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Technical Landfill Center's Contribution to the Concretization of Social and Environmental Challenges of Circular Economy: Case of the TLC Bougeurgeur-Guelma

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Abstract: On the path of circular economy, Algeria has initiated several waste management plans. Technical landfill centers (TLCs) installation was one of the adopted solutions. In this context, the purpose of this study is the clarification of TLCs role on realization of social and environmental challenges of circular economy, by analyzing the TLC Bougeurgeur-Guelma Data, while adopting a qualitative approach. Results showed that this center achieves effective results on the social dimension and considerable results on the environmental one.

Keywords: Circular Economy; Environmental Challenges; Social Challenges; TLC Bougeurgeur.

1. Introduction

In the last few decades, ecological transactions have significatively impacted numerous alterations at various aspects and levels. Economic dimension, which aims only at profit creation, is surpassed towards other dimensions; such as social and environmental. The various pressure exerted, ecological and environmental specially, have pushed economic actors, in the strict sense, and government, at large sense, to take these issues into account when developing their strategies, and so have become decisive factors. Furthermore, demographic growth and climate change caused by linear economic model, which aims to extract, produce and discard, have led to the emergence of circular economic model, allowing in addition to recycle, re-employ and reuse, guaranteeing wealth creation and economic development ensuring wealth creation and economic development, while limiting the exhaustion of natural resources. Therefore, the circular economy emerged as a replacement for the conventional linear model, which was limited in terms of extraction, production, use, and rejection, in order to lessen the strain on natural resources and reduce

the amount of waste produced. As a result, circular economy has come to be as the cornerstone for a regenerative economy, by minimizing detrimental impacts on the environment and boosting new business opportunities (Awan & Sroufe, 2022).

However, to implement this innovative approach, changes must be made on both macroeconomic and microeconomic levels. Hence, in order to deploy it, the State's efforts must be coordinated with those of private businesses and individuals. On this path, Algeria has initiated a lot of programs and plans in order to engage on circular economy and concretizing its social, environmental and economic challenges. Technical Landfill Centers (TLCs) are one of government instruments implanted at the level of each city, to eradicate harmful environmental impact of waste. This implicates organizing the collection, transport, sorting and sometimes recycling of waste. Further, they contribute in the problematic of unemployment through job creation.

1.1. Research Problematic

In this research, we will address the following issue: **How does a Technical Landfill Center (TLC) contribute to the realization of social and environmental challenges of circular economy approach?**

This study will be carried out at the Technical Landfill Center (TLC) of the city of Guelma (TLC Bougeurgeur).

1.2. Research Aims

This study is curried out for the following purposes:

• Emphasize the significance of the circular economy topic and the need for enterprises, the government, and citizens to become aware of the advantages of this approach;

• Clarify the role of technical landfill centers in achieving the social and environmental objectives of circular economy;

• Clarify the role of government in the implementation of such an innovative approach;

• Make suggestions for enhancing the TLC's Bougeugeur functioning, which will be valid for all existing TLCs in the national territory.

1.3. Research Organization

Our reflection is focused on the following axes: the circular economy (challenges and implementation) and the TLCs (contribution to the realization of the challenges of this innovative approach). To address the research problematic, this study was organized in two parts. The first aims to present conceptual framework, where we will highlight the concept of circular economy, its social and environmental challenges and its implementation. The second empirical, meanwhile, aims to highlight the implication of TLC Bougeurgeur-Guelma in the concretization of social and environmental challenges of circular economy.

2. Literature Review

2.1. Transition towards Circular Economic Model

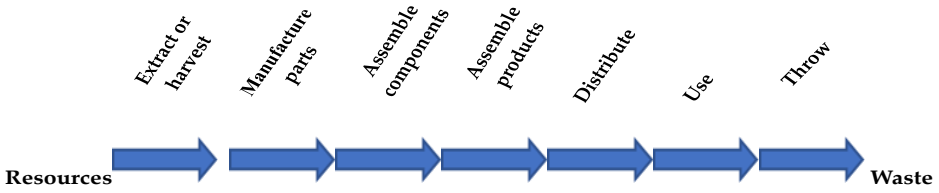
The degradation and the limited capacity of natural resource regeneration, the depletion of these resources, and climate change, in line with progressive demographic and industrial evolution that threatens natural resources and generates waste, are the main signaled raisons for switching to another environmentally responsible economic model. (Potočnik, 2014)

These ecological repercussions caused by linear economic model (see Fig.1), which aims to extract, produce and reject, have contributed on its questioning. For this reason, the circular economy has emerged as the best way to get around these environmental limitations. This new model specifically attempts to lessen the pressure on the use of raw materials and the negative impact on the environment, also to widen job offers by the creation of new

economic activities (green activities).

