

CIRCULAR ECONOMY AND PRODUCT-SERVICE SYSTEMS IN CUSTOMER PERSPECTIVE: A SYSTEMATIC LITERATURE REVIEW

Nursery Alfaridi S. Nasution¹, Viany Utami Tjhin²

^{1,2}Management Department, BINUS Business School Doctor of Research in Management, Bina Nusantara University

*Corresponding Author: nursery.snasution@binus.ac.id

Abstract. Circular economy means an economy system of restoration and recycling. On the other hand, product service system is one example of circular business model. The objective of this study is to elaborate more about circular economy and product service system, and to examine how customers accept the product system service in order to enhance circular economy. Previous literature did not cover much about customer perspective. This study presents systematic literature review approach, and thematically synthesizes the findings of 70 articles. This study reveals that circular economy is defined well, and customers are willing to use the product service systems in order to enhance the circular economy. Finally, we suggest the future research direction.

Keywords: *circular economy, product service system, customer perspective, customer acceptance, systematic literature review.*

Introduction

The use of disposable products without recycling, usually called as linear economy, often becomes a bad scourge for the environment. Linear economy means we make the products, we use them, and we throw them away (Fernandes, Pigosso, McAloone, & Rozenfeld, 2020; Halstenberg & Stark, 2019; MacArthur, 2015; Reike, Vermeulen, & Witjes, 2018). Afterwards, the goods will end up in the landfills and some of them are in the ocean. Circular economy is more substantial term rather than sustainability. Sustainability describe how we can achieve circular economy (Geissdoerfer, Savaget, Bocken, & Hultink, 2017). The study on circular economy is established on macro level (country, region, or city), micro level at the operational on single firms, and at meso level at the implementation on industrial symbiosis (Lieder, Asif, Rashid, Mihelič, & Kotnik, 2018).

The most cited article on product service systems is (Mont, 2002) and he described product service system as: “a system of products, services, supporting networks and infrastructure designed to be competitive, to fulfil customers’ needs and to have a lower environmental impact than traditional business models.”

By reviewing 70 articles, this study provides comprehensive insight in circular economy and product service systems in customer perspective. It explores the definition of circular economy and product service systems and explain how the customer accept product service system in order to accelerate circular economy. Thus, the research questions are as follows:

RQ1: What is circular economy?

RQ2: What is product service system?

RQ3: How customer accept the product service system in order to enhance the circular economy?

Finally, we suggest the future research direction for product service systems and circular economy.

Method

A systematic approach was applied in this study, we used Sciencedirect database to find the relevant articles, and the following keywords were used for article searching *circular economy*, *product service system*, and *customer*. Table 1 shows the searching criteria for this finding. The first attempt we found 328 articles. After limiting the search in review and research articles the finding was brought down to 323 articles. In order to make the review more reliable, we considered the main journals with the highest impact on Scopus—Q1 and Q2—with the greatest number of papers published on circular economy and the search was brought down to 123 articles. Furthermore, for this research, we checked on the title, abstract and keywords afterwards, and managed to read them, thus we eliminated irrelevant papers and showed 70 relevant papers from seven journals.

Table 1 Searching and selection of articles from the Web of Science and Scopus databases, 2008 - June 2020.

Criteria for searching and selecting articles	Sciencedirect.com	Descriptions
Searching articles using three keywords	328	"circular economy" AND "product service system" AND "customer"
Selecting documents of only article and review category	324	Documents of article and review category were selected since other categories articles were not peer-reviewed or academic contribution
Selecting only Q1 & Q2 Found 212 articles, 2 can't be downloaded	210	Q1 - Q2 were more reliable
Quick checking of the focus of the articles, including title, abstract and keywords. Attempting to download all the relevant articles and deep review on the selected articles	123	Quick check on the focus of the articles so that we could remove articles which were obviously irrelevant and removing the articles that were not relevant with our findings
Number of articles considered for this study	70	Found the relevant articles for this study

Discussion and Result

This present research, the literature on circular economy and product service system had been started on 2008 to 2020. Before 2006 circular economy was not defined as a field of research (Merli, Preziosi, & Acampora, 2018). Starting from 2008, the growth of publications has increased significantly. The number of publication has been increasing from 2016 onwards, which was in line with Sustainable Development Goals project set in 2015 by United Nations (United Nations, 2015).

