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Analyzing the Potential of Job Creation by Taking the First Step Towards Circular Economy: Case Study of Brazil

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***Abstract*—**The Brazilian economic projections and social indicators show a future of crisis for the country. Solutions to avoid this crisis scenario are necessary. Several developed countries implement initiatives linked to sustainability, mainly related to the circular economy, to solve their crises quickly - green recovery. This article aims to assess social gains if Brazil followed the same recovery strategy. Furthermore, with the use of data presented and recognized in the international academic society, the number of jobs that can be created, if Brazil took the first steps towards a more circular economy, was found. Moreover, in addition to the gross value in the number of jobs created, this article also detailed the number of these jobs by type of activity (collection, processing, and manufacturing) and by type of material.

***Keywords*—**Circular economy, green recovery, job creation, social gains.

I. Introduction

A. Income Generation Impacts

THE projections of the Brazilian economic and social future point to a chaotic scenario. The Brazilian gross domestic product (GDP) was projected within the conditions brought by COVID-19 [1]; by developing scenarios where the temporary stoppage of economic activities due to social isolation lasted for two months; the author discovered that the best scenario foresaw a reduction of 1.21% in the national GDP growth rate, while the worst figured out the value of 1.87%. Another projection, which considers a longer stoppage of economic activities, proposed a 7% drop if the working hours throughout the year suffered a 50% reduction [2]. Although, continued economic growth - represented by rising GDP projections - does not, necessarily, mean prosperity; economies must aim to bring prosperity, whether they grow or not, so that they can safeguard the living world on which everyone depends while guaranteeing the essential goods for human life [3]. For this reason, this article is based on the promotion of strategies, linked to the circular economy, that can help human well-being - through the generation of jobs - and natural capital preservation - through restoring resources. In this way, projections for the future of the country's workforce were also collected.

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B. Level of Jobs Impacts

Regarding the perspectives related to job creation - the focus of this article - already in the 4th quarter of 2019, before the pandemic was detected in the country, Brazil was already facing a high unemployment rate. Reference [4] mentioned that 11.9% of the population, which corresponds to a total of 12.6 million people, was unemployed on that quarter. Reference [2] also made predictions on unemployment rates; considering the same scenario that was previously mentioned, it was found that an increase in the unemployment rate is expected, which according to projections will be approximately 24% of the economically active population, if the number of this population remains constant.

C. Literature Review

Several academic studies have investigated plausible solutions; one widely advocated by articles is the green recovery - using sustainable systems to drive the recovery. Reference [5] points out that shifting away from unsustainable natural resource use would not only reduce environmental impacts and supply risks, it could also create job opportunities, for example in collecting recyclables. A Computable General Equilibrium (CGE) model was used to assess the impact of a tailored green investment policy that supports economic activity and simultaneously invest in the transition towards climate neutrality in Belgium, this model showed an evolution of the economy active at a 10% level, although it is necessary to assess the social dimension of the new policy proposals [6]. Furthermore, a pattern of encouraging sustainable development emerges within the most prominent counties. Several of these countries have already prepared studies that qualify and quantify the economic and social gains in this approach. Within these studies, the adequacy to a circular economy stands out. In the Netherlands, through an analysis of the opportunities and obstacles that the country would face in moving towards a more circular economy it was estimated that the annual economic impact of this kind of economy would represent a generation of 7.3 billion pounds of value and a creation of 54,000 jobs [7]. For the case of the United Kingdom, [8] suggested that the circular economy can generate 200,000 to 500,000 gross jobs and reduce unemployment between 50,000 and 100,000 by 2022. Analyzing the potential for Charlotte, North Carolina, [9] reported the following: “it was calculated that the 900,000 tons

of annual waste represent a residual value of roughly $111 million per year and the city could create more than 2,000 jobs by harnessing material instead of dumping it into landfill". Another article, focused on the state of California, mentioned that at least 200,000 jobs would be generated if recycling rates went from 50% to 75% [10]. In [11] was projected a generation of 200,000 green jobs in Brazil, if all the measures in the National Plan on Climate Change were implemented by the country, including a 20% increase in the recycling rate.

