

EFFECTIVENESS OF POST-CONSUMER METAL PACKAGING RECOVERY PRACTICES IN SA

SUBTHEME: SUSTAINABLE DEVELOPMENT AND GREEN ECONOMY

Manikam Michael Nadar, Manduth Ramchander, Raveen Rathilall, and Kishan Singh
Durban University of Technology: Department of Operations and Quality Management

ManikamN@dut.ac.za, Manduthr@dut.ac.za, Raveenr@dut.ac.za, kishan@metpacsa.org.za

Author's Bibliography

Author 1: Manikam Michael Nadar

Manikam Michael Nadar is a lecturer at the Durban University of Technology, Department of Operations and Quality Management. His qualifications include: a Diploma and a BTech degree in Human Resource Management, a Masters and a Doctor of Philosophy degree in Quality Management. His expertise extends beyond the classroom, as he has published articles in the fields of Safety, Health, Environment, and Quality Management, and has presented research papers at prestigious conferences such as the 2021 Mbali Virtual International Conference hosted by the University of Zululand and the 2023 BRICS Research Virtual International Conference hosted by the University of Kota, India.

Author 2: Manduth Ramchander

Manduth Ramchander is an Associate Professor and the Head of Department of Operations and Quality Management at the Durban University of Technology. His qualifications include: BPaed(Sc), NDip (Engineering), Diploma in Management Sciences, MBA and D.Com. He has previously lectured at the University of Zululand and thereafter at the University of KwaZulu-Natal. He has published in the fields of Teaching and Learning, Entrepreneurship Education, Research Methodology, and Operations and Quality Management.

Author 3: Raveen Rathilall

Raveen Rathilall serves as a lecturer in the department of Operations and Quality Management at the Durban University of Technology. His educational background encompasses qualifications in engineering, statistics, and quality. With over a decade of experience in the manufacturing sector, he has developed extensive expertise in production and process engineering, quality management, and reliability engineering. His research focuses on process optimisation through statistical engineering, quality management principles, and Lean six sigma methodologies to enhance continuous improvement.

Author 4: Kishan Singh

Kishan earned his BSc from the University of Durban Westville in 1987 and a Post Graduate qualification in Management Sciences in 1995. In 2016, he achieved Lean Six Sigma Black Belt status through the Six Sigma Management Institute, USA. He also holds a master's degree and PhD degree in Business Administration. With

nearly 35 years of experience in training and consulting, Kishan specialises in business systems design, quality management, supply chain management, business risk management, environmental sustainability and packaging technology. He is currently the CEO of MetPac-SA, focusing on the circular economy of metal packaging in South Africa.

¹ Correspondence Author

Abstract

The South African packaging industry's economic trends, coupled with the 184,000 tons of metal packaging introduced into the market in 2022, underscore key socio-economic and socio-political challenges in the collection, recovery, and recycling of post-consumer metal packaging. A Circular Economy shifts from the linear "take-make-use-throw" model to a sustainable system that minimises environmental impact and retains packaging materials like aluminum and ferrous within the economy.

In 2022, South Africa recovered 53.48% (98,403 tons) of post-consumer metal packaging out of 184,000 tons placed on the market, falling 5.52% short of the DFFE target. Projections indicate this gap could expand to 9.19%. Failure to meet recovery targets may lead to penalties, potentially threatening business closures in the metal packaging industry.

This study focused on examining the effectiveness of post-consumer metal packaging recovery practices in SA. The objective of the study was to evaluate the current SA post-consumer metal packaging recovery practices by executing two qualitative surveys, administered to metal packaging convertors / brand owners and recyclers in South Africa. The data analysis process involved reviewing participant information and conducting thematic analysis to systematically summarise large datasets, highlighting similarities and differences while extracting key insights from the research findings.

The study found that inefficiencies in collection, recycling systems, and infrastructure, along with inadequate policy support and a lack of incentives for informal waste collectors, are hindering post-consumer metal packaging recovery, causing it to fall short of national targets with a projected widening gap.

Keywords: Post consumer metal packaging, green economy

1 Introduction

Following the gazetting of the Extended Producer Responsibility (EPR) legislation by the Department of Forestry, Fisheries and Environment (DFFE) on 5 November 2021, the South African packaging industry was required to show continual, year-on-year improvements in the recovery and reuse of post-consumer packaging materials (Packaging SA 2023: para. 1 line 2; Modise 2023). The DFFE set a target recovery rate for post-consumer metal packaging of 59% for 2022, with a planned increase to 67% by 2026 (South Africa. Department of Forestry, Fisheries and Environment 2023). For comparison, the 2022 DFFE target of 59% was notably lower than the 2021 European benchmark of 78.5% (Rivers 2023).

Although metal possesses intrinsic value due to its high recyclability without degradation of its properties, as highlighted by Deshwal and Panjagari (2020), the recovery rate of post-consumer metal packaging in South Africa has stagnated over the past two decades, with little to no growth projected (Braithwaite et al. 2021). This trend implies that South Africa's metal packaging recovery rate lagged significantly behind that of Europe and based on the current post-consumer metal packaging recovery systems in South Africa, the DFFE's recovery targets are unlikely to be met unless strong and effective interventions are implemented to bridge the projected shortfall of 9.19%.

South Africa's current post-consumer metal packaging recovery system relies heavily on unemployed, informal waste pickers, a dependence that renders the system unsustainable (Council for Scientific and Industrial Research 2017). This suggests that the metal packaging industry benefits from the unpaid labour of informal waste pickers, raising concerns about its neglect of social responsibility.

The study aimed to propose a model that will improve the recovery and recycling rates, as well as the data reporting integrity, of post-consumer metal packaging in SA, enhancing the metal packaging circular economy, aligning with global sustainable development principles and South African legislation. The following are the key objectives of the study:

- i. To evaluate the current South African post-consumer metal packaging recovery model against global best practice models by deploying two qualitative surveys.
- ii. To determine the reliability of the current South African post-consumer metal packaging data acquisition and reporting systems by deploying two qualitative surveys.

The following are the research questions that stemmed from the research objectives:

- i. How effective is the post-consumer metal packaging recovery model in SA?
- ii. How accurate and reliable are the South African post-consumer metal packaging data acquisition and reporting systems?

2 Literature Review

According to the 2022 South African packaging statistics report by Braithwaite and Musingadi (2022), the metal packaging industry saw a 12.3% increase in volume in 2021, primarily driven by strong demand for beverage cans, staple food cans, and other metal packaging. Meanwhile, the industry's value rose by 61.7%, due to sharp increases in raw material costs. These price hikes, however, limited margin growth across both raw material suppliers and converters, as passing on the added costs throughout the value chain proved challenging.

In 2022, the metal packaging industry experienced a slight volume decline of 0.7% but a 3.9% increase in value. The drop in volume was mainly attributed to supply constraints in the drum sector, though this was partially offset by steady sales in the cans sector, supported by a continued recovery in the food services industry and sustained demand for both alcoholic and non-alcoholic beverages (Braithwaite and Musingadi 2023). Figure 1 illustrates the SA packaging market growth trend from 2012, estimated to 2023.

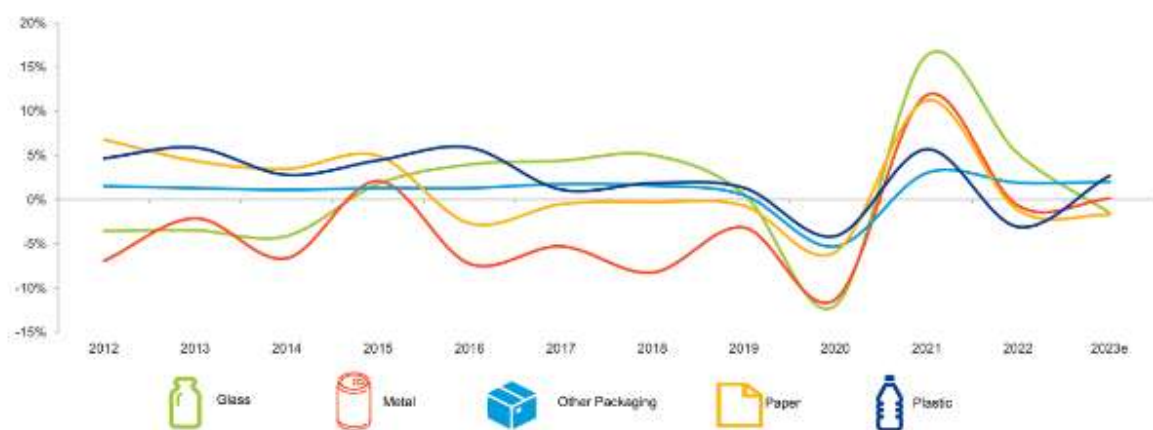


Figure 1: Year-on-year SA packaging market trend (Source: Adapted from Braithwaite and Musingadi 2023)

Figure 1 illustrates the slow yet steady growth of glass, metal, paper, and plastic packaging in South Africa over the past decade, up to the estimated figures for 2023. The only exception was in 2020, when all packaging substrates experienced negative growth due to the impact of COVID-19 lockdown restrictions (Braithwaite and Musingadi 2023). This pattern underscores the need for a robust and sustainable post-consumer metal packaging recovery model, despite anticipated challenges that will affect multiple stakeholders across the South African metal packaging value chain, including raw material suppliers, converters, brand owners, and the retail sector.

