Digital Infrastructures for Governance of Circular Economy: A Research Agenda

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Abstract: Circular economy and sustainability are high on the political agendas of governments. Governments, but also other actors like banks, insurance companies, and auditing firms play a key role in setting (regulatory) requirements, instruments and incentives, as well as monitoring mechanisms to stimulate and monitor CE activities. Governance of CE for ensuring that CE regulation and instruments are properly implemented is key, however, lack of visibility in CE flows poses a major challenge. Digital infrastructure innovations hold potential to provide visibility into the CE flows. However, so far, in the IS and eGovernment research, there is very limited research on how digital infrastructure innovations can enable and support CE governance. In this paper, therefore, we provide a framework and outline a research agenda on that topic.

1. Introduction

Our society is facing big challenges today of how to combat climate change and move towards a sustainable way of living and circular economy (CE). Circular economy can be defined as "an industrial system that is restorative and regenerative by design. It rests on three main principles: preserving and enhancing natural capital, optimizing resource yields, and fostering system effectiveness" (MacArthur, 2016, p. 32). At an international level, developments such as the Paris

agreement have put these issues as high priority on the political agenda. In the EU, the ambitious Green Deal of the European Commission sets the targets for Europe to move to circular and climate neutral economy by 2050. Governments, but also banks providing green loans play a key role in developing instruments to stimulate businesses and citizens to move in that direction. For example the European Commission is now introducing new instruments such as the Carbon Border Adjustment Tax that will be imposed on imports of carbon-intensive goods such as steel and cement, with the idea to protect EU industries from cheaper foreign goods from countries where no carbon taxes are in place. These instruments will only be effective if proper monitoring mechanisms are in place to reduce adverse effects. Governance of CE, for ensuring that instruments and measures that are put in place to stimulate CE, coupled with the appropriate monitoring measures is key for achieving the transition towards CE. Governance can be broadly defined as all processes of governing, whether undertaken by a government, market, or network, whether over an entire system, formal or informal organizations, or individuals part of such a system, and whether through laws, power, contracts, norms, language (adjusted from Bevir, 2012, p. 1). In our context, we will limit that definition to the context of CE. In our understanding governance applies to governments, but also other actors such as banks, insurance companies, and auditing firms, which have a keen interest in CE. Governance of CE is very challenging due to the lack of visibility in the CE flows. While digital technologies hold great potential for enhancing visibility, the area of CE governance and the role of digital technologies to enable that is an area that is largely unexplored in the Information Systems (IS) and eGovernment research and this is an area which we set to explore.

2. CE in IS and eGovernment research

While digital technologies hold great potential to support CE, this is still an area that has not received much attention in the IS community. To address this gap a recent paper published in one of the top IS journals (Zeiss et al., 2020) called for mobilizing IS scholars for CE. Still, in this call limited attention is paid to the role of IS and digital technologies to support CE governance. Similarly, the topic has also received very limited attention in the eGovernment literature. When conducting a SCOPUS search on publications (including journals and conferences) with Circular economy (in title, abstract, keywords) and Government (in source title) we identified only 22 papers, majority appearing in proceedings of the International Conference on E-Business and E-Government, ICEE in 2010 and 2011). After that there appear to be limited follow-up research on circular economy in conferences or journals containing government in their title. We do see a growing interest in the eGovernment community on the broader topic of sustainability (e.g. in D.go2021 a dedicated track on Digital Government and Sustainable Development Goals), however this is still on a broad range of topics and not specifically directed towards CE and CE governance. While we do acknowledge that our literature search is limited, it does indicate a gap in the existing IS and eGovernment literature on CE goevrnance and how IS and digital innovations can support it.

