pol. 40 (5), 650–663.

Golnam, A., Ritala, P., Wegmann, A., 2014. Coopetition within and between value networks–a typology and a modelling framework. Int. J. Bus. Environ. 5 (6), 47–68, 1.

Gregson, N., Crang, M., Fuller, S., Holmes, H., 2015. Interrogating the circular economy: the moral economy of resource recovery in the EU. Econ. Soc. 44 (2), 218–243.

Haas, W., Krausmann, F., Wiedenhofer, D., Heinz, M., 2015. How circular is the global economy? An assessment of material flows, waste production, and recycling in the European Union and the world in 2005. J. Ind. Ecol. 19 (5), 765–777.

Hamel, G., 1991. Competition for competence and interpartner learning within international strategic alliances. Strat. Manag. J. 12 (S1), 83–103.

Henderson, R., Clark, K.B., 1990. Architectural innovation: the reconfiguration of existing product technologies and the failure of established firms. Adm. Sci. Q. 9–30.

Hofmann, E., Strewe, U.M., Bosia, N., 2017. Supply Chain Finance and Blockchain Technology: the Case of Reverse Securitisation. Springer.

Ivanova, D., Stadler, K., Steen-Olsen, K., Wood, R., Vita, G., Tukker, A., Hertwich, E.G., 2016. Environmental impact assessment of household consumption. J. Ind. Ecol. 20 (3), 526–536.

Jagdev, H.S., Thoben, K.D., 2001. Anatomy of enterprise collaborations. Prod. Plann. Contr. 12 (5), 437–451.

Kanemoto, K., Moran, D., Lenzen, M., Geschke, A., 2014. International trade undermines national emission reduction targets: new evidence from air pollution. Global Environ. Change 24, 52–59.

Larios-Hernández, G.J., 2017. Blockchain entrepreneurship opportunity in the practices of the unbanked. Bus. Horiz. 60 (6), 865–874.

Leising, E., Quist, J., Bocken, N., 2018. Circular Economy in the building sector: three cases and a collaboration tool. J. Clean. Prod. 176, 976–989.

Lenzen, M., Moran, D., Kanemoto, K., Foran, B., Lobefaro, L., Geschke, A., 2012a. International trade drives biodiversity threats in developing nations. Nature 486 (7401), 109.

Lenzen, M., Kanemoto, K., Moran, D., Geschke, A., 2012b. Mapping the structure of the world economy. Environ. Sci. Technol. 46 (15), 8374–8381.

Lieder, M., Rashid, A., 2016. Towards circular economy implementation: a comprehensive review in context of manufacturing industry. J. Clean. Prod. 115, 36–51.

Loorbach, D., Wijsman, K., 2013. Business transition management: exploring a new role for business in sustainability transitions. J. Clean. Prod. 45, 20–28.

MacArthur, E, 2014. Towards the Circular Economy: Accelerating the scale-up across global supply chains. Ellen MacArthur Foundation, WEF, p. 15. http://www3.weforum.org/docs/WEF_ENV_TowardsCircularEconomy_Report_2014.pdf. (Accessed 30 January 2018).

MacCarthy, B.L., Jayarathne, P.G.S.A., 2012. Sustainable collaborative supply networks in the international clothing industry: a comparative analysis of two retailers. Prod. Plann. Contr. 23 (4), 252–268.

MacInnis, D., 2011. A framework for conceptual contributions in marketing. J. Market. 75, 136–154.

Meadows, D., Randers, J., Meadows, D., 2004. Limits to Growth: the Thirty-Year Update. Chelsea Green, White River Junction, VT.

Moran, D., Kanemoto, K., 2017. Identifying species threat hotspots from global supply chains. Nature Ecology & Evolution 1 (1), 0023.

Mudgal, S., Tan, A., Lockwood, S., Eisenmenger, N., Fischer-Kowalski, M., Giljum, S., Brucker, M., 2012. Assessment of Resource Efficiency Indicators and Targets. Final Report. European Commission-DG Environment, BIO Intelligence Service.

Murray, A., Skene, K., Haynes, K., 2017. The circular economy: an interdisciplinary exploration of the concept and application in a global context. J. Bus. Ethics 140 (3), 369–380.

Narayan, R., Tidström, A., 2019. Circular economy inspired imaginaries for sustainable innovations. In: Innovation for Sustainability. Palgrave Macmillan, Cham, pp. 393–413.

Naustdalslid, J., 2014. Circular economy in China–the environmental dimension of the harmonious society. Int. J. Sustain. Dev. World Ecol. 21 (4), 303–313.

Notheisen, B., Cholewa, J.B., Shanmugam, A.P., 2017. Trading real-world assets on blockchain. Business & Information Systems Engineering 59 (6), 425–440.

Onik, M.M.H., Ahmed, M., 2018. Blockchain in the Era of Industry 4.0. *Data Analytics*. CRC Press, Boca Raton, FL, USA, pp. 259–298.

Pagoropoulos, A., Pigosso, D.C., McAloone, T.C., 2017. The emergent role of digital technologies in the Circular Economy: a review. Procedia CIRP 64, 19–24.

Park, B.J.R., Srivastava, M.K., Gnyawali, D.R., 2014. Walking the tight rope of coopetition: impact of competition and cooperation intensities and balance on firm innovation performance. Ind. Market. Manag. 43 (2), 210–221.

Pilkington, M., 2016. Blockchain technology: principles and applications. In: Research Handbook on Digital Transformations. Edward Elgar Publishing.

Pitelis, C.N., 2009. The co-evolution of organizational value capture, value creation and sustainable advantage. Organ. Stud. 30 (10), 1115–1139.

Pitelis, C., 2012. Clusters, entrepreneurial ecosystem co-creation, and appropriability: a conceptual framework. Ind. Corp. Change 21 (6), 1359–1388.

Planko, J., Cramer, J., Chappin, M., Hekkert, M., 2016. Strategic collective system building to commercialize sustainability innovations. J. Clean. Prod. 112, 2238–2341.

Prendeville, S., Sanders, C., Sherry, J., Costa, F., 2014. Circular Economy: Is it Enough. EcoDesign Centre, Wales available from: http://www.edcw.org/en/resources/circulareconomy-it-enough. (Accessed 12 March 2019).

Preston, F., 2012. A Global Redesign? Shaping the Circular Economy. Chatham House, London.

Ramani, K., Ramanujan, D., Bernstein, W.Z., Zhao, F., Sutherland, J., Handwerker, C., Choi, J.K., Kim, H., Thurston, D., 2010. Integrated sustainable life cycle design: a review. J. Mech. Des. 132 (9), 091004.

Reniers, G., Dullaert, W., Visser, L., 2010. Empirically based development of a framework for advancing and stimulating collaboration in the chemical industry (ASC): creating sustainable chemical industrial parks. J. Clean. Prod. 18, 1587–1597.

Reuter, M.A., 2016. Digitalizing the circular economy. Metall. Mater. Trans. B 47 (6), 3194–3220.

Rifkin, J., 2009. The Empathic Civilization: the Race to Global Consciousness in a World in Crisis. Penguin.

Ritala, P., 2009. Is coopetition different from cooperation? The impact of market rivalry on value creation in alliances. Int. J. Intellect. Property Manag. 3 (1), 39–55.

Ritala, P., Tidström, A., 2014. Untangling the value-creation and value-appropriation elements of coopetition strategy: a longitudinal analysis on the firm and relational levels. Scand. J. Manag. 30 (4), 498–515.

Ritala, P., Hurmelinna-Laukkanen, P., Blomqvist, K., 2009. Tug of war in innovation–coopetitive service development. Int. J. Serv. Technol. Manag. 12 (3), 255–272.

Ritala, P., Agouridas, V., Assimakopoulos, D., Gies, O., 2013. Value creation and capture mechanisms in innovation ecosystems: a comparative case study. Int. J. Technol. Manag. 63 (3–4), 244–267.

Ritala, P., Golnam, A., Wegmann, A., 2014. Coopetition-based business models: the case of Amazon. com. Ind. Market. Manag. 43 (2), 236–249.

Schnitzer, H., Ulgiati, S., 2007. Less bad is not good enough: approaching zero emissions techniques and systems. J. Clean. Prod. 13 (15), 1185–1189.

Schulte, U.G., 2013. New business models for a radical change in resource efficiency. Environmental Innovation and Societal Transitions 9, 43–47.

Skene, K., Murray, A., 2017. Sustainable Economics: Context, Challenges and Opportunities for the 21st-Century Practitioner. Routledge.

Snyder, H., 2019. Literature review as a research methodology. An overview and

guidelines. J. Bus. Res. 104, 333–339.
Solitander, M., Tidström, A., 2010. Competitive flows of intellectual capital in value creating networks. J. Intellect. Cap. 11 (1), 23–38.
Spring, M., Araujo, L., 2017. Product biographies in servitization and the circular economy. Ind. Market. Manag. 60, 126–137.
Stahel, W.R., 2016. The circular economy. Nature News 531 (7595), 435.
Su, B., Heshmati, A., Geng, Y., Yu, X., 2013. A review of the circular economy in China: moving from rhetoric to implementation. J. Clean. Prod. 42, 215–227.
Swan, M., 2015. Blockchain: Blueprint for a New Economy. O'Reilly Media, Inc.
Tapscott, D., Tapscott, A., 2016. Blockchain Revolution: How the Technology behind Bitcoin Is Changing Money, Business, and the World. Penguin.
Teece, D.J., 1986. Profiting from technological innovation: implications for integration, collaboration, licensing and public policy. Res. Pol. 15 (6), 285–305.
Tidström, A., 2009. Causes of conflict in intercompetitor cooperation. J. Bus. Ind. Market. 24 (7), 506–518.
Tidström, A., 2014. Managing tensions in coopetition. Ind. Market. Manag. 43 (2), 261–271.
Tidström, A., Rajala, A., 2016. Coopetition strategy as interrelated praxis and practices on multiple levels. Ind. Market. Manag. 58, 35–44.
Torraco, R., 2005. Writing integrative literature reviews: guidelines and examples. Hum. Resour. Dev. Rev. 4 (3), 356–367.
Velu, C., 2018. Coopetition and business models. In: Fernandez, A.-S., Chiambaretto, P., Le Roy, F., Czakon, W. (Eds.), Routledge Companion to Coopetition Strategies. Routledge, pp. 336–346.
Westerkamp, Martin, Friedhelm Victor, Küpper, Axel, 2018. Blockchain-based supply chain traceability: token recipes model manufacturing processes. In: IEEE International Conference on Internet of Things (iThings) and IEEE Green Computing and Communications (GreenCom) and IEEE Cyber, Physical and Social Computing (CPSCom) and IEEE Smart Data (SmartData). IEEE, pp. 1595–1602, 2018.
Wiedmann, T.O., Schandl, H., Lenzen, M., Moran, D., Suh, S., West, J., Kanemoto, K., 2015. The material footprint of nations. Proc. Natl. Acad. Sci. Unit. States Am. 112 (20), 6271–6276.
Zareiyan, B., Korjani, M., 2018. Blockchain Technology for Global Decentralized Manufacturing: Challenges and Solutions for Supply Chain in Fourth Industrial Revolution.

Leveraging resource ecologies for sustainability transitions – a waste management case

Rumy Narayan
School of Management, University of Vaasa, Vaasa, Finland, and
Annika Tidström
Faculty of Business Studies, University of Vaasa, Vaasa, Finland

Abstract

Purpose – Addressing fundamental sustainability challenges has now become strategic for multi-national corporations. However, such challenges by their very nature are complex and require resources that are frequently beyond those that are traditionally accepted as relevant and crucial to a firm's core business operations. The purpose of this paper is to illustrate how firms identify and integrate diverse groups of actors using social intelligence to build an ecology of resources to tackle these complex challenges.

Design/methodology/approach – The empirical part is based on qualitative single case study research of a packaging company and its waste management program.

Findings – Organizing for sustainability requires business activities to be conceptualized as a continuous process of project building, involving actors in diverse settings and responsibilities divided thematically and spatially forming nets within a network to solve problems, collectively. There is a fundamental analytical problem of integrating a diversity of value spheres, and society has a set of rational methods for planning and action where decisions are made to privilege one aspect to the exclusion of others. Artificial separation of activities that are interdependent and failure to allow these activities to evolve through interactions in time and space could threaten sustainability.

Research limitations/implications – This is a single case study within a certain context, therefore ways for orchestrating resource ecologies need further investigation.

Practical implications – For managers, it is very important to recognize and appreciate the interconnectedness of resource ecologies but also that interactions resulting in joint actions can often have different rewards and benefits for the diverse range of actors implicated in such networks. This kind of social intelligence offers managers options to experiment with transitional pathways that match the objectives of diverse network actors and provide unique resource combinations for building competitive advantage. There is only so much that is under the control of managers or even firms, which means both must embrace uncertainty and the phenomenon of emergence.

Social implications – From a societal perspective, the findings of the study show how the open and transparent activities for the sustainability of one firm spread through different layers of the society through connecting, sharing and developing resources. Therefore, it is important for societies to enable and support the open sharing of resources for sustainability. Investments in large programs for transitions to sustainability tend to spread from a focal company into various projects for sustainability involving several layers of actors within society. This ensures that awareness, behaviors and attitudes related with sustainability become rooted in society and give rise to valuable innovations.

Originality/value – This study illustrates how resources are created and shaped through nets during transitions toward sustainability using social intelligence.

Keywords Sustainability, Ecology, Networks, Resources, Transition, Social intelligence

Paper type Case study

Introduction

Sustainability has increasingly attracted interest among both practitioners and business network scholars (Lacoste, 2016; Johnsen *et al.*, 2017; Press *et al.*, 2020). The challenges related to climate change, pollution, waste and growing inequality are difficult to resolve as they are deeply embedded in societal structures and institutions (Grin *et al.*, 2011; Loorbach *et al.*, 2011; Loorbach *et al.*, 2010; Dirven *et al.*, 2002). The globalization process has intensified sustainability challenges such as global warming, chemical pollution, ocean acidification, water scarcity and biodiversity (Folke *et al.*, 2010). These challenges are often understood as consequences of globalized production and consumption systems and have invited questioning of the legitimacy of businesses (Buckley and Ghauri, 2004; Kramer and Porter, 2011) and calls for a new way of looking at resources.

The current issue and full text archive of this journal is available on Emerald Insight at: **https://www.emerald.com/insight/0885-8624.htm**

Journal of Business & Industrial Marketing

[DOI 10.1108/JBIM-12-2019-0516]

Received 5 December 2019
Revised 20 May 2020
15 August 2020
22 August 2020
Accepted 22 August 2020

Transitions toward sustainability require new ways of thinking and acting (Medrano *et al.*, 2020). Issues related to production, distribution and consumption of goods and services are putting pressure on the operations of corporations (Czinkota *et al.*, 2014; Scherer and Palazzo, 2011). The multiple causes and consequences extend across a range of societal domains, actors and scales, which implies the presence of a diverse range of nets and also brings into focus the resources that could be leveraged across networks to address complex challenges (Loorbach and Wijsman, 2013). Press *et al.* (forthcoming) find that heterogeneity in ecosystems related to sustainability leads to increased sharing of creative ideas, which, in turn, tend to stimulate opportunities for innovation and success.

Existing research on corporate sustainability remains anchored in firm and industry level behavior with an inadequate integration of systems thinking in empirical designs (Whiteman, *et al.*, 2013). Sustainability challenges are interrelated in complex, non-linear ways and could be better addressed through a multiple network-related actor perspective. A study by Tura *et al.* (2019), discusses how organizational decisions, with the objective of implementing sustainable business practices, could lead to tensions and conflicts when a single stakeholder makes such decisions. Goals related to sustainability cannot be attained by the action of a single firm alone, and instead require action by networks of interacting actors of various kinds, such as businesses, governmental institutions and consumers (Patala *et al.*, 2014; Öberg *et al.*, 2012). Networks provide actors with resources that otherwise would be difficult to develop or acquire (Ahuja *et al.*, 2012). Research has shown that both business networks and resources may enable and benefit sustainability activities (Lacoste, 2016; Patala *et al.*, 2014). Sustainability in business requires a host of things related to actors, resources and activities and extends beyond a firm's own business operations (Høgevold and Svensson, 2012). Combinations of resources to advance sustainability can be seen as resource ecologies that comprise the totality or pattern of relations between resources and the environment of actors within which they exist (Odum and Barrett, 2004). The heterogeneity of ecosystems enmeshed in imaginings of sustainability (Press *et al.*, forthcoming) indicate relational elements among the required resources, thus implying an ecology (Lejano and Stokols, 2013). The term *ecology* is commonly applied in relation to sustainability and environmental issues to bring into focus the various relationships that are related to such issues, and based on the work of Lejano and Stokols (2013), we suggest it is also applicable in the context of sustainability in business networks.