D. The Study Purpose

All these articles, reports and books, presented in Subsection *C*, provide confirmation that the circular economy is a reliable way to overcome the economic problems. And, therefore, they were a great motivation for the creation of this paper; that seeks to quantify how many jobs by type of waste and type of activity can be created with the incorporation of this approach in Brazil and in the city of Rio de Janeiro in the horizon of the next 10 years.

II. Context of Waste Management

A. The Brazilian National Policy

In Brazil since 2010, there is a National Solid Waste Management Policy, a milestone that represents a regulatory advance for the country; the policy covers guidelines related to integrated management and solid waste management, addressing for the first time legally the shared responsibility for the life cycle of products, the possibility of sectoral agreements and the importance of reverse logistics [12]. However, as much as the law was a milestone, public agencies have difficulties regarding the application and enforcement of measures, since the sector is characterized by being heterogeneous, deficient and with great regional contrasts, mainly due to the political and federal administrative authority [13]. Reference [14], in a more recent study, established a comparison between 2010 and 2020, evaluating the evolution of the legislation after ten years of its appearance and evinced this difficulty when concluding the need for a greater coverage of governments and educational institutions to disseminate this environmental theme, reinforcing the existence of specific legislation for recycling.

B. Waste Management Data

As an endorsement of the content presented by the articles presented above, it is valid to present some data regarding waste management in the country. In 2018, 79 million tons of waste were generated in the Brazilian territory (0.38 tons per resident per day), an increase of just under 1% over the previous year. However, only 92% of this amount was collected (72.7 million). Therefore, 6.3 million tons of waste were not collected from the generation sites. As for the final disposition, the framework is even more delicate; 29.5 million tons of solid waste - approximately 40.5% of the total waste collected - are sent to dumps or similar places without any control - but, in most cases, almost 60% of the total, the waste is destined to landfills [15].

C. Current Recovery Rates

Once these data are presented, the extremely low national solid waste recycling index is understandable. The volume of dry waste recovered for recycling reached the highest historical mass recovered in 2018, with a recovery of 923,286 tons, almost 3.9% of the potentially recyclable waste collected [16]. Reference [16] points that the low coverage of selective collection services is the main responsible for the current recycling rate; and it highlighted the need for investments to increase that percentage, optimizing the use of natural resources and reducing the volume of waste sent for final disposal. Regarding organic waste, the percentage of diverted is even lower; only 127,498 tons were recovered in composting units, and in relation to anaerobic digestion, another way to take advantage of organic waste, there are only initiatives in two Brazilian cities, one of which is in Rio de Janeiro and will be more commented on [17]. These numbers further prove the Brazilian fetal stage in relation to waste management; since, within the circular economy strategies, recycling presents itself as one of the least efficient in maintaining value in the production chain, being able only to capture more value than the energy recovery strategy - incineration and composting processes [18]. Reference [19] estimated that low-value activities, that result in incineration, landfilling and composting, only generate 1–6 jobs per 10,000 tons of goods disposed of, while recycling generates an estimated 36 jobs for the same amount of material and, reuse and refurbishment are by far the biggest winners, creating almost 300 jobs for each 10,000 tons of waste. In these circumstances, the Brazilian government should, at first, invest in eliminating dumps as a destination. This alternative brings extremely negative consequences to society, such as the contamination of natural resources and various public health problems [20]. In addition, efforts should be made to raise recycling rates; if recycling is not possible, waste should be sent to landfills and composting - ensuring greater value capture. Eventually, if Brazil can take this first step, it should focus on strategies that generate even more value, such as reuse and remanufacturing. However, it is worth emphasizing that, currently, Brazil needs to be strongly concerned with eliminating dumps and increasing the recycling rate.