For Le Moigne (2018), linear economy is an economic model based on extracting of resources or raw materials, manufacturing, and using products and then disposing waste. Stated differently, it is the consumption of natural resources and energy to make products that will ultimately become waste. (Le Moigne, 2018, p. 7) The figure below illustrates the conceptualization of linear economic model:

Fig. 1. The flow of materials, components and products in a linear economy



Source: Le Moigne, 2018, p.7

However, circular economy opposed to linear economy and aims to redesign the old model into a loop system. It entails putting resources and energies in a cyclical economic model, through eco-innovations, to achieve the sustainable development goals (Prieto-Sandoval, Jaca, & Ormazabal, 2018).

The functioning of this new paradigm is summarized by its three areas of action and seven pillars. Its three areas of action are interdependent. Indeed, the supply of sustainable products (products from the circular economy) from economic actors requires the existence of an adequate and compatible demand from consumers (responsible consumption). On the other hand, a shift in consumption patterns is essential to ensure responsible management of end-of-life products, through: reuse, repair, reuse and recycling. Again, the following is an explanation of the model's pillars:

• **Sustainable supply:** it consists of purchasing from suppliers offering materials or materials that are « less toxic, renewable, recycled, recyclable, of lower energy content, « natural», agro-sourced or reused » based on the eco-design principle. (Brodhag, 2021, p. 32)

• **Eco-design:** refers to the consideration of environmental issues when designing products in order to reduce its impact on the environment (Fernandes & Kadio, 2018). On the other way, this approach focuses on designing products with the least environmental impact as possible by preventing end-of-life management options (reuse, repair and recycling), which implies fostering the integration of renewable resources or materials with low environmental impact (Collard, 2020).

• **Industrial and Territorial Ecology (EIT):** this approach is based on the proximity between the territory and the industries in which it operates. In essence, it's networking enterprises and local authorities to pool materials and resources (Fernandez, Petit, & Lancini, 2014). So, it relies on the mutualization, in which a sector or an enterprise's production processes relies on the residues (materials or energies) of another (Perret, 2021).

• **Economy of functionality:** it concerns offer and sale of the product service rather than the product itself.

• **Responsible consumption:** responsible consumption consists of purchasing and using materials that have less environmental impact (Badis, 2019).

• Product life extension: re-employment, reuse and recycling

-Re-employment: signify using the product on second hand, by a new user, through donation or resale.

-Repair: is a form of maintenance that consists on putting into working order products that are out of order or defective.

-Reuse: refers to the product use by the initial user for a different object from the original one.

-Recycling: consists of the processing of waste into materials, called secondary materials or recycled materials.

2.2. Social and Environmental Challenges of Circular Economy

2.2.1. Environmental Challenges

Circular economic model inspires from nature functioning « nothing is lost, everything is transformed » (Le Moigne, 2018, p.24). To this extent, the successful completion of this ecological revolution requires the development of new production methods and techniques.

From an environmental standpoint, circular economy generates numerous beneficial effects. First, it responds to the issue of environmental pollution and the depletion of natural resources and by lowering the consumption of primary raw materials and the production of waste. In this regard, less than 40% of petroleum consumption is used in the reproduction of a used tire than another new one. As well, the valorization of used products and materials, one of the objectives of circular economy, reduces energy consumption, while retaining the embodied or intrinsic energy, resulting from the extraction and processing of raw materials. Indeed, extraction and processing of primary raw materials lead to energy overconsumption: the conversion of alumina into aluminum uses over 4% of the world's energy production, and metal ores account for 10% of it. As well as, reducing greenhouse gas emissions through lowering the extraction and processing of virgin materials. According to the Ellen MacArthur Foundation, 19% of greenhouse gas emissions are due to the extraction and processing of primary raw materials. (Le Moigne, 2018, p.p.50-51)