Resource ties of networked firms have been a core focus area of the business network approach (Axelsson and Johanson, 1992; Håkansson and Snehota, 1995) that refer to aspects of the resource based view (RBV) in its perspective of resource interactions (Baraldi *et al.*, 2012). However, research on sustainability within the business network approach and the IMP (industrial marketing and purchasing) perspective is scarce. Waluszewski *et al.* (2019) call for more IMP-related research capturing continuous and emergent phenomena, such as those related to climate change and environmental threats.

Most of the research on sustainability within the business network approach relates to purchasing, supply management (Johnsen *et al.*, 2017) or supply chain management (Frostenson and Prenkert, 2015). The authors are aware of no studies focusing on how firms can facilitate transitions to sustainability by leveraging resource ecologies through a process of upstream activities and interactions of a diverse group of actors. Such a study would have the potential to illustrate how the configuration of actors comes about as the transition process unfolds over time. This dimension lends an understanding of how time is conceptualized within business networks (Halinen *et al.*, 2012) and could have a profound impact on business sustainability (Bansal and DesJardine, 2014). Studies exploring the dimensions of time and process during resource interactions are important within inter-organizational networks (Baraldi *et al.*, 2012). Conceptualizations of time imply change and emergence are part of a continuous process in which social entities are seen as temporary stabilized clusters organized around projects (Nayak and Chia, 2011). Therefore, in this study, we attempt to fill this research gap by adopting a network view on the development of resource ecologies.

The aim of this paper is to improve knowledge about sustainability transitions through the development of resource ecologies in the interactions of diverse actors. The research question explores how relational resources are developed into resource ecologies through interactions among diverse actors in sustainability transitions. We draw upon Goleman and Boyatzis's (2008) notion of social intelligence as a set of interpersonal competencies geared toward inspiring others to frame our understanding of the term, in this context, as the ability for building resource ecologies. The empirical part of the study is based on single-case-study research on the waste management program of a multi-national packaging company operating in India. We contribute to business network research by enhancing the knowledge related to sustainability, and more particularly that on how resource ecologies are shaped from a process perspective through interactions of relational resources of diverse actors.

The paper is structured as follows: In the following section, the theoretical background of the paper is presented. First, the context for a network approach to sustainability transition is created before the methodology is described. Thereafter, the findings of the empirical study are presented and analyzed. This is followed by a discussion comparing the key findings with prior literature. The final section presents the conclusions, including the study's contribution and suggestions for future research.

A theoretical framework for a network approach to sustainability transitions

Context of sustainability transition

The social responsibilities of firms have been important issues for decades (Scherer and Palazzo, 2007). The discussions have focused on how these responsibilities should be defined and the best ways in which firms incorporate ethical concerns within traditional management activities (Jones and Wicks, 1999). In the context of a globalized business environment characterized by a diverse range of institutional and cultural dimensions,

firms need resources that help them support their legitimacy claims while managing to sustain competitive advantage. One of the biggest shifts in the competitive landscape is currently evident in the growing expectation that firms take responsibility for the impact of their production and consumption systems. This is why, while it is important to remember a network perspective is helpful when studying sustainability, it is still relevant to scrutinize a focal firm (Frostenson and Prenkert, 2015).

Firms have a basic area of competence they hone through learning and experience over a period of time; enabling that competence to become their source of competitive advantage. However, there is also a paradox to this: overextending into diverse domains could dilute competence and increase costs due to lack of expertize and competence in those domains. One suggested remedy is leveraging resources to perform closely related activities that could cut costs (Madhok, 2002). When firms make their transition toward sustainability, their focus shifts to how they compete in organizing activities related to the transition process and their efficiency in doing so. The process could uncover the reasons for cost differences in organizing particular activities among firms and reveal the institutional structure of production in the system as a whole. The cost of organizing any activity within a firm depends on the kinds of activities that are already being conducted within the firm and therefore, some activities facilitate, while some hinder and these relationships determine the actual organization of production (Coase, 1990). Sustainability should be viewed from a wider perspective, as consumers not only value a product's physical attributes, but increasingly place importance on *values* (Medrano *et al.*, 2020).

Long *et al.* (2018) argue that a sustainable future relies on change happening on multiple levels, specifically, the individual, organizational and the systems level. Long *et al.* (2018) find that collaboration is a critical success factor in transitions to sustainability. To achieve the necessary collaboration, firms should seek cooperation opportunities and interact in networks to continuously coordinate resources dedicated to sustainability transitions. In this context, relational resources acquire relevance.

Relational resources

The RBV has influenced the development of the view on resources within the business network approach (Baraldi *et al.*, 2012). The ARA (activities-resources-actors) model captures the idea of resources that become specific through adaptation in the course of interactions (Choi and Hara, 2018). It is important for business-to-business scholars to explore complementarity and the combination of resources, as the performance of the resources of one firm is dependent on the resources of the other firm (Choi and Hara, 2018).

The network perspective highlights the importance of common resources that cannot be generated independently (Dyer *et al.*, 2018; Arya and Lin, 2007; Lavie, 2006). From a network perspective, resources such as products and services are seen and valued as a part of the network. Spring and Araujo (2017, p. 127) argue that products should be viewed as "open-ended propositions subject to constant re-definition and re-valuation as they are attached to and detached from successive contexts and networks."

Zhang and Wu (2017) stress the importance to the development of dynamic capabilities of the interplay between firm-internal resources and external network-embedded resources. Network resources have been described as assets existing in networks within which firms are embedded (Gulati, 1999). Important attributes of network resources are their utility, rarity, appropriability and complementarity (Gulati *et al.*, 2011). Alinaghian and Razmdoost (2018) also found accessibility, usability, scalability and versatility to be essential network resource attributes that influence firm performance and conclude that firms need to interact with actors within their network to identify, create and develop value-creating resources. Given that these resources are created in networks of different actors, we call them relational resources.

Relational resources are unique sources of competitive advantage (Gulati, 1999) and generate value for the organizations within the networks (Shan *et al.*, 1994) especially when the network consists of organizations with diverse resources (Rothaermel, 2001). When analyzing these relational resources, it is not sufficient merely to look at snapshots or outcomes at a certain point in time, for we need to understand how resources develop over time through interaction among actors (Håkansson and Ford, 2002; Håkansson and Snehota, 1989).

Cantù *et al.* (2012) argue that it is important to consider resources from both the provider's and users' perspectives. The same study also stresses that resources have no meaning without actors that conceive, activate and use them. To combine resources to find solutions, it is necessary to integrate resources across the boundaries of business organizations. The findings of Cantù *et al.*'s study show that combining resources is a process and an ongoing accomplishment based on the interaction between the actors involved.

Sustainability through networks

Most research on sustainability from a B2B perspective relates to purchasing and supply (Johnsen *et al.*, 2017). The most common theoretical perspectives applied are stakeholder theory, institutional theory and the RBV (Johnsen *et al.*, 2017). For instance, Ferro *et al.* (2017), try to determine the extent to which a firm's efforts toward sustainable business practices consider stakeholders in their organizations and business networks, the market place and society. While Svennson *et al.* (2016), propose a framework for assessing the general status of stakeholders in a firm's sustainability efforts within their networks. There are few available studies applying an IMP approach (Ritvala and Salmi, 2010; Aarikka-Stenroos and Ritala, 2017), although IMP-based research could advance research on sustainability in business networks (Johnsen *et al.*, 2017).

From a business network perspective, the IMP approach provides an understanding of issue networks–or nets–that emerge and change over time to pursue collective goals specific to networks (Mouzas and Naudé, 2007). Another function of such nets is to explore challenges related to legitimacy and Crespin-Mazet and Dontenwill (2012) illustrate how the IMP ARA model and supply network frame of Gadde and Håkansson (2001) could be used to analyze legitimacy as an element of sustainability development within supply networks. In a business network, the nature of a resource is not only

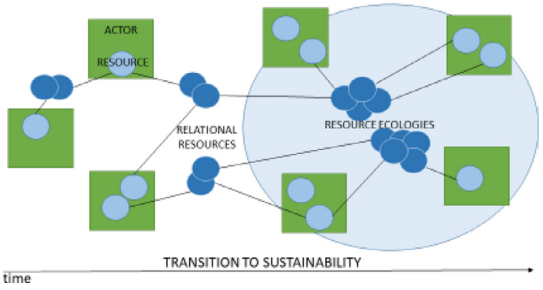
created in interaction among actors, but is also dependent on the actor's perceptions of how the resource can be used in combination with other resources (Abrahamsen and Håkansson, 2015). Such perceptions are critical during sustainability transitions as resources required for sustainability embody complexities that require a creative and unique combination of networks.

There have been attempts to discuss the potential of the IMP interaction approach, for instance, to underpin studies of sustainable purchasing and supply management (Johnsen *et al.*, 2017). The inter-organizational dimension of this approach, along with its focus on interdependence in relationships (Håkansson and Snehota, 1995; Dubois *et al.*, 2004) and network effects (Ritter, 2000) means it can offer rich insights into networks and the relationships that underpin them. Accordingly, the analysis has often expanded beyond business networks to incorporate multiple layers of actors including those from political and civil society (Ritvala and Salmi, 2010). In addition, collaborative arrangements for value creation have led to the exploration of ecosystems in B2B and business network literature (Aarikka-Stenroos and Ritala, 2017). This presents the opportunity to frame transition stories by incorporating change while retaining sight of the continuity of the process, and its social dimensions, something that is vital for understanding sustainability transitions (Kuzemko *et al.*, 2016).

The tentative theoretical framework is illustrated in Figure 1 and is described below.

The focus of this study lies on the transition to sustainability aided by relational resources and resource ecologies developed in interactions between various actors. Value creating relational resources are formed when actors in a network interact. The transition process enables an evolution from relational resources toward resource ecologies that takes account of the time and space when specific resource configurations come together. The transition is a social process that calls for a certain flair for what we understand as social intelligence, to harness the imagination and creativity of the interacting actors in networks for identifying and combining resources targeting building resource ecologies. Next, we present the empirical case study that illustrates the key ideas of this tentative framework.

Figure 1 Tentative theoretical framework: transition to sustainability through networks of resource ecologies



Methodology

A qualitative single-case study was considered the most appropriate research approach for this study because the research focuses on a new subject (Eisenhardt, 1989). A single-case study approach facilitates exploring dynamics across different levels (Bansal and Corley, 2011). Although single-case-study research has been criticized for lacking external validity and for offering poor generalizability of its results, the method can be useful when investigating complex structures because it facilitates an extensive description and analysis of rich data and context dependent issues (Dubois and Gadde, 2014). A case can comprise an individual, an organization, an event or a process and, in our study, the case involves a waste management program of a firm that encompasses several projects.

The case was purposefully selected. According to Lincoln and Guba (1985, p. 202), purposive sampling concerns "maximizing information instead of facilitating generalization." The case centers on a waste management program of a multinational packaging company operating in India, catering mainly to firms selling beverages. The packaging material is a composite of paper, plastic and aluminum. The chosen focus meets the definition of a case proposed by Stake (1995), who referred to a case as "a bounded system" with working parts. First, the case context is Indian cities, a context that rarely features in research related to sustainability from a network perspective. Second, the case offered a unique opportunity to study a sustainability transition process from the perspective of a firm with freedom of network access. Such network access enabled the analysis to capture the transition process beyond the perspective of the firm to include the evolving relations, making the level of analysis at the level of interactions. This helped in understanding the transition process as it advanced within the case, including the waste management program and the emerging projects attached to that program. The focus of the analysis is particularly on the process of activities and interactions related to creating and combining resources for sustainability.

Our research follows a narrative approach and is based on using ethnography to acquire a perspective on learning and the use of sociological and organizational imagination (Gaggiotti *et al.*, 2017) because we are attempting to capture a transition process as it emerged. The narrative approach captures the emergence of network processes in terms of interactions between individuals from diverse network actor organizations. The approach permits an examination of the motives and activities of those individuals and their interplay within contexts (Makkonen *et al.*, 2012).

The research methods applied are unstructured interviews and participant observation. The empirical study was carried out between 2011and 2015 (with a one-year gap 2012–2013, and short monthly gaps in between). In total, 50 interviews were conducted. The informants were 5 senior and mid-level managers of the focal company, 6 small recycling business owners, 6 non-governmental organizations (NGOs) that work with issues related to the waste ecosystem, 10 members of civil society, 5 activists focused on waste, 5 waste workers, 5 waste aggregators and recyclers, 8 school and college teachers and students. The informants were chosen because they were part

of the stakeholder network of the focal firm and were instrumental in establishing further projects including networks for sustainability, thereby enabling the continuous emergence of the waste management program. One of the researchers acted as a participant observer in five workshops and engagement forums involving both direct and indirect stakeholders of the waste management program, over six years. In addition to the interviews, data were drawn from extensive field notes, internal documents and news reports.

While it is common to view ethnography merely as a research method (Dahles *et al.*, 2014), we adopt a much broader perspective to include what it is like to be embedded in the research environment (Czarniawska, 2014; Watson, 2001; Van Maanen, 1998). That level of embeddedness was possible with the consent of the organization and the objective was neither to be subjective nor objective but to proceed interpretively. Therefore, it was important to get to know the actors, be party to their interactions and to understand the personal networks, the socializing and the institutional and the social structures that influenced how actors came together to organize the transition toward sustainability.

One of the researchers worked within the waste management team at the case company, yet the role did not have a clear title, which offered opportunities to interact with diverse stakeholders, as they did not attach any singular identity to the researcher. The firm's staff sometimes treated her as an observer and as a conduit through which to convey messages to other stakeholders that they could not reach themselves. At other times, they identified her as an expert, and asked for suggestions, and also sometimes involved her in certain core activities. The broad scope of the researcher's involvement meant she participated in seeing, understanding, problematizing, practicing and learning within the case context; a level of involvement that opened up ways of understanding change and continuity within transition processes.

Qualitative content analysis (Mayring, 2000) was applied to understand the empirical material. It was a reflective process that consisted of reading and constantly referring back to interview, discussion and conversation notes, material distributed during workshops and internal reporting documents of the focal company.

The interviews offered the first level of information about the actors, their relationships and the resource connection that led them into the network. The distributed stories captured through extended interactions during workshops, presentations, news reports and other documents facilitated the identification and mapping of different relational networks that emerged along with the need for resources. The analysis began with the focal company and later as the stories unraveled, it became clear that the relational resources and how the focal firm was able to sense and configure them, could reveal the organizational logic of the resource ecology networks. The analysis indicated that as the need for resources became apparent, actors tapped into available networks to access them and many of these initiatives progressed toward resource ecology networks.

The focus was on understanding how the issues relating to waste affect actors with different dispositions and in different situations to identify the intertwined causality of the various resource relationships. These resource relationships emerged from a complex combination of personal stories and contexts and other events and activities related to the evolving waste management program. The process helped identify an overarching theme through distilling meanings, which involved condensing the text to be reflected by the use of code words and sorting them into categories according to who, what, when and where questions.

Thereafter, the empirical material was coded based on the aim and research question. With a focus on relational resources, resource ecologies and interactions among diverse actors, it was possible to code the empirical material into three categories, namely, need for recycling resources, locating synergy for recycling and matching value for recycling. The need for recycling resources was for example coded based on the following quotes:

- "Nobody would like to buy a beverage in a pack that creates waste, therefore the motivation to take it on even before the volumes grow to create a viable recycling chain."
- "[. . .] we began to hear some noise not from the market but internally, global, that we needed to start thinking about post-consumer [. . .]." Locating synergy for recycling was, for example, related to quotes like "they offer a great platform with limitless possibilities [. . .]" and the matching value for recycling was coded based on excerpts like " [. . .] you want an opportunity to learn, we can help you [. . .]."

