Available online at www.sciencedirect.com

ScienceDirect

Procedia CIRP 64 (2017) 49 – 54

www.elsevier.com/locate/procedia

The 9th CIRP IPSS Conference: Circular Perspectives on Product/Service-Systems

Supporting circular economy through use-based business models: the washing machines case

Maria Grazia Gnoni[a], Giorgio Mossa[b], Giovanni Mummolo[b], Fabiana Tornese[a]*, Rossella Verriello[b]

[a]*Department of Innovation Engineering, University of Salento, Campus Ecotekne, Via per Monteroni, 73100 Lecce, Italy*
[b]*Department of Mechanics, Mathematics and Management, Polytechnic of Bari, Viale Japigia 182, 70126 Bari, Italy*

* Corresponding author. Tel.: +39-3298471817. *E-mail address:* fabiana.tornese@unisalento.it

Abstract

The circular economy paradigm is being widely studied as a possible path to a sustainable development, decoupling economic growth from material consumption and environmental impacts. The introduction of new business models, based on use rather than ownership, has been identified as one of the possible enabling actions for the implementation of circular economy strategies. Thus, product-service systems (PSS) can represent a viable way for companies and customers to switch from a linear to a circular scheme, keeping together the advantages of a customer-oriented offer to those of dematerialization. In this work, an example of innovative, circular business model for the large appliances sector is proposed, based on a PSS and a closed-loop supply chain. A context study, supported by a deep literature analysis, is performed to identify the main changes involved in the transition from a traditional to a circular supply chain in the sector, as well as the main impacts on the actors involved, through causal loop diagrams. The study is a first step for the realization of a system dynamics model, for a further research on impact assessment.

Peer-review under responsibility of the scientific committee of the 9th CIRP IPSS Conference: Circular Perspectives on Product/Service-Systems.

Keywords: Circular economy; PSS; closed-loop; impacts evaluation; supply chain.

1. Introduction

The increasing environmental burden related to economic growth has been pushing institutions and governments worldwide to seek for more sustainable economic models. In this context, increasing attention is being given from both academics and businesses to the circular economy (CE) paradigm, which has been defined as a way to decouple economic growth and environmental burden [1]. Unlike linear systems, CE models are based on resource conservation and material flows valorisation through reuse, recovery and recycling, but the path towards the implementation of a CE is still long [2], [3].

Business model innovation has been widely recognized as one of the levers that can effectively support a transition towards the CE [2]–[4]. In particular, business models based on refurbishment and product life extension have been already tested in the electronic and electric equipment (EEE) sector [2], [5], which is crucial both for the volume of e-waste generated annually [6] and for the composition of end-of-life products, which contain high value materials, as well as hazardous substances [7].

This work is an attempt to evaluate the potential impacts and benefits of CE tools, in particular combining business model innovation through product-service systems (PSS) and closed-loop schemes, on the EEE sector on a supply chain (SC) level, identifying the main actors involved and the challenges related to such a strategy.

2. Literature review

The scientific interest about the Circular Economy paradigm has been growing in the last decades, several applications have been studied, some more successful than

Peer-review under responsibility of the scientific committee of the 9th CIRP IPSS Conference: Circular Perspectives on Product/Service-Systems.
doi:10.1016/j.procir.2017.03.018

others, and some barriers and challenges have been identified [8]. In this section, the role of closed-loop schemes and PSS business model as enabling actions for the implementation of CE has been investigated.

2.1. Closed-loop towards CE

A recent review on reverse logistics and closed-loop (CL) systems outlines the need for integration of environmental objectives in the design and assessment of closed-loop models [9].