D. The Waste Pickers Situation

Another point that deserves to be highlighted on the national scenario is the strong impact of the waste pickers class. This class is made up of people who survive by collecting recyclable materials; in Brazil, this class has a high level of informality, which is not seen in official records, that makes it difficult to recognize them by research agencies and institutions. As an evidence, the divergence found between two sources can be mentioned that presents an estimation of the number of waste pickers in activity in the country. From data of the federal agency IBGE, [21] considers the number of approximately 388 thousand recyclable material collectors throughout the Brazilian territory. While in a survey carried out by the National Movement of Recycled Material Collectors - MNCR, in partnership with the economy department of the Federal

University da Bahia - GERI, it was found that the number of collectors is between 800 thousand to 1 million [22]. In addition to the lack of precision in the number of waste pickers in the country, another negative consequence of the informal work is the appalling working conditions that generate health risks for these workers [23]. The deficient management and the development models, that relegate the environment, public health, and workers health to a secondary level, raise problems related to collective health and occupational health to those associated with municipal solid waste [24]. And, although around 60% of the collectors have low or incredibly low efficiency due to the appalling working conditions [25], they collect an estimate of 90% of all recycled material in Brazil [23]. Thus, beside the scenario of economic crisis, triggered by COVID-19, which drives to an increase in the unemployment rate, there is an evident problem of informality among the class of waste collectors, which is responsible for generating the appalling working conditions, as mentioned above. Therefore, the combination of these factors makes the need to create formal and official jobs in Brazil even greater.

E. The Rio de Janeiro Scenario, Specifically

The issues related to the city of Rio de Janeiro reflect the general characteristics presented in the country where it is located. Table I presents an overview of the composition of Rio de Janeiro's overall Disposed waste stream by material type in 2018, showing the percentage and quantity in tons of each material.

TABLE I
COMPOSITION OF RIO DE JANEIRO'S OVERALL COLLECTED WASTE STREAM BY MATERIAL TYPE IN 2018 [26], [27]

Material	Est. Percent (by Weight)	Est. Tons
Paper	14.31%	252,764
Glass	3.47%	61,292
Metal	1.81%	31,971
Electronics	0.38%	6,712
Plastic	15.33%	270.781
Other Organic (food, leaves, manures, bones)	52.45%	926,448
Inert and Other	2.62%	46,278
Textiles (cloth, rags, and leather)	2.90%	51,224
Mixed Residue (disposable absorbent and candle)	6.73%	118,875
Totals	100.00%	1,766,346

As shown in Table I, a total of 1,766,346 tons of waste was generated in Rio de Janeiro in 2018. Without considering the action of waste collectors, the city collection is done mainly by Comlurb, a public company - representing about 90% of the waste, while the remaining 10% is managed by several private initiatives. The destination, for approximately 93.2% of these materials, is the Rio Waste Treatment Center 'CTR-Rio', located in Seropédica [28]. At 'CTR-Rio' there is a landfill, the destination of most of the waste, and in addition there is a biomethanation plant for reuse of organic waste, which was mentioned earlier. The biomethanization plant, which generates biogas for energy generation, biofuel, or soil conditioner from organic compounds, has the maximum capacity to process 100 tons of organic waste per day, and therefore reuses 4.0% of the total organic waste generated in the city [29]. This index is theoretically a low value, however when compared to the national recycling index it becomes a considerable value, even more because it uses a rare strategy in the country that has the potential to produce good inputs and generate more jobs.

Comlurb collects potentially recyclable materials with the selective collection, according to data presented in the Selective Collection Report in 2019, these materials represent 2.9% of all collected waste [26]. These potentially recyclable residues are destined for the 25 centers of collector's cooperatives, two of which are central sorting (Irajá and Bangu); they separate and sell recyclables to specialized companies [30]. So, the city of Rio de Janeiro manages to divert only 3.9% of organic waste and recycle, at most, 2.9% of waste.

III. MATERIAL AND METHODS

A. Advocated Goal

Brazil is missing out on a great social, financial, and environmental opportunity by allocating most of its waste to the landfill. Therefore, it is necessary to increase the rates of recycling/reuse of waste. To elaborate the employment generation scenarios, this article advocates a goal to reach 30% in the diverted rates by 2030.