The South African packaging industry relies heavily on the intricate interdependence between raw material suppliers, converters, brand owners, and retail groups across its multiple supply chains. This interconnectedness is crucial both upstream and downstream to ensure the efficient movement of packaged products and related information, ultimately fulfilling the needs of the South African consumer. Converters are synonymous with manufacturers and refer to entities that transform raw materials into consumer and industrial packaging, while brand-owners are individuals or organisations that own and manage a specific brand or trademark, directing its

strategy, marketing, and overall identity (Board Committee 2023). Figure 2's bar chart illustrates the growth trajectory of the South African packaging sector from 2012 to 2022, showing a consistent upward trend that was only disrupted in 2020 due to the economic slowdown caused by COVID-19 trade restrictions. This data highlights the industry's year-on-year growth and underscores its expected contribution to the South African economy in terms of transformation and job creation, as detailed in the Council for Scientific and Industrial Research (2017) report.

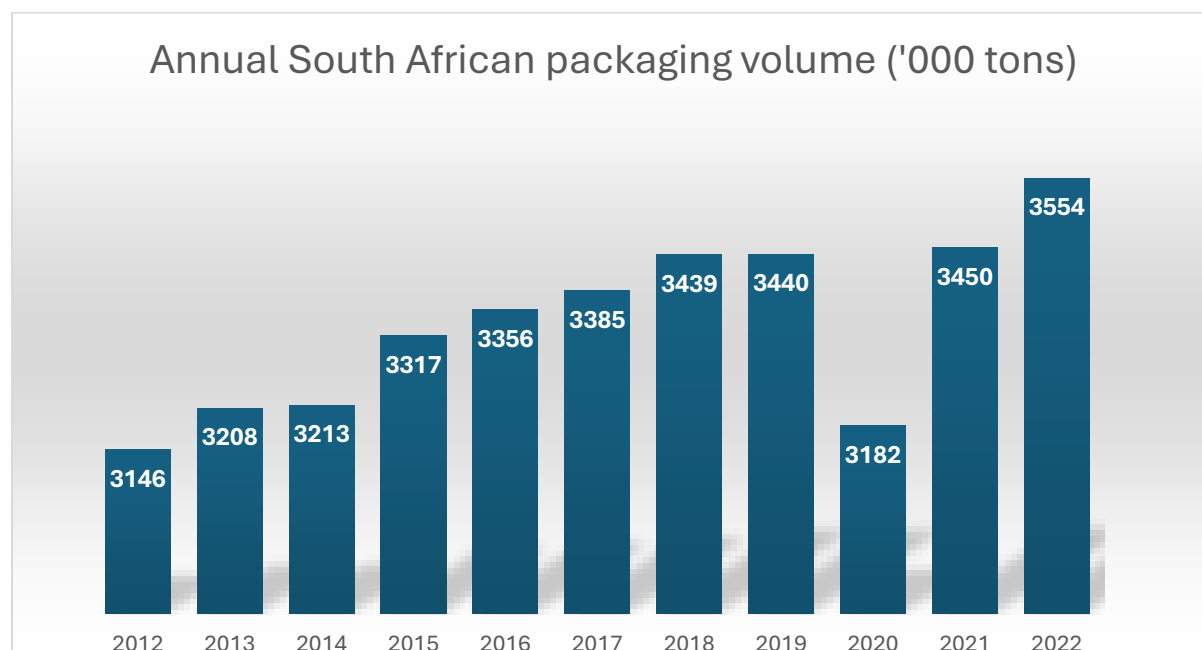


Figure 2: Growth of the SA packaging industry. (Source: Adapted from Braithwaite et al. 2021; Braithwaite and Musingadi 2023)

Based on historical trends and South Africa's growing population, packaging volumes are expected to continue increasing annually, indicating a need to strengthen post-consumer packaging recovery infrastructure to accommodate the increasing volume effectively.

Figure 3 illustrates the correlation between South Africa's packaging GDP and the national GDP, with graphical trends indicating a strong positive relationship, as noted by Tinga (2019).

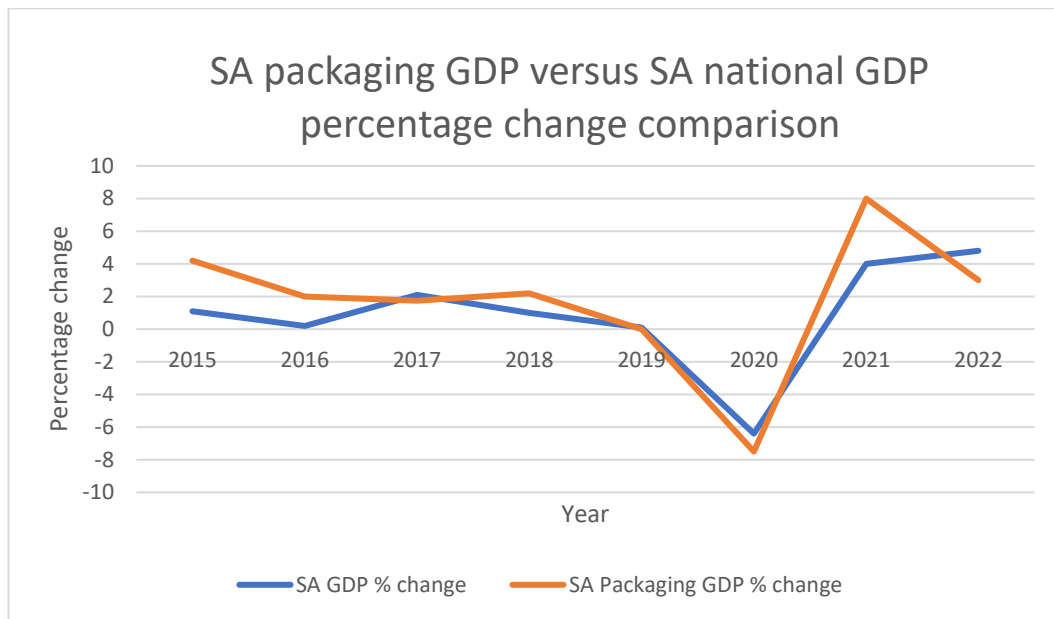


Figure 3: Correlation between year-on-year changes in SA packaging GDP and SA economic GDP (Source: Adapted from Tinga 2019; Braithwaite and Musingadi 2023)

Figure 3 correlation suggests that the packaging GDP serves as a reliable indicator of the overall strength of the South African economy.

Table 1 reflects points that are pertinent to the recent challenges facing the packaging industry in SA.

Table 1: Challenges in the SA Packaging industry

No.	Challenges	Citation
1	The South African economy suffered a major setback due to the mid-2021 riots in KwaZulu-Natal and Gauteng, which disrupted local industries and caused lasting damage to infrastructure and operating businesses, recovery from which is expected to take years. Additionally, the multiple COVID-19 lockdowns imposed significant emotional strain on the population, leading to reduced productivity and widespread job losses, which in turn adversely affected the packaging industry.	Africanews (2021)
2	South Africa's unemployment rate rose from 2021 to 2022, reaching 31.9% in the second quarter of 2023, reflecting ongoing instability within the service and manufacturing sectors	Trading Economics (2023)
3	The 2022 international conflict between Russia and Ukraine has impeded South Africa's economic progress, with adverse effects particularly felt in the energy sector due to Russia's role in the natural gas market, and further exacerbated by global shortages of fertiliser components, maize, and wheat.	Braithwaite and Musingadi (2023)
4	The ongoing Israel-Palestine conflict is expected to impact the South African economy due to the resulting rise in crude oil prices.	Watson (2023)
5	The packaging industry, due to the recent EPR legislation, will be paying EPR fees based on tonnage of packaging placed in the South African economy. Brand-owners must select materials and design packaging that facilitate easier recovery and recycling, reducing their EPR liability; this is referred to as an "eco-modulated" approach to EPR fee determination.	Modise (2023)

Source: Researcher's own construction

As evident in Table 1, despite the challenging trading conditions during and after the COVID-19 pandemic, as well as the ongoing Russia-Ukraine and Israel-Palestine conflicts, the packaging industry has shown remarkable resilience, sustaining supply chains, maintaining the lifestyles of South Africans, and continuing to contribute to the national GDP.

In 2017, the Department of Forestry, Fisheries, and the Environment (DFFE) implemented Section 28 of the National Environmental Management: Waste Act (NEMWA), known as the "duty of care" provision, which mandates the prevention of environmental pollution across South Africa (Muller 2020). This was followed by the

enforcement of Section 18 in May 2021, focusing on Extended Producer Responsibility (EPR) within the South African packaging industry (Modise 2023). EPR is a regulatory approach that shifts the responsibility for recovering post-consumer packaging materials from the government to the producers of those materials (Gadnis 2023). These producers, which include packaging converters, brand-owners, and retailers, are thereby held accountable for managing the entire lifecycle of their packaging, including collection, recycling, waste management, and proper disposal (Gadnis 2023).

Together, Sections 28 and 18 require packaging producers and brand-owners to take responsibility for the recovery and reuse of post-consumer packaging, aiming to reduce pollution in public spaces such as parks, gardens, streets, rivers, oceans, and landfills (Muller 2020). This responsibility includes establishing Material Recovery Facilities and developing business infrastructures to support nationwide recycling efforts. The recovered materials and energy are then reintegrated into manufacturing processes, contributing to circular economy models and aligning with sustainable development goals (Didenko, Klochkov, and Skripnuk 2018).