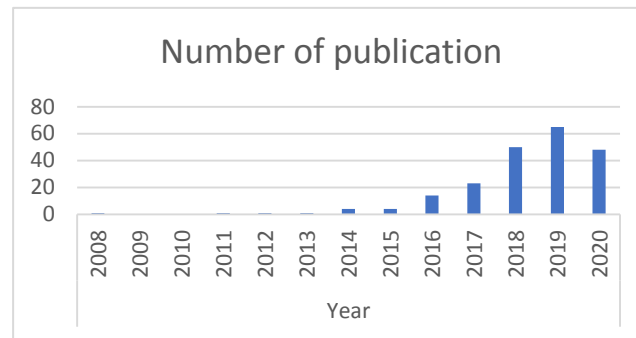


Figure 1 Trend publication overtime, 2008 – June 2020

Table 2 shows the main journals published article about circular economy and product-service systems, those journals were Q1 and Q2 with high impact factor.

Table 2 List of journals that suitable with the research, 2008 – June 2020

Journal Name	No. of Publications
Journal of Cleaner Production	48
Resources, Conservation and Recycling	12
CIRP Annals	1
IFAC-PapersOnLine	2
Procedia Manufacturing	1
Environmental Innovation and Societal Transitions	2
Computers in Industry	3

Circular economy

Circular economy has significant attention from scholar, practitioners, policymakers, and also individuals (Pieroni, McAloone, & Pigosso, 2019). Circular economy has the same meaning with “loop economy” or “cradle to cradle” (Stahel, 2013). The concept of circular economy focuses on redesigning waste to create valuable goods, and replace the concept of linear economy, so that the economy does not eventually generate waste, in other words, circular economy is a system when the resources are being utilized as long as possible (Ackermann, Mugge, & Schoormans, 2018; Muranko, Andrews, Newton, Chaer, & Proudman, 2018; Ranta, Aarikka-Stenroos, Ritala, & Mäkinen, 2018; Sousa-Zomer, Magalhães, Zancul, & Cauchick-Miguel, 2018). Circular economy is believed to help countries to achieve the United Nation Sustainable Development Goals, especially SDG12 which are related to sustainable consumption and production.

Previous study explored circular economy in large incumbent companies such as Unilever, Google, Carlsberg, and Renault, possibly because those are large companies with high influence on their market, and no empirical study carried out circular business model in order to accelerate circular economy in start-up company (Henry, Bauwens, Hekkert, & Kirchherr, 2020). Some of industries are easy to shift to renting or leasing the product, and some are not. Companies need to adopt new business model and more resources are needed, especially for the design (Alix & Zacharewicz, 2012).

(Bocken, Schuit, & Kraaijenhagen, 2018). Experimenting circular business model was done in eight cases companies on their pathway to become sustainable business, and it was found that two companies implemented circular economy concept. Three companies understood the circular economy concept where as one company was aware with the circular economy concept, and two companies were unfamiliar with circular economy concept but wanted to explore it.

Those companies come from different industries, such as: fashion industry, electronics, food, and social. Adopting circular economy or “closed loop” will need the company to innovate the new business model.

The goals of circular economy is eliminating all resources input into and leakage out of the system, and benefiting the economic actors, economy, environment, and society because there will be an environmental improvement (Geissdoerfer et al., 2017).