2.2.2. Social Challenges

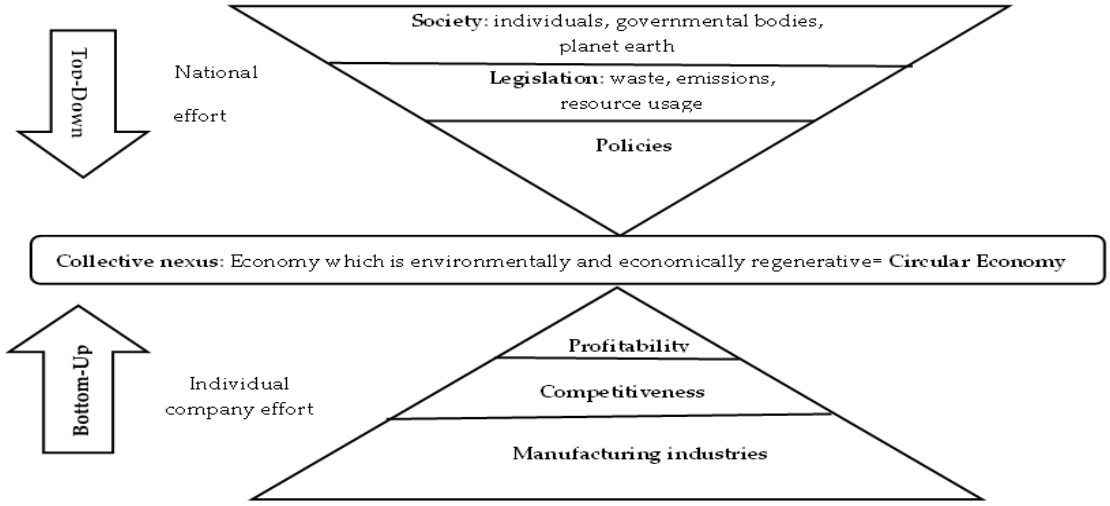
Circular economy is an innovative approach, considered as an engine of economic growth and job creation.

Activities stemming from the circular economy strengthen job creation and contribute to reducing the problem of unemployment. According to the Department for Environment, Food and Rural Affairs, remanufacturing, reconditioning and repair are also labor-intensive activities that create jobs. According to European Commission, « recycling waste creates 6 times more jobs than its energy valorization and 25 times more than its landfill ». In Europe, remanufacturing has already created 19200 jobs. In the United Kingdom, methanization would create 35000 new jobs. (Le Moigne, 2018, p.49)

2.3. Implementation and Deployment Approaches of Circular Economy

Circular economy implementation consists of the association of two approaches Top-Down and Bottom-Up. The figure below depicts peculiarities of these approaches.

Fig. 2. Implementation of circular economy



Source: Lieder & Rashid, 2016

The implantation of a circular strategy is based on the intersection of Top-Down and Bottom-Up approaches. The purpose of the top-down approach, is the clarification of public policies role on the proper functioning of circular model, by enacting laws aimed at limiting the depletion of natural resources, reducing waste and harmful emissions, causing climate change. This approach requires a high degree of government commitment to stimulate economic actors and citizens-consumers to adopt practices that support its deployment. The Bottom-Up approach describes how individual company's initiatives can contribute to the creation of an environmentally and economically regenerative economy. It bases this on the financial advantages that an enterprise can obtain from adopting this strategy, such as increased profitability and competitiveness. Therefore, enterprises represent the critical vector to create new business model that reconcile economic profitability and ecological sustainability (Loorbach & Wijsman, 2013).

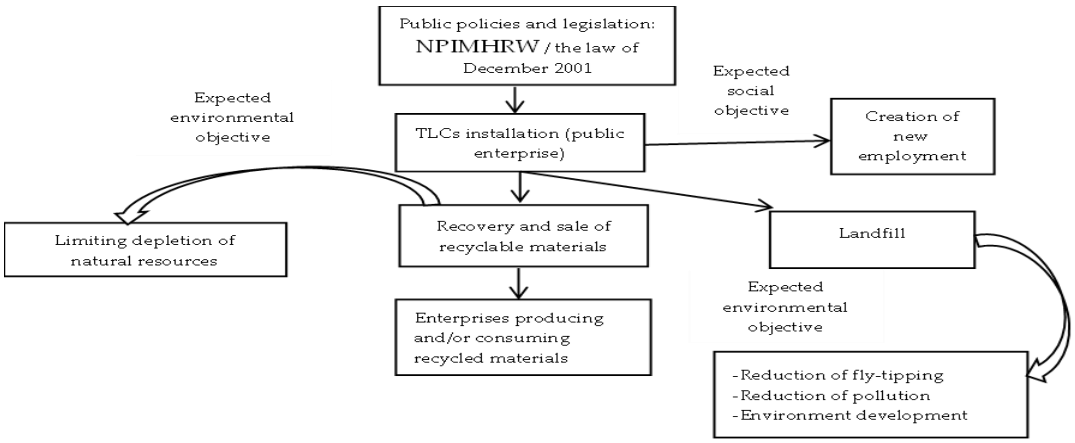
2.4. Place and Role of TLC in the Deployment of Circular Economy Approach and the Realization of its Social and Environmental Challenges in Algeria