The legislative pressure led to the establishment of substrate-specific, non-profit packaging Producer Responsibility Organisations (PROs), funded by members operating within their respective packaging stream value chains to fulfill the compliance requirements of the EPR legislation (Packaging SA 2023). Under the new EPR regulations in South Africa, all packaging producers with an annual production volume exceeding 10 tons are classified as “obliged industries” and must either join an existing PRO or develop an individual EPR scheme for their products (South Africa. Department of Forestry, Fisheries and Environment 2020).

Packaging SA serves as an umbrella organisation representing packaging converters, brand-owners, PROs, and other stakeholders within South Africa (Packaging SA 2023). The creation of material specific PROs has focused efforts on managing post-consumer packaging recovery and recycling in South Africa (Muller 2020). These PROs are actively driven by their respective packaging industry sectors and are responsible for maximising the recovery and reuse of specific packaging materials, either by returning them to their original manufacturing processes or redirecting them into alternative production paths. Ultimately, their goal is to divert used packaging materials from landfill sites, as emphasised by the Council for Scientific and Industrial Research (2017).

The implementation of EPR regulations in South Africa, along with the establishment of PROs, represents a major step toward a circular economy by holding producers accountable for managing their packaging waste, thereby reducing the collection and disposal costs that were previously borne by the public (Howells 2022). The National Environmental Management: Waste Act 59 of 2008, together with its 2013 list of waste management activities, requires obtaining a waste management license for re-use, recycling, or recovery operations involving significant quantities of general or hazardous waste (Rapson and Novotny 2021). This requirement may have important implications for major producers or PROs regulated under the EPR framework and sector notices, yet the packaging industry has not yet addressed these potential consequences (Rapson and Novotny 2021).

According to Muller (2020), the PROs are tasked with responsibilities including close collaboration with municipalities to enhance post-consumer material recovery and the development of packaging recovery infrastructure across key regions in South Africa. Muller (2020) further notes that these organisations have

actively worked in recent years to promote and sustain circular economy models within the South African packaging industry, engaging a broad range of stakeholders such as material suppliers, converters, brand-owners, retailers, informal waste pickers, buy-back centers, recyclers, foundries, and consumers. These PROs operate under the umbrella of Packaging South Africa (PSA), which represents the entire packaging industry in the country (Packaging SA 2023).

The EPR scheme outlined in Government Gazette 43879 specifies the full statutory obligations of a PRO, including the following key responsibilities (South African. Department of Forestry, Fisheries and Environment 2020):

- i. Ensuring compliance with EPR legislation,
- ii. Managing material data and reporting to the DFFE on the annual percentage of packaging material recovered, percentage recycled, recycled content, waste-to-energy statistics, data source verification reports, internal audit reports, and EPR fee calculations.
- iii. Implementing waste minimisation or avoidance strategies,
- iv. Engaging with municipalities to develop packaging recovery infrastructure,
- v. Increasing demand for recyclables,
- vi. Conducting packaging material flow analyses and Life Cycle Assessments (LCA),
- vii. Paying waste picker service fees for identified products.

To address the shared challenges arising from Section 18 of NEMWA and the accompanying EPR regulations that define the legislative responsibilities of PROs, a collective decision was made by the PROs to collaborate and leverage the advantages of joint effort and economies of scale; this led to the establishment of the Paper and Packaging PRO Alliance, a non-profit organisation (Modise 2023; Packaging SA 2023).

According to the minutes of MetPac-SA's fourth Annual General Meeting (AGM) held on 31 August 2023, MetPac-SA is a Producer Responsibility Organisation (PRO) registered with the Department of Forestry, Fisheries and the Environment (DFFE) under EPR registration number 19/7/5/P/PRO/20210720/005, and operates as a non-profit company as per Section 21 of the Companies Act No. 71 of 2008, with CIPC registration number 2017/216419/08 (Board Committee 2023). Representing the metal packaging value chain in South Africa, MetPac-SA serves 67 members, ranging from raw material suppliers and converters to brand-owners and retailers, by defining metal material flow paths and reporting to the DFFE on post-consumer metal packaging recovery, recycling, imports/exports, and waste-to-energy initiatives (Board Committee 2023). Its primary objectives include fulfilling EPR obligations on behalf of its members, promoting industry-wide metal packaging recycling and re-use, ensuring stakeholder alignment, operating as a self-regulating and self-funding entity, managing communications and data, and advancing environmental sustainability. Additionally, through the Paper and Packaging PRO Alliance, MetPac-SA collaborates with other packaging PROs to implement a unified, sustainable EPR strategy aligned with national development goals (Modise 2023).

The data in table 2 demonstrates actual post-consumer metal packaging material recovery statistics from 2020 to 2022, estimated for 2023, and forecast to 2024.

Table 2: post-consumer metal packaging material recovery statistics from 2020 to 2022, estimated for 2023, and forecast to 2024.

Metal packaging in SA	2020	2021	2022	2023 estimated	2024 forecast
Tons placed in the market	152 391	180 165	184 000	183 046	186 920
Post-consumer recovery in tons	100 349	111 036	98 403	96 986	98 712
DFFE Target in tons	Not available	Not available	108 560	111 658	115 890
Post-consumer recovery rate%	65.85%	61.63%	53.48%	52.98%	52.81%
DFFE Target	Not available	Not available	59.00%	61.00%	62.00%
Gap	Not applicable	Not applicable	5.52%	8.02%	9.19%

Source: Adapted from Braithwaite and Musingadi (2023) and (South Africa. Department of Environmental, Forestry and Fisheries 2023)

Table 2 highlights that post-consumer metal packaging recovery rates in South Africa are currently falling short of the Department of Forestry, Fisheries and the Environment (DFFE) targets, indicating that the metal packaging industry will require urgent and robust interventions to meet these targets within the next three years. Notably, the 2021 recovery rate of 61.63%, as shown in Table 2 is significantly lower than the European benchmark of 78.5% for the same year (Rivers 2023). Consequently, the South African metal packaging industry must adopt global best practices and intensify efforts to maximise recovery and re-use to improve performance and align with international standards.

Figure 4 illustrates the diverging trends between the volumes of metal packaging placed onto the South African market, the actual post-consumer metal packaging recovery rates, and the Department of Forestry, Fisheries and the Environment (DFFE) recovery targets, as projected through to 2024.

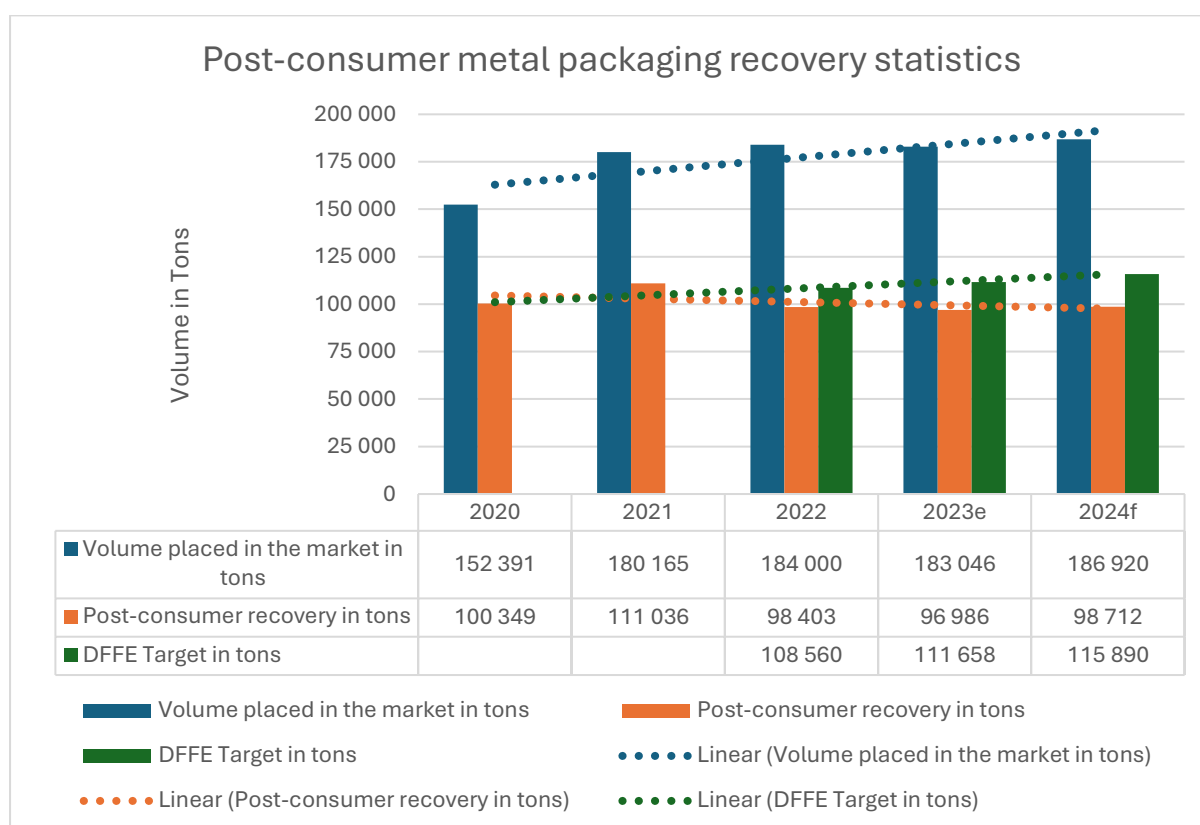


Figure 4: Post-consumer metal packaging recovery. (Source: Brathwaite and Musingadi 2023; South African Department of Environmental, Forestry and Fisheries 2023)

The extrapolated trendlines in Figure 4 show a declining trajectory in the post-consumer metal packaging recovery rate, which is expected to significantly diverge from both the projected growth in metal packaging volumes and the DFFE recovery targets set in Government Gazette 48527, resulting in an anticipated 9.19% gap by 2024, as shown in Table 2. This scenario underscores the inadequacy of the current recovery system and points to the urgent need for incentivised post-consumer metal packaging initiatives that not only improve recovery rates, but also promote transformation, job creation, human dignity, and social equity, addressing exploitation within the informal waste-picking sector.

