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Value Creation for Stakeholders: A Comparative Analysis of the Linear and Circular Waste Chain.

LARISSA GUIMARÃES NOGUEIRA
UNIVERSIDADE DE SÃO PAULO (USP)

FLÁVIA BITTENCOURT MORÉ
ESCOLA DE ENGENHARIA DE SÃO CARLOS - EESC

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Abstract

This work investigates if the circular chain provides more value creation for Stakeholders in the context of Solid Waste Management. To this aim, a systematic review was made, following screening criteria to assess the waste management literature and empirical work that could provide evidence of value creation in the linear and circular waste management systems. The steps to this end were first defining the system to identify the flow of materials in the linear and the circular waste management chain. The next step was the stakeholder's classification by role. Finally, the value creation was associated with each stakeholder. The findings showed five different groups of value in the literature related to waste management: economic growth, creation of new businesses and job opportunities, saving materials costs, security of supply, and reduction of pressures and environmental impact. In conclusion, the circular waste management system includes more stakeholders than the linear one and creates more value for them. Moreover, value destruction was identified in the linear waste management system, corroborating the proposition of this study.

Keywords: Solid waste management. Circular waste chain. Value creation.

1. Introduction

Solid waste (SW) is a by-product of human activities. In this way, its generation is inevitable and independent of political regime or social class. Therefore, the accelerated population growth associated with the search for practicality and the high consumption of goods and services culminated in the exponential increase in the generation and disposal of urban SW. Consequently, socio-environmental impacts arose due to the difficulties associated with the correct management of these large volumes of waste. This is a result of a linear SW management system, which is based on the collection of mixed solid waste and its disposal without any kind of treatment or recovery (Ibáñez-Forés, Coutinho-Nóbrega, Bovea, Mello-Silva & Virgolino, 2018).

In opposition to the linear system, the circular economy (CE) introduces the concept of circular chains, and once we connect that concept to SW management research, the circular chain focuses on reducing the number of materials destined for landfills and dumps.

In Brazil, the National Solid Waste Policy (NSWP) of August 2, 2010, presents innovative instruments to the national SW management, such as social control, logistics reverse, shared responsibility, incentives to create cooperatives for recyclable materials, including collectors in selective collection programs and, tax incentives for recycling industries (Santos & Van Elk, 2021). This expansion of the boundaries of responsibility is a remarkable gain, as is the quest to integrate stakeholders.

Furthermore, the circularity of the waste sector presents promising opportunities for resources to be converted into value-added products (Robles, O'Dwyer, & Guo, 2020). In this sense, waste management becomes a significant challenge for society and provides much business potential as waste can be turned into something valuable, for example, energy or new materials (Peltola, Aarikka-Stenroos,Viana, & Makinen, 2016). However, full exploitation of waste resource value requires a transformative waste-value chain, calling for the whole systems analysis and optimization of waste recovery (Robles, O'Dwyer & Guo, 2020). To this end, it is expected that a circular waste system can create value by promoting: economic growth, creating new businesses and job opportunities, saving materials costs, dampening price volatility, and

improving the security of supply while at the same time reducing pressures and environmental impacts (Kalmykova, Sadagopan & Rosado, 2018; Hazen., Russo, Confente, & Pellathy, 2021).

Despite that, researches focused on the interaction between the waste value chain and its stakeholders are still incipient. For this reason, this paper aims to identify the difference between value creation for stakeholders in the linear and circular solid waste chain.

This work is divided into five subsections. In the first one, both waste management circular and linear systems are defined, so each system's stakeholders are identified in the second and third sections. Subsequently, the value creation for those stakeholders is assessed in both systems separately. In the final of this section, a comparison of value creation for stakeholders between both systems is made.