B. Waste Generation in 2030

To reach the advocated target for 2030, it is necessary to estimate the number of tons of reused waste that must be added. Thus, the first step taken was to elaborate a projection for the generation of waste in 2030. To make this estimate are required: the tons of waste per resident per year was used - which corresponds to the value of 0.38 tons [15]; and a projection of demographic evolution from the Brazilian Institute of Geography and Statistics. In the projection, the estimated population for the country in 2030 is 224,868,462 inhabitants [31]. So, it has reached the generation of 85,450,016 tons of waste.

C. Incremental Waste Tonnage

Considering the arbitrated target of 30%, the country would have to divert an additional 24,548,221 tons of materials by 2030 (30% of 85,450,016; minus 1,086,784 - current quantity of waste diverted, by recycling and composting). For the estimation in Rio de Janeiro the same methodology was used.

D. Estimated 2030 Composting

It is necessary to estimate the composition of the garbage collected for 2030. To that end, from [26] and [32], the composition of waste in recent years was also assessed; the results found are in evidence in Fig. 1.

Fig. 1 indicates that Rio de Janeiro has a disposed waste composition like other cities in undeveloped countries. For example, the percentage of organic wastes in the city of Rio de Janeiro is 55% while in Istanbul (Turkey), Abuja (Nigeria) and Phnom Penh (Cambodia) are, respectively, 54.1, 62.9 and 61.2 [33].

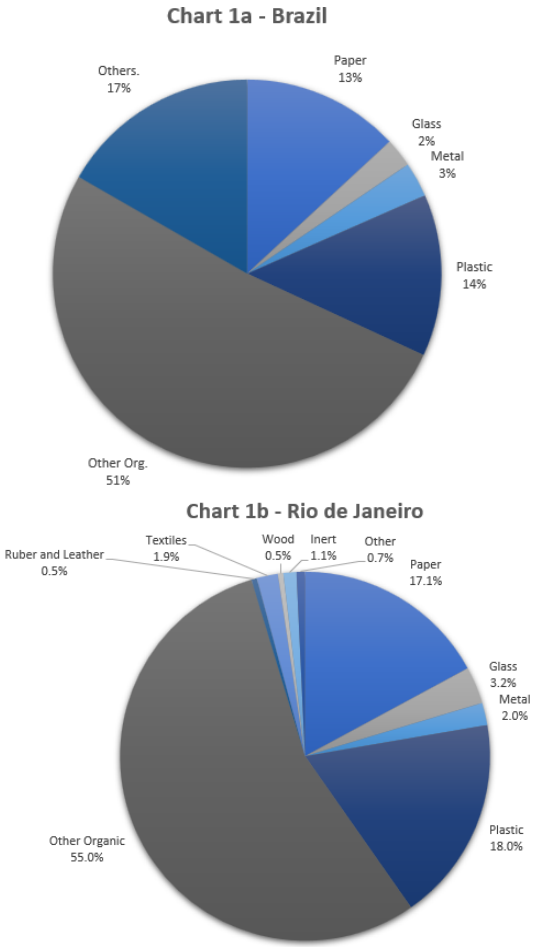

Fig. 1 Estimated 2030 Composition of Disposed Waste. In Rio, based on data collected from 1995 to 2019 [26], [32].

E. Incremental Waste Tonnage by Material

Having the knowledge of the composition of the waste contributes to estimate the number of jobs created closer to reality. Since the characteristics of the waste and the divert processes have their peculiarities, directly impacting the number of jobs required. So, to reach the goal, another 24,548,221 tons of materials should be diverted in Brazil, while Rio de Janeiro must add 534,155 tons. It is possible to use the waste composition to know the need of tons of each specific type of material, as shown in Table II.

Table II shows the additional tons needed by material category to achieve 30% overall recycling by 2030. These data, in conjunction with the table of jobs production factors (that will be presented in the next topic) function as an input to discover the number of jobs that will be generated with this approach. It is interesting to note that this analysis does not consider subcategories within each type of material. For example, for plastic there are several subcategories, as ethylene poly terephthalate, polypropylene, polyvinyl chloride, and many others; each of these subcategories is best suited to a specific recycling technique [34]. Plastic is just one example, but for other types of materials there is a similar situation. In the future, another study can be developed projecting the generation of employment for each of the subcategories found, helping the development of more assertive recycling plants. However, the main purpose of this article is to show the potential still unexplored by the Brazilian government's public bodies, so that the projections do not need to be more specific to give credence to the content objective.