On a strategic level, the role of closed-loop production systems in the realization of both economic and environmental goals is underlined by Winkler [10], who stresses in particular the potential of sustainable supply chain networks (SSCN) in the transition to a CE. The author underlines the importance of realizing closed-loops at a supply chain level, as single companies cannot implement effective closed systems on their own. Similarly, Sheehan et al. [11] explore the role of closed material loops for the implementation of CE, analysing material waste forms and their interdependencies. From this study, a causal-loop diagram is derived for future analysis through system dynamics simulation, as a tool to support decision-making in waste minimization. Jawahir and Bradley [12] outline the lack of technological elements to implement CE strategies, and propose the framework of sustainable manufacturing as a starting point to realize closed-loop systems based on the 6-Rs (reduce, reuse, recycle, recover, redesign, remanufacture). De los Rios and Charnely [13] focus on the transformation needed in production and consumption systems to implement CE, analysing the role of design in the transition towards closed-loop systems. Starting from some multinational enterprises case studies, they provide a list of capabilities required and some guidelines for companies for a successful implementation of circular systems.

A few case studies on specific sectors have also been analysed in the last years. Reuter [14] highlights the importance of the metallurgic sector for CE, underlining the necessity of exploring new business models to realize effective closed-loop systems. Accorsi et al. [15] focus on the design of a closed-loop network in the furniture industry, considering economic and environmental optimization functions in a mixed-integer linear programming model, and including all the actors of the supply chain, from raw materials suppliers to recyclers and disposal centers. The authors aim at providing some guidelines to practitioners for the transition to a CE scenario. Niero and Olsen [16] compare the environmental impacts of a closed loop versus a traditional recycling strategy for aluminium cans through LCA, elaborating some recommendations to improve the environmental performance of this sector towards the implementation of CE strategies. On the same case study, Niero et al. [17] explore and compare the efficacy of the Life Cycle Assessment (LCA) methodology and the Cradle-to-Cradle (C2C) certification in supporting the implementation of CE strategies, identifying both their benefits and challenges. Richter and Koppejan [18] analyse the application of the Extended Producer Responsibility (EPR) as a tool to support eco-design and closed-loop for gas discharge lamps, in a CE perspective. Their study reveals best practices in the sector in the Nordic countries, and identifies some key challenges for the implementation of EPR strategies. Sinha et al. [19] propose a system dynamics simulation model to explore the main paths and drivers for closing material flow loops in the global mobile phone product system. They identified four main drivers that could possibly support the transition to circular economy closed-loop systems: (i) improving collection systems, (ii) longer mobile phone use time, (iii) improved informal recycling in developing countries and (iv) shorter mobile phone hibernation time. Finally, Silva et al. [20] describe three case studies of policy support to sustainable waste management (San Francisco area, Flanders and Japan), comparing the policy directions observed and suggesting some further developments in policy, planning and behaviour change to realize effective closed-loop systems.

2.2. PSS towards CE

Focusing on the potential of PSS to support CE strategies, in his recent review about PSS Tukker underlines the high potential of this business model in the journey towards CE [21]. However, he also points out that PSS are not by definition more resource efficient and sustainable than the sole product: it is necessary to evaluate the sustainability of such systems since the design phase, to ensure their economic, environmental and social viability. Moreover, some main barriers in the diffusion of PSS (such as the consumer's need to keep control over the product) were identified. Lewandowski [22] provides an overview of different possible circular business models, including PSS, contributing to the definition of a framework for supporting companies in the business model design phase. Catulli and Dodourova [23] explore the challenges related to the adoption of PSS, as well as the benefits entailed, underlining the necessity of an innovation-oriented approach for businesses, institutions and policy makers. They identify cooperation as one of the keys to a successful PSS business model.

Some examples of CE-oriented PSS are also provided in literature. Iung and Levrat [24] describe and analyse the role of maintenance in PSS offers as a way to guarantee service continuity towards circular economy paths. Johansson et al. [25] describe the PSS business model for the urban mining segment, as a path towards circularity, defining the key topics to address and a set of guidelines to follow when developing the business model. Lelah et al. [26] discuss the use of a machine-to-machine PSS solution in glass waste collection for recycling, analyzing its main environmental impacts and benefits through LCA. Moreno et al. [5] present two case studies of circular-oriented PSS applied in the large household appliances sector, displaying the results of a workshop aiming at identifying the main barriers, drivers and benefits related. Finally, Pialot et al. [27] explore the concept of upgradability as a way to contrast product obsolescence, combining it with the PSS business model. In the so called "Upgradable PSS", optimized maintenance, refurbishment and offer servitization can open new perspectives for businesses and customers,