3. Foundations for understanding CE governance

3.1. Understanding CE system

For understanding CE governance, it is crucial to make the CE flows explicit. The Circular Economy Systems Diagram[1] of the Ellen MacArthur Foundation, which is widely used in research and practice, provides a solid base to make the CE flows explicit. The model contains two loops. One focusing on finite materials and one on renewables. It allows to trace how materials and renewables are used in the processes of parts manufacturing, product manufacturing, and service provisioning with the goal to minimize waste. This is done by stock management of the finite material flows, which can be via prolonged use to refurbishment and recycling, and management of the renewable flows ensuring an environmentally-friendly return of the flows to the environment. This model can help actors to better understand which part of the process they are focusing on. Let's take export of plastics from the Netherlands to a third country outside of the EU. This would relate to the part of the model that refers to reuse and recycling. In practice, the CE flow of plastics is part of international supply chains where many borders are crossed. The crossing of borders is a key step where government authorities (in our example customs, as well as the Human, Environment and Transport Inspectorate) play a key role in monitoring the CE flows. Such cross-border aspects, however, are not captured explicitly in the CE model and need to be made explicit when discussing governance of CE. To be able to better monitor the CE flows and ensure that the CE instruments that are put in place (such as subsidies, taxes and penalties) are applied correctly, government authorities need to have access to information and obtain more visibility on the (cross-border) CE flows. However, looking at some recent scandals with export of plastics it becomes evident that it is very hard for the authorities in the country of export to monitor what actually happens with this plastic when it enters the third country and whether it is indeed used for recycling as stated on export documents, or disposed as waste. Next to the border crossing, there is another aspect, i.e. the aspect of visibility and the use of digital innovations to enable visibility of CE flows. The visibility aspect is not captured in the CE model but is crucial for the governance of CE flows.

3.2. Digital trade infrastructures as potential enablers for CE governance

Digital innovations (digital infrastructures and platforms, internet-of-things, physical internet, blockchain) have a great potential to create visibility. However, for CE governance we need to get a visibility and understanding of CE flows that cross international supply chains and how governments and other agencies can use such visibility for CE governance. To understand these aspects we draw upon a stream of research from the international trade domain, namely research

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[1] See https://www.ellenmacarthurfoundation.org/circular-economy/concept/infographic (last visited 27-5-2021)

on digital trade infrastructures (Rukanova et al., 2018)[2]. The research on digital trade infrastructures has been developed in a series of EU-funded innovation projects (ITAIDE, INTEGRITY, CASSANDRA, CORE, PROFILE and PEN-CP), a key example being the so-called data pipeline concept (Klievink et al., 2012, Hesketh, 2010). The ideas have been further extended to focus on voluntary business-government information sharing (Rukanova et al., 2020), big data analytics (Rukanova et al., 2021a), as well as on the use of blockchain-enabled data pipelines (Tan et al., 2019). The idea of the data pipeline can be metaphorically seen as a sort of "internet for logistics" which enables supply chain visibility. The data pipeline concept includes a physical layer where the goods travel; an organizational layer, capturing key actors like the sellers and the buyer. Understanding this network of actors is very important for customs as knowing who the real buyer and seller of the goods are forms a key part of the customs risk analysis. Next, there is an information layer. The data is captured at the source where the data is produced. Via the data pipeline, parties that hold specific data (e.g. invoice) can, on voluntary basis, grant access to that data to other businesses or government authorities. Finally, the data pipeline concept also explicitly includes the authorities, indicating that different authorities of different countries or regions can set rules and supervise the flows of goods on their territory. Some blockchain-enabled data pipeline solutions such as TradeLens have already been commercialized on a global scale. The traditional data pipeline concept takes as a starting point the seller and the buyer and related visibility. For CE purposes, the data pipeline concept needs to be extended to capture CE flows such as production, recycling and re-use and at the border (Rukanova et al., 2021b). Further elaboration of how such extensions can be done is lacking. Furthermore, the focus on using the data pipeline so far has been limited only to monitoring and control by government. This provided a limited view on CE governance. In this paper we broaden this view to other actors and other functions than monitoring.

3.3. CE Governance

In the introduction we started with a broader definition of governance (Bevir, 2012) and we limited our focus on CE. The definition that we use is broad and allows both government authorities, businesses and other actors to take part in governance. For our further understanding we will first focus on the role of government and we will then broaden to other actors. Maciejewski (2017) distinguishes among three functions of government, namely: "(1) Public supervision – identifying irregularities (e.g. legal incompliance) and taking responsive action. (2) Public regulation – regulating social conduct and shaping social relations by means of permits, prohibitions or orders. (3) Public service delivery – providing certain services or products" (Maciejewski , 2017, p. 124). We use these functions to define CE governance more precisely. We use these in a broad sense, to include government, but also other actors, such as banks, insurance companies, and auditing firms. This is feasible, as e.g., while governments are introducing CE regulation and instruments to stimulate plastic recycling and re-use, banks are introducing CE regulation and instruments regarding green loans for plastic, and auditing firms are auditing the more and more looking into the corporate social

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responsibility aspects. Second, when discussing CE governance, we are interested not only in the monitoring, but in all three aspects, namely: (1) regulation including instruments for CE, (2) supervision, including monitoring of CE activities, (3) CE service delivery. This last can be seen as CE services that can be provided to businesses and citizen (e.g. assurances about CE flows).