TABLE II
ADDITIONAL TONS TO BE RECYCLED IN ORDER TO ACHIEVE 30% OVERALL RECYCLING BY 2030, BY MATERIAL CATEGORY

Materials	Brazil - 2030 Additional Tons Recycled (1,000 tons)	Rio de Janeiro - 2030 Additional Tons Recycled (1,000 tons)
Paper	3215.8	91.3
Glass	589.2	17.3
Metal	711.9	10.5
Plastics	3314.0	96.1
Other Organics	12617.8	293.9
Rubber & Leather	-	2.6
Textiles	-	9.9
Wood	-	2.5
Other Inert	-	6.1
Other	4099.6	3.9
Total	24,548	534.2

IV. RESULTS AND DISCUSSION

Key factors in reaching the value of jobs that can be generated are the factors of job creation, given in Table III. The table segregates the reuse strategies, such as recycling, remanufacturing and reuse, from incineration and landfill, showing that the former is more beneficial in relation to job creation. These data are closely related to other references that were previously mentioned, bringing more credibility to each of these sources.

From the job production factor table, it can be seen that reuse and remanufacturing strategies have a better job creation potential, mainly in the case of metals, plastics and textile materials, which makes its application more beneficial. However, in the previous topics were presented the precarious performances of the current federal and municipal administrations in terms of solid waste management, showing that the country needs to develop gradually and that the first step is to increase recycling rates.

Despite the data in Table III being a great source of reference, some values are not faithful to Brazilian reality, since the data were developed to be applied in the state of California in the USA, as [10] points out. The two places have drastic differences in development and modernity, so that, even if Brazil applies the same processes carried out in California, there is likely to be a difference between the modernity of machinery, impacting the job generation factor. In the Brazilian case, due to the lower level of technology used in the processes, making them less automated, there would be a need to involve more people, corroborating for a higher degree of hiring. Thus, for the application of the table in Brazil and Rio de Janeiro, some practical changes in the factors would be positive and would guarantee a more realistic final number of jobs created.

The processes related to diverting organic materials are a good example for two reasons; first, Table III shows the value

of 1.73 jobs created for every 1,000 tons of diverted organics, although the strategy used is composting. For the Brazilian scenario it would be acceptable to maintain these values. However, currently, Rio de Janeiro uses the methanization strategy, which has a greater potential for job creation, in a plant of this type, with the capacity to process 100 tons per day, the number of hires is quadruple, so the most appropriate factor would be approximately 3. The second reason, which also highlights the impact of modernity on the job creation factor, is that in these same 100 tons per day plants, in Brazil would be necessary from 8 to 10 people to operate the machinery, while in several developed countries, as U.S. and countries in Europe, would only be necessary 4 people. So, if the values were changed, a greater number of jobs would be created. For the case of organic waste, as the example comments, the amount could be more than double. However, the author decided to keep the data produced by [35], which were presented in Table III, and insert the word 'at least' before presenting the estimated number of jobs generated through recycling - the result of the work, ensuring greater security regarding the data presented. So that, regardless of the processes chosen by the municipal and federal government, and the modernity involved in these processes, if Brazil reaches a recycling rate of 30% by 2030 it will have generated - at least - 109.285 jobs.

TABLE III
JOB PRODUCTION FACTORS BY MATERIAL AND MANAGEMENT ACTIVITY (JOBS PER 1000 TONS)