Increasing the diversion of packaging waste from landfills toward reuse, recycling, and recovery is key to unlocking the potential of a circular economy. Such a shift not only supports environmental sustainability but also drives job creation and business growth across the value chain (Godfrey 2021). Despite this potential, forecasts suggest a decline in post-consumer metal packaging recovery by 2024 (Braithwaite and Musingadi 2022), highlighting an opportunity for South Africa to enhancement recovery rates in line with DFFE targets. Addressing this gap could create significant economic value: recovering an additional 2 million tons of packaging material is estimated to generate R712.5 million upstream of recyclers and R2.53 billion downstream in manufacturing industries supporting a circular economy (Council for Scientific and Industrial Research 2017). Unlike the linear economy, the circular economy (CE) aims to create a sustainable, closed-loop system by recovering, reusing, and recycling finite resources, thereby reducing waste, environmental impact, and reliance

on raw materials (Lederer, Bartl, Blasenbauer, Breslmayer, Gritsch, Hofer, Lipp and Muhl 2022). Design for recovery is a proactive strategy that prioritises the creation of metal packaging to enable efficient, safe, and easy recovery, reuse, and recycling of materials post-consumer usage supporting the circular economy philosophy (Horani, 2023). Effective post-consumer metal packaging recovery is vital to realising the goals of the circular economy, but its full potential depends on the complete integration and coordination of all stakeholders involved in the recovery system (Lederer et al. 2022).

According to Calza, Sorrentino and Tutore (2022), enhancing post-consumer metal packaging recovery is vital for environmental sustainability and improving corporate environmental performance, yet organisations still face significant challenges in effectively executing these strategies. Battle and Hobley (2020) expresses that aluminium and steel are the two metal packaging substrates and both are infinitely recyclable without losing its chemical properties. Around one-third of global aluminium that is used comes from recycled sources (Sulaiman, Makanjuola 2022). According to the Metal Packaging Manufacturers Association UK (2023) and earlier findings by Olivieri, Romani, and Neri (2006), recycling recovered aluminium saves up to 95% of the energy required to produce aluminium from primary bauxite ore. According to the Aluminium Bottle Report (Ball Corporation, Bali, 2022), aluminium is a permanent material that can be endlessly recycled without quality loss, with 75% of all aluminium ever produced still in use today; its recycling saves 95% of the energy compared to virgin production and ensures the highest material recycling yield benefits that are fully dependent on effective recovery systems.

According to the Metal Packaging Manufacturers Association UK (2023), recycling steel saves around 70% of the energy required to produce steel from primary ore, a benefit that relies heavily on efficient and consistent recovery efforts. The use of magnetic retrieval for steel, combined with tailored metal recovery strategies adapted to local conditions, ensures efficient sorting, recovery, and recycling advancing a sustainable and integrated waste management approach (Wolper 2019). Sulaiman, Makanjuola and Samson (2022) expresses that steel packaging, thanks to its magnetic properties, is easily and cost-effectively recovered from mixed waste and is fully recyclable, with new products often containing recycled steel content.

Wagner (2013) identifies the following key factors that influence effective recovery and recycling rates:

- i. individuals must invest time to gain knowledge about material types, segregation requirements, collection schedules, and drop-off procedures,
- ii. proximity to recycling sites significantly affects participation, as greater distances reduce convenience,
- iii. providing more flexible drop-off times, such as evenings and weekends, increases accessibility,
- iv. appealing and strategically located sites reduce the need for special trips, enhancing convenience,
- v. simplifying the recycling process encourages participation by minimising required time and effort; and
- vi. the amount of effort needed for sorting and separating materials can discourage potential recyclers if perceived as too burdensome.

Responsible packaging manufacturers worldwide play a vital role in promoting the use and reuse of existing materials through Extended Producer Responsibility (EPR), a sustainable development approach that requires producers and brand owners to take financial and operational responsibility for managing products at the end

of their life cycle, a concept highlighted by Lovins and Braungart (2014) and more recently supported by Batista et al. (2019) and (Greenblue 2021). Although manufacturers and importers of metal cans do not directly handle the collection and sorting of scrap metal, legislation requires them to meet recovery targets by paying an EPR fee, calculated based on production or import tonnage to their Producer Responsibility Organisation (PRO), which oversees the recovery and recycling of metal packaging (Park 2021).

According to Patorska and Paca (2019), deposit return schemes that compensates for recovery of post-consumer metal packaging, have been shown to deliver a range of benefits in countries where they are implemented, including increased post-consumer packaging recovery, greater availability of secondary raw materials, and improved environmental awareness. Kim and Hong (2019) argue that Unmanned Aerial Vehicles (UAVs), or advanced heavy-duty drones capable of lifting over 250 kg, can significantly support packaging recovery in remote areas lacking buy-back centers and materials recovery facilities (MRFs).

3 Research Method

This study utilised a qualitative research methodology that entailed gathering data through semi structured, in-depth interviews and recording of verbal expressions of prominent SA packaging industry convertors, brand-owners, and metal recyclers. According to Denny and Weckesser (2018), this approach provides valuable insights into individuals' experiences, helping to identify barriers, inform interventions, and support the effective implementation of improvements. The research instrument used for the converter/brand-owner interviews comprised 21 items: 6 related to biometric data in Section A and 15 open-ended questions in Section B (Appendix 1). The research instrument used for the metal recycler interviews consisted of 14 items: 6 pertaining to biometric data in Section A and 8 open-ended questions in Section B (Appendix 2). Both sets of open-ended questions were aligned with the study's research questions to ensure objectivity and were specifically designed to elicit participants' perspectives on the success and integrity of metal packaging recovery in South Africa. The open-ended interview questions addressed key aspects of the packaging industry, ranging from global trends in sustainable development and the circular economy to specific challenges within the South African packaging sector, all in alignment with the research questions. During the interview sessions, participants responded to a fixed set of open-ended discussion questions, with the researcher recording their responses on a laptop, aiming to capture their exact words as accurately as possible.

For qualitative studies, a minimum of 18–20 interviews are generally recommended to achieve comparative and saturation adequacy (Given 2008; Leavy 2017). Accordingly, a sample size of 18 interviews for each of the two qualitative studies, stratified across South Africa's main provinces, was deemed satisfactory and manageable within the given time frame and budget. The inclusion criteria comprised individuals employed in senior or decision-making roles within converter or brand-owner organisations, as well as those working in metal recycling companies. Metal packaging stakeholders representing less than 20% of the total packaging volume placed on the South African market annually were excluded from the study, as they constitute a minor portion of the industry and fall outside its focus on the 80% "critical mass. All non-packaging metal recovery and recycling

operations were also excluded, as these do not qualify as “identified products” under the Department of Forestry, Fisheries and the Environment (DFFE) definition.

Pilot testing of the research instruments was conducted to test potential concerns and participant fatigue. The two qualitative studies gathered responses through personal interviews with key converters, brand-owners, and metal recyclers in South Africa’s packaging and metal recycling industries to assess their commitment to metal packaging recovery, the circular economy, and sustainable development principles. Pilot testing of the research instruments was conducted to test potential concerns and participant fatigue. The pilot testing identified potential issues with the research instruments, such as unclear questions and participant fatigue. Based on these findings, the instruments were refined to improve clarity, reduce burden, and ensure reliable data collection. The recruitment and interview process involved obtaining gatekeeper permissions and individual participant consent via email, with confidentiality maintained in accordance with the Protection of Personal Information Act (POPIA). Structured questionnaires guided the interviews, which were conducted in English either via Zoom or in person depending on participant preference; participants were informed of their right to withdraw at any time without providing a reason, thereby ensuring informed consent.

To assess language clarity, interview length, and potential ambiguities, a pre-interview was conducted with a subject expert using the draft questionnaire. Based on this feedback, the questionnaire was revised to improve language, reduce duration, eliminate ambiguity, and clarify confusing items. Responses from the pre-interview were excluded from the final analysis. Pre-testing helps identify errors to ensure the questionnaire functions effectively as a research tool (Ruel, Wagner III, and Gillespie 2018). To ensure the reliability of this research, consistent data collection procedures were applied beyond the analysis phase, transparent coding schemes and decision rules were established for replicability, pilot testing addressed potential issues and participant fatigue, and NVivo V12 software was utilised to maintain consistency, collectively enhancing the credibility and trustworthiness of the study and supporting the validity of its findings.

The analysis and interpretation approach, based on qualitative research methods, supported by Bazeley (2013) and Creswell and Creswell (2018), involves transforming collected qualitative data to clarify, understand, and interpret individuals and situations studied. “Qualitative” refers specifically to words and observations, aiming to interpret and present the data meaningfully (Creswell and Creswell 2018). Thematic nodes and sub-nodes were identified and analysed descriptively to detect trends using NVivo version 12 software.

Reliability was ensured through consistent data collection procedures, transparent and well-defined coding schemes, pilot testing of research instruments, and the use of NVivo software to maintain analytical consistency.