4. A Framework for understanding of digital infrastructures for governance of CE

Figure 1 presents a framework for understanding digital infrastructures for governance of CE. We distinguish three levels: (1) CE system which would allow to make the CE flows explicit; (2) Digital infrastructures for CE visibility: here we use the extended data pipeline concept (Rukanova et al., 2021b) which includes also aspects such as extended visibility on (2a) production; (2b) re-use/recycling; (2c) at the border; (3) CE governance: inspired by Maciejewski (2017) our framework explicitly includes three aspects of CE governance: (c1) Regulation (instruments- incentives and taxes), (c2) Monitoring (by authorities, banks, auditors) and (c3) Service delivery.

For the visibility to the production process a key question is what information can be of value for CE governance. Possible directions to consider would include information on raw materials and how these raw materials were obtained, information on ingredients, parts used in manufacturing and product manufacturing itself. This entails that the information and the stakeholder network connected to the data pipelines need to move upstream and include information on suppliers of parts and raw materials. This requires capturing new type of information on the production process such as information on bill-of-materials, (blending) methods used, types of farming (e.g. intensive vs. extensive) and harvesting, product recipes, etc. For visibility in re-use/recycling, it would require a deep understanding of actors and information requirements. These will be new actors that collect, repair, or re-use products at the end of the lifecycle. Visibility related to earlier phases such as production and use are crucial for the re-use stage both for the businesses that are involved in the reuse and recycle processes, as well as for other parties like governments, banks, insurers and auditors responsible for compliance monitoring of these flows. Of particular interest for governance of CE is also information on secondary raw materials that are result from the recycling processes. A third way to improve visibility is to improve visibility of the CE flows at the border. Aspects of this increased visibility may include data on sustainable certificates (e.g. UTZ cocoa, FSC timber, MSC fish), digital product passport, chemical composition etc. At the same time, at the borders, increasingly sophisticated technologies are available at the disposal of governments (such as novel scanning and detection technologies that can detect the chemical composition of goods, lab equipment etc.). These technologies offer opportunities to compare the physical and document flows and identify mismatches and irregularities. For example governments are now using instruments to stimulate CE products via the classification system of goods descriptions (HS codes).

In practice, current developments in digital infrastructures such as blockchain-based platforms like TradeLens for container shipping, FoodTrust for food visibility and Vinturas for second-hand cars are setting steps towards supply chain visibility. However, these do not, or only to a limited extent, address the issue of CE governance. Taking the CE view from our framework reveals that

TradeLens covers container level visibility and visibility of documents (e.g. invoice, Bill-of-Lading) and events (e.g. container loaded). But TradeLens does not cover the production processes, neither what happens with the product after it is delivered to the buyer.