	Diverted Waste (Jobs per 1,000 tons)				Disposed Waste (Jobs per 1,000 tons)		
Materials	Collection (2030)	Processing	Manufacturing	Reuse/Remanufacturing	Collection (2030)	Landfill	Incineration
Paper & Paperboard	1.23	2	4.16	-	0.56	0.1	0.1
Glass	1.23	2	7.85	7.35	0.56	0.1	0.1
Metals							
Ferrous	1.23	2	4.12	20	0.56	0.1	0.1
Aluminum	1.23	2	17.63	20	0.56	0.1	0.1
Other Nonferrous	1.23	2	17.63	20	0.56	0.1	0.1
Plastic	1.23	2	10.30	20	0.56	0.1	0.1
Rubber & Leather	1.23	2	9.24	7.35	0.56	0.1	0.1
Textiles	1.23	2	2.5	7.35	0.56	0.1	0.1
Wood	1.23	2	2.8	2.8	0.56	0.1	0.1
Other	1.23	2	2.5	-	0.56	0.1	0.1
Food Scraps	1.23	0.5	-	-	0.56	0.1	0.1
Yard Trimmings	1.23	0.5	-	-	0.56	0.1	0.1
Waste	1.23	0.5	-	-	0.56	0.1	0.1

In Table IV, 30,194 of the 109,285 direct jobs generated in Brazil would be created in the collection process, creating the opportunity to formally employ the country's waste pickers, to provide better working conditions and, consequently, better quality of life. The manufacturing stage also stands out for being able to generate approximately 55 thousand direct jobs.

The greatest potential by far lies in recycling plastic waste, almost 45,000 direct jobs. This is due to the high factor of job creation in the manufacturing phase and the high percentage of this waste in the total composition discarded. Another point that can be a differential is the number of direct jobs generated with organic waste. Table IV considers employment generation data referring to the composting strategy, which, as previously mentioned, has less potential for job creation. If methanation is used instead, the value could increase considerably. For example, in the city of Rio de Janeiro, from the data presented by the article, two projections were made for the total generation of direct jobs: in the first, the estimate is that 2,874 jobs will be generated, considering that organic waste will be destined to composting; the second, which considers methanization as the final destination, estimates a generation of 3.609. On a federal scale, the difference would be even greater. In addition to Brazil, other undeveloped countries could also invest in methanation as a strategy, once they had a similar percentage of organic waste.

Note that so far only direct jobs have been considered. Indirect jobs, created in other sectors that provide equipment and services for recycling plants or manufacturers that use recycled material as an input, were not included. Estimates consider that direct jobs created from material management activities represent about two thirds of total job creation, with indirect jobs accounting for about 25% and jobs induced by 10% of total jobs, as shown in a study prepared for [36]. Applying the study to the results of this article there is an even greater generation for the Brazilian scenario, a further 40,891 jobs, referring to indirect jobs, should be added to the presented results.

V. CONCLUSION

Economically and socially, Brazilian projections predict a chaotic future. Encouraging a green recovery, led by investments in the circular economy, the country can partially solve this situation. Because the country still manages its solid waste in a lethargic manner, by destining their waste to either ancient dumps that are proven to be harmful to health or unattractive landfills that do not take advantage of the real value of the waste - the first step for Brazil towards a circular economy should be to increase recycling rates.

TABLE IV
JOB PRODUCTION FACTORS BY MATERIAL AND MANAGEMENT ACTIVITY (JOBS PER 1000 TONS)

Materials	Additional Tons Recycled	Tellus Job Production Factor				Employment Associated with Recycling Activities			
	(1,000 tons)	Collection	Processing	Manuf.	Total	Collection	Processing	Manuf.	Totals
Paper	3215.8	1.23	2	4.16	7.39	3,955	6,432	13,378	23,765
Glass	589.2	1.23	2	7.85	11.08	725	1,178	4,625	6,528
Metal	711.9	1.23	2	4.12	7.35	876	1,424	2,933	5,232
Plastic	3314.0	1.23	2	10.30	13.53	4,076	6,628	34,134	44,839
Other Organic	12617.8	1.23	0.5	-	1.73	15,520	6,309	-	21,829
Rubber and Leather		1.23	2	9.24	12.47	0	0	0	0
Textiles		1.23	2	2.50	5.73	0	0	0	0
Wood		1.23	2	2.80	6.03	0	0	0	0
Inert		1.23	0.5	-	1.73	0	0	-	0
Other	4099.6	1.23	0.5	-	1.73	5,042	2.050	-	7,092
Total						30,194	24,020	55,070	109,285

To show the advantages of investing in this approach, this article found the total number of jobs generated, by type of material and by type of activity; such analysis brings innovative content to the country. Furthermore, ultimately, this article seeks, with proven evidence, to show the delicate current Brazilian situation, while brings rich information - regarding job creation - relevant to the academic community and federal public agencies. The information presented can inspire future studies in circular economy, arousing and triggering interest in developing the theme not only in brazil but also in other undeveloped countries with similar characteristics.