Therefore, our definitions of circular economy is: *alternative to linear economy where we use our product as long as possible, then recover and regenerate products and materials at the end of service life.*

Product-service system

Product-service systems (PSS), sharing economy and collaborative consumption are the examples of the circular business model (Muranko et al., 2018). PSS is a specific value offered by a company or business to its client. PSS is the combination of tangible and intangible so that the product can fulfill the customer's needs, in other words, product-service system is when the company offers the extended services to customers for enabling closed-loop supply chain (Elzinga, Reike, Negro, & Boon, 2020; Michelin, Moraes, Cunha, Costa, & Ometto, 2017; Song, 2017; Tolio et al., 2017; Tukker, 2015). However, not all product-service system definitions refer to sustainability (Fernandes et al., 2020).

Product service system has the same meaning with these following terms: industrial product-service system; product service combinations; product-to service; servicification; post-mass production paradigm; functional sale and functional product; total care product; and integrated solutions hybrid product; hybrid value bundles; and hybrid value creation (Annarelli, Battistella, & Nonino, 2016)

According to (Mont, 2002; Rousseau, 2020) product-service system is classified into several categories, they are: 1) product, services, or various combination of product and services or substitutions; 2) services at the point of sale; 3) different concept of product use, and divided into two categories, which are use oriented and result oriented ; 4) maintenance services; 5) revalorization services. Meanwhile (Tukker, 2004) divided the product-service system into eight types: product-oriented service (product-related service, and advice and consultancy), use-oriented services (product lease, product renting or sharing, and product pooling) and result-oriented services activity management/outsourcing, pay per service unit and functional result). (Tukker, 2004) found comparing the genuine product and product-service system. Product service system has potential for environmental gains. Product service system consists of various components, they are: hardware; software; services; and products service system heterogeneity. Communication with stakeholder and mix-match the component are the challenges in developing and implementing product-service system.

Thus, it needs a lot more effort in promoting the product-service system because not every customer is aware with the current environmental issue. Campaigning and asking the customers to take their part in saving the environment are the ways to promote the product-service system.

Therefore, our definitions of product service systems is: *the combination of product and service that is environmental friendly in order to fulfill customer needs.*

Customer Acceptance

There is a few research about customer perspective, especially customer behavior, customer acceptance, and customer motivation to participate in circular economy (Elzinga et al., 2020). Meanwhile, there are a lot of research that examine theory of Planned Behavior (TPB), which was proposed by Ajzen in several sectors, but not related to circular economy. The hypothesis is that when these following theories (Theory of Planned Behavior (TPB), Persuasive Communication (PC) and human values) are combined into a framework, they could identify,

change, and maintain the Pro-Circular Behaviors (Muranko et al., 2018). TPB is also used to examine customer acceptance and willingness to participate in circular business models (take-back management, product lease and pay per use (Elzinga et al., 2020; Tukker, 2004), and the result shows customers prefer take-back management over the other two business models (Elzinga et al., 2020), whereas in case of two time remanufactured washing machine, (Lieder et al., 2018) found that the customers are likely to choose pay per use. It is clearly seen that the customers are afraid that when they buy the two-time remanufactured washing machine, they will spend more money to repair it and cost them more rather than they do pay-per-use scenario, hence the cost and effectivity dimension need to take into account. Customers tend to buy a new phone (product with rapid innovation) rather than lease it. They are afraid to take risk for uncertainty, such as privacy and losing the phone (Hobson, Lynch, Lilley, & Smalley, 2018; Rousseau, 2020)

User or customer acceptance is one of the primary barriers in implementing circular economy, the research about circular offering that leads to circular economy in fashion industry done by (Camacho-Otero, Boks, & Pettersen, 2019) and reveals that customer acceptance are triggered by several factors, namely; economic; demographic; and psychosocial. To implement circular business model, companies need to understand the customer point of view and how it changes the customer behavior.