In the following coding-stage, these three categories were from a time perspective coded based on the involved actors and the resource combinations. Based on that, we were able to identify the transition to sustainability that could be divided into five phases based on various combinations of actors and resources, which through the interactions among the diverse actors evolved from relational resources to resource ecologies for sustainability.

Findings

The role of networks in developing resource ecologies for sustainability transitions

Phase 1: Internal waste recycling: from the transfer of technology to leveraging resources through consumer connect.

Initially, waste recycling was not high on the agenda of the focal company in India. The initiatives on waste were driven by global best practice for dealing with factory waste, which involved simple technology transfers and drawing on knowledge from the company's existing global recycling networks.

> So there again, it wasn't as though we were starting from scratch, markets like Brazil were already down that road, and before Brazil there were other markets, so one of the good things about being in a multinational set up is that you keep learning from within the global linkages. (Manager 2)

The company's production facilities were primed for both waste reduction and recycling and factory waste recycling began in 1998. The idea of waste recycling had a strategic intent but as the interactions evolved and the network expanded, the scope of this strategic intent not only widened but also acquired depth. The initial trigger was the proactive global initiative on waste that pushed the local managers to formulate a local waste management strategy for managing

waste. According to a senior manager, factory waste was recycled into a panel board through a simple process. He describes it as follows *it was a simple tech transfer from other parts of the world. The recycler was taken to these recycling plants to show how this was being done.* This acted as an incentive for both the company and the recycler. The recycler saw a business opportunity and the company a partner for managing waste.

The company's new practices of waste reduction and recycling were not only influenced by the global network but also by the customers.

> If I take a global perspective, a lot of this is being driven by the sentiments of the consumer (this was also substantiated earlier when we conducted a global survey and consumer feedback indicated a growing concern about the waste generated by used cartons). Nobody would like to buy a beverage in a pack that creates waste, therefore, the thrust of our focus has been on this specific thing, which is always [. . .] in any research we do it always comes out pretty predominantly, out of all the different environmental factors, the recyclability and extent of recycling, that I guess is the motivation for the company in India also, to take it on even before the volumes looked good (high) enough to create a viable recycling value chain. (Manager 3)

In 2003–2004, the company realized the importance of creating a customer connection. From a strategic perspective, it was important for the company to build the right image and to gain trust in the context of customer relationships.

> Our business is to produce cartons not to manage or recycle waste, but we understand our responsibility in the larger context, in the system, and also in terms of the business perspective, this is a growth market for us so there is a need to connect with individual customers as well. Direct dealing is with institutional customers, we need to be able to connect with the end consumer and one of the ways of building an image is not just as a company that makes packaging but as a company that cares. The consumption experience of the customer is the stuff that is inside the packaging, food, a deeply intimate experience that has health and cultural implications. In such a scenario, trust is a key element of beginning the conversation with the customer. Incidentally, the waste management project was not designed with that in mind but as the project evolved it developed these dimensions. We are creating awareness related to waste by opening up our system and empowering partners. (Manager 1)

It is apparent from the findings that, initially, activities and resources related to sustainability occurred on a firm level and were directed toward internal waste reduction and recycling. The global network contributed to this undertaking by providing resources in the form of knowledge, connections and ideas. These activities and resources led the company to extend its sustainability operations to include recyclers and primary customers (mainly beverage companies) through technology and knowledge resource transfers. Over time, secondary customers (ones who buy the beverages in cartons) were identified as important resources, and thus, the meaning of resources also progressed from being related to internal knowledge and networks and technology to opening up these internal systems to leverage wider capabilities, thus furthering engagement and trust. The waste management strategy of the company progressed as the needs of the process evolved. From leveraging internal knowledge and networks, the strategy evolved into a process of identifying waste management needs in cooperation with existing network actors and letting those needs guide the identification of added resources and subsequent network building. As this network of secondary customers expanded to address the waste management issues, these engagements also played an important role in creating a direct connection related to the value of the packaging with this class of customers. The secondary customers through their preference for beverage packaging determine a brand's choice of packaging, an important step toward making inroads into a market where price consciousness is an important factor.

Phase 2: Relational resources: developing waste recycling through the resources of non-business actors.

The search for efficient post-consumer recycling proved the process was far more complex than the straightforward recycling of factory waste. The resource mix needed was beyond the scope of the best practice for resolving PCC (post-consumer cartons) recycling issues as the context was very different.

> Even when households segregate waste, by the time the segregated waste reaches the municipal collection centers, it is frequently mixed up. In terms of planning, this situation threw up a completely different challenge – that of unpredictability and loss of control over the quality of the waste. (Manager 2)

There was a fundamental change in the process as it meant moving away from full material recycling of clean factory waste to contaminated used carton waste, and that demanded an understanding India's unorganized and complex waste management and recycling system. It was difficult to find any recycler who would take the contaminated PCCs, as waste segregation at the household level is not common in India.

The managers needed to understand the waste management system, so they researched the waste stream and system of waste management in India. The managers identified the resources required and the actors that could deliver them: NGOs, individual civil society members, the informal recyclers (who buy recyclable waste from waste pickers) and the paper industry.

The NGOs had resources for working with the most important unit of the informal waste system in India – the waste pickers – who comb through waste at the municipal collection centers or at landfill sites and sell the recovered materials to the local recyclers. The NGOs work with waste pickers on issues such as health and safety, education, exploitation and the right to a livelihood. The company was interested in engaging the waste pickers to increase PCC collections by diverting them from the landfills and the most efficient way to do so was to involve the NGOs who had access to the waste picker networks. One of the partners in this particular network was a street theater performance group who became instrumental in conveying important messages relating to waste, health, education and livelihoods. Another was a stay-at-home mother who became involved because of her interest in waste management, and who had social ties with local retailers. She later established an NGO to manage the growing interactions.

Over a period of time, the company engaged with the NGOs and through them the community leaders of the waste pickers to explain the value of the PCCs. Simultaneously, it was also working with various recyclers and the paper mills to fulfill the promise of realizing the recycling value of the PCCs. In doing so, it was creating an ecology of resources through networks across Indian cities to increase the collection of PCC.

In this phase, the company expanded its operations targeting sustainability through interaction with various non-business actors. These actors either directly or indirectly facilitated the creation of relational resources related to recycling. These resources are the actors themselves, their knowledge, contacts and influence on a societal level. These interactions increased the profile of the focal company and its product offering and

also won over institutional customers who instructed their beverage vendors to switch to the focal company's packaging.

Phase 3: Resource ecosystem management: from network builder to ecosystem orchestrator.

Phase 3 overlapped with the previous phase; as the company and its network partners learned about the waste management process, the added layers of complexity became evident. By 2008–2009, the company actively encouraged recyclers to accept PCCs by offering them access to clean and dry waste from the factory at a lower rate as a subsidy. The company also began engaging with its primary customers (mainly beverage companies) and encouraged them to send waste from their filling machines to the recyclers. At one end, there were the recyclers and at the other, the NGOs connected with waste pickers who collected the PCCs along with other waste. The firm supported the NGOs with resources such as funds and equipment to initiate the recycling process.

The focal company interacted with both downstream and upstream actors for them to facilitate the development of necessary resources for waste recycling. Producing value related to sustainability requires an interconnected and collaborative network and as the awareness increased, the company was able to focus on strategies enabling designing for ecosystems. The shift in focus created opportunities to develop a number of networks performing tasks designated as projects that contributed toward the main goal. The focal company took the role of key orchestrator of these networks.

> Our business is to produce or manufacture the packaging material and recycling is not our business, but it is our business to make recycling work. (Manager 1)

As a network orchestrator, the firm also looked for separated material (paper, plastic and aluminum) recycling options to generate additional value for waste collectors and segregators, an action intended to help increase collection rates. While solutions for paper recycling were readily available, few existed for the aluminum and plastic mix. The unsegregated material was already being recycled into composite boards and the recyclers were happy to continue making them without paper as the sheets deteriorated faster with paper included. The focal company's search for additional innovations related to waste recycling was linked with its intention to incentivize collections. Over a period of time, the range of recyclable products has expanded, and this has incentivized network partners to commit additional resources in terms of time, funds, space and equipment to promote waste collection.

The recycling process involves envisaging a new ecosystem, where the materials and their recyclability determine the ecosystem building process. The network of recyclers continues to work with the company on these innovations. The network partners have over time, become invested in the initiative through projects that range from collection to storage to recycling and have brought their own connections, both personal and professional.

This phase of ecosystem management is characterized by the focal firm's role as an orchestrator of networks of actors pooling resources into relational resources for sustainability. Those networks of actors characterized by their championing of innovative ecological products grew from the intentions of both the focal firm and the network actors. A consequence of this was the inclusion of the focal company in policy level discussions on waste that improved its chances of being part of waste policy frameworks.

Phase 4: Emergent resource ecosystem design: leveraging network resources through social intelligence.

By 2010–2011, a resource ecosystem was emerging. The ecosystem design is determined by the need for resources as the waste management process matures, therefore it is emergent. These resources at the network level act as a repository for capabilities that all network partners, including the focal company, can draw upon. The firm made a conscious decision to facilitate this process as it enables the company to address evolving needs related to consumer perspectives on business responsibilities, the environmental and social impacts of products and services and regulatory demands.

The capability to design ecosystems requires a keen understanding or "sensing" of opportunities facilitated by actions in an environment where creativity is critical. The resource that enables creative action in this context can be categorized as social intelligence that is an awareness of contexts, social dynamics and strategic interactions that help achieve objectives. Issues related to sustainability and sustainable development are tied to their context: For instance, the focal firm has identified waste related to packaging as an issue that is common across markets, yet each market has its own unique context that requires specific solutions to be designed. Generic approaches only work to a certain extent, after which local imperatives take over. This calls for a process of emergent design of ecosystems, each of which is conceived as a project.

In practice, the PCC carton collection can serve as an example. Recycling PCCs always occurs in a broader context, whether it is waste management as a system or sustainability as a motivator for action. This is a conscious strategy for building an ecosystem consisting of networks that find value in association because the actors involved perceive they own their space within these interactions. Consequently, while the focal firm may anchor many of these interactions and facilitate them, the effort is always directed toward finding a way to make the interactions relevant within the existing context.

> And whenever we have gone and met people we have never talked or presented just one dimension or one side of the issue at hand. For instance, when there was a food safety forum, we would always dutifully talk about food safety within the context of environment. In an environment forum we'd present the various aspects that contribute to the environment and that could include food safety, for example. (Manager 4)

Similarly, the social intelligence applied by the focal company can also be identified through trustful product narratives linking the production, consumption and disposal of the products.

> With this company, I was energized and immediately felt comfortable, they admitted that they did not have the answers. Also, they never talked specifically about the product, it was always in the context of how we use it and how we can use it better, make it work longer. (A student)

The emergent and context-driven way of leveraging resources was also evident when the PCC recycling plan was evolving and the focal firm realized that it needed some credible studies to establish the quality of the paper derived from a PCC; a requirement for communicating the qualities of the paper to the paper mills. One of the recycling partners helped identify a credible research organization (central pulp and paper institute) and also conducted workshops with paper mills. The

research institute leveraged its network to involve almost 50 paper mills in the workshop showcasing the recycling opportunities with PCCs, and the participants, in turn, involved their network of waste paper suppliers who were interested in setting up recycling facilities, thus expanding the network further.

> We would start something in a new city or new recycler with no particular plan in mind. The approach was more like "let's just start and we will help you as you go along. You need a bit of financial support, we can help you with that, you want to know how something works, we will show you or find someone who can help, you want an opportunity to learn we can help you with such opportunities in countries similar to India, be it in Iran, Egypt, Pakistan, Thailand." That is how it happened, during our interactions. (Manager 5)

The members of the network also support each other by conducting or participating in workshops, linking organizations to resources relevant to waste within particular contexts, and at times sharing their own. The network looks for solutions, whether for issues around collection, storage, transportation or recycling. Even NGOs who feel the company could do more to scale up the recycling process acknowledge that it has developed the ability to understand and identify the systemic nature of issues such as waste and has proved itself capable of building networks equipped to address those issues systematically.

> Our organization is focused on the environment and we had no past experience with the kind of interventions they were talking about, yet they gave us the platform to explore our larger goals along with their specific ones. We work with schools, colleges, and companies on the issue of waste and we are now using the company's program as a tool for explaining what recycling actually means. The program is so solid that people believe in it and it fires their imagination about waste and recycling; it makes recycling more tangible for everyone. People actually witness what is possible and this helps them set benchmarks for their own initiatives. They think, if the company can do this, why can't we? They offer a great platform with limitless possibilities and that has helped us grow and mature as an organization. (NGO Partner)

The collaborative action that the company supports provides all actors in the network with the necessary space and opportunity to contribute ideas and perspectives and also to critique the program. Several network partners reported the interactions were inclusive and felt they were collaborators and partners and a part of the solution.

Phase 4 is characterized by social intelligence and how it is leveraged as a resource for contextualizing, developing and connecting other resources to facilitate ecosystem design. At this stage, the process of transition to sustainability was no longer limited to the focal firm, the connected network actors and value chains of products and innovations: it had spread to the emergent context-driven ecosystems as well. The skill for sensing and orchestrating activities that allow for social, environmental and economic elements to emerge require what we understand as social intelligence.

Phase 5: Resource ecologies for waste management: diffusion of sustainability through transparency, discourse and mimicking.

In 2011–2012, as the network evolved, transparency became important. Transparency encourages trust and enables the focal firm to go beyond adhering to societal expectations to participate in a broader discourse on how norms and rules should evolve to address the complex issues arising owing to current systems of production and consumption. The company has become an important partner and stakeholder in policy discussions relating to waste. These activities have also resulted in lucrative business relationships for both the focal company and its business customers; for instance, individual consumer beverage preferences and institutional shifts in procurement policies that favor beverages sold in the focal company's packaging.

Partners value transparency. When a recycler was uncomfortable about inviting NGOs for a plant visit, a team from the focal firm convinced the recycler to treat the visit as an opportunity to learn from the experience and improve. The recycler hosted the visit and the sincerity and openness was appreciated by the visiting NGOs and consequently the relationships established have thrived.

The NGOs always help by lending support to the businesses that are part of the network, by helping them connect with those parts of the value chain they understand best, the waste pickers and workers in the informal garbage collection and segregation function. There are for-profit businesses, social businesses, NGOs, educational institutions and even the odd theater group, but all actors sense their role and purpose, and understand the connections.

Partners also mirror each other's actions, and that helps extend best practice and to establish those practices so they become part of normal routines.

> Interaction with other schools gave us access to many ideas. For example, we saw a school in Delhi making their school handbooks out of recycled paper from the beverage package and thought it was a great idea to do the same for our own. Children also contribute to changing behavior by constantly questioning and discussing. (A teacher)

The school level programs are instrumental in encouraging questions and debates on sustainable development; the college level programs are pushing ideas on sustainability leadership, and specifically within the context of PCC recycling, these programs are preparing the ground for ideas and discussions on the circularity of materials and conceptualizing waste as wealth. These interactions and engagement arenas at times exude an atmosphere of transition, where people irrespective of their identities (as managers, NGOs, garbage collectors, etc). discuss some of the fundamental social, economic and environmental issues and how they can collectively address them within their own network's area of expertize and how they might involve more actors. A result of one such discussion was the *two bins* awareness program to encourage the separation of household waste. The program showcased how municipalities could leverage local networks to spread awareness of the benefits of household waste separation.

The company encourages an entrepreneurial environment with an open space for recycling experimentation. The experimentation involving new processes and products focuses on learning and is highly tolerant of mistakes. Business plans are not a prerequisite for funding an idea or an initiative, as they are not clearly visible in the beginning. The managers recognize that each partner or stakeholder has their own strength in the way they work toward the goal.

> There is never any one best way of doing things, we encouraged our partners to deploy their own models for collection and recycling and internally, we followed our own way of building the network, designing engagement processes and enabling support for the network. We were very clear that we want to be inclusive because we knew those were the guys we had to work through, they were the backbone, the basic support for what needed to be done. By engaging with them, we help each other. (Manager 1)

In creating such resource ecologies the network allowed for imagining and putting into practice activities that blend in the social, environmental and economic elements. The unit of analysis for creating such resource ecologies is not restricted to one notion of value, it takes into account the distributed nature of value spread across social, environmental and economic aspects of activities, and letting network interactions evolve in time.