2 Literature review

2.1 Linear and circular SW management system framework

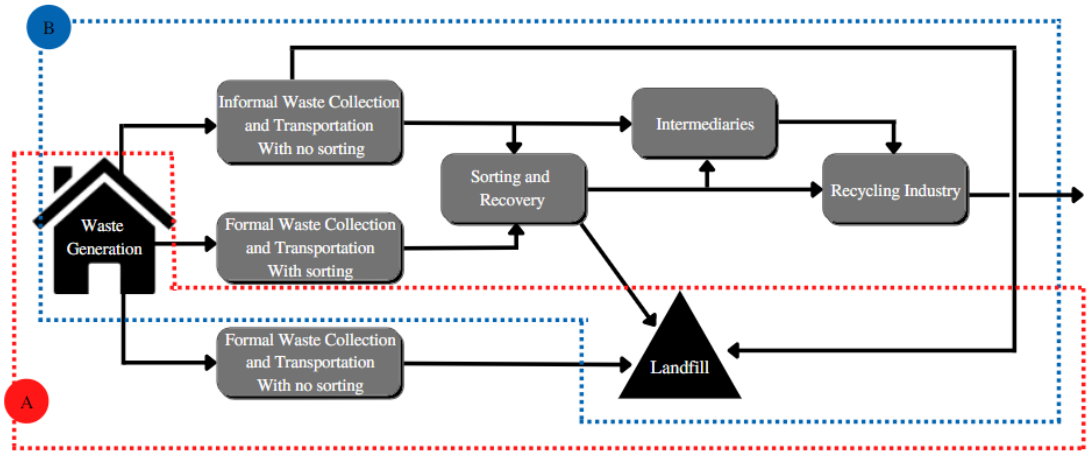
The Overview of Solid Waste in Brazil (2021) states that 60% of residues collected in Brazil in the year 2020 were disposed of in landfills. According to the same report, 40% of the waste ends in dump sites, which is corroborated by Conke and Nascimento (2018) who say that, in Brazil, the selective collection is still incipient in terms of coverage and efficiency. Saying that it can be inferred that the Brazilian SW management system is mainly a linear system. Which can be organized into five organizational functions: waste generation, waste handling at source, collection, transportation, and disposal, as shown in Figure 2 process (A) (Yay, 2015; Poletto, De Mori, Schneider & Zattera, 2016; Omid, Derakhshan, & Mokhtari, 2017; Matinez-Sanchez, Levis, Damgaard, DeCarolis, Barlaz, & Astrup, 2017; Ibáñez Forés et al., 2018; Khan, Anjum, Raza, Bazai, & Ihtisham, 2022).

On the other hand, the circular economy is an alternative to a traditional linear economy (make, use, dispose of). It can be applied to reduce disposal in landfills and increase preparation for the reuse and recycling of key waste streams, such as municipal waste and packaging waste, and the improvement of extended producer responsibility schemes (Kalmykova et al., 2018).

As its prerogative, the circular economy has the integration of stakeholders to set up an inter-organizational, interrelated, and interdependent system. Based on this assumption, the circular chain seeks to integrate the actors to keep the waste in the chain, generating value and reducing externalities (Kraaijenhagen, Van Oppen & Bocken, 2016; Kalmykovaa et al., 2018). Therefore, are considered stakeholders: local authorities, provincial and national governments, formal private waste collection companies (large-scale enterprises and registered small-scale enterprises), business associations, compost and bio-gas facility operators, farmers, waste-pickers, informal waste collectors and buyers, materials dealers, recyclers, service users (residents, commercial establishments, and others), NGOs, CBOS, religious institutions, universities, banks, and others.

These stakeholders usually have different interests (economic, political influence, social status, and others.) and play different roles (Klundert, 2000; Associação Brasileira de Empresas de Limpeza Pública Especiais [ABRELPE], n.d.; Conke e Nascimento, 2018; Kalmykovaa et al., 2018). Figure 2, shows the study object in detail: (A) Linear system composed of waste generation, collection, transportation, and disposal to a landfill; (B) Circular system composed of waste generation, collection, transportation, and integration of industry and other intermediaries (Yay, 2015; Poletto et al, 2016; Matinez-Sanchez et al. 2017; Ibáñez Forés et al., 2018; Thushari, I., Vicheanteab, J. & Janjaroen, D., 2020).

Fig. 2 - Linear and Circular Waste Management system framework.



Source: the authors.