Technical Landfill Centers are one of state institutions, whose role is to clean up and develop the environment and green spaces. These organisms are in charge of landfill activity as well as the collection, sorting, and distribution of sorted waste to recyclers. In accordance with the law 01-19 of 12 December 2001 stating « the organization of sorting, collection, transport and treatment of waste; … and the environmentally rational treatment of waste », Algeria has installed 95 TLCs (AND, 2018), on its territory, and it has adopted landfilling as a principal method to waste disposal. These TLC are designed primarily to mitigate the harmful environmental impact of waste. National Waste Agency states that in addition to the disposal of waste, these centers «ensure a transition to circular economy in which waste will be transformed into an economic sector that generates wealth and creates jobs» and they « will be key entities in the implementation of this new approach » (AND, 2018).

The figure below illustrates clearly TLC's role as an intermediary for the concretization of circular economy approach. According to the National Program for the Integrated Management of Household and Related Waste (NPIMHRW) and the promulgation of the law of December 2001, TLCs were installed. As was previously mentioned, these TLCs are mostly responsible of waste disposal through landfill method. Secondly, they are in charge of recovery and sale of recoverable materials. Thus, TLCs act as an intermediary for the realization of social challenges, by creating job opportunities, and environmental challenges of circular economy, while limiting natural resources depletion, by the recovery and sale of recyclable materials, and by reducing fly-tipping which caused pollution and deterioration of

green spaces.

Fig. 3. TLC Role on the implementation of circular economy approach and its challenges



Source: Elaborated by the authors

The realization of TLCs by government assistance is deemed necessary to address the issues associated with this strategy.

3. Methodology

Case studies can be conducted in particular situations to obtain new perspectives, allowing researchers to understand the topic under investigation (Awan & Sroufe, 2022). Therefore, we have adopted a case study research methodology to analyze in depth the contribution of TLCs to the concretization of social and environmental challenges of economy circular. To conduct this study, we have collected social and environmental data from the TLC Bougeurgeur-Guelma. Also, we have conducted semi-structured interviews with the TLC's managers (director of the TLC, vice-director of the TLC, director of the operational unit for landfill and waste sorting, human resources director). An average of one hour was lasted with each interviewee in order to elicit the principal causes related to the alteration of social and environmental indicators over the studied period.

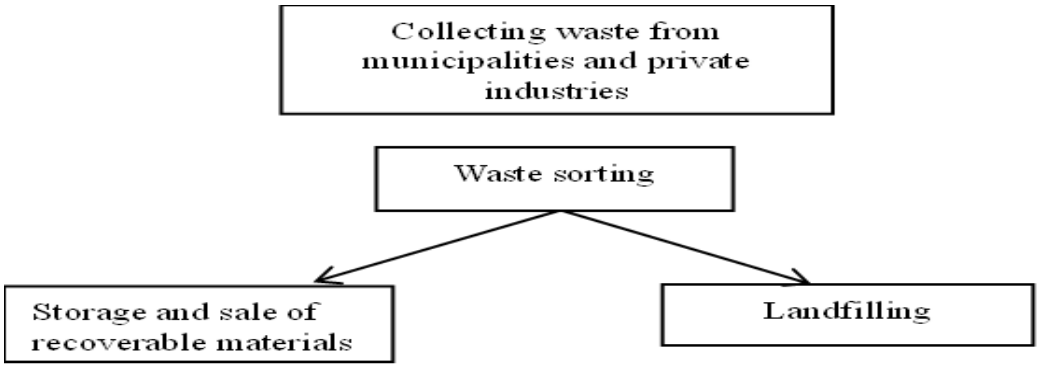
4. Results and Discussion

4.1. Presentation and Functioning of the TLC Bougeurgeur-Guelma

TLC Bougeurgeur-Guelma (TLC class II) is a public economic enterprise with industrial and commercial character. This center is responsible for the management of household and similar waste, and it has been operational since January 2012. Currently, it is responsible for the waste of 13 communes, namely: Guelma, Héliopolis, Boumehra-Ahmed, Bendjerrah, El Fedjoudj, Nechmaya, Belkheir, Guelaat Bousbaa, Djeballah, Beni-Mazline, Khezarah, Oued Znati et Bouati-Mahmoud, as well as private sector waste. Its principal mission is landfilling. In addition, sorting is a secondary operation carried out by this center to identify recyclable waste.

