Opportunities for the Circular Economy in Smart Cities: The Role of Digital Technology

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ABSTRACT

Our current global economy is based on the linear flow of material and energy at a speed faster than earth can regenerate its services. A logical answer is reversing this into a circular economy, implemented through Circular Business Models (CBM). While cities count for the majority of current and future inhabitants, consumption and negative externalities people presume the CE should play an important role in coping with its challenges. To maintain urban livability, there is another emerging city strategy. That is to integrate technology in the urban domain and make a city “smart.” This development questions how digitization can also leverage CBM in the smart city area. However, little research is known on this topic. This article therefore studies the relationship between the circular economy and a circular smart city by exploring digital technology as a common variable. The authors first conceptualize the possibilities to enhance CBM by digital technology and then apply concept mapping to determine if and which CBM have greatest possibility to flourish in a circular smart city context.

KEYWORDS

Circular Business Models, Circular City, Circular Economy, Digital Technology, Smart City

INTRODUCTION

A major issue in our current global system is the linear flow of material and energy between nature and human economy (Korhonen et al., 2018a) at a speed faster than earth can regenerate its services. The subsequent depletion of our natural resources will be worsened by the significant growth of world population and people moving to cities (https://www.unfpa.org/migration). This migration will improve the lives of many to middle class standards synchronously causing an increase in the per capita consumption. Subsequently earth is reaching it planetary boundaries (Broman and Robert, 2017) and the global natural eco-system is becoming smaller (Korhonen et al., 2018a; Broman and Robert, 2017) in seize and volume. A logical answer to this challenge is reversing the linear model: a circular economy (CE) matching the ecosystem service cycles (Korhonen, 2018a). The CE is implemented through Circular Business Models (CBM).
We observe an enormous increase in circular initiatives but reviewing the literature on this topic also reveals several challenges. A 2018 report released in Davos during the World Economic Forum (Wit et al., 2018) stated that only 9% of the economy can be classified as circular. Most of the circular economy (CE) initiatives are small scale, non-complex projects often only in conjunction with a company’s suppliers. Many companies that are publicly categorized as circular, only implement several elements of the CE (Jonker, 2016b). The sharing platform-economy, such as Uber and AirBnb, highlight several positive attributes of the circular economy such as using over-capacity, but they tend to push out their negative side effects from their value proposition thereby not creating multiple positive value streams (Jonker, 2016a). Nußholz (2017) mentions that it isn’t clear how the CBM actually differ from LBM and Korhonen (2018b) even classifies the CE as essentially contested. The theoretical foundations on sustainable and circular business models have not been established yet.

From the transition to this new economic paradigm we can make several observations. Urban migration makes us realise that cities are now already responsible for the majority of consumption and it is clear that they must play an important role in sustainable development (Al-Nasrawi et al, 2015; Goonetilleke et al., 2014). The relevance of the CE in this city context is already acknowledged as particularly relevant (Sukhdev et al., 2017). It positions the city area as an interesting starting place for realizing the CE and sustainable development beyond small scale initiatives. Specifically, within the development of cities we see an emerging strategy to integrate technology in the urban domain and make a city “smart” in order to mitigate urban problems (Chourabi et al., 2012;). This suggests the enabling role of digital technology within the city and circular economy context (EMF, 2017). However, little research is known on the relationship between CE and digital technology (Pagoropoulos et al., 2017; Planning, 2015) and there is no research known examining the role of city technology as a strategic option for implementing CBM. These observations make the following research questions relevant:

- How can digital technology be integrated in CBM?
- How can smart city development leverage the implementation of CBM?
- Which CBM have the highest potential for success in a smart city context?

This article is structured as follows. In section 2 we highlight the current insights in the circular economy (section 2.1), circular business models (section 2.2), transformation aspects to the CE (section 2.3), integration of digital technology in CBM (2.4). In section 2.5 we describe the smart city (2.5.1) and circular city (2.5.2) and circular smart cities. Our research methodology is described in section 3. In section 4 we present our findings by first deriving the architecture designs for the circular smart city and digital CBM in section 4.2. The results of mapping these concepts is described section 4.2. In section 5 we will present our conclusions and discussion including a description of the impact to the smart city and circular economy domains. The section we be closed by our suggestions for further research. A schematic overview of the main steps is presented in Figure 1.

THE CIRCULAR ECONOMY AND SMART CITIES

In this section we discuss several aspects of the CE and the essence of the smart city. The CE concept has its origin in several scientific research streams such as industrial ecology, industrial ecosystems, cleaner production, product-service systems (Korhonen, 2018a; Nußholz, 2017; Urbinati et al., 2017; Lewandowski, 2016). However, the link from these scientific contributions to the CE concept is unclear, difficult to comprehend and there is hardly any scientific research on this link (Korhonen, 2018a).
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