REFERENCES

[1] Porsse, A., Souza, K. B., Carvalho, T. S., & Vale, V. A. Impactos Econômicos do COVID-19 no Brasil. Nota Técnica NEDUR-UFPR No 01-2020.
[2] Miranda, L.; Pinto, V.; Martins, T.; Peruchetti, P. Novos cenários para a evolução da atividade econômica brasileira em 2020. Retrieved from www.blogdoibre.fgv.br/posts/novos-cenarios-para-evolucao-daatividade-economica- brasileira-em-2020, 2020.
[3] Raworth, K. (2017). Doughnut economics: seven ways to think like a 21st-century economist. Chelsea Green Publishing.
[4] Pesquisa Nacional por Amostra de Domicílios (PNAD) 2019. Retrieved from www.agenciadenoticias.ibge.gov.br/agencia-noticias/2012-agencia-de-noticias/noticias/26741-desemprego-cai-para-11-9-na-media-de-2019-informalidade-e-a-maior-em-4-anos
[5] Agrawala, S., Dussaux, D., & Monti, N. (2020). What policies for greening the crisis response and economic recovery? Lessons learned from past green stimulus measures and implications for the COVID-19 crisis.
[6] Lahcen, B., Brusselaers, J., Vrancken, K., Dams, Y., Paes, C. D. S., Eyckmans, J., & Rousseau, S. (2020). Green recovery policies for the COVID-19 crisis: modelling the Impact on the economy and greenhouse gas emissions. Environmental and Resource Economics, 76(4), 731-750.
[7] Bastein, A. G. T. M., Roelofs, E., Rietveld, E., & Hoogendoorn, A. (2013). Opportunities for a Circular Economy in the Netherlands (pp. 1-13). Delft: TNO.
[8] Morgan, J., & Mitchell, P. (2015). Employment and the circular economy: Job creation in a more resource efficient Britain. Green Alliance.
[9] Metabolic. (2018). Circular Charlotte: Becoming a zero waste and inclusive city. Retrieved from https://www.metabolic.nl/projects/circular-charlotte/
[10] Goldstein, J. (2014). From Waste to Jobs: What Achieving 75 Percent Recycling Means for California.
[11] Muçouçah, P. S. (2010). A política nacional de resíduos sólidos e a geração de empregos verdes. Bahia análise & dados, 20(2/3), 349-359.
[12] Brasil. (2010) Law N° 12.305 - Política Nacional de Resíduos Sólidos (PNRS).
[13] Godoy, M. R. B. (2013). Dificuldades para aplicar a Lei da Política Nacional de Resíduos Sólidos no Brasil. Caderno de Geografia, 23(39), 1-12.
[14] De Oliveira Morais, M., Brejão, A. S., Silva, U. J., & Neto, J. S. (2020). Dez anos da política nacional de resíduos sólidos: um estudo comparativo entre 2011 e 2020 sobre o entendimento dos consumidores referente ao descarte de equipamentos eletroeletrônicos. Brazilian Journal of Development, 6(11), 91851-91873.
[15] Abrelpe. (2019). Panorama dos resíduos sólidos no Brasil 2018/2019 Retrieved from www.abrelpe.org.br/download-panorama-2018-2019/
[16] SNIS. (2020). Diagnóstico do manejo de Resíduos Sólidos Urbanos - 2019. Retrieved from www.snis.gov.br/diagnostico-anual-residuos-solidos/diagnostico-do-manejo-de-residuos-solidos-urbanos-2019
[17] SNIS. (2019). Diagnóstico do manejo de Resíduos Sólidos Urbanos - 2018. Retrieved from www.snis.gov.br/diagnostico-anual-residuos-solidos/diagnostico-do-manejo-de-residuos-solidos-urbanos-2018