Trustworthiness in this study was ensured through multiple strategies. Credibility was achieved by confirming interpretations with participants, while transferability was supported through thick descriptions of the research context and participating organizations. Dependability was ensured by maintaining a detailed audit trail of raw data, field notes, transcripts, and the reflexive journal, allowing independent verification of the research process. Confirmability was strengthened through independent expert review of the research plan, data analysis, and findings to ensure interpretations were grounded in the data rather than the researcher’s assumptions. To

further safeguard the integrity of the data, potential social desirability bias was mitigated by assuring participants of confidentiality, reinforcing the voluntary nature of participation, and emphasizing the importance of candid, reflective responses. These measures helped reduce the likelihood of participants tailoring their input to align with perceived expectations or social norms, thereby enhancing the authenticity and reliability of the findings.

4 Results and discussions

4.1 Introduction

A total of 36 semi-structured interviews were conducted in South Africa, 18 with converter/brand-owners and 18 with metal recyclers, achieving a 100% response rate relative to the targeted sample size. As illustrated in Figure 5, participants were selected from key provinces, namely Gauteng, KwaZulu-Natal, Mpumalanga, Western Cape, and Free State.

4.2 Section A, Biometric information

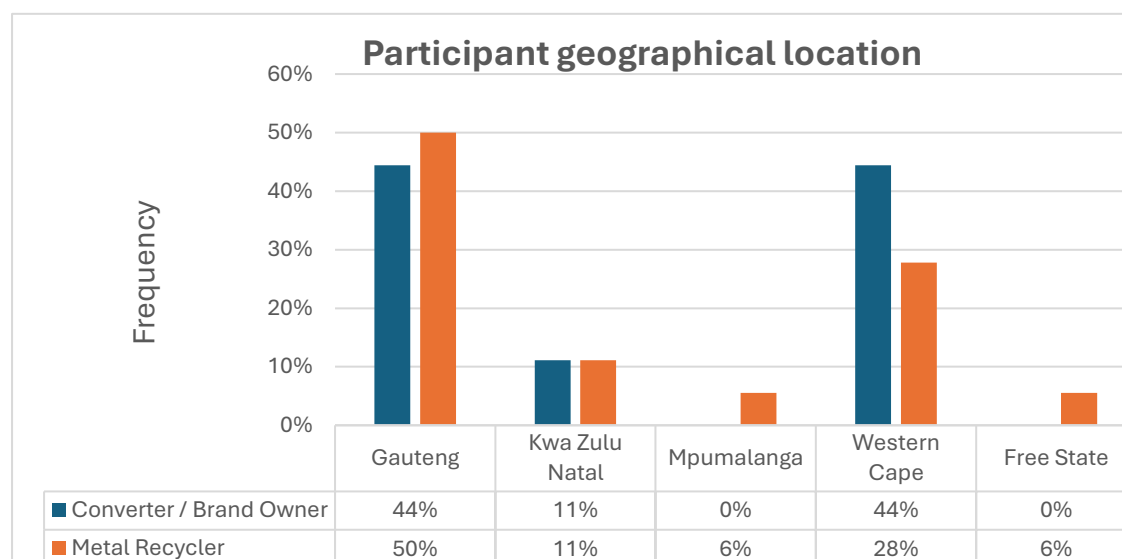


Figure 5: Participant graphical location (Source: Researcher's own construction)

Of the total interviews, 88% of the converter/brand-owners and 78% of the metal recyclers were based in the Western Cape and Gauteng. Both converter/brand-owners and metal recyclers are predominantly located in the Western Cape, Gauteng, and KwaZulu-Natal, reflecting the concentration of business activity in these economic hubs. However, metal recyclers are more widely distributed across the provinces due to the broader geographic demand for metal collection and re-melting services. Overall, the interviews reflected the distribution patterns of metal packaging across South Africa and were reasonably stratified to capture insights from key industry role-players in regions with higher industry density.

Figure 6 illustrates the gender profile of the participants.

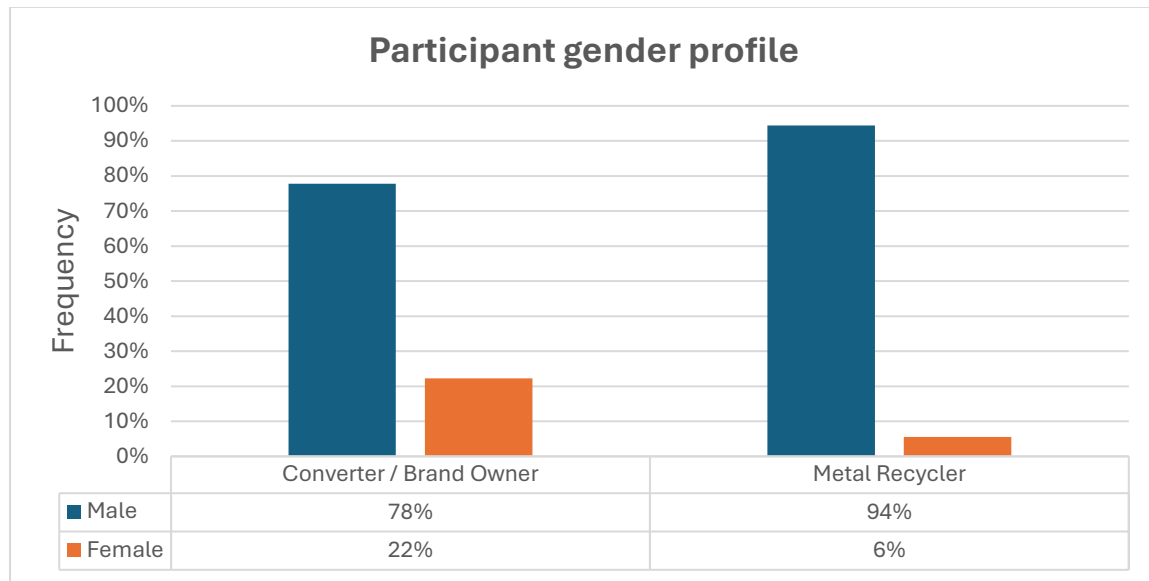


Figure 6: Participant gender profile (Source: Researcher's own construction)

Among the converter/brand-owner interviews conducted, 22% of respondents were female, while 78% were male. In contrast, only 6% of the metal recycler interviewees were female, with 94% being male. These figures clearly indicate that both sectors are male dominated, with the metal recycling sector showing an even greater gender imbalance. Nonetheless, it is important to emphasise that the interviews focused on converter/brand-owners and metal recyclers who handle a significant volume of metal in South Africa irrespective of gender.

The job designation profile of the participants is illustrated in Figure 7.

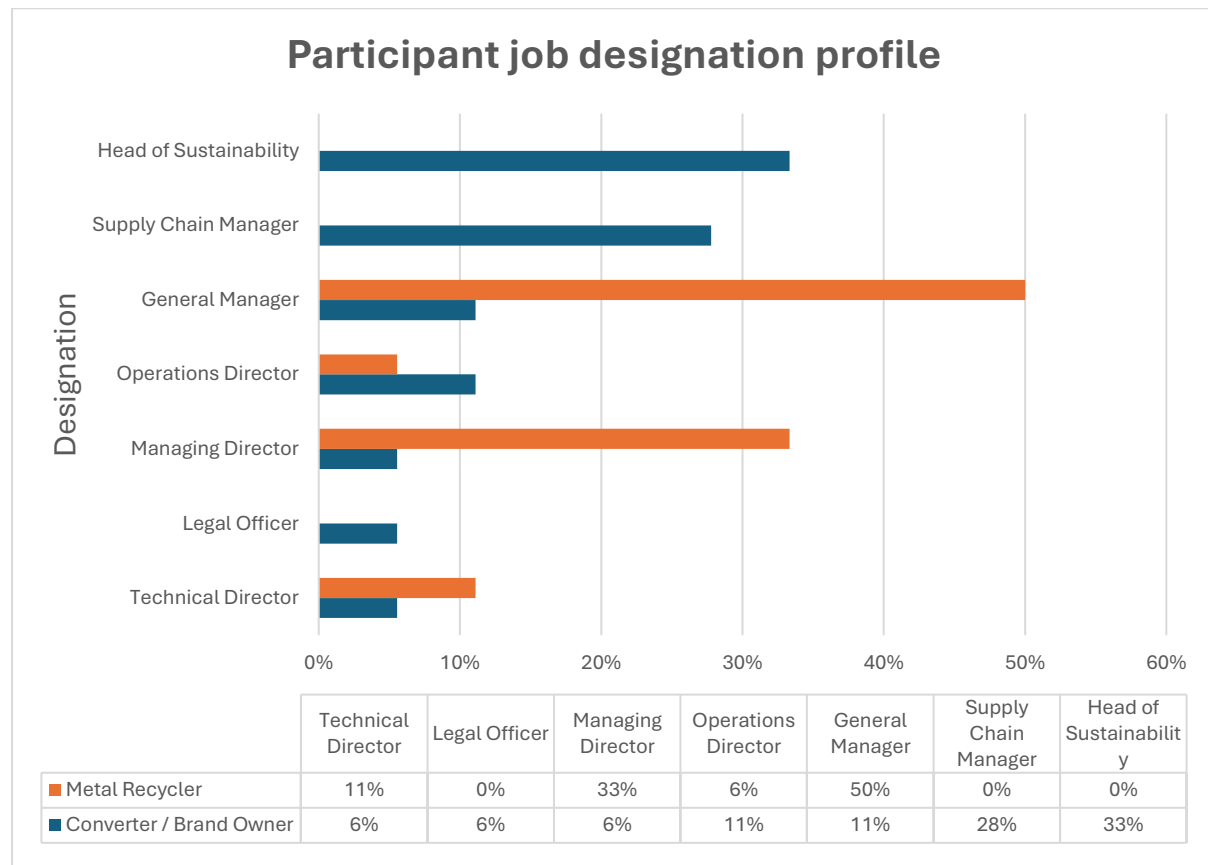


Figure 7: Participant designation profile (Source: Researcher's own construction)

Figure 7 illustrates the rank and leadership positions of the individuals selected for interviews conducted in this study. These senior-level participants represent the leadership of both the packaging and metal recycling industries in South Africa, making them well-positioned to provide a comprehensive perspective on the research questions. Notably, roles related to supply chain management and sustainability are less common within the metal recycling sector compared to the converter/brand-owner segment of the metal packaging industry. This discrepancy may be linked to the fact that converter/brand-owner companies are largely global corporate entities, influenced by international markets and supply chains, which necessitate dedicated functions in sustainability and supply chain management (Bag, Dhamija, Bryde, and Singh 2022).

