A technological framework for scalable ground-up formation of Circular Societies

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Abstract

The Circular Economy (CE) is regarded as a solution to the environmental crisis. However, mainstream CE measures skirt around challenging the ethos of ever-increasing economic growth, overlooking social impacts and under-representing solutions such as reducing overall consumption. Circular Societies (CS) address these concerns by challenging this ethos. They emphasize ground-up social reorganization, address over-consumption through sufficiency strategies, and highlight the need for considering the complex inter-dependencies between nature, society, and technology on local, regional and global levels. However, no blueprint exists for forming CSs. An initial objective of my thesis is exploring existing social-network ontologies and developing a broadly applicable model for CSs. Since ground-up social reorganization on local, regional, and global levels has compounding effects on network complexities, a technological framework digitizing these inter-dependencies is necessary. Finally, adhering to CS principles of transparency and democratization, a system of trust is necessary to achieve collaborative consensus of the network state.

Keywords

circular societies, ground-up social reorganization, social-network ontologies, digitization, democratization, transparency, network consensus,

1. Foreword

I would like to thank the organizers of the ICT4S Doctoral Symposium for creating this platform, and allowing the participation of prospective doctoral researchers like myself. The following text details the doctoral thesis topic that I have built for myself while doing research in the Emerging Technologies for the Circular Economy research group, under the primary supervision of Dr. Benjamin Leiding. By participating in the symposium, I hope to gain valuable feedback from interactions with other researchers from diverse backgrounds, which would help me to solidify this research direction that I have built as my doctoral dissertation topic.

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2. Background and Motivation

The abundance of cheaply exploitable natural resources and human labor has fueled a global system of production and consumption, which follows a uni-directional pattern of "take, make and dispose"; beginning with material and resource extraction, followed by applying (often non-renewably sourced) energy and human labor, in order to manufacture products that are subsequently sold to consumers, who discard them when they are of no further use [1]. This economic model, popularly known as the Linear Economy (LE), has been the driving force of anthropogenic climate-change and its associated widespread socio-ecological damage.

2.1. Circular Economy

While in the LE, materials are extracted from nature and are used to manufacture products, only to be eventually turned into waste; the model of a Circular Economy (CE) employs strategies such as sharing, leasing, reusing, re-manufacturing and recycling to keep existing materials and manufactured products in use for as long as possible. The CE aims to design a system of production and consumption that eliminates the concept of "waste", by designing products that are optimized for cycles of disassembly and reuse [1]. The goal of this redesign, is to close the loop in the system of "take, make and dispose"; thus reducing material and resource extraction from nature, the creation of waste, and environmental pollution.

In pursuit of similar goals, several governing bodies have adopted this model in recent years. For instance, the EU Commission has drafted a circular economy action plan as one of the main building blocks of the European Green Deal [2].

While the CE is a necessary and important step towards transitioning away from the destructive LE, CE in practice has been cricised in recent research as being insufficient to achieve the transformational change necessary to address the current socio-ecological crisis.

2.2. Criticisms of the Circular Economy

The central cause of the current socio-ecological crisis lies in the unidirectional logic that characterizes global systems of consumption and production today. This logic is fueled by industrialization and the narrative of free-market capitalism, whose primary function is to maximize economic value of natural and human resources that are converted into market commodities [3]. CE measures in practice however, tend to focus on recovery rates, resource efficiency, and waste reduction while overlooking aspects that can challenge this fundamental logic. For instance, while the necessity for radical transformation of the systems of production and consumption has been acknowledged by proponents and stakeholders of CE measures alike, the positive environmental potential of the concept of sufficiency is paradoxically disregarded for being too radical, and is excluded from current CE debates [4]. The concept of sufficiency is tightly linked with sustainability. If human society aims to be sustainable, i.e., satisfying the needs of the present without compromising the needs of future generations, it must also aim to consume enough to ensure universal human social well-being and quality of life, while restricting this consumption within the confines of the Earth's biocapacity [5]. In other words, we must also practice sufficiency.

Another criticism of current CE measures, is that they often also display a lack of consideration towards social sustainability alongside economic and ecological sustainability [6].

While the CE is a necessary step towards addressing the current climate crisis, for a successful transition to a sustainable circular economy that is truly within planetary boundaries, there is also the need for an expansion of unidimensional value definitions to multidimensional and holistic constructs that highlight the importance of sufficiency and reducing resource consumption. The concept of a Circular Society (CS) is such a holistic construct.

2.3. Circular Society

The CS is a holistic version of the CE, in which transition "requires a fundamental reorientation and reorganization of practices and processes in all areas of life — from nutrition mobility and energy use, to work models and housing concepts. This holistic vision, hearkens back to the roots of the CE; "1. to adopt a system perspective that considers the complex ways in which nature, society and technology are interdependently interacting on a local, regional and global level; 2. to aim for closed loops and organize production and consumption practices in circular flows that imitates the "eco-logic" of ecological systems; 3. to create a resilient production and consumption metabolism taking the need for regeneration of natural capital into account" [3]. Unlike modern CE measures, which implemented these concepts only through new business models and technologies, the proponents of CS also call for a "re-valuation of human labor and an enhanced role and conditions for productive work, service provision and do-it-yourself (DIY) activities" [7].

Aiming to challenge and transform the aforementioned unidimensional value definitions, CS focuses on the creation of multidimensional concepts of value creation "that define qualitative and quantitative indicators for social and ecological value creation and which take into account the many forms of work (care work, informal work, community work, DIY) that contribute to societal well-being" [7].

The CS also "aims to establish a participatory, communitarian, solidary and circular consumption and production system" [3], by championing the idea of people as 'embedded' in these complex systems, rather than as passive recipients [7].