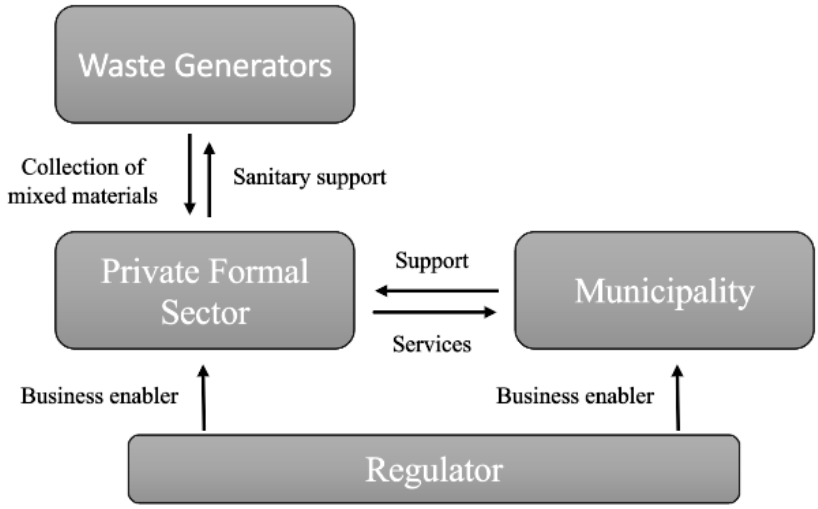
Once this work only considers municipal SW, the waste source consists of actors that generate only inert waste, such as houses, schools, and stores. Considering the linear system, there is no waste sorting before the collection. In Brazil, according to NSWP, the municipality is responsible for the waste management system, where the waste is collected door-by-door and disposed of in landfills without any further treatment (Silva, Contreras, & Borboleto, 2021).

2.2 Stakeholder identification at linear chain

In this research stage, the stakeholders were associated with the systems described above. However, most studies present the stakeholders as result of an indirect perspective (ABRELPE, n.d.; Andrade, Zanghelini & Soares, 2017; Ibáñez-Forés et al., 2018; Ibáñez-Forés, Bovea, Coutinho-Nóbrega & Medeiros, 2019; Rebehy, Lima, Novi & Jr. Salgado, 2019; Robles et al., 2020). Concerning linear waste management systems, the first process that occurs is waste generation. For this reason, as presented in Figure 3, the waste generators can be represented by households, commercial, and public users, that generate municipal SW. In linear systems, there is no sorting, which results in no value generation (Peltola et al., 2016).

It was considered that the formal collection is done by urban cleaning services(hired through public bids), which are responsible for collecting the waste dor-by-dor and disposing of it in a landfill (Associação Brasileira de Empresas de Limpeza Pública Especiais [ABRELPE], 2021). At this stage, the stakeholder provides services to the municipality, despite no material sorting or treatment. Finally, at the dump of the waste on the landfill, the value associated with the material is lost since the current landfill does not perform energy recovery of organic waste or recovery of recyclable material (Ibáñez-Forés et al., 2018). As a private organization, the landfill is the main stakeholder, followed by municipal actors, such as regulatory institutions (also represented by the State and the Constitution).

Fig. 3 - Stakeholders in the linear management waste system and its interactions.



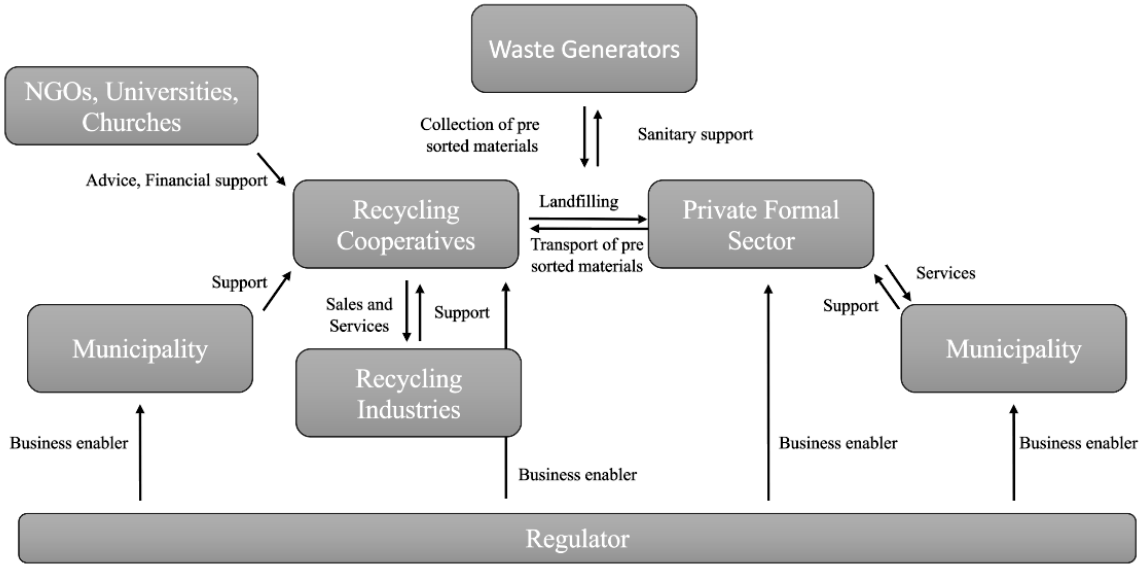
Source: the authors.

