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## A Benchmark Study of Waste Tyre Recycling in South Africa to European Union Practice

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### Abstract

The number of vehicles is increasing globally resulting in an increase in end of life tyres. Waste tyres are now considered to be a source of valuable materials and structures which can be used to produce new goods and products of useful significance. Technologies and innovations for recovering end of life tyres are well established. Reuse, re-treading, energy and material recovery of end of life tyres are viable options. However, the recycling of waste tyres is not globally successful. The aim and motivation for this study was to compare the success of South Africa in waste tyre recycling to that of countries in the European Union and elucidate on factors that can help explain the gaps in recycling uptake. The European Union tyre recycling rates are closer to 100% while in South Africa the rate is less than 20%. Thus the EU is four times more effective than South Africa in addressing the problem of waste tyres. Legal regulations banning end of life tyre in landfills as well as waste tyre management models, such as extended producer responsibility, free market and tax system were evaluated. The paper contributes to an understanding of the differences, challenges and opportunities for waste management that can be obtained from international benchmarks.

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**Keywords:** End of life tyres; Legal regulations; Waste tyre management models; Recycling of tyres

### 1. Introduction

To meet the demand for automobiles, the global market for tyres is predicted to reach 2.5 billion units by 2022 [1]. This is associated with a high number of tyres reaching end of life. Tyres are composed of different materials, which include rubber/elastomers (45 to 47%), carbon black (21.5 to 22%), metal (12 to 25%), textile (0 to 10%), zinc oxide (1 to 2%), sulphur (1%), additives (5 to 7.5%) [2]. End of life options are needed for tyres. Landfilling requires large quantities of space as tyres cannot be compacted to reduce space occupied during disposal. To reduce the space occupied by waste tyres in the landfills, shredding of the waste tyres prior to disposal is an option but high operational costs make it unattractive. Sending materials to landfill represents a lost opportunity in terms of a

circular economy and deriving more value from waste. There are solutions enabling this substantial stream of rubber wastes to be converted into energy or new polymer materials. As such, the disposal of waste tyres is considered a growing environmental problem [3] and lost economic opportunity.

According to the Recycling and Economic Development Initiative of South Africa (REDISA) Annual report, in 2014 the tyre waste arising in South Africa was 177 385 tonnes and 32% was diverted from landfill [4]. Earlier on in 2012, more than 3.4 million tonnes of used tyres were managed in an environmentally sound manner in Europe (EU27, Norway, Switzerland & Turkey). This corresponded to 95% of used tyres [5]. This a major success when compared to EU recovery rates for paper (71%) and plastics (62%) and the tyre recovery rates in South Africa [4]. There is a large gap in recovery rates

for waste tyres in South Africa compared to the EU. Thus, the aim of this study was to compare the waste tyre recycling in South Africa to the European Union and explore lessons that can be learnt in order to promote more tyre recycling or re-use. The comparison was based on the waste tyre regulations, waste volumes, landfill taxes, recycling levies, responsible bodies for recycling and recycling rates.

## 2. Waste tyre regulations

Legal regulations in SA and the EU prohibit the disposal of end of life tyres in landfill sites. While, waste tyre management models focus on achieving recovery of close to 100% of end of life tyres. Legal regulations and waste tyre management models adopted by the major manufacturers in South Africa and the European Union are shown in Table 1 [6-9].

Table 1. The legislation of used tyres recovery in South Africa and the European Union [6-9].

Republic of South Africa (RSA)	European Union (EU)
<b>National Environmental Management: Waste Act of 2008, Act No. 59 of 2008 [6]</b> Regulation 6(3) of the Waste Tyre Regulations requires all tyre manufacturers registered under REDISA to comply with the approved REDISA Integrated Waste Tyre Management Plan (IWTMP)	<b>Directive on the Landfill of Waste 1999/31/EC (1999) [7]</b> - Ban on the disposal of whole used tyres in the landfills since July 2003 and stockpiling of ground used tyres since July 2006.  <b>End of Life Vehicle Directive 2000/53/EC (2000) [8]</b> - End of life vehicles have to be recovered; tyres have to be removed from vehicles before these are scrapped.  <b>Directive on Incineration of Waste - 2000/76/EC [9]</b> the directive prohibit combustion of end of life tyres in older cement kilns

### 2.1. South Africa end of life tyre management

South Africa has formal waste tyre regulations that govern the industry. Currently, waste tyre management in South Africa is based on the National Environmental Management: Waste Act of 2008, Act No. 59 of 2008 [6]. These regulations apply to all provinces of the Republic of South Africa. They regulate the management of waste tyres. Waste type management options include, Reuse, recycling of waste tyres and energy recovery, and duties of tyre producers and tyre dealers and integrated industry waste tyre management plans.