Figure 8 illustrates the experience profile of the participants.

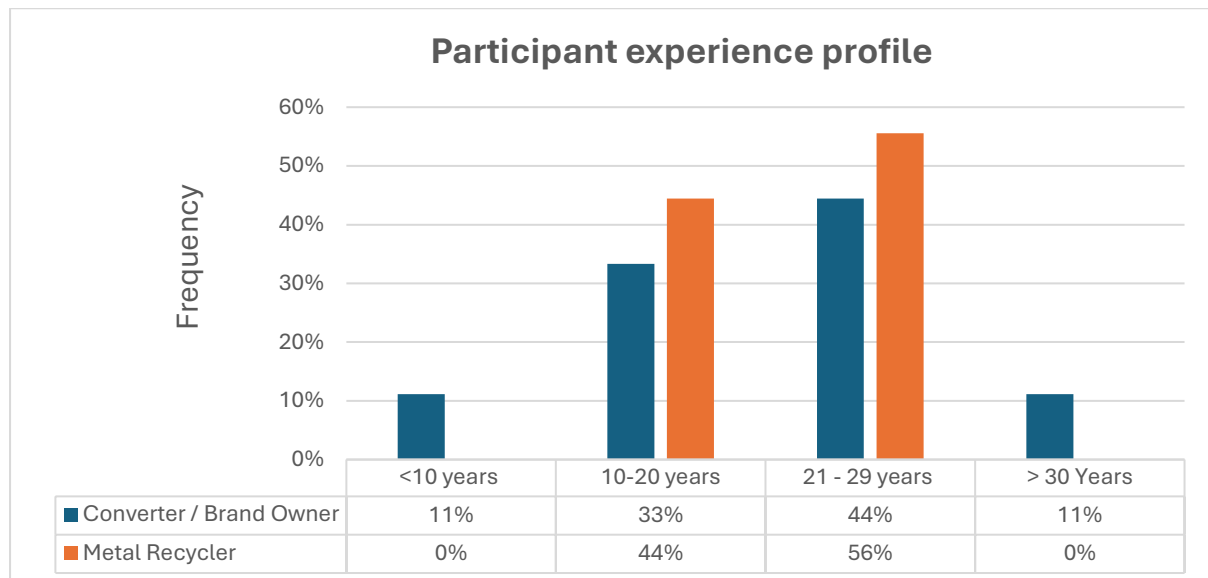


Figure 8: Participant experience profile (Source: Researcher's own construction)

Figure 8 illustrates that over 50% of both converter/brand-owner and metal recycler participants have more than 20 years of experience in their respective fields highlights the industry's reliance on seasoned professionals. This distribution of experience provides valuable insight into the workforce composition and expertise across both sectors. The concentration of highly experienced individuals suggests that the metal packaging and recycling industries in South Africa are supported by a mature and knowledgeable workforce.

4.3 Section B, results of the interview questions

Figure 9 reflects the key words, by frequency, arising from the interviews with the converter/brand-owners.



Figure 9: Word cloud - converter/brand-owner (Source: NVivo version 12)

Figure 10 reflects the key words, by frequency, arising from the interviews with the metal recyclers.



Figure 10: Word cloud - metal recyclers (Source: NVivo version 12)

An analysis of the word clouds generated from the converter/brand-owner and metal recycler interviews reveals several key themes:

- i. For the converter/brand-owner group, the most prominent terms included metal, packaging, recovery model, consumer, circular, waste, recycling, collection, sustainability, model, and brand.
- ii. In contrast, the dominant terms from the metal recycler interviews were metal recovery, energy management, operations, efficiency, processing, environmental compliance, waste, and recycling.

These findings indicate a shared focus on metal recovery and recycling across both sectors, reinforcing their mutual commitment to advancing a circular economy within the metal packaging value chain. These observations created a platform for the thematic analysis reflected in Table 3.

Thematic nodes and sub-nodes were identified and analysed using NVivo version 12. All 36 interview transcripts were collated, and participants' responses were coded against the research questions. NVivo helped reveal repetitive trends and phrases, enabling the identification of common themes, with subthemes derived where responses connected to main themes. To enhance validity, a cross-section of responses from individual participants ("common participant – cross section of questions" was examined to ensure consistent theme identification across questions. Additionally, responses were weighted according to participants' roles and positions within the industry. Inter-coder reliability was ensured through collaborative review and consensus on coding decisions.

Table 3: Thematic analysis

Research Question	Theme number and description	Subtheme number and description
1	<i>Effectiveness of the SA post-consumer metal packaging recovery system</i>	1.1 Recovery mechanism
		1.2 Recovery percentage
		1.3 Recovery reliability and sustainability
2	<i>Accuracy and reliability of existing post-consumer metal packaging recovery system data</i>	2.1 Data source
		2.2 Confidence level
		2.3 Challenges

Source: Researcher's own construction

The effectiveness of South Africa's post-consumer metal packaging recovery system is underpinned by a combination of critical elements. These include the accessibility and efficiency of collection infrastructure, active involvement of informal waste pickers, public support facilitated through education and awareness campaigns, the use of advanced sorting and separation technologies, and the presence of well-equipped recycling facilities capable of processing recovered materials. Additionally, supportive government policies and regulations, strong stakeholder collaboration, and a robust market demand for recycled metals further contribute to the system's overall performance (Godfrey 2021; Council for Scientific and Industrial Research 2017). Success is measured not only by the volume of metal packaging recovered in South Africa but also by the broader environmental benefits achieved, such as reduced energy consumption, lower greenhouse gas emissions, and the conservation of natural resources (Godfrey 2021; Howells 2022).

4.4 Theme 1: Effectiveness of South Africa's post-consumer metal packaging recovery system.

Figure 11 presents the project map for Theme 01, illustrating the components that influence the effectiveness of South Africa's post-consumer metal packaging recovery system.

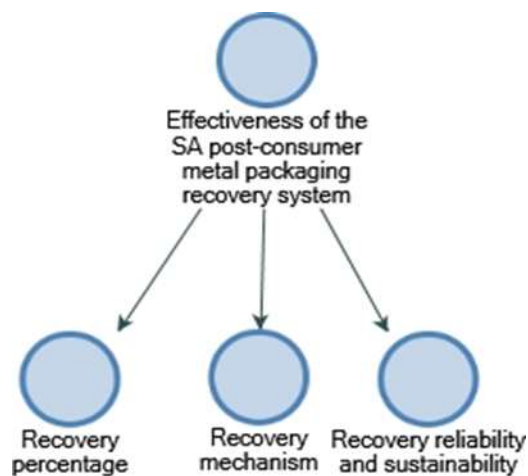


Figure 11: Theme 01 Effectiveness of the SA post-consumer metal packaging recovery system (Source: Construction by NVivo version 12)

Figure 11 presents the cross-tabulation for Theme 01, which explores the effectiveness of South Africa’s post-consumer metal packaging recovery system. It is important to note that the accompanying subtheme bar chart reflects the frequency with which participant responses were coded under each subtheme. This representation should not be interpreted as a ranked perception or level of agreement, as would be the case with a Likert scale.