Jaeger-Erben et. al [7] formulated some central topics for a "roadmap towards a CS", in which they highlight that unlike modern CE measures, CS concepts must also emphasize the concept of sufficiency through strategies such as "refuse, rethink and reduce". This focus on sufficiency can shift the focus to alternative value definitions that can aim to reduce, if not eliminate over-consumption.

The authors [7] also identify some core prerequisites that need to be fulfilled, in order to foster community, collaboration and solidary practices of a CS. Firstly, *Accessibility and Transparency* are recognized as central prerequisites for participation in the social and economic practices of a CS, meaning access to natural resources as well as education, health services and knowledge of the consumption and production processes is shared rather than monopolized, and "political and economic action is subject to the duty of transparency". Secondly, "*Democratization and Empowerment* should create unconditional opportunities for participation and engagement in political, economic and cultural processes. Participation opportunities are linked with strategies for activation, capability boosting, and empowerment." A focus on encouraging sufficiency

practices is also a key ingredient in achieving a circular society.

3. Research Gap

There is a limit to what an individual alone can accomplish to incorporate sufficiency practices in their life. For instance, as individual computer scientists that recognize the socio-ecological damage associated with the lifecycle of smartphones, we can refuse to buy new smartphones, and rather utilize our expertise by repurposing electronics that we already possess, and build our own software alternatives to fit our daily needs. However, at least for me personally, the expertise ends here; since I would be unable to repair or build custom hardware components to sustain such a device forever. At a certain point, the lack of expertise of a single individual would be a barrier preventing them from pushing this practice further. Thankfully, for this specific scenario, the concept of a Hackerspace [8] is already quite popular. A Hackerspace is a collaborative workspace for people to work on projects while sharing tools and knowledge to realize projects. Generalizing, in order to break such barriers, individuals would need to collaborate and work together in order to practice sufficiency strategies that they could not have achieved on their own. Put together, several individuals can form a collaborative environment that collectively finds creative solutions to sustainability challenges; a circular society.

A similar analogy can be made on a slightly more macro scale: individual local CS might also have similar limitations that they can only overcome by networking with other CSs. Working inductively, there needs to be perpetual scaling-up/networking of CSs, to actualize the goal of a socially and environmentally sustainable global circular society.

Jaeger-Erben et. al. [3] recognize that "fertile ground" needs to exist for these innovative practices to be ubiquitous. Such a fertile ground needs to be capable of networking individuals together to facilitate these practices. There is however, no "blueprint" for the creation and organization of CSs.

As mentioned in Section 2.3, general guiding principles for CSs exist. However, the idea of CSs is still relatively new, and there are already several examples of the principles of the CS being put into practice, e.g., the Free and Open Source Software (FOSS) movement [9], solidarity economics [10], micro-energy cooperatives [11], eco-villages and co-housing projects [12]. Exploring the commonalities and differences between such societies, is a necessary step in understanding how to replicate the fertile ground that facilitates their operation.

Also, the perpetual scaling-up/networking of new and existing societies towards the goal of a global CS would require a generic framework that works on an individual, societal and macro-societal level, and that can streamline the formation and continuous operation of these CSs: the so-called fertile ground. Since this networking will exponentially increase in complexity, tracking the various interdependencies between individuals, society, nature and technology, in an analog manner would be infeasible. Hence, this would require this network of interdependencies to be digitized, calling for a technological framework (at least) consisting of:

1. An ontology (consisting of individuals, society, nature, technology, and their various relations), that is broadly applicable to, and serves as a means of understanding of the dynamics of collaborative practices within and between CSs, inspired and compatible with

existing concepts such as solidarity economics, eco-villages, collaborative development, etc.

2. A common communication network that allows transparent and democratized inter- and intra- networking of CSs by forming a *decentralized knowledge graph* [13] that adheres to, and is described by the ontology.
3. A system of trust that is able to achieve (decentralized) consensus of the state of this decentralized knowledge graph.

These three building-blocks can satisfy the previously mentioned prerequisites identified by Jaeger-Erben et. al [3], for a fertile ground that can foster the creation of CSs. The democratization in the formation of the *decentralized knowledge graph* would allow for universal engagement in the sufficiency practices followed by the various actors in the network. The *decentralized knowledge graph* being transparent, is also universally accessible, and allows knowledge to be extracted and understood based on the defined ontology, empowering others with blueprints of successful formations of CSs for independent formation. Additionally, the documentation of sufficiency practices, could also allow for their evaluation in terms of positive environmental impact.

4. Research Questions

The main goal of my thesis is to fill the gap in the existing research identified in Section 3. To this end, I define the main research question for my thesis as follows:

RQ: How to create a technological framework to facilitate the formation and networking of circular societies?

For a more focused exploration of the main research question, I have further sub-divided the main research question into the following:

- **RQ1: How to create an ontology that is broadly applicable to circular societies?**
- **RQ2: How to network circular societies in a transparent, democratized, and decentralized knowledge graph?**
- **RQ3: How to create a system of trust to achieve consensus in the decentralized knowledge graph?**

These sub-questions are suitably phrased in order to collectively answer the main research question.

In order to answer each of these questions, a preliminary research direction of my thesis would be to do systematic literature review into various subjects, including but not limited to: existing ontologies of social networks and frameworks for their development such as OWL (the Web Ontology Language) [14], decentralized knowledge graphs, technologies supporting decentralized autonomous organizations [15] (including non-blockchain [16] related solutions), and decentralized consensus mechanisms [17].

Secondary research directions of my thesis will also include exploring methods of evaluating sufficiency practices for their positive environmental impact using this technological framework.

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