Management waste is done on daily basis. The following figure provides a holistic view of the waste stream circuit. Trucks bring waste from the 13 communes, and also waste from the private sector. After collecting operation, waste passes through the tipping bridge for weighing. Then, trucks dump near the locker to recover the recyclable waste by the sorting agents. Finally, the bulldozer pushes and compacts the non-recoverable waste into the locker for the final purpose of landfill.

Fig. 4. Presentation of the waste stream circuit



Source: Elaborated by the authors based on data from the TLC Bougeurgeur

4.2. Contribution of TLC Bougeurgeur on the Realization of Social and Environmental Challenges of Circular Economy

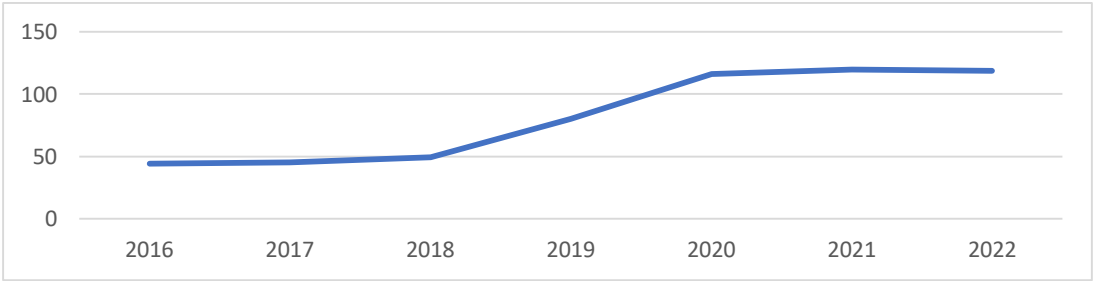
4.2.1. Contribution of TLC Bougeurgeur on the Realization of Social Challenges by the Creation of Job Positions

In Algeria, the issue of unemployment has worsened in recent years. According to statistics from the International Monetary Fund, unemployment rate is rising and reached 14.86% in 2022 (IMF, 2021).

In this context, public policies and measures have been assigned to increase employment in Algeria. The creation of public enterprises, operating in the different sectors of activity, is one of the solutions evoked by the Algerian government. As such, in the last decade, 95 TLCs have been installed on Algerian territory to fight unemployment, and to contribute to economic and environmental development.

The TLC Bougeurgeur contributed to lower the number of unemployed persons at the city of Guelma, while offering suitable employment positions for different levels of education (graduates or without a diploma), different genders (men or women), and different age groups (young people or adults). The following figure exposes the evolution of the average number of TLC Bougeurgeur employees from 2016 to 2022.

Fig. 5. Evolution of the average number of TLC Bougeurgeur employees from 2016 to 2022



Source: Elaborated by the authors based on data from the TLC Bougeurgeur

Corresponding to the diagram above, a significant evolution in the average of employees is recorded throughout the period from 2016 to 2022. The average number of employees almost doubled in 2019 (an evolution of 31 employees on average between 2018 and 2019), and has also continued to evolve over the following years. This evolution is mainly related to:

• The diversification of its activities through the creation of new operational entities connected to this TLC, namely: DDI Bouzitoun center (responsible for management of inert waste), Guelma Nadhifa center (responsible for collecting and sorting waste), Guelma Khadra center (responsible for landscaping), Guelma Daouia center (responsible for lighting management);

• The increase of communes' number under agreement with the TLC from 10 to 13, started from 2018 to 2019, which requires the hiring of additional employees (particularly the hiring of sorting agents);

• The development of new cells within the administrative team, such as: the creation of the health and safety at work and heritage safety cell in 2020.

These job positions are assured by determinate or indeterminate contracts. Additionally, recruiting goes through the same processes as any other public company: posting job offers through the National Employment Agency, screening candidates, conducting recruitment interviews and finally selecting the chosen candidates.

From that, we conclude that the average number of employees has increased over the studied period (2016-2022), indicating that the TLC Bougeurgeur has had a positive impact on the issue of job creation and, consequently, the realization of social challenges related to circular economy.

Furthermore, by guaranteeing a steady stream of recyclable materials for recycling operators, especially Small and Medium Enterprises (SMEs), this TLC indirectly supports the creation of jobs by assuring the development and viability of these businesses and, consequently, the employment opportunities they provide.