Figure 1: A Framework for understanding the governance of CE enabled by digital infrastructures
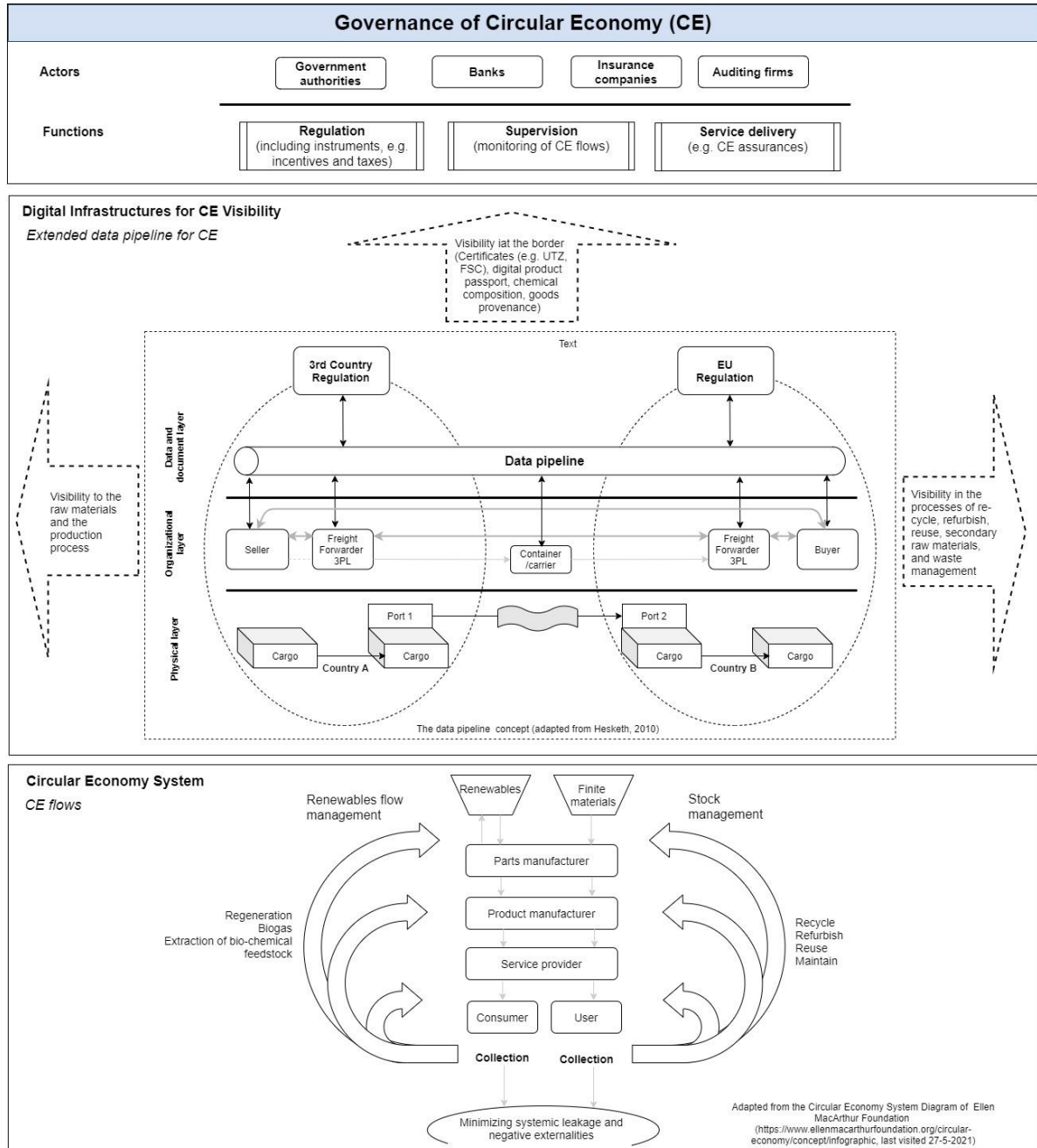
Other platforms such as FoodTrust for food traceability and Vinturas for second hand cars do cover item-level tracking but also have a limited CE focus and limited interactions with authorities. These, blockchain-based, but also other industry-driven initiatives such as One Record of IATA could provide a good starting point for extending the visibility in the directions needed for CE governance. Based on the discussion so far, we derive several broad research questions/themes that can advance the understanding of digital infrastructures for governance of CE.

Digital Infrastructures for Circular Economy Governance
(I) What are potential data sources that can be used to extend digital trade infrastructures to include CE aspects to support CE governance? This could include data sources to help to create: (1) Visibility on the production processes (e.g. through bill-of-material, product recipes); (2) Visibility on re-use/recycling (e.g. goods provenance, visibility on secondary raw materials for recycling/ re-use); (3) Visibility at the border (e.g. digital product passports; data from detection technology and lab equipment that can perform real-time analysis of chemical composition of materials at the border). The exploration of these data sources can include but is not limited to business supply chain or production data, data from platforms (eCommerce platforms, other platforms), open (government) data, geo-special data, data from sensors and devices.
(II) What is the role of new technology for CE governance? The role of technologies such as blockchain technologies for immutability of data, Internet of Things (IoT) and Physical Internet (PI), data analytics and artificial intelligence (AI), as well as standards (such as chain-of-custody) in enabling cradle-to-cradle visibility can be examined.
(III) How can digital infrastructures for CE visibility support CE governance? Topics for further research can focus on: (1) How can CE visibility be used by governments, banks, insurance companies, auditing firms to set new CE instruments and (regulatory) requirements or to redesign current CE instruments? (2) How can government, banks, insurance companies and auditing firms use CE visibility offered by digital infrastructures to monitor, audit and account CE supply chains? (3) How can this enhanced CE visibility be used by government, banks, auditing firms to enhance service delivery (e.g. offering CE assurances to consumers)?

5. Conclusions

The transition to CE heavily depends on CE governance performed by actors such as governments, banks, insurance companies and auditing firms. In this paper we propose a framework and outline a research agenda on digital trade infrastructures for CE governance. This paper can be seen as a response to the call for mobilizing IS researchers for CE, where our specific focus is on CE governance and how digital infrastructures can support that.

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