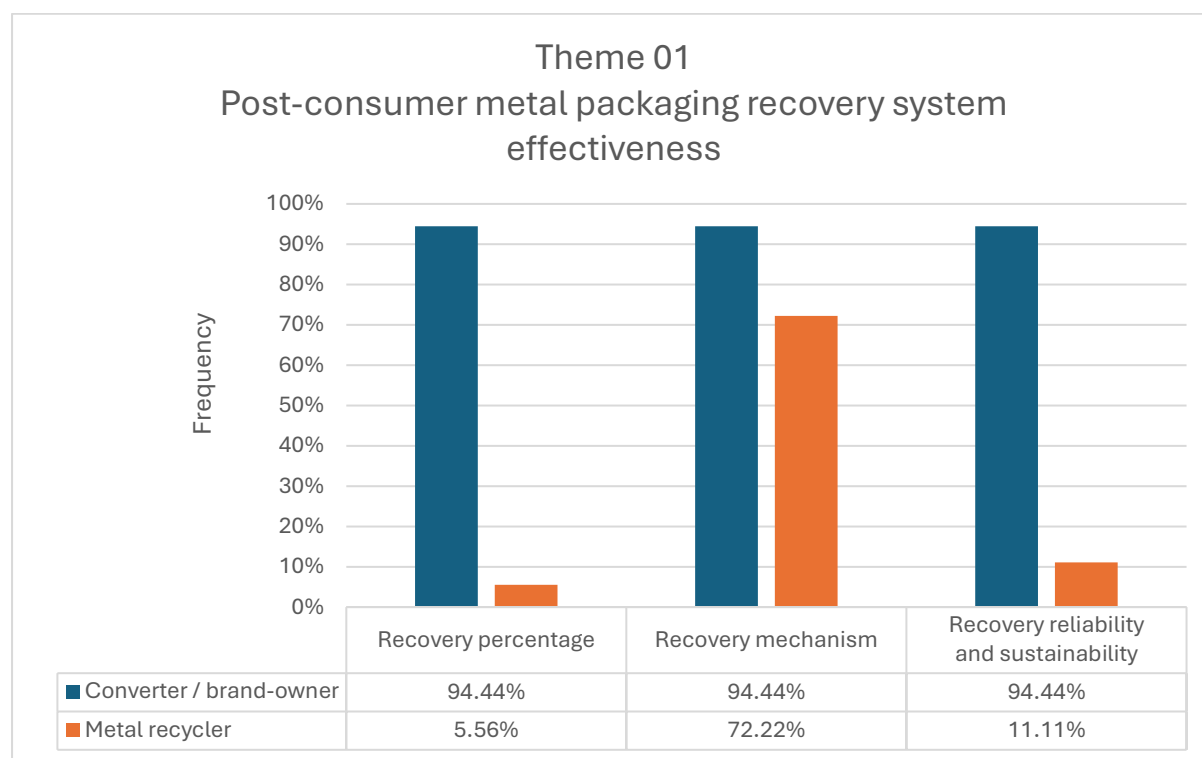


Figure 12: Theme 01: Cross tabulation (Source: Researcher’s own construction)

The following sections examine each of the sub-themes identified under Theme 01, as outlined in the project map (Figure 12). These sections explore key focus areas, analyse participant perspectives, and incorporate relevant excerpts from the interviews where appropriate, to support and illustrate the insights and inferences drawn.

As illustrated in Figure 12 (**Recovery Percentage**), there is a notable disparity in the emphasis placed on post-consumer metal packaging recovery statistics between the two stakeholder groups. Specifically, 94.44% of references to recovery rates originated from converter/brand-owner participants, compared to only 5.56% from metal recyclers. This discrepancy is likely attributable to the implementation of Extended Producer Responsibility (EPR) legislation, gazetted in May 2021, which has placed considerable pressure on the packaging industry. In response, the metal packaging sector has prioritised the measurement of post-consumer recovery rates, primarily through the Producer Responsibility Organisation (PRO), MetPac-SA (Muller 2020). In contrast, insights from the recycler interviews indicated that metal recyclers in South Africa process all types of used metal, not solely metal packaging, making post-consumer packaging recovery rates a less significant metric within their operations. In contrast, insights from the recycler interviews revealed that metal recyclers process all forms of used metal in South Africa, not just post-consumer metal packaging, making specific recovery rate measurements for packaging less relevant to their operations.

Metal **recovery mechanisms** were referenced by 94.44% of converter/brand-owners and 72.22% of metal recyclers, indicating that both groups are invested in recovery systems, albeit from different perspectives. From the converter/brand-owner standpoint, post-consumer metal packaging recovery is primarily driven by the need to comply with Extended Producer Responsibility (EPR) legislation. In contrast, for metal recyclers, metal recovery is central to their operations, serving as the primary input material for re-melting and refining processes aimed at producing metals for reuse in various applications. Furthermore, several converter/brand-owner participants highlighted that post-consumer metal packaging recovery in South Africa is heavily dependent on informal waste pickers. This system is largely shaped by high unemployment, the intrinsic value of metal, and broader economic conditions, rather than by a formal, coordinated framework designed to support efficient recovery of post-consumer metal packaging.

Under the subtheme of **Recovery Data Reliability and Sustainability**, 94.44% of converter/brand-owners expressed views on this topic, compared to only 11.11% of metal recyclers. This disparity likely stems from the differing regulatory obligations faced by the two groups. Converter/brand-owners are required to demonstrate compliance with Extended Producer Responsibility (EPR) legislation specific to metal packaging, making accurate and reliable recovery data essential to their reporting processes. In contrast, metal recyclers are not subject to the same legislative requirements under the metal packaging EPR framework and, as such, are less dependent on system-level recovery data (South Africa. Department of Forestry, Fisheries and Environment 2020).

4.5 Theme 2: Accuracy of South Africa's post-consumer metal packaging recovery system

Figure 13 presents the project map for Theme 02, illustrating the components that influence the accuracy of South Africa's post-consumer metal packaging recovery system.

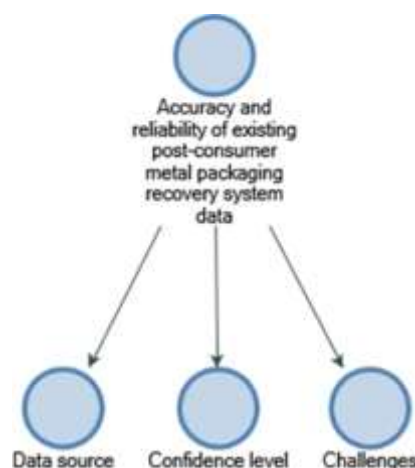


Figure 13: Accuracy and reliability of existing post-consumer metal packaging recovery system data
(Source: Construction by NVivo version 12)

It is important to note that the following subtheme bar chart represents the frequency with which participant responses were coded under each subtheme. This should not be interpreted as a ranked perception of the subthemes, as would be the case with a Likert scale.

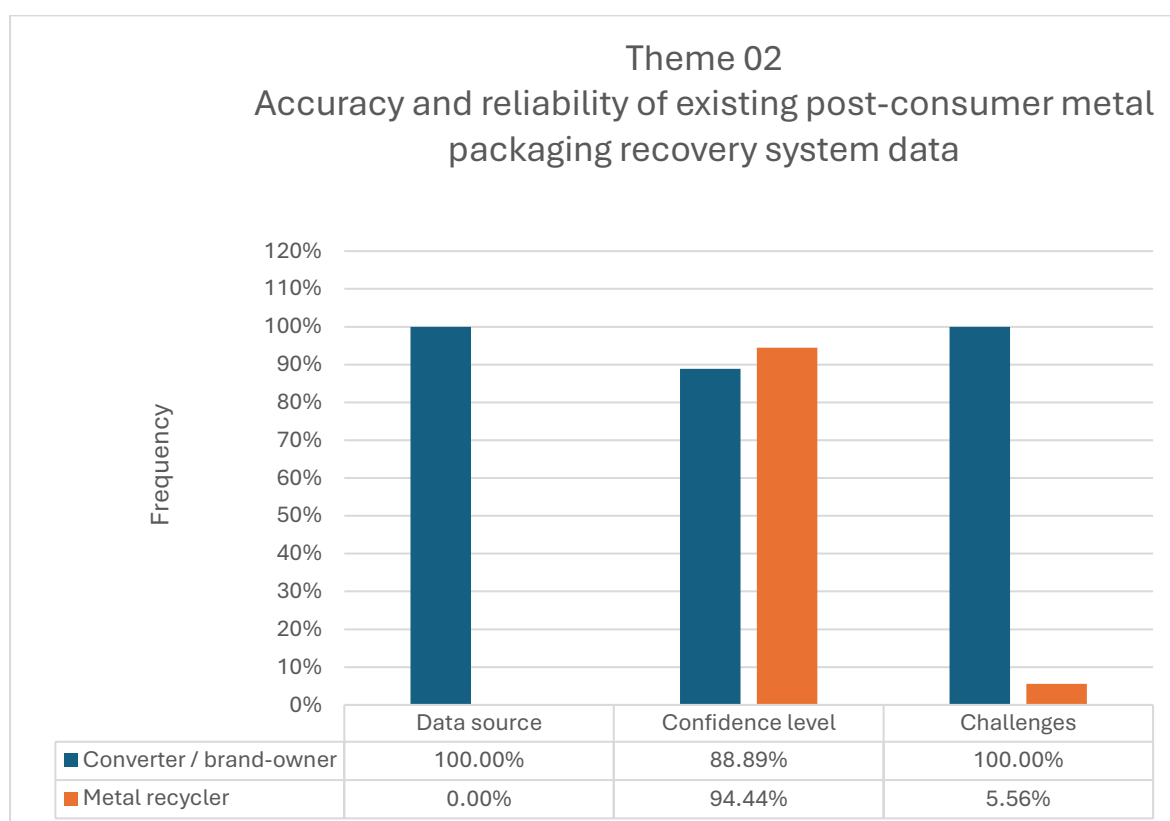


Figure 14: Theme 02: Cross tabulation (Source: Researcher's own construction)

The following discussions focus on each of the sub-themes identified within Theme 02, as depicted in the project map, figure 14. These sections explored the focal points, delved into the perspectives of the participants, and included, where required, relevant excerpts from the interviews conducted, to underscore inferences.