2.3 Stakeholder identification in the circular chain

For a better analysis, the identification of stakeholders was divided into six different groups: waste generators (households, offices, and others), municipalities, the private informal sector (waste pickers, informal cooperatives), the formal private sector (business, formal cooperatives, and urban cleaning services), donor agencies (ONG's and Universities) and the regulator, presented in Figure 4. Despite the user specified in the linear chain, when treating it from a shared responsibility and integration of the actors, the waste generator moves from the position of a mere generator of waste to a preventer and active actor in the circular chain (prevention through conscious consumption, waste separation, and delivery to selective collection centers). In the form of the law, municipalities play the role of regulator and articulator of policies; however, from a circular perspective, municipalities have an essential role in support and coordination, responsible for affecting opportunities for other stakeholders (Peltola et. al, 2016).

The informal private sector is composed of informal collectors and cooperatives formed from the organization of these individuals in the system, being responsible for the capillarity of waste collection and security of the supply chain. On the other hand, the formal private sector is composed of urban cleaning services (private companies working with public licitation of waste management referenced in this work as urban cleaning services) and industries, that are large companies that produce waste that needs to be recycled by law and companies that combine EC with their business models to reduce costs and increase the green footprint for sustainability reports (Bocken, Schuit & Kraaijenhagen, 2018). The donor agencies are examples of NGOs and universities that, in addition to being incorporated as waste producers, can provide funding and knowledge for waste management. The regulator is still the key actor to drive by law the changes in the linear system to a circular system, by attributing shared responsibility for waste management.

Fig. 4 Stakeholders in the circular management waste system and its interactions.



Source: the authors.

Table 1. Stakeholders' role in the solid waste management

Stakeholder	Role	
	Linear Chain	**Circular Chain**
Waste Generators	Users of the system generates mixed waste with no previous sorting.	Beyond being systems users, they prevent waste generation and engage with conscious consumption and waste generation with the previous sorting.
Municipality / Local Authorities	Provide an urban cleaning service to the waste generators and a landfill for disposal.	Encourage previous waste sorting at the household level; provides an urban cleaning service to the waste generators, support and include recycling cooperatives in the SW management system and constitute means to the non-recyclable waste disposal into a landfill.
Urban Cleaning Services / Private Formal Sector	Collection, transport, and disposal of mixed waste / Landfills, with no material or energy recovery.	Collection of sorted waste, transportation to recycling cooperatives, and disposal of non-recyclable waste into landfills/treatment units for material or energy recovery.
Recycling Cooperatives / Formal or Informal Sector	-	Separation of the sorted material and selling for recycling/recovery industries.
Recycling Industries / Private Formal Sector	-	Treatment/Recycling of the material. Transformation in raw material, reducing the pressure above natural resources.
NGOs, Churches, and	Users.	Beyond being users, it shares knowledge and financial or non-financial support to the SW

Universities		management system.
Regulator / Policy, legal, political	Through laws and ordinances, regulate the urban solid waste management system in the environmental, social, and economic spheres.	Through laws and ordinances, it regulates the urban solid waste management system in the environmental, social, and economic spheres.

Source: The authors.

3 Value creation for stakeholders

The value identified in this topic was described considering the following five main groups found in the literature: economic growth, creation of new businesses and job opportunities, saving materials costs, security of supply, and reduction of pressures and environmental impact. Table 2 summarizes the value created for each stakeholder, in the different systems.

Table 2. Evidence of value creation for solid waste management identified stakeholders

Stakeholder	Value created for stakeholders at the circular chain	References	Value created for stakeholders at the linear chain	References
Waste Generators	Health and environmental gains (reduce pollution of water and air) and ensuring resources for future generations	Menikpura et al., 2012; Ribic et al., 2017; Ribeiro et al., 2021; Abdoli et al., 2016;	No value creation	-
Private Formal Sector/ Recycling Industries	Saving materials costs, job opportunities, security of supply chain, and strategic positioning by green footprint.	Dias, 2016; Zaman & Swapan, 2016; Ribic et al., 2017; David et al., 2020	Value destruction (environmental negative impacts, natural resources scarcity)	Diaz-Barriga -Fernandez et al., 2017.; Rebehy, P. et al., (2019)
Private Formal Sector / Urban Cleaning Services	Job opportunities and increased the lifespan of the landfill.	Menikpura et al., 2012; Valencia-Vázquez, R. et al., 2014; Dias, 2016; Ribic et al., 2017; David et al., 2020;Tsai, F. M., Bui, T.-D., Tseng, M.-L., Wu, K.-J., & Chiu, A. S. (2020); Dinh et al., 2021; Noufal & Maalla, 2021	Job opportunities. Value destruction (environmental negative impacts, natural resources scarcity)	Pikón & Gaska, 2010; Sibanda et al., 2017
Recycling cooperatives	Improvement of income, work facilities, and conditions, job creation	Menikpura et al., 2012; Valencia-Vázquez, R. et al. 2014; Dias, 2016; David et al., 2020; Noufal &	No value creation	-