The relationship between the company and their customer plays an important role in how the product-service system should be designed and carried out. Some operating companies have begun to work closely with their customers, and relied on them for all information, including environment. Also, companies often have an early understanding of customer tastes, preferences and their buying behavior. Hence, companies play a critical role in satisfying customer needs, including their environmental dimensions (Mont, 2002), to gain trust, relationship and exchange data information between customer and provider in product-service systems. ICT can be used, so that customer can be assured with the product they purchase (Maleki, Belkadi, & Bernard, 2018; Ness, Xing, Kim, & Jenkins, 2019)

Most of the customers are very satisfied with the product that can be disposed through reuse, remanufacture, and recycle. It will reduce the waste. When the customers buy the product they do not expect that the product will be going through 3R process, hence it is important to know rather customers will accept those scenario and which scenario they prefer. Future research could examine how users will accept the product service-systems because it is important to identify if the customer will accept and adapt their behavior, as well as support the new business model. In addition, it is important to have different marketing approach to enhance the customers environmental knowledge (Atlason, Giacalone, & Parajuly, 2017; Rousseau, 2020) (Schallehn, Seuring, Strähle, & Freise, 2019)

Conclusion

Circular economy was first launched in Europe, and the publication and implementation are mainly in China and Europe, thus, research from different countries and different industries were needed. The same goes for literature on product service system. The number of published papers has been increasing year by year, hence it was progressing well. Future research could examine the circular economy practice from consumer to consumer side for reselling goods.

The motivations in adopting the product service systems are environmental concern, fast innovation of the product and the customers relationship in community (Rousseau, 2020). Successful implementation of circular economy needs internal and external collaboration and integration in multiple organizational function.

The previous research reveals that customers accept the concept of product service systems for household devices (Lieder et al., 2018) and electronics (phone) (Hobson et al., 2018; Raihanian Mashhadi, Vedantam, & Behdad, 2019), medical device (Guzzo, Carvalho, Balkenende, &

Mascarenhas, 2020). Future research could study more about customer perspective in other goods, other industry, so that the circular economy goals can be achieved in all sectors. Study about customer perspective and behavior are needed because knowing what customers need and want are essential since they are the decision makers for making circular economy works. One motivation for customers to repair and maintain their goods is, people tend to keep the expensive goods (than the cheaper one), so they can use it for longer period time (Ackermann et al., 2018), future study should examine more on this aspect.

The study has some limitations that can be used as the future research directions. This study mainly analysed the peer-reviewed paper, future research may consider analyzing white papers and policy papers. This study used only one database because of restricted access, future research may consider searching for the articles on the other reliable database. Future research should aim to more deeply understand the relation between customer acceptance, the responsibility, and payment structure characteristics of circular business models. Based on the evidence found about product service systems and circular economy, there are only few studies about customer perspective, thus, future researchers should do more study about it.

References

- Ackermann, L., Mugge, R., & Schoormans, J. (2018). Consumers' perspective on product care: An exploratory study of motivators, ability factors, and triggers. *Journal of Cleaner Production*, 183, 380–391. <https://doi.org/10.1016/j.jclepro.2018.02.099>
- Alix, T., & Zacharewicz, G. (2012). Product-service systems scenarios simulation based on G-DEVS/HLA: Generalized discrete event specification/high level architecture. *Computers in Industry*, 63(4), 370–378. <https://doi.org/10.1016/j.compind.2012.02.011>
- Annarelli, A., Battistella, C., & Nonino, F. (2016). Product service system: A conceptual framework from a systematic review. *Journal of Cleaner Production*, 139, 1011–1032. <https://doi.org/10.1016/j.jclepro.2016.08.061>
- Atlason, R. S., Giacalone, D., & Parajuly, K. (2017). Product design in the circular economy: Users' perception of end-of-life scenarios for electrical and electronic appliances. *Journal of Cleaner Production*, 168, 1059–1069. <https://doi.org/10.1016/j.jclepro.2017.09.082>
- Bocken, N. M. P., Schuit, C. S. C., & Kraaijenhagen, C. (2018). Experimenting with a circular business model: Lessons from eight cases. *Environmental Innovation and Societal Transitions*, 28(July 2017), 79–95. <https://doi.org/10.1016/j.eist.2018.02.001>
- Camacho-Otero, J., Boks, C., & Pettersen, I. N. (2019). User acceptance and adoption of circular offerings in the fashion sector: Insights from user-generated online reviews. *Journal of Cleaner Production*, 231, 928–939. <https://doi.org/10.1016/j.jclepro.2019.05.162>
- Elzinga, R., Reike, D., Negro, S. O., & Boon, W. P. C. (2020). Consumer acceptance of circular business models. *Journal of Cleaner Production*, 254. <https://doi.org/10.1016/j.jclepro.2020.119988>
- Fernandes, S. da C., Pigosso, D. C. A., McAloone, T. C., & Rozenfeld, H. (2020). Towards product-service system oriented to circular economy: A systematic review of value proposition design approaches. *Journal of Cleaner Production*, 257. <https://doi.org/10.1016/j.jclepro.2020.120507>