This regulatory mechanism requires tyre producers and dealers to investigate the options of reusing or recycling waste tyres before recovering the energy potential of waste tyres or disposing of a waste tyre at a waste disposal facility. They must also ensure that the reuse, recycling or recovery of the waste tyre is less harmful to the environment than the disposal of a waste tyre.

The tyre industry in South Africa is dominated by four global tyre companies: Goodyear, Bridgestone, Continental and Sumitomo. These companies have established their tyre

manufacturing plants in South Africa to cater towards the growing demand for tyres in the country.

Tyre producers are required to register with the Minister within 30 days of commencing business providing the name and registered address of the tyre producer and the physical address where the waste tyre business will take place. The tyre producer is also required to submit an integrated industry waste tyre management plan within 120 days of registering with the minister. A tyre producer may not import, distribute or sell new or part worn tyres, unless measures have been taken to ensure that those tyres that have become waste tyres are dealt with in accordance with the provisions of the approved integrated industry waste tyre management plan.

On the other hand, tyre dealers are required by the legislation to classify any used tyre as either a part worn tyre or a retreadable casing. According to the National Environmental Management: Waste Act of 2008, Act No. 59 of 2008 [6] part worn tyre signify a used tyre that conforms to the Road Traffic Act and can be safely returned to its original intended use. A retreadable casing refers to the structural part of a used tyre that may or may not have residual tread depth for further road use. After inspection of the structural soundness a retreadable casing can be reprocessed by vulcanising new tread to the casing and can be safely returned to its original intended use. Any tyre out of these categories must be classified as a waste tyre. Tyre dealers must inflict serious damage on all waste tyres in their possession to avoid any further usage of the tyre on the road. Mutilated waste tyres must be managed in accordance with the approved integrated industry waste management tyre plan of the producer.

According to the Environment Conservation Act of National Environmental Management: Waste Act of 2008, Act No. 59 of 2008 [6], an integrated industry waste tyre management plan must provide quantities and types of tyres that are generated or imported that will become waste tyres.

In the year 2012, the Recycling and Economic Development Initiative of South Africa (REDISA) set an integrated industry waste tyre management plan. The plan supports and promotes tyre recycling. It also provides the collection and depot infrastructure required to collect waste tyres in South Africa and deliver them to approved recyclers [10]. REDISA was registered as a nonprofit making organization with the company registration number NPC (2010/022733/08). The REDISA plan was been accepted in accordance with the National Environmental Management Waste Act of 2008, Act No. 59 of 2008 [6]. Under the REDISA plan, every producer and importer of tyres and casings had to pay a contribution fee to REDISA (the manager of the plan), which was used to facilitate the collection, transport, distribution and storage of these waste tyres. The waste management fee was R2,30 (€0.14) plus VAT per kilogram of manufactured and/or imported tyres and casings. This was levied and collected by REDISA. A tyre producer had to subscribe to the integrated industry waste tyre management plan otherwise they committed an offence.

In terms of operation, REDISA registered Transporters collected tyres from dealers and other collection points and took them to nearest depot. The depot tyres were sent to recyclers either after being downsized to particular recycler

requirements, baled into manageable blocks, or in their normal form. REDISA supplied tyre feedstock to recyclers at no cost.

Examples of tyre recyclers in South Africa are South African (SA) Tyre Recyclers in Atlantis and Dassenberg, South Africa and Dawhi Rubber Recycling Rubber products in Germiston, South Africa. South African (SA) Tyre Recyclers in Atlantis who produce granules rubber products. The granules are used as shreds (for matting, sport surfaces, turf and playgrounds); granules and chips (used in athletic tracks, playgrounds, horse arenas and asphalt); crumbs and powders (used in new tyres, brake pads, road sealing, adhesives and paints); and large shred tyre chips (used in civil engineering and fuel derivatives).