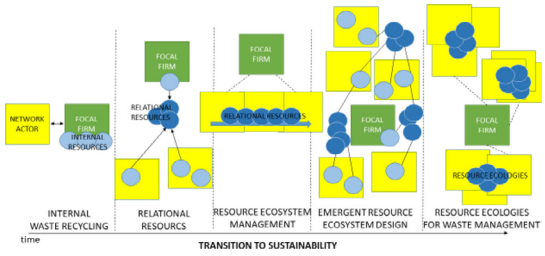
The findings of the empirical study are illustrated in Figure 2. Figure 2 illustrates the different phases of a transition process to sustainability. It is apparent from our findings that the process starts with internal waste recycling activities of a focal firm that in the second phase interacts with diverse actors and thereby relational resources are developed. These relational resources are managed and orchestrated by the focal firm. Eventually, resource ecosystems are emergently developed through formal and informal interactions among diverse actors, and these ecosystems shape into resource ecologies consisting of networks of diverse interacting actors and relational resources that are combined for sustainability.

Discussion

From a business network perspective, the findings of our study indicate that the process underpinning a transition to sustainability evolves from using internal resources to creating networks of resource ecologies for waste management. As far as the development of resources for sustainability is concerned, our findings are in line with those of Abrahamsen and Håkansson (2015), who argue that the nature and value of a resource is dependent on the actor's perceptions of how it can be used with other resources. Moreover, in line with the results of Choi and Hara (2018), our findings show that it is important to explore complementarity and the combination of resources, as the performance of the resources of one firm is dependent on the resources of the other firm. However, the findings show that although a network perspective is highly relevant for transitions to sustainability, the activities and strategy of a focal firm remain central (Frostenson and Prenkert, 2015). In business networks, value is created through interaction with other firms and matching a company's offering to specific user contexts that are characterized by certain resource combinations (Baraldi *et al.*, 2012).

Interorganizational approaches have often been applied to capture relational interdependence (Håkansson and Snehota, 1995; Dubois *et al.*, 2004) and the resulting network effects

Figure 2 Transition to sustainability – from internal waste recycling to resource ecologies for waste management



(Ritter, 2000) even beyond business networks (Ritvala and Salmi, 2010). However, the sustainability context that considers a wider system view, the connectedness and entanglement of our social, economic and ecological existences requires a reframing of contexts. Such a reframing would encourage a better understanding of how a firm's success is increasingly determined by its ability to adapt, integrate, reconfigure and leverage internal and societal skills, resources and functional competencies to address complex problems arising from its production and consumption system. As the case shows, in such situations, firms invest in internal resources that are, in turn, able to identify and operationalize resources to address impacts of the production and consumption system. Research on business networks has expanded over time to include the underlying formation of networks of business relationships, their interdependencies and connectedness, their consequences for business landscapes and implications for politics, policy and society (Waluszewski *et al.*, 2019). This case captures what Waluszewski *et al.* (2019) describe as emergent phenomena of a decentralized economic exchange that is important for efficiency and innovation and fosters economic and societal prosperity. Such decentralization is critical as single organizational efforts toward fostering sustainability without taking into account other network partners' values and objectives could result in economic, structural, psychological and behavioral tensions (Tura *et al.*, 2019).

From the perspective of sustainability, we find that leveraging resource ecologies for sustainability requires a combination of network configurations. In that respect, our findings are in line with Long *et al.* (2018), who argue that collaboration is a key aspect of sustainability. The matching of value requires a framing that takes into consideration the past, present and the future. The focal case illustrates that transition processes revolve around developing abilities for social intelligence primed to facilitate resource ecologies, and that nurturing such abilities expands a firm's competitive landscape from the traditional focus on developing operational, organizational and technological capabilities. These interconnected networks form diverse configurations within dynamic contexts to address problems as they emerge. There is an element of continuity where becoming is prioritized over being as the process of transition unfolds (Nayak and Chia, 2011).

Our findings indicate that there is a fundamental analytical problem of integrating a diversity of value spheres, and society has a set of rational methods for planning and action where decisions are made to privilege one aspect to the exclusion of others. This has led to an artificial separation of activities that are in reality interdependent, and failure to allow for these activities to evolve through interactions in time and space is resulting in the issues that threaten sustainability. The notion of resource ecologies enables the reconciliation of activities by acknowledging their roles in network building for transitions to sustainability. Our findings show that resource ecologies for sustainability transition emerge directly and indirectly over time within specific contexts and nets of interacting actors creating, developing and sharing resources to find valuable solutions for sustainability.

Conclusion

From a theoretical perspective, this article contributes to business network research by adding knowledge related to the connection between relational resources, resource ecologies and sustainability transition. The findings indicate that sustainability transitions occur by leveraging appropriate network resources and enabling connections using social intelligence, between such networks within contexts, thus creating solution-oriented ecosystems.

From a managerial perspective, the findings of the study reveal a need for managers to adopt an entrepreneurial and creative problem-solving mindset. The question for managers needs to shift from *how to be sustainable*? (an inward focused approach) toward *what are the conditions that deter sustainability*? (a networked system approach). That shift involves visualizing sustainability issues that are specific to the firm within their wider contexts and developing social intelligence abilities that contribute to building networks for managing issues within their appropriate contexts. Social intelligence is an ability that is critical to help firms identify, match and combine the complex resources that is essential during sustainability transitions. Social intelligence offers managers options to experiment with transitional pathways that match the objectives of diverse network actors and provide unique resource combinations for building competitive advantage. For managers, it is important to recognize and appreciate the interconnectedness of such resource ecologies but also that interactions resulting in joint actions can often have different rewards and benefits for the diverse range of actors integrated into such networks. There is only so much that is under the control of managers or even firms, which means both must embrace uncertainty and the phenomenon of emergence. It is important that firms involved in a transition toward sustainability have an attitude of openness and transparency. Key tasks are related to learning and sharing best practice to nurture sustainability.

From a societal perspective, the findings of our study show how the open and transparent activities to advance the sustainability of one firm spread through different layers of the society through connecting, sharing and developing resources. Therefore, it is important for societies to enable and support the open sharing of resources for sustainability. Investments in large programs supporting transitions to sustainability tend to spread from a focal company into various sustainability projects involving several layers of actors within society. In this way, awareness, behaviors and attitudes related to sustainability become rooted in society and give rise to valuable innovations.

It is not possible to generalize the findings of a single qualitative case study that took place within a specific context, and therefore, ways of orchestrating resource ecologies for sustainability from a network perspective should be explored further. Avenues for future research might include studying the interrelatedness of different networks/ecosystems. Another suggestion for future research would be to focus on the individual level, by exploring practices of individuals involved in transitions toward sustainability.

References

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

Abrahamsen, M. and Håkansson, H. (2015), "Resource heterogeneity and its effects on interaction and integration in customer-supplier relationships", *The IMP Journal*, Vol. 9 No. 1, pp. 5-25.

Ahuja, G., Soda, G. and Zaheer, A. (2012), "The genesis and dynamics of organizational networks", *Organization Science*, Vol. 23 No. 2, pp. 434-448.

Alinaghian, L. and Razmdoost, K. (2018), "How do network resources affect firms' network-oriented dynamic capabilities?", *Industrial Marketing Management*, Vol. 71, pp. 79-94.

Arya, B. and Lin, Z. (2007), "Understanding collaboration outcomes from an extended resource-based view perspective: the roles of organizational characteristics, partner attributes, and network structures", *Journal of Management*, Vol. 33 No. 5, pp. 697-723.

Axelsson, B. and Johanson, J. (1992), "Foreign market entry: the textbook vs the network view", in Axelsson, B. and Easton, G. (Eds), *Industrial Networks: A New View of Reality*, Routledge, London, pp. 218-231.

Bansal, P. and Corley, K. (2011), "From the editors the coming of age for qualitative research", *Academy of Management Journal*, Vol. 54 No. 2, pp. 233-237.

Bansal, P. and DesJardine, M.R. (2014), "Business sustainability: it is about time", *Strategic Organization*, Vol. 12 No. 1, pp. 70-78.

Baraldi, E., Gressetvold, E. and Harrison, D. (2012), "Resource interaction in inter-organizational networks: foundations, comparison, and a research agenda", *Journal of Business Research*, Vol. 65 No. 2, pp. 266-276.

Buckley, P.J. and Ghauri, P.N. (2004), "Globalisation, economic geography and the strategy of multinational enterprises", *Journal of International Business Studies*, Vol. 35 No. 2, pp. 81-98.

Cantù, C., Corsaro, D. and Snehota, I. (2012), "Roles of actors in combining resources into complex solutions", *Journal of Business Research*, Vol. 65, pp. 139-150.

Choi, Y. and Hara, Y. (2018), "The performance effect of inter-firm adaptation in channel relationships: the roles of relationship-specific resources and tailored activities", *Industrial Marketing Management*, Vol. 70, pp. 46-57.

Coase, R.H. (1990), "Accounting and the theory of the firm", *Journal of Accounting and Economics*, Vol. 12 Nos 1/3, pp. 3-13.

Crespin-Mazet, F. and Dontenwill, E. (2012), "Sustainable procurement: building legitimacy in the supply network", *Journal of Purchasing & Supply Management*, Vol. 18 No. 4, pp. 207-217.

Czarniawska, B. (2014), *Social Science Research: From Field to Desk*, Sage.

Czinkota, M., Kaufmann, H.R. and Basile, G. (2014), "The relationship between legitimacy, reputation, sustainability and branding for companies and their supply chains", *Industrial Marketing Management*, Vol. 35 No. 1, pp. 91-101.

Dahles, H., Höpfl, H. and Koning, J. (2014), "Organizational ethnography: the theoretical challenge", *In EGOS 2014 Conference, Sub-Theme*, Vol. 15.

Dirven, J., Rotmans, J. and Verkaik, A.P. (2002), *Society in Transition: An Innovative Viewpoint*, *Transition* Essay, The Hague, The Netherlands.

Dubois, A. and Gadde, L.E. (2014), "Systematic combining-a decade later", *Journal of Business Research*, Vol. 67 No. 6, pp. 1277-1284.

Dubois, A., Hulthén, K. and Pedersen, A.C. (2004), "Supply chains and interdependence: a theoretical analysis", *Journal of Purchasing & Supply Management*, Vol. 10 No. 1, pp. 3-9.

Dyer, J.H., Singh, H. and Hesterly, W.S. (2018), "The relational view revisited: a dynamic perspective on value creation and value capture", *Strategic Management Journal*, Vol. 39 No. 12, pp. 3140-3162.

Eisenhardt, K.M. (1989), "Building theories from case study research", *Academy of Management Review*, Vol. 14 No. 4, pp. 532-550.

Ferro, C., Padin, C., Svensson, G., Varela, J.C.S., Wagner, B. and Høgevold, N.M. (2017), "Validating a framework of stakeholders in connection to business sustainability efforts in supply chains", *Journal of Business & Industrial Marketing*, Vol. 32 No. 1, pp. 124-137.

Folke, C., Carpenter, S.R., Walker, B., Scheffer, M., Chapin, T. and Rockstrom, J. (2010), "Resilience thinking: integrating resilience, adaptability and transformability", *Ecology and Society*, Vol. 15 No. 4, pp. 20.

Frostenson, M. and Prenkert, F. (2015), "Sustainable supply chain management when focal firms are complex: a network perspective", *Journal of Cleaner Production*, Vol. 107, pp. 85-94.

Gadde, L.E. and Håkansson, H. (2001), *Supply Network Strategies*, Wiley, Chichester.

Gaggiotti, H., Kostera, M. and Krzyworzeka, P. (2017), "More than a method? Organisational ethnography as a way of imagining the social", *Culture and Organization*, Vol. 23 No. 5, pp. 325-340.

Goleman, D. and Boyatzis, R. (2008), "Social intelligence and the biology of leadership", *Harvard Business Review*, Vol. 86 No. 9, pp. 74-81.

Grin, J., Rotmans, J. and Schot, J. (2011), "On patterns and agency in transition dynamics: some key insights from the KSI programme", *Environmental Innovation and Societal Transitions*, Vol. 1 No. 1, pp. 76-81.

Gulati, R. (1999), "Network location and learning: the influence of network resources and firm capabilities on alliance formation", *Strategic Management Journal*, Vol. 20 No. 5, pp. 397-420.

Gulati, R., Lavie, D. and Madhavan, R. (2011), "How do networks matter? The performance effects of interorganizational networks", *Research in Organizational Behavior*, Vol. 31, pp. 207-224.

Håkansson, H. and Snehota, I. (1995), "Analysing business relationships", in Håkansson, H. and Snehota, I. (Eds), *Developing Relationships in Business Networks*, Routlegde, London, pp. 24-49.

Håkansson, H. and Ford, D. (2002), "How should companies interact in business networks?", *Journal of Business Research*, Vol. 55 No. 2, pp. 133-139.

Håkansson, H. and Snehota, I. (1989), "No business is an island: the network concept of business strategy", *Scandinavian Journal of Management*, Vol. 5 No. 3, pp. 187-200.

Halinen, A., Medlin, C.J. and Törnroos, J.Å. (2012), "Time and process in business network research", *Industrial Marketing Management*, Vol. 41 No. 2, pp. 215-223.

Høgevold, N.M. and Svensson, G. (2012), "A business sustainability model: a European case study", *The Journal of Business & Industrial Marketing*, Vol. 27 No. 2, pp. 142-151.

Johnsen, T., Miemczyk, J. and Howard, M. (2017), "A systematic literature review of sustainable purchasing and supply research: theoretical perspectives and opportunities for IMP-based research", *Industrial Marketing Management*, Vol. 61, pp. 130-143.

Jones, T.M. and Wicks, A.C. (1999), "Convergent stakeholder theory", *Academy of Management Review*, Vol. 24 No. 2, pp. 206-221.

Kramer, M.R. and Porter, M. (2011), "Creating shared value", *Harvard Business Review*, Vol. 89 Nos 1/2, pp. 62-77.

Kuzemko, C., Lockwood, M., Mitchell, C. and Hoggett, R. (2016), "Governing for sustainable energy system change: politics, contexts and contingency", *Energy Research & Social Science*, Vol. 12, pp. 96-105.

Lacoste, S. (2016), "Sustainable value co-creation in business networks", *Industrial Marketing Management*, Vol. 51, pp. 151-162.

Lavie, D. (2006), "Capability reconfiguration: an analysis of incumbent responses to technological change", *Academy of Management Review*, Vol. 31 No. 1, pp. 153-174.

Lejano, R.P. and Stokols, D. (2013), "Social ecology, sustainability, and economics", *Ecological Economics*, Vol. 89, pp. 1-6.

Lincoln, Y.S. and Guba, E.G. (1985), *Qualitative Inquiry. Thousand Oaks*, CA.

Long, T., Looijen, A. and Blok, V. (2018), "Critical success factors for the transition to business models for sustainability in the food and beverage industry in The Netherlands", *Journal of Cleaner Production*, Vol. 175, pp. 82-95.

Loorbach, D. and Wijsman, K. (2013), "Business transition management: exploring a new role for business in sustainability transitions", *Journal of Cleaner Production*, Vol. 45, pp. 20-28.

Loorbach, D., Frantzeskaki, N. and Thissen, W. (2011), "A transition research perspective on governance for sustainability", in *European Research on Sustainable Development*, Springer, Berlin, Heidelberg. pp. 73-89.

Loorbach, D., van Bakel, J.C., Whiteman, G. and Rotmans, J. (2010), "Business strategies for transitions towards sustainable systems", *Business Strategy and the Environment*, Vol. 19 No. 2, pp. 133-146.

Madhok, A. (2002), "Reassessing the fundamentals and beyond: Ronald Coase, the transaction cost and resource-based theories of the firm and the institutional structure of production", *Strategic Management Journal*, Vol. 23 No. 6, pp. 535-550.

Makkonen, H., Aarikka-Stenroos, L. and Olkkonen, R. (2012), "Narrative approach in business network process research–implications for theory and methodology", *Industrial Marketing Management*, Vol. 41 No. 2, pp. 287-299.