[18] Blomsma, F., Pieroni, M., Kravchenko, M., Pigosso, D. C., Hildenbrand, J., Kristinsdottir, A. R., ... & McAloone, T. C. (2019). Developing a circular strategies framework for manufacturing companies to support circular economy-oriented innovation. Journal of Cleaner Production, 241, 118271.
[19] Institute of Local Resilience. (2002). Recycling means business. Retrieved from www.ilsr.org/recycling-means-business/
[20] Ramos, N. F., Gomes, J. C., Castilhos Jr, A. B., & Gourdon, R. (2017). Desenvolvimento de ferramenta para diagnóstico ambiental de lixões de resíduos sólidos urbanos no Brasil. Engenharia Sanitária e Ambiental, 22(6), 1233-1241.
[21] Silva, S. P.; Goes, F.; Alvarez, A. (2013) Situação social das catadoras e dos catadores de material reciclável e reutilizável: Brasil. Brasília: Ipea.
[22] MNCR. (2006). Sobre o Movimento. Retrieved from www.beta.mncr.org.br:8080/site/sobre-o-mncr/duvidas-frequentes/quantos-catadores-existem-em-atividade-no-brasil
[23] IPEA. (2012). Diagnóstico dos resíduos sólidos urbanos - relatório de pesquisa. 2012. Retrieved from www.ipea.gov.br/agencia/images/stories/PDFs/relatoriopesquisa/121009_relatorio_residuos_solidos_urbanos.pdf
[24] Ferreira, J. A., & Anjos, L. A. D. (2001). Aspectos de saúde coletiva e ocupacional associados à gestão dos resíduos sólidos municipais. Cadernos de saúde Pública, 17, 689-696.
[25] Damásio, J. (2010). Impactos socioeconômicos e ambientais do trabalho dos catadores na cadeia da reciclagem. GERI/UFBa–Centro de Referência de Catadores de Materiais Recicláveis–PANGEA.
[26] COMLURB. (2021). (personal communication, January 15, 2020).
[27] Conde, A., Campos, J., Quintaes, B., Hinojosa,M., Amorim, V., Tonnera Jr, J., & França, J. (2019). Composição de resíduos sólidos domésticos na cidade do Rio de Janeiro, Brasil: uma visão histórica
[28] Rio de Janeiro. (2016). Plano municipal de gestão integrada de resíduos sólidos - PMGIRS. Retrieved from www.rio.rj.gov.br/dlstatic/10112/3372233/4177431/D.O._28112016DECRETO42.605_2016PMGIRScompletocomanexos.pdf
[29] Ornelas, B. (personal communication, September 25, 2020).
[30] Rio de Janeiro. (2020). Cooperativas de catadores cadastradas. Retrieved from www.rio.rj.gov.br/web/comlurb/exibeconteudo?id=1141317
[31] IBGE – Instituto Brasileiro de Geografia e Estatística. (2020). Projeções da População. Retrieved from www.sidra.ibge.gov.br/tabela/7358#resultado

[32] Brazil. (2019). Ministério do Meio Ambiente(MMA) - Programa Lixão Zero.
[33] Conde, A.,Campos, J., Quintaes, B., Hinojosa, M.,Lourenço, A.F., Tonnera Jr, J., & França, J. (2018). Household Solid waste composition in Rio de Janeiro city - 2018.
[34] Chawla, K., Singh, R., & Singh, J. (2020). Segregation and Recycling of Plastic Solid Waste: A Review. In Advances in Materials Science and Engineering (pp. 205-221). Springer, Singapore.
[35] Tellus Institute and Sound Resource Management. (2011). More Jobs, Less Pollution: Growing the Recycling Economy in the U.S. Retrieved from wwwnrdc.org/globalwarming/files/glo_11111401a.pdf.
[36] Innes Hoos Consulting, Inc for the Environmental Standards Branch, British Columbia Ministry of the Environment. (2013). Zero Waste Business Case, Draft for Expert Review.