- Geissdoerfer, M., Savaget, P., Bocken, N. M. P., & Hultink, E. J. (2017). The Circular Economy – A new sustainability paradigm? *Journal of Cleaner Production*, 143, 757–768. <https://doi.org/10.1016/j.jclepro.2016.12.048>
- Guzzo, D., Carvalho, M. M., Balkenende, R., & Mascarenhas, J. (2020). Circular business models in the medical device industry: paths towards sustainable healthcare. *Resources, Conservation and Recycling*, 160(April), 104904. <https://doi.org/10.1016/j.resconrec.2020.104904>
- Halstenberg, F. A., & Stark, R. (2019). Introducing product service system architectures for realizing circular economy. *Procedia Manufacturing*, 33, 663–670. <https://doi.org/10.1016/j.promfg.2019.04.083>
- Henry, M., Bauwens, T., Hekkert, M., & Kirchherr, J. (2020). A typology of circular start-ups: Analysis of 128 circular business models. *Journal of Cleaner Production*, 245. <https://doi.org/10.1016/j.jclepro.2019.118528>
- Hobson, K., Lynch, N., Lilley, D., & Smalley, G. (2018). Systems of practice and the Circular Economy: Transforming mobile phone product service systems. *Environmental Innovation and Societal Transitions*, 26(April), 147–157. <https://doi.org/10.1016/j.eist.2017.04.002>
- Lieder, M., Asif, F. M. A., Rashid, A., Mihelič, A., & Kotnik, S. (2018). A conjoint analysis of circular economy value propositions for consumers: Using “washing machines in Stockholm” as a case study. *Journal of Cleaner Production*, 172, 264–273. <https://doi.org/10.1016/j.jclepro.2017.10.147>
- MacArthur, E. (2015). Towards a Circular Economy: Business Rationale for an Accelerated Transition. *Ellen MacArthur Foundation (EMF)*, 20.
- Maleki, E., Belkadi, F., & Bernard, A. (2018). Industrial Product-Service System modelling base on Systems Engineering: Application of sensor integration to support smart services. *IFAC-PapersOnLine*, 51(11), 1586–1591. <https://doi.org/10.1016/j.ifacol.2018.08.270>
- Merli, R., Preziosi, M., & Acampora, A. (2018). How do scholars approach the circular economy? A systematic literature review. *Journal of Cleaner Production*, 178, 703–722. <https://doi.org/10.1016/j.jclepro.2017.12.112>
- Michellini, G., Moraes, R. N., Cunha, R. N., Costa, J. M. H., & Ometto, A. R. (2017). From Linear to Circular Economy: PSS Conducting the Transition. *Procedia CIRP*, 64, 2–6. <https://doi.org/10.1016/j.procir.2017.03.012>
- Mont, O. (2002). Clarifying the concept of product–service system. *Journal of Cleaner Production*, 10, 237–245. <https://doi.org/10.1109/ACIIDS.2009.18>
- Muranko, Z., Andrews, D., Newton, E. J., Chaer, I., & Proudman, P. (2018). The Pro-Circular Change Model (P-CCM): Proposing a framework facilitating behavioural change towards a Circular Economy. *Resources, Conservation and Recycling*, 135(February 2017), 132–140. <https://doi.org/10.1016/j.resconrec.2017.12.017>
- Ness, D., Xing, K., Kim, K., & Jenkins, A. (2019). An ICT-enabled Product Service System for Reuse of Building Components. *IFAC-PapersOnLine*, 52(13), 761–766. <https://doi.org/10.1016/j.ifacol.2019.11.207>