Through the tyre management levy, small entrepreneurs and previously disadvantaged individuals are awarded opportunities to earn an income [10]. Currently, REDISA provided about 3152 employment opportunities. Through the REDISA plan, Small Medium-Micro Enterprises (SMMEs) and Broad-Based Black Economic Empowerment (BBBEE) are funded for establishment of depots. Tyre manufacturers and importers through the extended producer responsibility are responsible for end of life tyre management. The REDISA plan also addresses training needs. Training is provided to stakeholders to equip them with relevant skills.

In 2009, the South African Tyre Recycling Plan (SATRP) company also submitted an Integrated Industry Waste Tyre Management Plan [11]. The plan holds a company registration no: 2002/027503/08. This plan's approach was to solve the waste tyre problem in South Africa. The plan is also intended to assist the creation of jobs for previously disadvantaged individuals (PDIs) and the establishment of Small Micro Enterprises (SMEs), providing training, research and development for alternative use of end of life tyres. However, the Department of Environmental Affairs raised objections about the plan not fully addressing end of life tyres through the waste Hierarchy and failure to address the development of previously disadvantaged communities, currently involved in the informal tyre sector.

The Integrated Industry Waste Tyre Management Plan of The Retail Motor Industry Organization (IIWTMP-RMIO) also aimed at addressing unemployment, research and development and skill development. The plan also encouraged the development of new technologies for addressing end of life tyre crisis. However, it was not inclusive of key issues such as implementation strategies and cost projections.

## 2.2. European Union end of life tyre management

The tyre industry in the European Union is managed through an association known as the European Tyre and Rubber Manufacturers Association. The end of life tyres within the European Union are managed by three different models. The models are as follows: Extended Producer Responsibility (EPR), Liberal system (Free market) and the Tax system (Government responsibility, financed through a tax).

The Extended Producer Responsibility (EPR) is the most widespread system in Europe with 21 countries which adopted the legal framework [12]. The law assigns the responsibility to the tyre manufacturers and importers to be responsible for the

management chain of end of life tyres. This means that the tyre manufacturer is responsible for tyres until they are finally disposed of. The manufacturers are required by the extended producer responsibility law to collect and arrange the treatment of end of life tyres equivalent to the amount of tyres they sold either individually or collectively annually. The end of life tyre collection and treatment is financed through an environmental contribution charged upfront by end of tyre companies to its affiliated tyre manufacturers and importers on tyre sales. The fee is passed on by producers and distributors throughout the value chain to the end user. For the end user, this system guarantees transparency of costs through a visible contribution, clearly indicated on the invoices. Countries which use this system are Belgium, Czech Republic, Finland, France, Greece, Hungary, Norway, Netherlands, Poland, Portugal, Romania, Spain and Sweden.

South Africa also has the extended producer responsibility scheme, it assigns the responsibility to tyre producers and importers for management of their end of life tyres.

Under this system, the EU law sets the objectives to be met, however; it does not designate those that are responsible. As such, the key players in the waste tyre recovery chain act under free market conditions and the requirements of the law [10]. To date, the free market systems operate in Austria, Switzerland, Germany, Ireland and the United Kingdom [13]. The United Kingdom operates a "managed free market" system as end of life tyre collectors and treatment operators have to report to national authorities [12].

Denmark, Latvia, Slovakia and Croatia are some of the countries known to operate under the tax system [13]. This system requires each country to be responsible for the management of end of life tyres. Tyre producers are taxed by the state and subsequently the tax is recovered from the tyre users. It is reported that this way tyre producers are assured that their end of life tyres have a suitable recycling and recovery route. A tax or levy is used in the organization of the waste tyre collection system and remuneration of the operators in the waste tyre recovery chain [12].

## 3. End of life tyre volumes

Fig. 1(a) compares the end of life tyre growth from 2011 to 2015 of countries operating under the three management models, extended producer responsibility, tax system and the free market in the European Union. While Figure 1(b) shows this data for 2015 normalized according to Gross Domestic Product (GDP) of each country. Under the extended producer responsibility, the research paper will focus on France, Spain, Sweden and South Africa. Denmark, Latvia and Slovakia will be used to evaluate the tax system, while under the free market the focus will be on Austria, Germany and the United Kingdom. In 2011, the end of life tyres arising from the European Union was 2645 kilo tonnes [5]. These volumes increased to 2765 kilo tonnes in 2012 and 2883 kilo tonnes in 2013 [12].