Mayring, P. (2000), "Qualitative content analysis", *Forum Qual. Sozialforsch./Forum Qual. Soc. Res*, Vol. 1 No. 2.

Medrano, N., Cornejo-Cañamares, M. and Olarte-Pascual, C. (2020), "The impact of marketing innovation on companies' environmental orientation", *Journal of Business & Industrial Marketing*,

Mouzas, S. and Naudé, P. (2007), "Network mobilizer", *Journal of Business & Industrial Marketing*, Vol. 22 No. 1, pp. 62–-71.

Nayak, A. and Chia, R. (2011), "Thinking becoming and emergence: process philosophy and organization studies", *Research in the Sociology of Organizations*, Vol. 32, pp. 281-309.

Öberg, C., Huge-Brodin, M. and Björklund, M. (2012), "Applying a network level in environmental impact assessments", *Journal of Business Research*, Vol. 65, pp. 247-255.

Odum, E. and Barrett, G. (2004), *Fundamentals of Ecology*, 5th ed, Thomson.

Patala, S., Hämäläinen, S., Jalkala, A. and Pesonen, H.L. (2014), "Towards a broader perspective on the forms of eco-industrial networks", *Journal of Cleaner Production*, Vol. 82, pp. 166-178.

Press, M., Robert, I. and Maillefert, M. (2020), "The role of linked legitimacy in sustainable business model development", *Industrial Marketing Management*, doi:10.1016/j. indmarman.2019.05.009.

Ritter, T. (2000), "A framework for analyzing interconnectedness of relationships", *Industrial Marketing Management*, Vol. 29 No. 4, pp. 317-326.

Ritvala, T. and Salmi, A. (2010), "Value-based network mobilization: a case study of modern environmental networkers", *Industrial Marketing Management*, Vol. 39 No. 6, pp. 898-907.

Rothaermel, F.T. (2001), "Incumbent's advantage through exploiting complementary assets via interfirm cooperation", *Strategic Management Journal*, Vol. 22 Nos 6/7, pp. 687-699.

Scherer, A.G. and Palazzo, G. (2007), "Toward a political conception of corporate responsibility: business and society seen from a habermasian perspective", *Academy of Management Review*, Vol. 32 No. 4, pp. 1096-1120.

Scherer, A.G. and Palazzo, G. (2011), "The new political role of business in a globalized world: a review of a new perspective on CSR and its implications for the firm, governance, and democracy", *Journal of Management Studies*, Vol. 48 No. 4, pp. 899-931.

Shan, W., Walker, G. and Kogut, B. (1994), "Interfirm cooperation and startup innovation in the biotechnology industry", *Strategic Management Journal*, Vol. 15 No. 5, pp. 387-394.

Spring, M. and Araujo, L. (2017), "Product biographies in servitization and the circular economy", *Industrial Marketing Management*, Vol. 60, pp. 126-137.

Stake, R. (1995), *The Art of Case Study Research*, Sage, Thousand Oaks.

Svennson, G., Høgevold, N.M., Petzer, D., Padin, C., Ferro, C., Klopper, H.B., Sosa Varela, J.C. and Wagner, B. (2016), "Framing stakeholder considerations and business sustainability efforts: a construct, its dimensions and items", *Journal of Business and Industrial Marketing*, Vol. 31 No. 2, pp. 287-300.

Tura, N., Keränen, J. and Patala, S. (2019), "The darker side of sustainability: tensions from sustainable business practices in business networks", *Industrial Marketing Management*, Vol. 77, pp. 221-231.

Van Maanen, J. (1998), "Different strokes: qualitative research in the administrative science quarterly from 1956 to 1996", *Qualitative Studies of Organizations*, pp. 8-33.

Waluszewski, A., Snehota, I. and La Rocca, A. (2019), "What remains to be discovered? Manifesto for researching the interactive business world", *Journal of Business & Industrial Marketing*, Vol. 34 No. 1, pp. 232-239.

Watson, T.J. (2001), *In Search of Management: Culture, Chaos and Control in Managerial Work*, Cengage Learning EMEA.

Whiteman, G., Walker, B. and Perego, P. (2013), "Planetary boundaries: ecological foundations for corporate sustainability", *Journal of Management Studies*, Vol. 50 No. 2, pp. 307-336.

Zhang, J. and Wu, W.P. (2017), "Leveraging internal resources and external business networks for new product success: a dynamic capabilities perspective", *Industrial Marketing Management*, Vol. 61, pp. 170-181.

Further reading

Rauschmayer, F., Bauler, T. and Schäpke, N. (2015), "Towards a thick understanding of sustainability transitions–linking transition management, capabilities and social practices", *Ecological Economics*, Vol. 109, pp. 211-221.

Rotmans, J. (2005), "Societal innovation: between dream and reality lies complexity", *ERIM Inaugural Address Series Research in Management*,

Corresponding author

Rumy Narayan can be contacted at: rumy.narayan@uva.fi

International Journal of Community Well-Being
https://doi.org/10.1007/s42413-020-00085-4

ORIGINAL RESEARCH ARTICLE

Leveraging Digital Intelligence for Community Well-Being

Rumy Narayan [1]

Received: 6 February 2020 / Accepted: 9 October 2020/

Abstract
The world of information is mediated by digital technologies, and the growing influence of Artificial Intelligence (AI) on society, through its involvement in everyday life, is likely to present issues with lasting consequences. In the context of improving community well-being using AI, the knowledge, insights, and impressions or analysis required for activating such improvement necessitate a frame of reference. This frame needs to take into account how well-being is understood within the current paradigm of technological innovation as a driver of economic growth. The evaluation of well-being, often defined as an individual's cognitive and affective assessment of life, takes into account emotional reaction to events based on how satisfaction and fulfillment are discerned. It is a dynamic concept that involves subjective, social, and psychological dimensions, along with a state of being where human needs are met and one can act meaningfully, thus highlighting a relational element underlying social and community well-being. Transitions from a predominantly industrial society towards one that is information-led demand a strategic social design for AI. This article evaluates how well-being is understood within the current paradigm to offer a framework for leveraging AI for community well-being.

Keywords Artificial intelligence · Community well-being · Decision making · Technology · Innovation · Economic growth

Introduction

A closer engagement is required with the prospect of Artificial Intelligence's (AI) radically transformative potential for outpacing human cognitive capabilities along with its ability for bringing technological and economic advances on unprecedented

✉ Rumy Narayan
rumy.narayan@uva.fi

[1] School of Management, Strategic Management, University of Vaasa, Tervahovi D303, Wolffintie 34, 65200 Vaasa, Finland

Published online: 20 October 2020

timescales (Bostrom et al. 2018). The advances in the capabilities and applications of AI systems have brought into sharper focus risks as well as opportunities for society (Yang et al. 2018). For instance, progress in AI technologies is increasingly making them powerful decision making tools, however, so far, the ability to capture the underlying logic and physical connotations of the problems they solve remain unclear (Guo et al. 2019; Silva et al. 2019).

There is an emerging body of research at the intersection of AI and individuals (Anderson and Rainie 2018), industry (Bolton et al. 2018; Hall and Pesenti 2017; Makridakis 2017), and society (Bostrom 2019; Cath et al. 2018). That AI is instrumental in shaping daily lives and key societal practices (Cai et al. 2014; Zheng et al. 2018) is apparent in mature information societies (Floridi 2016). As data and training remain core to AI algorithms and systems (Cath et al. 2018; McGovern et al. 2017), it becomes imperative to engage with and question the antecedents of what is known and how that knowledge influences the existing sociotechnical systems in order to imagine what community well-being would mean, in practice. Artificial Intelligence-based innovation is largely powered by corporations with some contribution from academia; the discussion around AI's relevance to society highlights the need for objectives that weave in social and political accountability and long-term planning necessary for a more egalitarian approach to benefits and opportunities (Cath et al. 2018). Within this frame of reference, the social construction of meaning gains relevance. Social meanings, socially and psychologically constituted, provide an understanding of a person's state of well-being in specific social and cultural contexts, also in the context of 'living well together' as a society influenced by social structures and institutions (Armitage et al. 2012; Deneulin and McGregor 2010). However, both meaning-making as well as the structures and institutions influencing such meaning-making continue to represent values and ideas that threaten societal well-being and require a wider conceptualization. Understanding community as more than a sum of parts, and capturing subjective aspects of local life as something that is not limited to the individual, but extends to ways in which people feel well together, is not an easy undertaking (Atkinson et al. 2019).

Therefore, using social theories of the self as relational makes it possible to put relations ahead of subjectivity, presenting the possibility for conceptualizing community well-being in terms of being well together. Such a relational approach to community well-being offers opportunities for engaging with complex societal interactions where issues are not limited to technology, but take into account political choice over time and space (Atkinson et al. 2019). Relational approaches could enable the conceptualization in terms of multiplicity of relations extending beyond people, and across structures, affects, materiality, places and so forth. This could demonstrate how the combination and assemblage of these relationalities generate ideas of identity, stability, and change for both individual and community well-being (Sung and Phillips 2018). A concept of assemblage that extends the understanding of how diverse aspects of life congregate at particular times and spaces is not easy to operationalize (Atkinson et al. 2019; Atkinson and Scott 2015; DeLanda 2016; Deleuze and Guattari 1988). As a tool, AI could be used for mapping and situating these multiple layers of relatedness. Making these layers visible would increase the possibilities for diverse ways of understanding well-being and letting pathways emerge towards such concepts. This complex weaving requires a distributed organizational model, similar to a polycentric organization (Aligica and Tarko 2012) able to accommodate self-determinative and participative formats attuned towards multiple and diverse ways of knowing.

In the backdrop of AI development, this acquires critical relevance as access to the world of information is increasingly being mediated by digital technologies with the aid of search-based AIs, owned and operated by a small cohort of companies, with discrete understandings of the world (Mccarthy 2017; Waller 2016; Halford et al. 2013). Literature on the semantic web delves into questions related to the development and cementing of knowledge and classification systems, processes through which such systems come to represent the world, including managing controversies arising from such representations (Mccarthy 2017). In a semantic web environment, content is consumed and generated by machines as well as humans, and it represents a new level of abstraction from the underlying network infrastructure. It allows programmers and users to refer to real world objectives without concerning themselves with the underlying documents that describe them (Silva et al. 2019; Hendler and Berners-Lee 2010). This places AI technologies in a position where they contain and furnish representations of the world, and since we are not fully conversant with these technologies from a social perspective, it is important to understand how they are developed and encoded. For instance, Friedman and Nissenbaum (1996) have used actual cases to illustrate how biases in terms of preexisting, technical, and emergent, take shape in computer systems.

Described as global socio-technical assemblages, AI systems and the diversity of their knowledge bases consist of *'globally distributed material and expressive components that continuously attempt to affirm the assemblage's identity and represent the world'* (Mccarthy 2017, p. 22), enabling certain understandings while excluding others. Such frames of understanding could become reinforced and even conjured and normalized. The field of social informatics, for instance, has made tacit knowledge processes (creation, sharing, and management) as well as ignorance processes such as the denial and obfuscation of knowledge (agnotology), explicit (Greyson 2019; Meyer et al. 2019). In business studies the presence of 'wealth equals well-being' construct has been held responsible for the dominance of a cognitive frame related to 'business case' within discourses related to sustainability (Painter-Morland et al. 2017; Hahn et al. 2015). A business case, from a practitioner's perspective, is a bid for an investment in a project, idea, or initiative that promises to yield a suitably significant financial return to justify the investment (Carroll and Shabana 2010; Kurucz et al. 2008). This further constrains the broader understanding of well-being.

These issues are pertinent as there is growing awareness that science itself is in crisis. The very foundations of knowledge acquisition appear to be plagued by reductionist-deterministic perspectives (Nadin 2018). Further, the present planetary problems being experienced on multiple scales are a result of a reductionist worldview that demands approaches beyond the traditional and hierarchical (Fiorini 2019). The shortcomings of reductionism have given rise to approaches that incorporate complexity where emergence is a foundational premise (Chorafakis 2020). As well-being requires a combination of multi-disciplinary perspectives (Zevnik 2014; McGregor 2007) complexity and emergence become implicit in its framings. The potential for AI as a tool for capturing such complexity is encouraging. However, given that AI and related technologies are often characterized as disruptive owing to their novelty and lack of practical experience in deploying them, using AI for community well-being will require reframing the uncertainty associated with AI as a resource instead of a problem (Fiorini 2019).

There is a stream of literature currently dealing with the development of laws, rules, standards, and best practices for ensuring socially beneficial AI (Floridi and Cowls 2019), but the underlying knowledge frameworks that inform our understanding of community well-being from the perspective of technological innovation-driven economic growth remain underexplored. As Musikanski et al. (2018), indicate, so far, marketplace relevance driven by economic imperatives has dominated conversations in the AI universe, but both corporations and policy makers recognize that well-being could be a greater measure of value than economic indicators alone. Capturing such metrics of well-being will require scrutinizing how well-being is framed and understood, a complex process, given the myriad relationships and connections through which well-being emerges. For creative and innovative policy solutions, Colander and Kupers (2016) have pointed towards the possibility of embracing complexity that will allow society to be envisioned as a complex evolving system. Such a system, they argue, cannot be controlled but influenced by channeling social instincts, where profits become tools for solving societal problems instead of goals. As the complexity frame shifts the focus away from efficiency towards resilience (Colander and Kupers 2016), the conceptual logic of the frame needs to change as well.

Such a conceptual logic needs to take into account that information is the sole content of thought, and thinking is, at its core, the processing of information (Adkins 2019; Floridi 2013). However, as Floridi (2017) argues, a conceptual logic of information that is steeped in analyzing the structural properties of a given system ceases to be a logic for design. Therefore, a framework for reimagining well-being requires a conceptual logic of design (Floridi 2017) as a logic of requirement. It takes into account what needs to change. The ultimate goal of this article is to suggest such a framework and to illustrate the ways in which some structural properties of the current system need to be uncovered in order to design a framework that can leverage AI as a resource for community well-being. The first step would be to uncover some of the dominant discourses related to technological innovation-led growth, as it is implicit in framings of well-being.

The Dominant Discourses of Technological Innovation-Led Growth

Discourses and accounts about how technological innovations develop often neglect the social interplay and arrangements that contribute to their inspiration, production, normalization, and use. For instance, within business ecosystems, network pictures are often used as strategic tools by managers to understand how new technologies influence relationships within business networks (Abrahamsen et al. 2016; Hopkinson 2015; Laari-Salmela et al. 2015; Möller 2010). The network picturing process reveals managerial decisions on interactions, mobilization, and influencing of other networks. However, this fails to take into account the underlying assumptions that drive managerial decision-making. For instance, DesJardine and Bansal (2019) have illustrated how negative outlook on organizational performance shortens managerial time horizons. The fact that this negative outlook mainly relates to financial performance, is taken for granted.

An instrumental logic that encourages separate management of social and environmental issues from the financial reinforces the tension between business and society

(Gao and Bansal 2013). It could also limit managerial sense-making capabilities as the limited perspectives manifested in the network pictures prevent managers from linking how social and environmental factors impact traditional strategic issues such as investment in innovation in product or service design. A logic encompassing the social and environmental systems that firms are embedded in could enable an integrative process capable of embracing the tension between economic, social, and environmental elements of the system (Gao and Bansal 2013). In order to facilitate this, the predominance of value priorities that equate well-being with wealth need to be challenged, while exploring mindsets that allow for a more comprehensive and expansive understanding of what well-being entails (Painter-Morland et al. 2017). This has led organizational scholars to question the very purpose of the theories of management, and call for ongoing conversations that encourage a human turn towards management. Such a turn, they argue, will prevent an algorithmic replication of ideas and practices that act as instruments of optimization and of alienation (Petriglieri 2020).