		Maalla, 2021; Ribeiro et al., 2021;		
NGOs, Universities, Churches	Attending to the claims correlated with the mission of these organizations	Klundert & Anschiitz,2000; Liu, C., & Côté, R. (2017)	No value creation	-
Municipality	Decrease in the public health pressure, improve the citizen's life, and achievement of Sustainable Development Goals, by attending to environmental, social, and economic claims in society.	Pikón & Gaska, 2010; Valencia-Vázquez, R. et al. 2014; Ribic et al., 2017; David et al., 2020; Dinh et al., 2021 Ribeiro et al., 2021; Noufal & Maalla, 2021	Value destruction (Environmental impacts, water pollution, an increase of disease, higher budget pressure)	Diaz-Barriga-Fernandez et al., 2017; Sibanda et al., 2017
Regulator	Political sustainable positioning (Sustainability Agenda)	Klundert & Anschiitz,2000; Liu, C., & Côté, R. (2017)	No value creation	-

Source: The authors.

4 Discussion

According to the literature, the linear chain of SW management captures little value, mainly justified to the non-integration of stakeholders, unknowledge of the type of materials in the waste stream, followed by the waste of the potential to produce energy and raw materials to reintroduce the waste in a production chain (Topic & Biedermann, 2015; Sibanda, Obange & Awuor, 2017). Moreover, landfilling can be categorized as a system of value destruction, once it causes negative impacts by degrading valuable land resources, increasing land costs, and creating long-term environmental and human health problems (Diaz-Barriga-Fernandez, Santibañez-Aguilar, Radwan, Nápoles-Rivera, El-Halwagi, & Ponce-Ortega, 2017).

On the other hand, the circularity associated with the SW management can lead to several benefits creating value for the stakeholders. This value is presented on the following topics.

4.1 Economic growth

The circular economy has a central role in reducing municipal waste, once the materials that once would end up in a landfill are introduced into a new supply chain. Thus, the first point highlighted by research is related to the economic growth associated with circular waste management.

The implementation of a bailing system reduces the transport and the management of the remaining waste costs by increasing the lifespan of the landfill, once less waste is deposited at the landfill, occupying less volume (Valencia-Vázquez, R., Pérez-López, M., Vicencio-De-La-Rosa, Martínez-Prado, M., & Rubio-Hernández, 2014; David, John & Hussain, 2020; Phu et al., 2020; Dinh, Fujiwara & Pham Phu, 2021). Moreover, Paes et al. (2019) present that more than 90

percent of the economic gains could come from the savings in operating costs and the rest of the potential gains from the Clean Development Mechanism and carbon credit projects.

Finally, it is important to point out that this approach facilitates greater social and economic inclusion of informal and formal scavengers in the recycling chain (Poletto, Mori, Schneider & Zattera, 2016). This is possible by the economic gain associated with the sale of materials for reuse and recycling (Menikpura, Gheewala & Bonnet, 2012; Ribić, Voća & Ilakovac, 2017; Deus, Bezerra & Battistelle, 2019; Avilés-Palacios & Rodrígues-Olalla, 2021; Sulewski et al., 2021; Shah, Srivastava, Mohanty & Varjani, 2021; Costa et al., 2022).

4.2 Creation of new business and jobs

Following the topic discussed above, the circular management of waste includes more stakeholders in the chain, such as waste pickers and recycling industries, which results in job creation, poverty alleviation, and growth of the small businesses (Sibanda, Obange & Awuor, 2017; Ibáñe-Forés et al., 2019; Lazo & Gasparatos, 2019; David, John, & Hussain, 2020; Tsai et al., 2020; Ribeiro, Rutkowski & Resende, 2021; Costa et al., 2022). For example, Ribić et al. (2017) show that Europe Union has the potential to promote more than 580.000 green jobs.