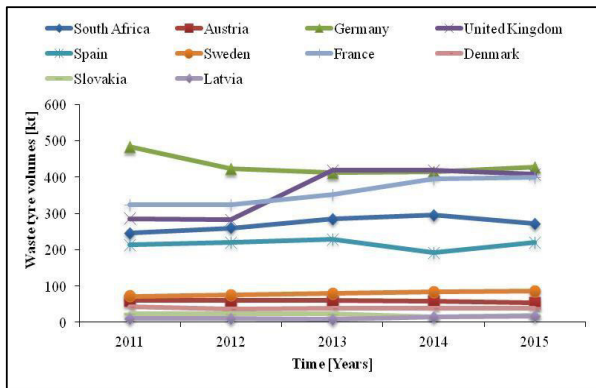


Fig. 1(a) End of life tyre volumes in South Africa and the European Union, data derived from [4, 5, 12].

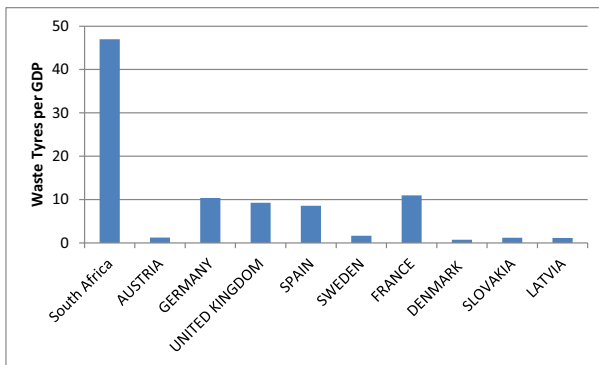


Fig. 1(b) End of life tyre volumes per GDP in South Africa and the European Union in 2015

Since 2011 there has been an overall growth in tyre arising in South Africa from 246.6 million tonnes to 260 million tonnes in 2012. The End of life tyres rose sharply to 285 kilo tonnes in 2013 and 295 million tonnes in 2014. However, REDISA reports that by the end of 2013, it collected 16 kilo tonnes. About 73, 182 and 239 kilo tonnes were collected in 2014, 2015 and 2016, respectively. Compared to France, Spain and Sweden under the extended producer responsibility management system, South Africa still have millions of tyres lost within the process.

Germany and the United Kingdom are amongst the largest contributors of end of life tyres in the European Union operation under the free market system. According to figures published by the European Tyre & Rubber Manufacturers' Association in EU Member States, Germany, United Kingdom and Austria, 483, 286 and 60 kilo tonnes of end of life tyres were generated in 2011, respectively [12].

Fig. 1(b) shows that South Africa has a relatively high number of waste tyre to GDP ratio compared to all the other countries in this study. One inference from this is that the South African economy is relatively low output (GDP) compared to the waste volumes that have to be processed. The causal effect or significance of the economic base on waste management is a factor that needs to be investigated. Germany, UK, Spain and France have comparable ratios of waste tyre to GDP ratio. Austria, Sweden, Denmark, Slovakia and Latvia have the

smallest ratio of waste tyres to GDP ratio mainly driven by low waste tyre volumes.

#### 4. Recycling Rates

Fig. 2, shows the tyre recycling rates. In the European Union, countries such as Spain, Sweden and France which operated under the extended producer responsibility system achieved 100 percent recycling rates since 2011 to date. Similarly, Germany and Austria in the same years achieved 100 percent recycling rates of end of life tyres under the free market system. However, under the free market system, countries such as the United Kingdom still reports recycling rates of 98, 96, 94, 97 and 98 percent from 2011 to 2015. Denmark again through the tax system achieved 100 percent recycling rates since 2011 to date while Slovakia only had 100 percent recycling rates in 2011 to 2013. In 2014 and 2015, the use of end of life tyres dropped to 80 and 89 percent, respectively. Latvia on the other hand achieved overall end of life tyre usage of 100 percent in 2013 with a balance of 50/50 use between materials recovery and energy recovery. The recycling rates significantly dropped to 53 and 56 percent in 2014 and 2015. This was because the use of end of life tyres through energy recovery dropped about 50 percent (2.250 kilo tonnes) as compared to 2011, 2012 and 2013.