4.2.2. Contribution of TLC Bougeurgeur on the Realization of Environmental Challenges of Circular Economy

A. Reducing Pressure on Natural Resources by Recovering Recoverable Waste

Recovery of recoverable waste is one of challenges targeted by circular economy. According to the figure (6), that shows the percentage of recoverable waste from 2016 to 2022, the TLC Bougeurgeur makes minimal contributions to waste recovery: 0.41%, 0.28%, 0.29%, 0.6%, 0.05%, 0.07% in 2016, 2017, 2018, 2019, 2020, 2021, 2022 respectively. This is because of:

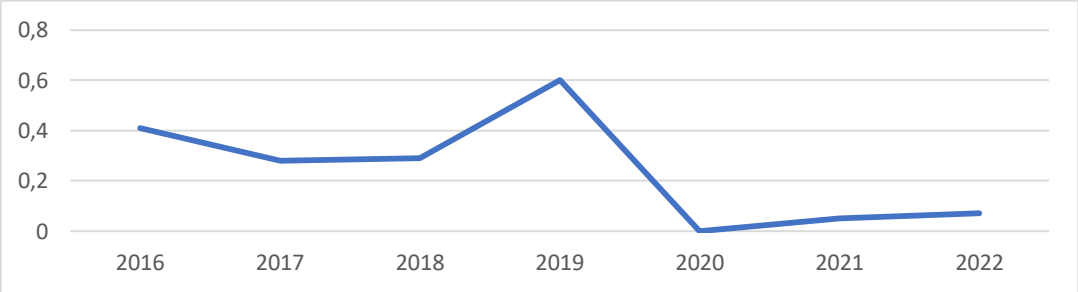
• Sorting waste activity that follows always the traditional method, requiring manual labor to get out recyclable waste from the locker during truck unloading. This method is inefficient and generates only weak quantities;

• Lack of sorting staff, particularly in 2021 and 2022, because of job rotation;

• Evolution of informal activities of waste recovery, which hampers the activity of TLC.

In order to improve the performance of the recovery operation, the «Clean Neighborhood» initiative was carried out in May 2018, to raise awareness among citizens and increase the amount of recoverable waste. In this framework, the TLC Bougeurgeur was charged for daily collection of recoverable waste from yellow bins, of selective sorting, installed in the commune of Guelma. The quantity retrieved from yellow bins during this year was 4.020 tons.

Fig. 6. Percentage of waste recovered from 2016 to 2022 (%)



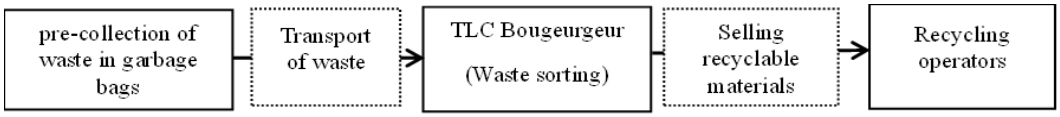
Source: Elaborated by the authors based on data from the TLC Bougeurgeur

B. Limiting Depletion of Natural Resources by the Sale of Recyclable Waste

The TLC serves as a main middleman for recycling operation through selling recyclable

materials to recycling operators.

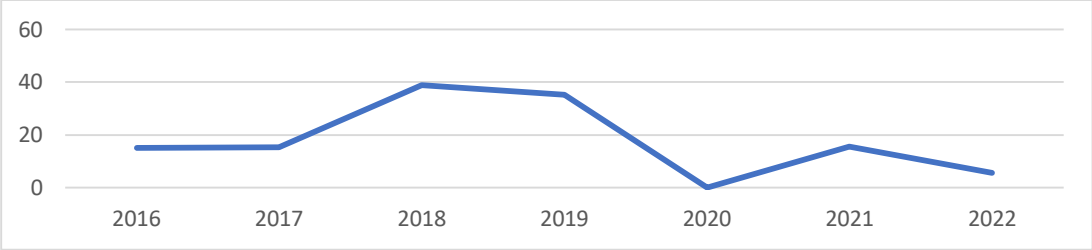
Fig. 7. TLC Bougeurgeur as an intermediary for recycling operation



Source: Elaborated by the authors

By selling sorted and crushed waste (especially plastic) to recycling businesses, the installation of this TLC has contributed to lessen the pressure on natural resources. According to data collected, the highest quantities are found to be plastic and paper-carton, unlike metal; where the quantities recovered and sold are lower. Figures below ((8); (9)) show the quantity of recoverable waste, of plastic and paper-carton respectively, sold to recycling operators among 2016 and 2022:

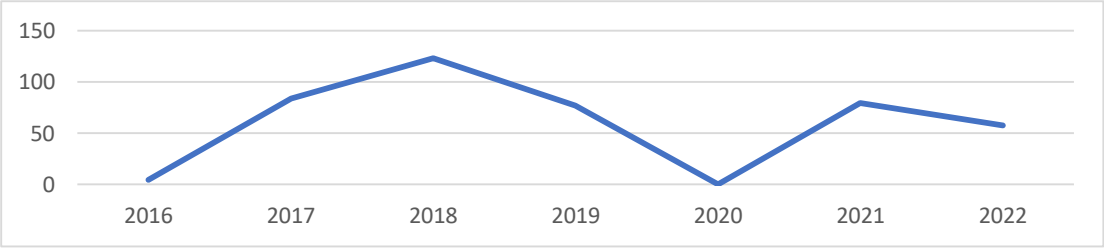
Fig. 8. Quantity sold of recovered plastic from 2016 to 2022 in (tons)



Source: Elaborated by the authors based on data from the TLC Bougeurgeur

The sale of plastic (particularly PET and HDPE) is evolving over the period from 2016 to 2018, where the peak of sales is reached in 2018 with an almost quantity of 40 tons. Following that, it started to degrade in 2019 and reached its lowest point in 2020, where no sales operation was carried out because of Corona-Covid 19. In addition, decisions made following this pandemic by the suspension of sorting agents work, means that the recovery operation was halted this year. The pandemic repercussions persisted throughout the following years (2021, 2022), despite the relaunch of waste recovery at the end of 2021, the quantity sold of plastic was only 15 tons, and continued to drop in 2022 to reach 5.1 tons; which is incomparable with other years.

Fig. 9. Quantity sold of paper-carton from 2016 to 2022 in (tons)



Source: Elaborated by the authors based on data from the TLC Bougeurgeur

The two curves of the quantity sold of plastic and paper-carton follow the same trend (see Fig. 8), Fig. 9). Indeed, there was a notable rise in the amount of paper-carton sold, with sales rising from 4.346 tons in 2016 to 122.740 tons in 2018.This increase is related also to the commune's number increase from 9 to 11, which denotes the increase of received waste quantities. Following a sharp decline in sales from 2019 to 2020, from 77 tons to 0 tons, due to the pandemic, where no recovery or selling activities were conducted. As a result of the recovery resumption, a significant uptick in paper-carton sales: (80 tons) in 2021 and (57,620 tons) in 2022. However, the decline in 2022 is related to the lack of sorting staff due to job rotation.

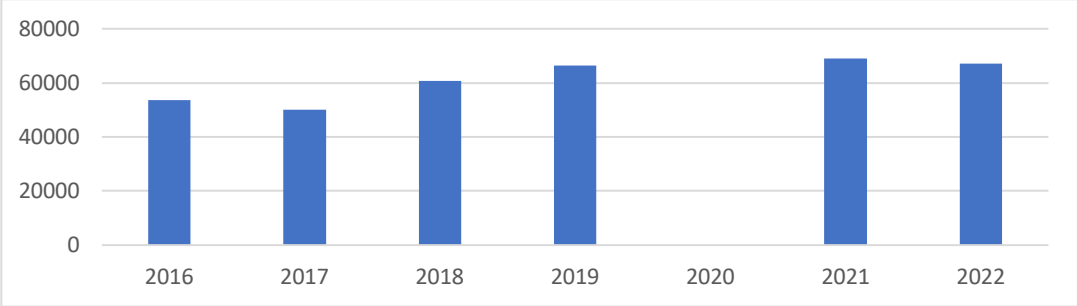
Apart from the pandemic's aftermath and the shortage of personnel for sorting, the decline in quantities sold, particularly plastic, is related to competition from the informal sector (recovery and sale of plastic) in the past two years. This is due to the competitiveness of their price compared to the TLC Bougeurgeur. Thus, the sale of recoverable waste from the TLC Bougeurgeur goes through the auction, which means that informal recycling operators buy their materials from informal suppliers in order to avoid traceability.

C. Fly-tipping Elimination by Landfill and Specialization of a Center for Inert Waste Disposal

According to TLC director declaration, the commissioning of this center has made it possible to organize waste flows and to reduce the existence of fly-tipping, at Guelma city. Consequently, the landfill activity is valuable, from an environmental standpoint. This activity leads to reducing pollution, particularly of soil and water, caused by fly-tipping, and therefore in the harmful impact of waste on the environment, due to the careful design and installation of these landfills (far from farmland, housing areas and water sources, etc.). In addition, the purpose of these landfills is to mitigate the environmental damage caused by fly-tipping, such as fires.

According to the figure (10), higher quantities of waste are received from the concerned communes and landfilled at the TLC Bougeurgeur. These quantities vary between 50000 and almost 70000 tons annually; except that in 2020 when the function was ceased due to Covid.