The implementation of this circular perspective also has an important role in the waste pickers working conditions (Lazo & Gasparatos, 2019). Once these workers come to be seen as service providers in socio-technical systems (collecting and recycling urban waste), economic actors (critical to the value chain), political actors (furthering social inclusion through collective action), and drivers of social change, providing a source of income generation for less disadvantaged communities (Menikpura et al., 2012; Poletto et al., 2016; Dias, 2016).

4.3 Saving materials costs

Once the collected material is sorted, it is sent to industrial facilities, providing revenue from the sale of recyclable materials (Noufal & Maalla, 2021). This process favors the waste characteristic for treatment, producing recycled material that can be used to substitute primary raw materials (David et al., 2020; Phu et al., 2020). It is important to highlight that not only the material is recovered, but once the life cycle of a product is extended, the expenditure of other resources such as water and energy, is also avoided (Abdoli, Rezaei & Hasanian, 2016).

Consequently, many potential economic benefits of resource recovery from waste can be found on basis of the monetary value of the substituted virgin materials on reusable trading markets (Zaman & Swapan, 2016; Tsai, Bui, Tseng, Wu &Chiu, 2020). Which is deeply connected to the topic discussed below, the security of material supply.

4.4 Security of supply chain

The security of the supply chain in a circular approach is associated with a lower need for virgin materials linked with an increased need for used material and collaboration with both suppliers and customers, the exposure to supply chain disruptions related to natural disasters, geopolitical imbalances or unsafe relations is decreased (Hazen et. al, 2021). Firstly, enabling materials to be reused or reprocessed, and providing valuable materials to competitive recycling industries can boost local supply chains, generating value for the community itself (Ribic et al., 2017; Tsai et al., 2020).

However still according to Lazo and Gasparato (2019), global markets have already been created in cases where no local industries can process specific materials. In fact, the informal sector intersects with the formal economy at various points and is an integral part of modern

economies, informal waste pickers can be considered key actors in securing the secondary raw materials in the global recycling industries (Dias, 2016).

4.5 Reducing Environmental impact and pressures

The environmental aspects related to the circular chain are the most discussed in the studied papers. Reducing municipal waste, landfilling, and increasing recycling can result in a positive gain for the environmental sphere such as reducing pollution in water and soil and greenhouse gas emissions (Dias, 2016; Ribic et al., 2017; Ali, Aslam & Mmtaz, 2018; David et al. 2020; Dinh et al., 2021; Ooi & Woon, 2021). Once the landfills are the source of considerable emissions of GHGs (greenhouse gas - mainly biogenic CH4 and CO2 as well as CO2 from fossil fuel combustion in processes accompanying landfilling), the minimization of waste volume sent to this kind of treatment can mitigate GHG emission (Pikón & Gaska, 2010; Abdoli et al., 2016; Sibanda, Obange & Awuor, 2017, Paes et al., 2018; Lazo & Gasparatos, 2019; Phu et al., 2020; Shah et al, 2021).

However, landfill is not the only source of environmental impacts. The raw material extraction and goods production depend on the expend of different material fluxes, such as energy, water, and fuels (Paes et al., 2019; Sulewski et al., 2021). Therefore, reduction of environmental pressures can also be achieved by increasing the useful life of materials and their reinsertion into production chains (Zaman & Swapan, 2016; Ibáñez-Fores et al., 2018). Moreover, according to Menikpura et al. (2012) besides the environmental gain, reducing the environmental emissions would directly help mitigate public health hazards, consequently reducing expenditure on health services.

5. Conclusions

This paper presented a counterpoint between linear and circular SW management. The results showed that the circular system includes a higher number of stakeholders involved in comparison with the linear one. However, it is important to highlight that the stakeholders of the linear chain are also present on the circular chain. Thus, the change from linear to circular SW management gives the opportunity to different actors to be part of the system.

Consequently, it can be seen that circularity creates more value for each stakeholder. This paper associated economic growth, creation of job opportunities, saving of materials costs, reduction of pressures and environmental impact, and security of supply chain to the application of circular economy on the waste management systems. On the other hand, the linear system showed as responsible for value destruction.

Finally, this work faced a few limitations such as the use of secondary data, and the consideration of generic scenarios of the circular and linear waste management systems. Therefore, a suggestion for future research is to analyze specific scenarios, considering the political specificities, geographical scope, and the stakeholders' particularities, collecting primary data from each stakeholder involved.

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