- Pieroni, M. P. P., McAloone, T. C., & Pigosso, D. C. A. (2019). Business model innovation for circular economy and sustainability: A review of approaches. *Journal of Cleaner Production*, 215, 198–216. <https://doi.org/10.1016/j.jclepro.2019.01.036>
- Raihanian Mashhadi, A., Vedantam, A., & Behdad, S. (2019). Investigation of consumer's acceptance of product-service-systems: A case study of cell phone leasing. *Resources, Conservation and Recycling*, 143(October 2018), 36–44. <https://doi.org/10.1016/j.resconrec.2018.12.006>
- Ranta, V., Aarikka-Stenroos, L., Ritala, P., & Mäkinen, S. J. (2018). Exploring institutional drivers and barriers of the circular economy: A cross-regional comparison of China, the US, and Europe. *Resources, Conservation and Recycling*, 135(August), 70–82. <https://doi.org/10.1016/j.resconrec.2017.08.017>
- Reike, D., Vermeulen, W. J. V., & Witjes, S. (2018). The circular economy: New or Refurbished as CE 3.0? — Exploring Controversies in the Conceptualization of the Circular Economy through a Focus on History and Resource Value Retention Options. *Resources, Conservation and Recycling*, 135(August), 246–264. <https://doi.org/10.1016/j.resconrec.2017.08.027>
- Rousseau, S. (2020). Millennials' acceptance of product-service systems: Leasing smartphones in Flanders (Belgium). *Journal of Cleaner Production*, 246, 118992. <https://doi.org/10.1016/j.jclepro.2019.118992>
- Schallehn, H., Seuring, S., Strähle, J., & Freise, M. (2019). Customer experience creation for after-use products: A product-service systems-based review. *Journal of Cleaner Production*, 210, 929–944. <https://doi.org/10.1016/j.jclepro.2018.10.292>
- Song, W. (2017). Requirement management for product-service systems: Status review and future trends. *Computers in Industry*, 85, 11–22. <https://doi.org/10.1016/j.compind.2016.11.005>
- Sousa-Zomer, T. T., Magalhães, L., Zancul, E., & Cauchick-Miguel, P. A. (2018). Exploring the challenges for circular business implementation in manufacturing companies: An empirical investigation of a pay-per-use service provider. *Resources, Conservation and Recycling*, 135(August), 3–13. <https://doi.org/10.1016/j.resconrec.2017.10.033>
- Stahel, W. (2013). Circular Economy. Retrieved July 11, 2020, from <https://www.emg-csr.com/circular-economy/>
- Tolio, T., Bernard, A., Colledani, M., Kara, S., Seliger, G., Duflou, J., ... Takata, S. (2017). Design, management and control of demanufacturing and remanufacturing systems. *CIRP Annals - Manufacturing Technology*, 66(2), 585–609. <https://doi.org/10.1016/j.cirp.2017.05.001>
- Tukker, A. (2004). Eight types of product-service system: Eight ways to sustainability? Experiences from suspronet. *Business Strategy and the Environment*, 13(4), 246–260. <https://doi.org/10.1002/bse.414>
- Tukker, A. (2015). Product services for a resource-efficient and circular economy - A review. *Journal of Cleaner Production*, 97, 76–91. <https://doi.org/10.1016/j.jclepro.2013.11.049>
- United Nations. (2015). History. Retrieved from <https://sdgs.un.org/goals>