Fig. 10. Quantity of landfilled waste in (tons) from 2016 to 2022

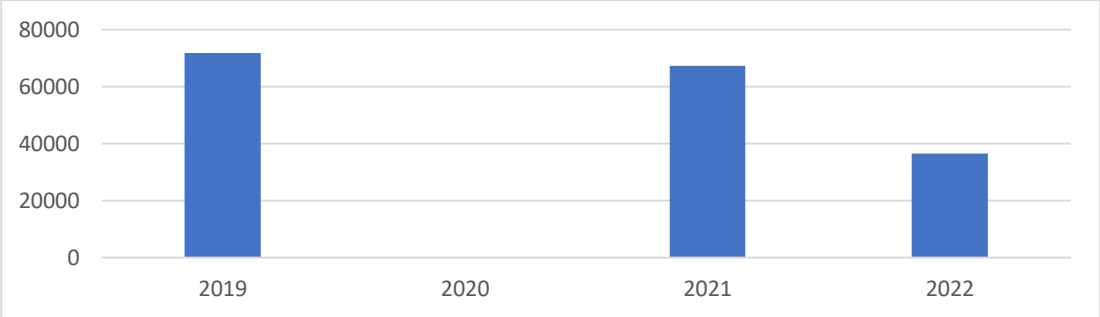


Source: Elaborated by the authors based on data from the TLC Bougeurgeur

However, it is the only TLC in Guelma, with only one locker, which is practically overexploited. It should be mentioned that out of the 34 communes in Guelma City, only 13 of them send waste to this TLC. This means that the rest of the communes dispose of their waste in fly-tipping.

Furthermore, to avoid the deterioration of the environment and green spaces, particularly agricultural land, by fly-tipping, the Bouzitoun DDI center has been opened and operational in 2019. This center is attached to the TLC, and is responsible for inert waste management. The following figure shows the quantities of inert waste received by the DDI Bouzitoun center since 2019.

Fig. 11. Quantity of inert waste received from 2019 to 2022 in (tons)



Source: Elaborated by the authors based on data from the TLC Bougeurgeur

5. Conclusion

From theoretical part, we have found that circular economy is an innovative approach, born out from the limitations of the linear economic model, aiming to meet social and environmental challenges in addition to economic ones. This model is based on seven pillars, and requires the combination between State efforts (laws, programs and plans), and private enterprises efforts for its implementation. Algerian government has also introduced several laws, programs and plans to concretize the challenges of this approach. As a result, the country has adopted landfill as principal method to waste disposal, with a large number of TLCs being installed on its territory. We have concluded as well that these TLCs have contributed to circular economy inclination and implementation, by the realization of its social (job creation) and environmental (reducing the virgin materials consumption, reducing pollution, developing the environment…etc.) challenges. This finding is checked by analyzing the TLC Bougeurgeur data. Based on the qualitative study conducted, by analyzing its social and environmental data, it appears that this center achieves effective results on the social front and considerable results on the environmental front.

On the social dimension:

A significant evolution on the average number of employees from year to year due to the expansion of TLC's Bougeurgeur fields of activity (creation of new centers, such as DDI Bouzitoun center). Also, by guaranteeing their partners constant access to recyclable materials, they ensure the viability of these enterprises, and consequently, the development of employment inside them.

On the environmental dimension:

The TLC Bougeurgeur does not contribute very effectively to the recovery operation because it follows traditional methods (manual recovery of recyclable materials by sorting agents). Nevertheless, it made an effective contribution to the sale of recoverable waste prior to covid (before 2020). However, its performance in this area has deteriorated in the post-covid years (2021, 2022) due to: the dominance of the informal sector on the secondary material market, particularly plastics during the last two years, and the shortage of sorting employees due because of job rotation. It also makes an effective contribution to the eradication of fly-tipping, by landfilling huge amounts of waste from the 13 communes and receiving huge quantities of inert waste. So, it serves to protect the environment from pollution, particularly farmland and water sources. However, the locker of this center is practically over-used, and it is unable to receive waste from the remaining 21communes of Guelma city.

From these results, this TLC contribution to the concretization of environmental impacts is minimal. Consequently, the following recommendations are proposed:

- The introduction of new sorting technologies to recover more recyclable materials;
- Increasing citizens awareness of the sorting process and the installation of selective

sorting bags in the communes of Guelma;

• Governmental sponsorship and permission are needed to expand landfill and recovery capacities for the remaining communes, by creating a new locker at the TLC Bougeurgeur, and by implementing the new TLC project of Ain-Hssainia.

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