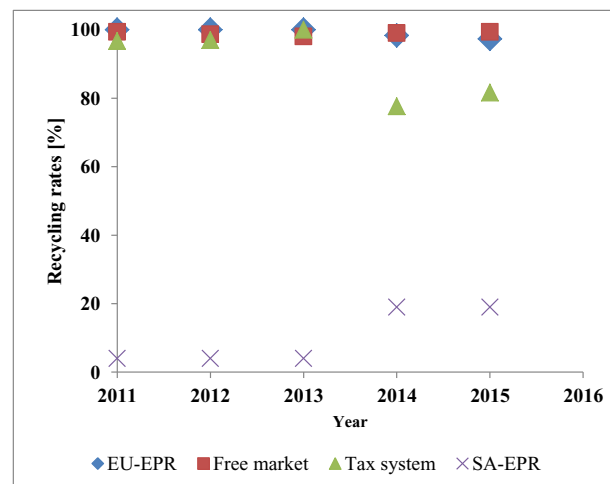


Fig. 2. End of life tyre recycling rates in South Africa and the European Union [4, 14-18]

In 2011, 4% recycling rate of end of life tyres was reported in South Africa. Since November 2012, through the Recycling and Economic Development Initiative of South Africa (REDISA) and the Integrated Industry Waste Tyre Management Plan (IIWTMP), approximately 170 000 tonnes of waste tyres have been recycled by October 2016. In 2014, REDISA reported 19% recycling rates of end of life tyres in 2014. There is still a large gap in terms of the success of tyre recycling for South Africa when compared to the EU countries reported here.

**5. End of life tyre management**

Fig. 3 shows end of life tyre management through recovery routes such as reuse, retreading, material recovery and energy recovery in the European Union.

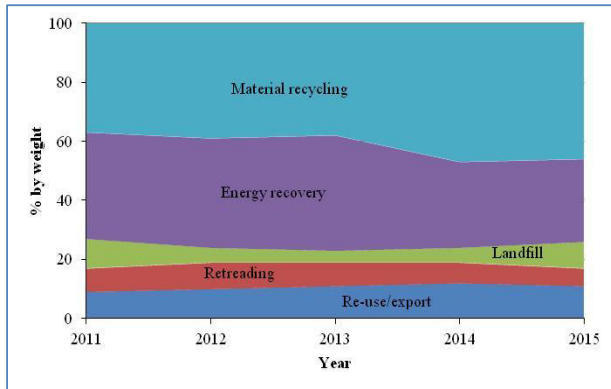


Fig. 3. End of life tyre management in the European Union [14-16].

The EU has seen a considerable decline in landfilling. In 2010 and 2012 only 4% and 5% of end of life tyres ended up in landfills, respectively [7]. In 2012, 19% (650,000 tonnes) were used mainly for re-treading, reuse and exports [7]. About 39% (1.34 million tonnes) end of life tyres have been recovered through material recovery. Energy recovery made up 37% (1.26 million tonnes) with the cement industry as the main user of end of life tyres [7]. By 2013, the percentage of end of life tyres processed through energy recovery increased to 48%. In 2015, only 9% of end of life tyres arising was landfilled, against 91% of other recovery routes (11% reuse/export, 6% re-treading, 46% material recycling and 28% energy recovery).

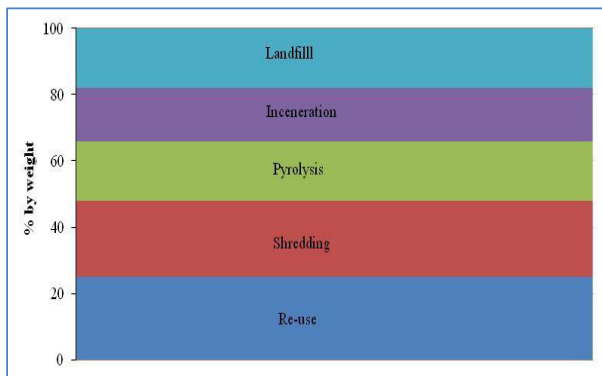


Fig. 4. End of life tyre management in South Africa in 2016 [18].

While the European Union reports high recycling rates of end of life tyres, the same is not true for South Africa. According to the South African Tyre Recycling Process Company (SATRP Co) South Africa was still faced with an estimated 800 million tyres in piles in the Western Cape region. In 2016, Hartley and Daniels [18] reported that recovery methods for end of life tyres in South Africa were re-used up to 25% of the market, shredding (23% ); incineration (16%),

pyrolysis (18%) and landfill (18%). This is shown in Fig. 4. Compared to the European Union, more work still has to be done regarding the end of life tyre management in South Africa.