Similar discussions, within the field of science and technology studies (STS), have attempted to highlight the interplay of economic, social, and environmental elements, while resisting technological determinism. They have engaged with framings that explore how machines are made by humans and that powerful institutions decide which technologies are worth such investment (Jasanoff 2015). Studies from this field show how often discourses and accounts crowd out alternative visions and plot a model of the future that reflects and reinforces existing problems and biases of socio-economic and socio-political systems. For instance, Sadowski and Bendor's (2019) study of IBM and Cisco's work on smart cities uncovers a narrative that tries to fit, and then subsequently sell and disseminate, different ideas and initiatives into a single coherent view of smart urbanism. Benjamin (2016) has combined STS and critical race theory to propose an expansive understanding of health and safety as forms of classification and control, in an environment of science and technology where subjugation is never an explicit objective. These perspectives echo Bostrom's (2019) call for a deeper engagement with assumptions that frame all technological progress as beneficial, examining the efficacy of complete scientific openness, and exploring if our societies have the requisite capabilities to deal with the aftermath of the potential downside of a technology already invented.

Drawing from STS, research relating to transition to sustainable energy reveals how and why singular narratives emerge and become the norm. It illustrates how the incumbent energy regime is organized through socio-technical configurations of technological artifacts, market structures, user practices, regulatory frameworks, cultural and scientific meanings (Fouquet 2016; Geels 2004). Such configurations privilege a certain narrative that places well-being within the realm of economic growth. These insights highlight how scientific and technological developments driving industrial society have resulted in wealth creation yet also actively contributed to global ecological degradation and social inequality (Schot and Kanger 2018; Kanger and Schot 2019).

However, to understand technological change, the analysis should be directed within the context of the social structure where such a change takes place (Castells 2002). The current growth-based and market-driven economic system that dominates our societal structures is at the heart of the interactions between the modes of production and modes of development that are instrumental in the generation of new social and spatial forms and processes (Castells 2002). Evidence points towards how the system contributes to

environmental degradation, perpetuates unequal access to resources and knowledge, and is instrumental in aggravating global financial crises, thus threatening social and community well-being as well (Matthey 2010; Stiglitz et al. 2010). The social and spatial forms and processes emerging from this system work towards institutionalizing the ideas, beliefs, and norms, thereby reinforcing these problems. This has led to studies critiquing the incumbent system as well as offering new transition pathways.

For instance, Rockström et al. (2009) have identified the nine critical boundaries essential for maintaining the planetary biosphere - climate change, ocean acidification, stratospheric ozone depletion, disruption of the nitrogen and phosphorus cycles, global freshwater use, land use changes, biodiversity loss, aerosol loading in the atmosphere, and chemical pollution. Based on these, Raworth (2012) contends that any vision for development needs to be within these boundaries. Raworth offers that resources should be mobilized to improve social indicators and has identified 12 social priorities: health, education, income and work, water and sanitation, energy, networks, housing, gender equality, social equity, political voice, and peace, and justice. Terming this as a *safe and just space*, Raworth conceptualizes the objective to be able to fit into a 'doughnut' where the planetary boundaries are represented in the outer border and the social foundation form the inner core. However, building on Raworth's model O'Neill et al. (2018) have questioned whether fitting into the doughnut is even possible given the relationship between social performance and resource use. Based on the current relationship between resource use and human well-being, meeting the basic needs of all people would result in humanity breaching multiple limits. It suggests that our systems need restructuring for these needs to be met at a much lower level of resource use, implying that the very idea of growth and the related assumptions, including those of well-being, needs deeper scrutiny.

The field of degrowth actively discusses and debates the role of technology. Some see potential threats from certain technologies to human societies (Samerski 2018; Andreoni and Galmarini 2014) and call for refraining from technology (Heikkurinen 2018), while others consider some technologies beneficial for democratization and facilitating alternative forms for production and consumption (Rommel et al. 2018; Bradley 2018). Some bring up concerns related to biophysical limits (Bonaiuti 2018; Gomiero 2018), and some want to appropriate technology for different purposes (Likavčan and Scholz-Wäckerle 2018). These discussions are relevant and important because they highlight and comment on the traditional idea of 'good living' that is tied to GDP (gross domestic product) growth policies. They urge for a rethink of economic policies and public discourse in general that continuously repeat the need for GDP growth thereby perpetuating social addiction to it (Hickel 2019).

As human society transitions from an industrial mode of development towards an information mode of development, the distribution and processing of information remain a constant challenge (Hayek 1945) but the source of productivity lies in the quality of knowledge (Castells 2002). The role of AI in the information mode of development is important as it has the ability for substituting, supplementing, and/or amplifying almost all mental tasks (Makridakis 2017) that could have profound implications on the quality of knowledge. Knowledge is implicated in all modes of development, be it agrarian, industrial or informational, as the level of knowledge determines the process of production. However, in the informational mode, knowledge mobilizes the generation of new knowledge for prompting higher productivity (Castells

2002). The generation of new knowledge becomes the key source of product through its impact on other elements of the production process and their relationsl Even if well-being may be a determinant of higher levels of productivity, the way productivity is pursued could potentially undermine well-being (Isham et al. 202(

It is against this backdrop that AI's role in community well-being needs t understood. Its ability to contribute will depend on the knowledge framework th used for its deployment, as learning is at the core of intelligence (Minsky 19 Emotions, intuitions, and feelings are not distinct things, but ways of thinking take the form of carefully reasoned analysis at times while turning to emotions at c times (Minsky 2007). To be able to recognize and embrace these ways of thinking requires rich and varied experiences (data) that could then enable us to build intelli tools. These tools could assist in making decisions with the ability to embrace uncertainty inherent to futures where the objective is that of creating individual v being that is accordant with the communities such individuals are embedded in.

Conceptualizing Community Well-Being

Well-being as a concept is an objective of development, in addition to being approach to developing an understanding about how people perceive the idea of 'li well' (Atkinson et al. 2019; Armitage et al. 2012; Copestake 2008; Gough McGregor 2007). A social conception of well-being allows for the individualistic basic needs aspects to exist within a wider social-psychological and cultural n perspective of living well (Deneulin and McGregor 2010; Coulthard et al. 2(Taking into account three dimensions – material, relational, and subjective – that re both the development and the social psychology perspectives, this idea recogr human well-being as an outcome and a process (Armitage et al. 2012).

The three dimensions help in understanding how the different facets of a 'life lived' come together to conceptualize well-being, not just as an objective to be desirec also an analysis of elements that drive our choices and behavior, indicating what mak thrive. The material dimension accommodates the physical and financial assets essenti well-being, and the relational dimension emphasizes interactions, that could take account reputation, sense of community, and reciprocity. The subjective dimension p on contentment and sense of happiness that is part of everyday as well as long- decision making. The three dimensions influence individual and collective behaviors are instrumental in capturing well-being at different scales (Coulthard 2012).

However, negotiating the multiple definitions, measurements, and the often hic assumptions underpinning the acts of being individual and collective is a complex theoretically challenging process, that can impede the conceptualization of the com relationships pertaining to interior life, self or relational selves and the exte environment (Atkinson et al. 2019; Allin and Hand 2017). Given this backdro becomes imperative that without explicit recognition of the assumptions that drive operationalization of these interactions, their impacts will remain under-speci Community well-being centers on an understanding of community and fulfilling needs and desires of its members (Sung and Phillips 2018). Therefore, theorizat that focus on relationality enable a notion of community that is greater than a sum c parts as well as highlight neglected aspects of community well-being. The com

inter-relationships that characterize how lives are lived in relation to other people, places, materiality and so forth, enable understandings of community well-being that derive meaning and acquire importance locally as well as through the wide range of interactions.

Within the policy domain, this approach has urged for a focus on how aspects of the local community impact individual well-being and on the quality of collective life as relational. Sung and Phillips (2018) have contended that community well-being that is premised on the autonomous, individual subject rather than the relational aspects leads to an impoverished understanding of what it means to be human, but more significantly, obscures the processes through which lived lives are differentiated. For greater transparency and awareness about the positions that contribute towards operationalizing community well-being, relational aspects offer a wide range of economic, social, environmental, political, and cultural dimensions that could uncover how communities are governed and make sense of their environments. Therefore, this conception of well-being derives from social needs of individuals and communities, and recognizes the dynamic, multidimensionality, and variability of human development and quality of life.

AI as a Resource for Community Well-Being

Buchanan (2005, p. 53) describes the history of AI as that of '*fantasies, possibilities, demonstration, and promise*'. Influenced by disciplines such as engineering (cybernetics including feedback and control), biology (neural networks in simple organisms), experimental psychology, communication theory, game theory, mathematics and statistics, logic and philosophy, and even linguistics, AI has grown beyond these disciplines and in turn influenced them (Buchanan 2005). From Simon's 'satisficing' as the fundamental principle of AI, (Rainey 2001), that looked at heuristics as a way of problem solving, in the absence of an effective method for decision making, to Minsky's (1961) search for effective techniques for learning, AI has evolved over time.

So far, AI's accomplishments have skewed mainly towards automating tasks associated with intelligence, without being intelligent itself. For instance, it has been observed that researchers applying deep neural networks for modelling limit their focus on the inputs and outputs, while the models themselves remain as *'black boxes'* (Guo et al. 2019, p. 926). The neural architectures are designed based on the experiences and intuition of researchers who often fail to link the problems to their physical backgrounds (Guo et al. 2019). Therefore, AI's progression towards deep learning warrants a better understanding of complexity, along with the ability to distinguish between the reactive nature of AI and the anticipatory nature of living intelligence (Nadin 2019). This is evident in the recent trajectory of research focusing on reassessing the existing knowledge systems and new ways of understanding them (Geva et al. 2019; Guo et al. 2019; Sap et al. 2019; Wang et al. 2019b; Nadin 2018). The impact of AI on social, socio-economic and environmental dimensions (Stanovsky et al. 2019; Schwartz et al. 2019), and how it can bring about social change (Abebe et al. 2020) is gaining relevance as well. Collectively, this literature indicates the importance of considering the contexts in which such technological tools should be deployed, as they determine the need, the design, and the effectiveness of such tools, which offers better

understandings of the contexts leading to better designed tools. For instance, data-based discrimination has been proven to be a reality for millions when algorithms try to predict and prioritize outcomes that affect basic human rights and imperil economic equity (Eubanks 2018; Noble 2018).

The ethical dimensions of AI, as it becomes the preferred option for efficient service delivery, are proving to be significant. On the surface, such a shift towards automated and algorithmic tools for determining eligibility and providing services might appear positive and efficient, as direct interactions always carry the risk of internal biases or poor work culture of individuals (Lipsky 2010). This does not reduce prejudice; on the contrary, it builds bias into the system with complete reliance on stored information and predictive algorithms producing results that are more difficult to scrutinize (Eubanks 2018). Friedman and Nissenbaum (1996) identified three categories of bias, preexisting, technical, and emergent, while analyzing actual cases. They proposed that preexisting bias is rooted in social institutions, practices, and attitudes, while technical bias is a result of technical constraints, and emergent bias arises in a context of use.

The advances in AI as it increasingly comes under the rubric of machine learning, where computers are programmed to learn from experiences and examples (Agrawal et al. 2017) open it up to a range of contexts. The contexts in which these experiences occur and the examples recorded, offer a more layered understanding. For instance, AI can significantly improve community well-being by aiding farmers to adapt to climate change, predicting disease outbreaks, and making congested urban centers more livable, among other things. However, it can also impinge on privacy, surveil and repress marginalized communities, lead to loss of jobs or trigger an arms race (Bostrom 2019). To extrapolate from Phillips and Wong (2017), well-being is influenced by, and evolves through, a number of issues and constraints that are part of a dynamic social context, and AI needs to take into account these issues and constraints for developing a decision intelligence system for community well-being. However, the data scientists and programmers often have limited experience or knowledge about these complex interactions and even as they design user-friendly digital tools, the validity of such design within diverse contexts remains under-explored. These systems, though nonhuman and automated, are created with specific goals in mind and are often laden with values of those designing them.

Within this frame of reference, acknowledging the complex interactions that are intrinsic to the very conception of well-being, and recognizing that addressing the problems threatening well-being emerge from those very interactions is critical. What we know is the outcome of our learning. Human evolution itself is in some ways the manifestation of how learning supports life, as it changes continuously (Nadin 2018). What we choose to learn indicates our anticipated action, therefore, when knowledge acquired is meaningful it reinforces life changes and when inappropriate, undermines them (Nadin 2018). The kind of knowledge, the way it is understood and presented, is core to the decision-making process. This capability is intrinsic to how AI systems could become a powerful resource for effective decision-making that would contribute towards a more diverse understanding of well-being.

Conceptualizing AI as a resource demands acknowledgment that problems emerging from complexity require solutions that are framed through a collective understanding, by applying rules governing complexity, with a variety of tools that are able to address such problems at their respective scales (Gatzweiler 2020). As such emergent

challenges are beyond the problem-solving capabilities of individuals, the resourcefulness of AI could come into play by uncovering the relatedness of our socio-technical systems, and enable us to use the knowledge to design context-specific solutions that contribute to our well-being. The design of such a framework needs to be non-linear and dynamic to accommodate intelligence as it evolves, and in doing so requires incorporating both the reactive nature of AI as well as the anticipatory nature of living intelligence (Nadin 2019).

A Framework for Leveraging AI for Community Well-Being

Societies are random, complex, and dynamic multiscale systems comprised of actors with varied and diverse interactions, experiences, and knowledge that emerge from sensitivities and sense-making from initial conditions. These combine in different ways leading to decisions that introduce aspects of unpredictability, chaos, non-linearity, yet could also exhibit self-organization. A framework for leveraging AI for community well-being needs to recognize and subsequently build in tools that can learn from these phenomena in order to offer intelligent decision-making models within diverse contexts.

The first step in designing such a framework would be to draw upon the definitions of well-being and to come up with one that best matches a particular localized context. The relational aspects could be captured through a combination of insights that take into account different aspects of AI and related technologies and the socio-technical, political, economic, and ecological aspects that influence well-being within diverse contexts. This is important for negotiating and conceptualizing well-being in diverse contexts.

Corea's (2019) AI knowledge map (AIKM) (see Fig. 1 below) can be a good guide for thinking about how this data could be categorized and organized. It presents a general understanding of various AI tools available for solving problems. The AI paradigms (X-axis) are approaches used by AI researchers for solving specific AI-related problems and the AI problem domains (Y-axis) are the type of problems AI has been able to solve until now. The AIKM is an effort to help access knowledge on AI and is a useful tool for designing solutions that target specific problems within their contexts. This AIKM could serve as an inspiration for categorizing disparate data sets. The model could be seen like an open floor plan that allows individuals with different needs to design their own solutions at the same time being aware of how these solutions relate to others.

The different classes of AI technologies represented in the Fig. 1 above are clustered into groups, each representing the activities they perform. The nature of the problem determines the technology or rather the mix of technologies deployed. However, as discussed earlier, even as these technologies are being deployed, there is a lack of understanding of the new kinds of problems such technologies create in solving the existing ones. As these technologies are just tools, the concerns relate to how they are being used and could be addressed by developing data structures that are representative of diverse knowledge frameworks. The potential capabilities of AI technologies represented within the AI Paradigms become valuable tools for capturing the relevant data representing the

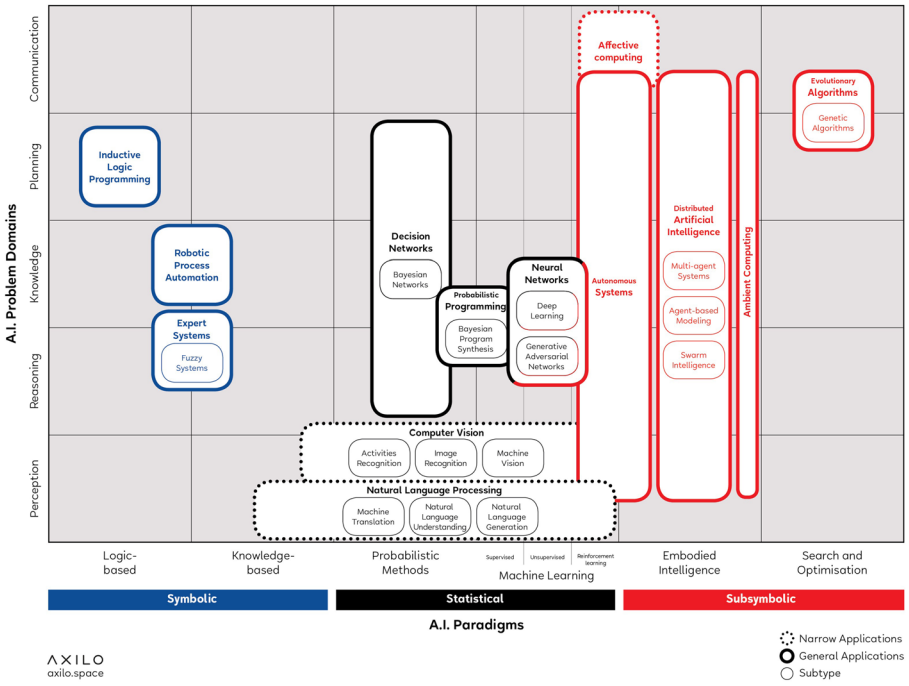


Fig. 1 Corea (2019) AI Knowledge Map: How to Classify AI Technologies. In: An Introduction to Data (pp. 25–29). Studies in Big Data, vol 50. Springer, Cham

complexity of interactions and relationships through which the idea of well-being is framed, within diverse contexts. These frames could offer opportunities for combining the tools depending on the need and context. For instance, the logic based tools used for knowledge representation and problem solving could be made more effective by data inclusiveness that adopts wide and diverse perspectives taking into account the material, relational, and subjective aspects of well-being. This could have consequences for the AI problem domain of perception and reasoning, and subsequently on knowledge, planning, and communications.

A diversity of perspectives would enable a rich and layered representation of knowledge while unveiling the connections and relationships embedded in these perspectives of well-being. Incorporating such diverse perspectives continuously in the design of the data structures that the algorithms depend on, would strengthen the tools and transform the AI technologies into valuable resources. The ontologies and databases of notions, information, and rules that inform the knowledge-based tools with better representation of rich and layered data would help design better probabilistic tools during incomplete information scenarios. This would make AI systems resilient, in addition to being efficient. Richer and more diverse data would allow for better search and optimization, and robust machine learning. This could enable a diverse and holistic understanding of well-being. The diverse knowledge or data sets become the ingredients for visualizing different scenarios or pathways. The data set is the source of inspiration as it brings together various forms of knowledge that could be mined based on the insights that evolved in step one.

Once this knowledge discovery process is underway, one can look at descriptive analytics (making sense of historical data) and/or diagnostic analytics (what factors influence thinking, behaviors, and events). Depending on the needs and requirements of particular communities, one can use statistical inference to make decisions about designing models for well-being. These decision models could be used as examples for learning about the models and predicting outcomes within diverse scenarios. As the data becomes richer, the models will become more sophisticated.

The Fig. 2 below is a conceptual view of AI as a resource for developing models for well-being. It takes into account the social conception of well-being as an emergent and scale-sensitive interplay of the objective (circumstances shaped by material and relational dimensions) and the subjective (values and perceptions) dimensions of agency and capabilities (Coulthard 2012). This conceptualization makes it possible to make sense of the data sets and their relatedness. Articles discussing decision-making by AI and data science practitioners and the literature reviewed for researching this article has inspired the steps presented. There is growing recognition among AI researchers about the importance of explaining what lies behind the algorithms for providing evidence to support the decisions being made by the algorithms and also to identify biased correlations. Coulthard's (2012) conceptualization captures the complex negotiations that the idea of well-being embodies, that can then serve as important guidelines for understanding the data with the AI tools and in the process make the tools more robust.

The first step uses data to improve the performance of the AI tools. The tools, as we know, are designed to support and expand human cognition and in some cases even replace them. The AI paradigms and the tool clusters, as described in Fig. 1 offer us a general understanding of their growth in processing power and accuracy in handling different levels of complexity. This could be understood as algorithmic complexity.

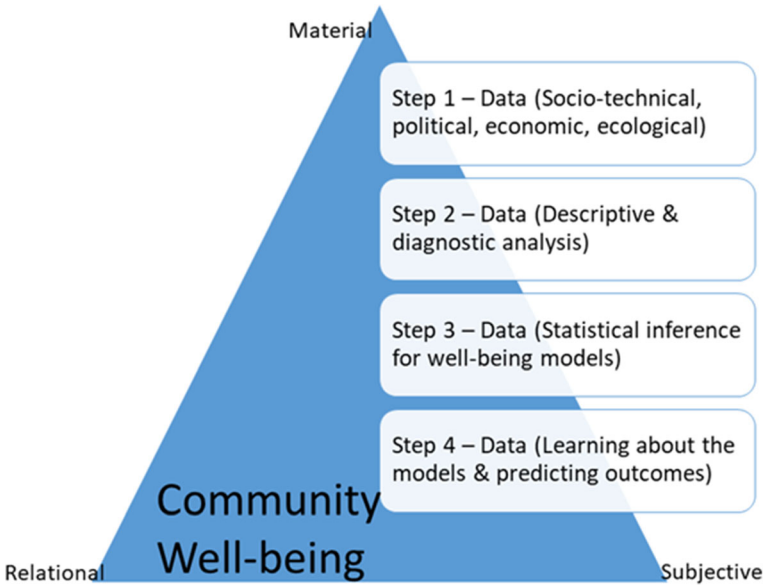


Fig. 2 A framework for leveraging digital intelligence for community well-being derived from Coulthard (2012). Can we be both resilient and well, and what choices do people have? Incorporating agency into the resilience debate from a fisheries perspective. *Ecology and Society*, *17*(1)

However, as discussed in the previous sections, there is a growing consensus towards understanding how these algorithmic decisions are arrived at, and more importantly, for the purpose of this article, a clear understanding of the content that these decision models draw upon, or the content's semantic interpretability. For designing community well-being models, the framework represented by Fig. 2 gains relevance, as it draws upon diverse data sources pertaining to social, technological, economic, and ecological factors that influence well-being within material, relational, and subjective dimensions.

In the next step, this data could be used for descriptive and diagnostic analytics to create a rich and layered understanding of well-being. The AI tools could become critical resources in understanding the complex relationships, for instance, between income levels, education, health, and general quality of life, within layered historical social, cultural, and political contexts. Such perspectives would contribute towards designing better decision intelligence models for well-being and contribute towards learning continuously through the experiences of these models, as represented by steps, 3 and 4 in Fig. 2. Even though the steps are described in a linear form, in practice this is a non-linear process. As the data sets acquire further layers through experiences, feedback mechanisms enrich the process of learning and the outcomes.

Discussion

This article suggests that designing a framework for leveraging digital intelligence for community well-being would require conceptualization of intelligence in terms of what it does (functionality) as well as where it belongs (context), and capturing how the two elements interact. Such a conceptualization classifies intelligence as a dynamic and evolving process making the design process an emergent one.

The AIKM's Y-axis (problem domain) corresponds to what AI can do and the X-axis (paradigms) corresponds to the contexts where specific problems belong or are located and experienced. In order to leverage digital intelligence – an interplay between functionality and context – for community well-being, the levels of analysis will need to take into account the dominant discourses related to technological innovation-led growth and scrutinize how well-being is framed within these discourses. The framework illustrated in Fig. 2 borrows from Coulthard's (2012) perspective on well-being through material, relational, and subjective dimensions, as it lends a systemic and relational understanding of well-being. It then suggests deploying AI tools for organizing diverse data sources pertaining to social, technological, economic, and ecological factors that influence well-being. This data is further enriched by building contexts and in doing so it can potentially reveal discourses that limit or restrict well-being and address the lack of social and political accountability and long-term planning that has been missing from the largely corporate-driven development of AI (Cath et al. 2018).

Take for instance, a case where a leading online retailer was found to be discriminating against a certain community of customers regarding delivery options (Ingold and Soper 2016, April 21). A closer look revealed that it was not just the retailer's algorithmic bias that favored those customers who buy more but also a historical factor that placed the discriminated community in a postcode not known for economic affluence. Relying on decisions based purely on economic objectives, as is the norm, can lead to unfair discrimination. Therefore, for this analysis to be effective, it is

important to identify, recognize, and call to attention some of the fundamental issues plaguing our knowledge systems and frameworks. There is a crisis in how we conduct science, in terms of how knowledge is acquired, validated, and shared. For instance, the diverse ways of understanding are lost in the pursuit of a homogeneous reality (Nadin 2018). Research from the field of social informatics is uncovering the significance of portions of knowledge production and consumption migrating online. The internet's ability to allow the distributed and shared production of knowledge has resulted in expanding the scope and scale of research using digital materials, yet it has also reconfigured the ways knowledge is created across disciplines (Meyer et al. 2019). Social informatics, in the era of distributed knowledge offers ways to understand the many aspects of knowledge production, distribution, and use. In doing so, it has revealed how intelligent agents could potentially reconfigure work, erode trust in technology, reduce privacy, and create social detachment. Evidence of intelligent agents' ability to manufacture computational propaganda, as a social and technical phenomenon, has come into focus recently and these could have serious consequences on community well-being. This reinforces the need for deeper scrutiny of ideas, norms, and practices that define the underlying logic of our current system, and the relationships that reinforce certain value systems.

The logic baked into the basic characteristics of the technological paradigm has fundamental social consequences as semantic data relies on definition of terms, properties, and relationships (Mccarthy 2017). Semantic interpretability is a requirement for any approach dealing with AI and should be relatable to a system's output as well as its architecture (Silva et al. 2019). Such technologies are embedded in the broader production and organizational system that has social roots, whose development is in turn fueled by these technologies (Castells 2002). The emergent complex interacting system that is giving rise to a new mode of development could potentially influence social and cultural mores in significant ways. The expanded role of information and its ability to influence and transform social relationships needs serious consideration. Hayek (1945) argued that the distribution and processing of information is a central problem in economics and urged for building an understanding of how markets distribute and process information. His solution was to move away from centrally planned economies. Following this solution and giving primacy to markets in all aspects has led to a concentration of market power followed by discourses of economic growth that perpetuate this power.

With AI being developed and deployed by a few powerful companies geared towards profits, it is critical to start questioning the underlying assumptions that drive well-being, that of endless economic growth. As this kind of growth implies a constantly increasing rate of energy and material demand resulting in increasing rates of resource depletion and environmental damage (Andreoni and Galmarini 2014), the efficient deployment of AI technologies itself could emerge as an issue with consequences for community well-being. For instance, the complexity of machine learning algorithms employed for face recognition could, and have been known to, result in misclassifications, and it illustrates how the interpretability of the model influences decision intelligence systems with critical consequences for individual lives. Such systems are used for medical diagnosis, insurance and credit assessment, and criminal recidivism prediction, among others, therefore, explaining and justifying such decisions is important for building trust and also improving the decision making process.

Adopting the smart agency of AI means willingly ceding some of our decision-making power to technological artefacts, requiring the balancing of decision-making power between humans and artificial agents, while being cognizant of the risk of undermining the flourishing of human autonomy in favor of the artificial (Floridi and Cowls 2019). Such an arrangement reinforces one of the objectives of this article, which is about taking into account the ways and means through which information is collected, understood, and processed. There is growing evidence on different kinds of issues that range from annotator, gender, racial, and class biases (Geva et al. 2019; Stanovsky et al. 2019; Wang et al. 2019a; Eubanks 2018; Noble 2018; Benjamin 2016) to fears of how such technological progress might impact people's capabilities or incentives in ways that could destabilize our societies (Bostrom 2019). This has prompted calls for a clear and convincing understanding of what a 'good AI society' would entail, accompanied by suggestions that this can be best achieved through independent, international, multi-stakeholder process of research and consultation on AI and Data Ethics (Cath et al. 2018).

This article proposes an approach by drawing attention to some of the fundamental systemic issues that need acknowledgment for diverse ways of understanding well-being. The approach presents the possibility for combining objective circumstances surrounding people and their perception of it, as a dynamic interplay of outcome and processes. Dynamic interplays need to be understood as being located in society and shaped by social, economic, political, cultural, and psychological processes (Gough and McGregor 2007), therefore it becomes imperative to investigate the ideas guiding these processes. If the general societal discourses maintain the need for economic growth and wealth as the cornerstones of well-being (Hickel 2019; Painter-Morland et al. 2017) then they will influence the basic conception of well-being in terms of what a person has, what they do with that, and how they think about what they have and can do (Gough and McGregor 2007). As corporations lead the development of AI, their narrow understanding of well-being (DesJardine and Bansal 2019; Painter-Morland et al. 2017; Gao and Bansal 2013), including a lack of social and political accountability (Cath et al. 2018), poses a challenge to well-being. The evidence of this happening is already building up (Eubanks 2018; Noble 2018; Benjamin 2016). In such a scenario, the framework presented above offers a two-pronged approach towards understanding well-being – the first involves taking a systemic and relational view of well-being in order to build context, and this leads to the second, which is attempting to uncover discourses that limit or restrain the concept of well-being.

Most frameworks assessing well-being are centered on the individual and how community aspects impact subjective individual well-being, ignoring layers of complexities brought about by spatial and social inequality, multiple settings and scales, and temporality and past legacies (Atkinson et al. 2019). In framing well-being through relationality as opposed to individual subjectivity, Atkinson et al. (2019) have offered a view that highlights a complex systems approach towards well-being where a community is understood to be more than a sum of its parts. This view echoes a growing number of scholars who are advocating for a similar approach (see Nadin 2018; Chorafakis 2020). A complexity approach highlights the relational elements of individual parts and in doing so opens up the possibilities for designing and learning from the diverse conceptualizations of community well-being. With AI as a tool, this becomes a possibility.

Conclusions

Algorithmic systems have the potential for predicting outcomes and allocating societal resources accordingly, and in such high-stake decision-making the lack of adequate understanding and contextualizing of information could introduce, perpetuate, and worsen issues related to well-being Such concerns are becoming more pronounced as technical interventions in the form of AI are becoming a way of life. Be it driverless cars, or the use of machine learning for improving healthcare and financial services, AI is instrumental in shaping daily practices and transforming certain fundamental aspects of our societal systems in the process. Sophisticated statistical and probabilistic methods, availability of enormous amounts of data associated with increasing transformation of places into IT-friendly environments, and cheap computational power are generating concerns about AI's impact on societies. As fundamental questions relating to the ethical, social, and economic impact of AI remain unanswered (Cath et al. 2018), its ability to shape decisions for community well-being needs to be carefully examined. This article argues that one way to do this is to analyze the knowledge systems and the societal and institutional infrastructures that inform the current understanding and conceptualization of well-being. The framework represented in Fig. 2 treats AI technologies as powerful tools for developing diverse ways of understanding and contextualizing information for imagining and creating well-being models tailored to community needs and aspirations.

As societies become more "information mature" and their reliance on AI increases, it is expected that this pervasiveness will make its existence and influence non-transparent, leading to a paradox where the more AI matters the less visible it will be (Floridi 2016). In such an event, it becomes even more important to examine the current knowledge systems and their influence on perceptions of well-being. Deploying AI as a resource to manage the layers of complexity implicit in the relational aspects and subsequent conceptualizations of community well-being could provide dynamic solutions tailored to specific communities.

Funding Open access funding provided by University of Vaasa (UVA).

Compliance with Ethical Standards

Conflict of Interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

References

Abebe, R., Barocas, S., Kleinberg, J., Levy, K., Raghavan, M., & Robinson, D. G. (2020). Roles for computing in social change. In *Proceedings of the 2020 Conference on Fairness, Accountability, and Transparency* (pp. 252-260).

Abrahamsen, M. H., Henneberg, S. C., Huemer, L., & Naude, P. (2016). Network picturing: an action research study of strategizing in business networks. *Industrial Marketing Management, 59*, 107–119.

Adkins, B. (2019). Information as the image of thought: A Deleuzian analysis. *The Journal of Speculative Philosophy, 33*(3), 489–500.

Agrawal, A., Gans, J., & Goldfarb, A. (2017). *What to expect from artificial intelligence*. MIT Sloan Management Review.

Aligica, P. D., & Tarko, V. (2012). Polycentricity: from Polanyi to Ostrom, and beyond. *Governance, 25*(2), 237–262.

Allin, P., & Hand, D. J. (2017). New statistics for old?—measuring the wellbeing of the UK. *Journal of the Royal Statistical Society: Series A (Statistics in Society), 180*(1), 3–43.

Anderson, J. & Rainie, L. (2018). Artificial intelligence and the future of humans. Washington DC: Pew research center. Retrieved from https://www.pewinternet.org/2018/12/10/artificial-intelligence-and-the-future-of-humans/. Accessed 2 Jan 2020.