**6. The future of end of life tyre options in South Africa**

Recently South Africa published the National Gazette No 40200 of 11-August-2016, Volume 614 on National Pricing Strategy for Waste Management (NPSWM) [19]. The new pricing supports the National Environmental Management: Waste Amendment Act, 2014 [20]. The Waste Act provides for economic instruments, and empowers the Minister of Environmental Affairs, in concurrence with the Minister of Finance, to make regulations for incentives and disincentives to encourage a change in behavior towards waste generation and management. There is a commitment to address the underpricing of waste services which undermines waste minimization efforts. The strategy is to have broad range of economic instruments implemented, as and when deemed appropriate to correct the market failure, at various points (upstream or downstream) along the waste value chain [19].

As from 1 February 2017, The South African Revenue Service (SARS) is now charged by law with the responsibility to collect a tyre tax and or environmental levy on tyres from the manufacturers, importers or producers of tyres and to pay these funds into the National Revenue Fund, according to section 213(1) of the Constitution. REDISA can no longer collect its contribution from tyre producers or importers in South Africa in terms of the REDISA plan unless such a contribution was due before 1 February 2017. The new arrangement moves the waste coordination from REDISA to the government, aims to address disincentives for waste management along the value chain. The impact of the new change is still to be evaluated.

**7. Discussions and Conclusions**

This paper has shown that there is an increasing number of end of life tyres. The European Union and South Africa have the same challenge of addressing the growing legacy of waste automobile tyres. Both EU and South Africa use waste tyre management models and restrictive legal regulations which ban the disposal of end of life tyres in landfill. Examining these differences may help shed light on improvements for either jurisdiction. The EU is significantly more successful in terms of tyre recycling rates and promoting higher waste hierarchy solutions. The EU tyre recycling rates are closer to 100% while in South Africa the rate is less than 20%. Thus the EU is four times more effective than South Africa in addressing the problem of waste tyres.

South Africa like the majority of EU countries rely on the extended producer responsibility scheme and tax levy. For the EU both EPR and free market waste tyre systems are making significant progress in terms of recycling rates. This suggests that there are more significant factors, for example, related to legislation and enforcement that are critical for successful uptake of recycling of tyres.

The EU, by implementing the End of Life Vehicle Directive 2000/53/EC (2000) it is enabling car users to contribute to waste tyre management thus engaging the waste supply chain. This is relevant for South Africa. Additionally, the EU has a Directive on Incineration of Waste - 2000/76/EC, and this obviously limits the environmental impact of addressing waste tyres by energy generation. This regulation will be important for a country like South Africa to reduce environmental damage and also promote higher waste hierarchy options by making the low waste hierarchy option less easy. These instruments should be considered by the South African authorities.

In South Africa, job creation and helping of disadvantaged communities is a key aspect for third party waste tyre recycling companies to get approved. This may be a lesson for the European Union in terms of maximising the social value of waste processing. The social metrics, and value of waste tyre processing needs to be evaluated and maximised for citizens. Waste processing is an opportunity for community engagement, job creation and new industrial systems.

A significant number of tyres are exported and imported. If the global nations legislated for companies to be responsible for end of life management for tyres that they sold internationally then this could have an impact in kick starting international collaborations and support for tyre end of life options in other countries. This is an issue relevant to other products used in an international market.

In some EU states, the manufacturers are required by the extended producer responsibility law to collect and arrange the treatment of end of life tyres equivalent to the amount of tyres they sold either individually or collectively annually. This is a very interesting point that could be considered for South Africa that could enable a step change in collection and recycling rates. Additionally, the regulation of emissions from recycling waste processing facilities could be a method for South Africa to promote cleaner processing and or higher waste hierarchy options.

Tyre recycling rates in South Africa are increasing but still lags behind the European Union and hence continuously evaluating the waste management systems will help in closing the gaps and identifying opportunities of improvement. In countries where recycling rates are reaching 100%, a focus on improving the social good of waste reprocessing and reducing the overall environmental burden will help move the agenda forward.

#### Limitations of the study

This study is based on information sources publicly available in literature and does not take into account not disclosed recycling rates and waste volumes. The paper helps to illustrate emerging trends from what is known and not to define absolute waste volumes.

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#### Data Statement

All data supporting this study was derived from the references provide in this paper.

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