Andreoni, V., & Galmarini, S. (2014). How to increase well-being in a context of degrowth. *Futures, 55*, 78–89.

Armitage, D., Béné, C., Charles, A. T., Johnson, D., & Allison, E. H. (2012). The interplay of well-being and resilience in applying a social-ecological perspective. *Ecology and Society, 17*(4).

Atkinson, S., & Scott, K. (2015). Stable and destabilised states of subjective well-being: dance and movement as catalysts of transition. *Social & Cultural Geography, 16*(1), 75–94.

Atkinson, S., Bagnall, A. M., Corcoran, R., South, J., & Curtis, S. (2019). Being well together: individual subjective and community wellbeing. *Journal of Happiness Studies*, 1–19.

Benjamin, R. (2016). Catching our breath: critical race STS and the carceral imagination. *Engaging Science, Technology, and Society, 2*, 145–156.

Bolton, C., Machová, V., Kovacova, M., & Valaskova, K. (2018). The power of human–machine collaboration: artificial intelligence, business automation, and the smart economy. *Economics, Management, and Financial Markets, 13*(4), 51–56.

Bonaiuti, M. (2018). Are we entering the age of involuntary degrowth? Promethean technologies and declining returns of innovation. *Journal of Cleaner Production, 197*, 1800–1809.

Bostrom, N. (2019). The vulnerable world hypothesis. *Global Policy, 10*(4), 455–476.

Bostrom, N., Dafoe, A., & Flynn, C. (2018). *Public policy and superintelligent AI: A vector field approach*. Oxford, UK: Governance of AI Program, Future of Humanity Institute, University of Oxford.

Bradley, K. (2018). Bike kitchens–spaces for convivial tools. *Journal of Cleaner Production, 197*, 1676–1683.

Buchanan, B. G. (2005). A (very) brief history of artificial intelligence. *AI Magazine, 26*(4), 53–60.

Cai, Y., Shen, Z., Liu, S., Yu, H., Han, X., Ji, J., ... & Miao, C. (2014). An agent-based game for the predictive diagnosis of parkinson's disease. In *Proceedings of the 2014 international conference on Autonomous agents and multi-agent systems* (pp. 1663–1664). International Foundation for kjAutonomous Agents and Multiagent Systems.

Carroll, A. B., & Shabana, K. M. (2010). The business case for corporate social responsibility: a review of concepts, research and practice. *International Journal of Management Reviews, 12*(1), 85–105.

Castells, M. (2002) *The informational mode of development and the restructuring of capitalism*, [published in I. Susser (Ed.) (2002) *The Castells Reader on Cities and Social Theory*, pp. 254–284. Oxford: Blackwell].

Cath, C., Wachter, S., Mittelstadt, B., Taddeo, M., & Floridi, L. (2018). Artificial intelligence and the 'good society': the US, EU, and UK approach. *Science and Engineering Ethics, 24*(2), 505–528.

Chorafakis, G. (2020). Emergence versus neoclassical reductions in economics. *Journal of Economic Methodology*, 1–23.

Colander, D., & Kupers, R. (2016). *Complexity and the art of public policy: Solving society's problems from the bottom up*. Princeton University Press.

Copestake, J. (Ed.). (2008). Wellbeing and development in Peru: Local and universal views confronted. Springer.

Corea F. (2019) AI knowledge map: How to classify AI technologies. In: An introduction to data (pp. 25-29). Studies in big data, vol 50. Springer, Cham.

Coulthard, S. (2012). Can we be both resilient and well, and what choices do people have? Incorporating agency into the resilience debate from a fisheries perspective. *Ecology and Society, 17*(1).
Coulthard, S., Johnson, D., & McGregor, J. A. (2011). Poverty, sustainability and human wellbeing: a social wellbeing approach to the global fisheries crisis. *Global Environmental Change, 21*(2), 453–463.
DeLanda, M. (2016). *Assemblage theory*. Edinburgh University Press.
Deleuze, G., & Guattari, F. (1988). *A thousand plateaus: Capitalism and schizophrenia*. Bloomsbury Publishing.
Deneulin, S., & McGregor, J. A. (2010). The capability approach and the politics of a social conception of wellbeing. *European Journal of Social Theory, 13*(4), 501–519.
DesJardine, M., & Bansal, P. (2019). One step forward, two steps back: how negative external evaluations can shorten organizational time horizons. *Organization Science, 30*(4), 761–780.
Eubanks, V. (2018). *Automating inequality: How high-tech tools profile, police, and punish the poor*. St. Martin's Press.
Fiorini, R. A. (2019). From autonomous systems to symbiotic system science. *Proceedings of the IEEE ICCI* CC*, 254-260.
Floridi, L. (2013). *The philosophy of information*. OUP Oxford.
Floridi, L. (2016). Mature information societies—A matter of expectations. *Philosophy & Technology, 29*(1), 1–4.
Floridi, L. (2017). The logic of design as a conceptual logic of information. *Minds and Machines, 27*(3), 495–519.
Floridi, L., & Cowls, J. (2019). A unified framework of five principles for AI in society. *Harvard Data Science Review, 1*(1). https://doi.org/10.1162/99608f92.8cd550d1.
Fouquet, R. (2016). Path dependence in energy systems and economic development. *Nature Energy, 1*(8), 1–5.
Friedman, B., & Nissenbaum, H. (1996). Bias in computer systems. *ACM Transactions on Information Systems (TOIS), 14*(3), 330–347.
Gao, J., & Bansal, P. (2013). Instrumental and integrative logics in business sustainability. *Journal of Business Ethics, 112*(2), 241–255.
Gatzweiler, F. W. (2020). Advancing urban health and wellbeing through collective and artificial intelligence: A systems approach 3.0. In *Urban health and wellbeing programme* (pp. 33–38). Springer, Singapore.
Geels, F. W. (2004). From sectoral systems of innovation to socio-technical systems: insights about dynamics and change from sociology and institutional theory. *Research Policy, 33*(6–7), 897–920.
Geva, M., Goldberg, Y., & Berant, J. (2019). Are we modeling the task or the annotator? An investigation of annotator Bias in natural language understanding datasets. In *Proceedings of the 2019 Conference on Empirical Methods in Natural Language Processing and the 9th International Joint Conference on Natural Language Processing (EMNLP-IJCNLP)* (pp. 1161-1166).
Gomiero, T. (2018). Agriculture and degrowth: state of the art and assessment of organic and biotech-based agriculture from a degrowth perspective. *Journal of Cleaner Production, 197*, 1823–1839.
Gough, I., & McGregor, J. A. (Eds.). (2007). Wellbeing in developing countries: From theory to research. Cambridge University Press.
Greyson, D. (2019). The social informatics of ignorance. *Journal of the Association for Information Science and Technology, 70*(4), 412–415.
Guo, L., Wu, J., & Li, J. (2019). Complexity at Mesoscales: a common challenge in developing artificial intelligence. *Engineering, 5*(5), 924–929.
Hahn, T., Pinkse, J., Preuss, L., & Figge, F. (2015). Cognitive frames in corporate sustainability: managerial sense-making with paradoxical and business case frames. *Academy of Management Review, 4015*, 18–42.
Halford, S., Pope, C., & Weal, M. (2013). Digital futures? Sociological challenges and opportunities in the emergent semantic web. *Sociology, 47*(1), 173–189.
Hall, W., & Pesenti, J. (2017). Growing the artificial intelligence industry in the UK. *Department for Digital, culture, Media & Sport and Department for Business, Energy & Industrial Strategy. Part of the Industrial Strategy UK and the Commonwealth.*
Hayek, F. A. (1945). The use of information in society. *American Economic Review, 35*(4), 519–530.
Heikkurinen, P. (2018). Degrowth by means of technology? A treatise for an ethos of releasement. *Journal of Cleaner Production, 197*, 1654–1665.
Hendler, J., & Berners-Lee, T. (2010). From the semantic web to social machines: a research challenge for AI on the world wide web. *Artificial Intelligence, 174*(2), 156–161.
Hickel, J. (2019). Is it possible to achieve a good life for all within planetary boundaries? *Third World Quarterly, 40*(1), 18–35.
Hopkinson, G. C. (2015). Network graffiti: interaction as sensemaking. *Industrial Marketing Management, 48*, 79–88.
Ingold, D., & Soper, S. (2016). Amazon Doesn't consider the race of its customers. Should it? Bloomberg.com. Retrieved from https://www.bloomberg.com/graphics/2016-amazon-same-day/

Isham, A., Mair, S., & Jackson T. (2020). Wellbeing and productivity: a review of the literature. CUSP working paper no 22. Guildford: University of Surrey. Retrieved from: *Online at: www.cusp.ac.uk/powering-productivity*. Accessed 5 Jan 2020.

Jasanoff, S. (2015). Future imperfect: science, technology, and the imaginations of modernity. *Dreamscapes of modernity: Sociotechnical imaginaries and the fabrication of power*, 1–33.

Kanger, L., & Schot, J. (2019). Deep transitions: theorizing the long-term patterns of socio-technical change. *Environmental Innovation and Societal Transitions, 32*, 7–21.

Kurucz, E. C., Colbert, B. A., & Wheeler, D. (2008). The business case for corporate social responsibility. *The Oxford handbook of corporate social responsibility*, 83–112.

Laari-Salmela, S., Mainela, T., & Puhakka, V. (2015). Beyond network pictures: situational strategizing in network context. *Industrial Marketing Management, 45*, 117–127.

Likavčan, L., & Scholz-Wäckerle, M. (2018). Technology appropriation in a de-growing economy. *Journal of Cleaner Production, 197*, 1666–1675.

Lipsky, M. (2010). *Street-level bureaucracy: Dilemmas of the individual in public service*. Russell Sage Foundation.

Makridakis, S. (2017). The forthcoming artificial intelligence (AI) revolution: its impact on society and firms. *Futures, 90*, 46–60.

Matthey, A. (2010). Less is more: the influence of aspirations and priming on well-being. *Journal of Cleaner Production, 18*(6), 567–570.

Mccarthy, M. T. (2017). The semantic web and its entanglements. *Science, Technology and Society, 22*(1), 21–37.

McGovern, A., Elmore, K. L., Gagne, D. J., Haupt, S. E., Karstens, C. D., Lagerquist, R., et al. (2017). Using artificial intelligence to improve real-time decision-making for high-impact weather. *Bulletin of the American Meteorological Society, 98*(10), 2073–2090.

McGregor, J. (2007). Research well-being: From concepts to methodology. In I. Gough & J. A. McGregor (Eds.), *Well-being in developing countries: From theory to research* (pp. 316–355). New York: Cambridge University Press.

Meyer, E. T., Shankar, K., Willis, M., Sharma, S., & Sawyer, S. (2019). The social informatics of knowledge. *Journal of the Association for Information Science and Technology, 70*(4), 307–312.

Minsky, M. (1961). Steps toward artificial intelligence. *Proceedings of the IRE, 49*(1), 8–30.

Minsky, M. (2007). *The emotion machine: Commonsense thinking, artificial intelligence, and the future of the human mind*. Simon and Schuster.

Möller, K. (2010). Sense-making and agenda construction in emerging business networks—How to direct radical innovation. *Industrial Marketing Management, 39*(3), 361–371.

Musikanski, L., Havens, J. & Gunsch, G. (2018). IEEE P7010 well-being metrics standard for autonomous and intelligence systems. IEEE standards association. Retrieved from http://sites.ieee.org/sagroups-7010/files/2019/01/IEEEP7010_WellbeingMetricsforA_IS_ShortPaper_December272018For_Submission_reviewedbyIEEELegal-1.pdf [online resource].

Nadin, M. (2018). Rethinking the experiment: necessary (r) evolution. *AI & SOCIETY, 33*(4), 467–485.

Nadin, M. (2019). Machine intelligence: a chimera. *AI & SOCIETY, 34*(2), 215–242.

Noble, S. U. (2018). *Algorithms of oppression: How search engines reinforce racism*. NYU Press.

O'Neill, D. W., Fanning, A. L., Lamb, W. F., & Steinberger, J. K. (2018). A good life for all within planetary boundaries. *Nature sustainability, 1*(2), 88–95.

Painter-Morland, M., Demuijnck, G., & Ornati, S. (2017). Sustainable development and well-being: a philosophical challenge. *Journal of Business Ethics, 146*(2), 295–311.

Petriglieri, G. (2020). F** k science!? An invitation to humanize organization theory. *Organization Theory*, 1(1), 2631787719897663.

Phillips, R., & Wong, C. (Eds.). (2017). *Handbook of community well-being research*. Dordrecht: Springer.

Rainey, H. G. (2001). A reflection on Herbert Simon: a satisficing search for significance. *Administration & Society, 33*(5), 491–507.

Raworth, K. (2012). A safe and just space for humanity: can we live within the doughnut. *Oxfam Policy and Practice: Climate Change and Resilience, 8*(1), 1–26.

Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin III, F. S., Lambin, E., et al. (2009). Planetary boundaries: exploring the safe operating space for humanity. *Ecology and Society, 14*(2), 32.

Rommel, J., Radtke, J., von Jorck, G., Mey, F., & Yildiz, Ö. (2018). Community renewable energy at a crossroads: a think piece on degrowth, technology, and the democratization of the German energy system. *Journal of Cleaner Production, 197*, 1746–1753.

Sadowski, J., & Bendor, R. (2019). Selling smartness: corporate narratives and the smart city as a sociotechnical imaginary. *Science, Technology, & Human Values, 44*(3), 540–563.

Samerski, S. (2018). Tools for degrowth? Ivan Illich''s critique of technology revisited. *Journal of Cleaner Production, 197*, 1637–1646.

Sap, M., Card, D., Gabriel, S., Choi, Y., & Smith, N. A. (2019). The risk of racial bias in hate speech detection. In *Proceedings of the 57th Annual Meeting of the Association for Computational Linguistics* (pp. 1668-1678).

Schot, J., & Kanger, L. (2018). Deep transitions: emergence, acceleration, stabilization and directionality. *Research Policy, 47*(6), 1045–1059.

Schwartz, R., Dodge, J., Smith, N.A., & Etzioni, O. (2019). Green AI. *ArXiv, abs/1907.10597*.

Silva, V. S., Freitas, A., & Handschuh, S. (2019). On the semantic interpretability of artificial intelligence models. *arXiv preprint arXiv:1907.04105*.

Stanovsky, G., Smith, N. A., & Zettlemoyer, L. (2019). Evaluating gender bias in machine translation. *arXiv preprint arXiv:1906.00591*.

Stiglitz, J. E., Sen, A., & Fitoussi, J.-P. (2010). *Mismeasuring our lives: Why GDP Doesn't add up*. New York: The New Press.

Sung, H., & Phillips, R. G. (2018). Indicators and community well-being: exploring a relational framework. *International Journal of Community Well-Being, 1*(1), 63–79.

Waller, V. (2016). Making knowledge machine-processable: some implications of general semantic search. *Behaviour & Information Technology, 35*(10), 784–795.

Wang, T., Zhao, J., Yatskar, M., Chang, K. W., & Ordonez, V. (2019a). Balanced datasets are not enough: Estimating and mitigating gender bias in deep image representations. In *Proceedings of the IEEE International Conference on Computer Vision* (pp. 5310-5319).

Wang, Y., Plataniotis, K. N., Kwong, S., Leung, H., Yanushkevich, S., Karray, F., ... & Tunstel, E. (2019b). On Autonomous Systems: From Reflexive, Imperative, and Adaptive Intelligence to Autonomous and cognitive Intelligence. *Proceedings of the IEEE ICCI* CC*, 7–12.

Yang, G. Z., Bellingham, J., Dupont, P. E., Fischer, P., Floridi, L., Full, R., et al. (2018). The grand challenges of Science Robotics. *Science Robotics, 3*(14)), eaar7650.

Zevnik, L. (2014). *Critical perspectives in happiness research: The birth of modern happiness*. Springer Science & Business Media.

Zheng, Y., Yu, H., Cui, L., Miao, C., Leung, C., & Yang, Q. (2018). SmartHS: An AI platform for improving government service provision. In *Thirty-Second AAAI Conference on Artificial Intelligence.*