All participating converters and brand-owners (100%) indicated that their **data source** for post-consumer metal packaging recovery statistics is either MetPac-SA or BMi Research. The annual post-consumer metal packaging recovery rate is defined as the total tonnage of metal packaging recovered by metal recyclers each year, expressed as a percentage of the total tonnage placed on the South African market by converters and brand-owners (Godfrey 2021). In light of the Extended Producer Responsibility legislative requirements, it is evident that converters and brand-owners now place increased emphasis on the accuracy and credibility of recovery data and its sources. As metal recyclers serve as the primary providers of this recovery data, their lack of reference to data sources is understandable

Both metal recyclers and converter/brand-owners expressed low **confidence level** in South Africa's post-consumer metal packaging recovery statistics, largely due to incomplete data and the risk of double-counting across various stakeholders (e.g. buy-back centers, MRFs, recyclers, and re-melters). Their perspectives diverge: recyclers focus on maximising material yields, optimising the efficiency of collection and processing, while converter/brand-owners prioritise compliance with Extended Producer Responsibility requirements, aiming to

meet regulatory and environmental obligations. The study highlights the importance of aligning these differing priorities to promoting a sustainable and collaborative recycling ecosystem.

With the introduction of EPR legislation, converter/brand-owners have shown a stronger interest in ensuring data integrity and accurate reporting of post-consumer metal packaging recovery rates. Double counting within the recovery value chain appears to be an unavoidable issue. Since metal recyclers are the primary source of recovery data, they are less likely to highlight data-related **challenges**, which may explain their limited concern on this matter.

The qualitative interviews captured insights from both converter/brand-owners and metal recyclers in relation to the research questions, centering around two primary themes.

5 Findings and recommendations

Tables 4 and 5 summarises the findings and offers recommendations related to the research questions, focusing on the effectiveness of South Africa's post-consumer metal packaging recovery model as reflected in Theme 01 on the "Effectiveness of the SA post-consumer metal packaging recovery" and Theme 02: "Accuracy of South Africa's post-consumer metal packaging recovery system".

Table 4: Theme 1: Effectiveness of the SA post-consumer metal packaging recovery

Sub-Theme	Finding	Recommendations
Recovery percentage	Converter/brand-owners place greater emphasis on post-consumer metal packaging recovery statistics than metal recyclers, likely due to the recent EPR legislation introduced in May 2021, which pressures the packaging industry to track recovery rates. Metal recyclers, however, process all used metal in South Africa, not just packaging, so these specific recovery measurements are less critical for them.	It is recommended that the PRO collect both pre- and post-consumer metal packaging data from the sector. Converters and brand-owners should report the annual tonnage of metal packaging placed on the market, which must be compared with recovered post-consumer tonnage to calculate an overall recovery rate. This metric should be included in PRO performance reports to the DFFE. Recovery rates and data accuracy will improve if EPR legislation is refined to formally include buy-back centres, recyclers, and re-melters. Strengthening data reliability through legislative updates is essential for building a fully integrated and effective recovery system.
Recovery mechanism	Post-consumer metal packaging recovery is essential for converters and brand-owners to demonstrate compliance with EPR legislation. For metal recyclers, recovered metal serves as a critical raw material for their re-melting and refining processes, enabling its reuse in various applications.	To improve recovery and recycling efficiency, it is recommended to implement metal compaction prior to remelting to enhance yield. Introducing Deposit Return Schemes (DRS) can further boost the recovery of packaging materials. Additionally, prioritising consumer awareness campaigns around separation-at-source initiatives will help optimise manual sorting and improve overall waste management outcomes.
Recovery data reliability and sustainability	Post-consumer metal packaging recovery is vital for converters and brand-owners to demonstrate compliance with EPR legislation. In contrast, metal recyclers fall outside the scope of metal packaging EPR regulations and thus do not depend on recovery system data specific to metal packaging.	Post-consumer metal packaging recovery is vital for converters and brand-owners to demonstrate compliance with EPR legislation. In contrast, metal recyclers fall outside the scope of metal packaging EPR regulations and thus do not depend on recovery system data specific to metal packaging.

Source: Researcher's own construction

Table 5: Accuracy and reliability of existing post-consumer metal packaging recovery system data

Sub-Theme	Finding	Recommendations
Data source	Post-consumer metal packaging recovery statistics are primarily sourced from MetPac-SA or BMi Research. Since metal recyclers are the original providers of this data, it explains why they do not reference external data sources in discussions about recovery statistics.	The adoption of Fourth Industrial Revolution (4IR) technologies is recommended at the re-melting stage nationwide to enable efficient, real-time data reporting on metal packaging recovery. These technologies play a key role in enhancing data integrity by ensuring accuracy, authenticity, and confidentiality that are critical for reliable decision-making and effective tracking of recovery performance.
Confidence level	There is low confidence in South Africa's post-consumer metal packaging recovery statistics due to incomplete data and the risk of double counting by various stakeholders, including buy-back centres, MRFs, recyclers, and re-melters. Metal recyclers shared these concerns, aligning with the views of converters and brand-owners.	To improve coordination and data integrity across the metal packaging recovery value chain, industry-wide partnerships and alliances should be established. It is recommended that clear memoranda of understanding be developed between PROs and key stakeholders, such as buy-back centres, recyclers, re-melters, and waste-to-energy operators, to facilitate data sharing while minimising the risk of double counting. Additionally, the implementation of rigorous, standardised, and independent auditing processes is essential to ensure the accuracy, reliability, and objectivity of reported recovery data.
Challenges	Due to EPR legislative obligations, converters and brand-owners place a stronger emphasis on data integrity and accurate post-consumer metal packaging recovery rates. However, double counting within the recovery value chain remains an unavoidable issue. As metal recyclers are the primary source of recovery data, they are less likely to highlight data-related challenges, which explains the limited concern from their side.	To address these challenges, collaborative and synchronised efforts, standardised reporting practices, and greater transparency within the metal packaging recovery ecosystem are essential. It is further recommended that metal re-melters serve as the primary data source for recovered metal packaging, as this would help minimise the risk of double counting across the value chain.

Source: Researcher's own construction

6 Conclusion

Given the mounting pressures of industrialisation, urbanisation, overpopulation, and the depletion of finite resources, radical and coordinated action is essential to improve post-consumer metal packaging recovery. While converters and brand-owners are increasingly focused on recovery statistics to meet EPR compliance requirements, metal recyclers, who process a broader range of scrap metals, are less dependent on packaging-specific data. This divergence highlights the need for a harmonised, sector-wide approach to recovery data and system design. To support EPR implementation and enable accurate performance reporting, it is recommended that Producer Responsibility Organisations collect comprehensive data on both pre- and post-consumer metal packaging. Converters and brand-owners must consistently report the tonnage of metal packaging placed on the market, which should be compared with recovered volumes to calculate and track recovery rates. Legislative refinements that formally integrate buy-back centers, recyclers, and re-melters into the EPR framework will be critical for improving data accuracy and promoting accountability.

However, overcoming key barriers such as inadequate collection infrastructure, low consumer awareness, weak incentives, limited adoption of Fourth Industrial Revolution (4IR) technologies, and fragmented stakeholder collaboration requires more than just regulatory compliance. A sustainable recovery system depends on enforcing EPR obligations, investing in infrastructure upgrades, promoting ISO 14001:2015 environmental management standards, and strengthening market demand for recycled materials. Additionally, enhancing recycling efficiency through measures like metal compaction before remelting, implementing Deposit Return Schemes and expanding consumer education around separation-at-source initiatives will improve both recovery rates and system sustainability. Ultimately, building a truly efficient and resilient post-consumer metal packaging recovery system requires a comprehensive, integrated, and synchronised approach involving all stakeholders from producers and consumers to recyclers and policymakers.

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8 Appendices

Appendix 1: Converter/brand-owner research questions and the intent

No.	Interview question	Question intent	Related research question
1	<i>How does your business relate to circular economy principles?</i>	Establishing global best practices	Research question 1
2	<i>Which countries are actively delivering against circular economy principles?</i>		
3	<i>How are you constantly benchmarking with global best practices on post-consumer metal packaging recovery?</i>		
4	<i>How is post-consumer metal packaging recovered in SA?</i>	Determining the effectiveness of current post-consumer metal packaging recovery system	Research question 2
5	<i>How reliable/sustainable is the current post-consumer metal packaging recovery system?</i>		
6	<i>Can you estimate the % of post-consumer metal packaging that is recovered by informal waste pickers and the formal waste collection systems in SA?</i>		
7	<i>What is the source of your statistics (above question)?</i>	Understanding the reliability of post-consumer metal packaging data acquisition and reporting	Research question 3
8	<i>Are you confident that these statistics are an accurate reflection of post-consumer metal packaging recovery in SA?</i>		
9	<i>If not, where do you think lies the challenges in accurate data reporting?</i>		
10	<i>Discuss the level of commitment of your business / brand to a triple bottom line strategy.</i>	Establishing commitment to metal packaging recovery and circularity	Research question 4
11	<i>Are there formal sustainable development goal setting within your business? Discuss measurement and successes achieved. How do you set new targets and timelines? Test for realism and practicality.</i>		
12	<i>How does your brand / business address post-consumer metal packaging recovery and recycling?</i>		
13	<i>How can such a model ensure transformation and job creation?</i>	Understanding how remodelling post-consumer metal packaging recovery may increase recovery volumes through local entrepreneurship.	Research question 5
14	<i>How can community awareness and education campaigns be integrated into the recovery model to promote responsible recycling behaviour?</i>		
15	<i>How would you be able to increase the metal packaging recovery in SA?</i>		

Appendix 2: Recycler research interview questions and the intent

No.	Interview question	Question intent	Related research question
1	<i>How does the metal recovery and processing model in South Africa compare with global best practices?</i>	Establishing global best practices	Research question 1
2	How effective is the SA metal recovery systems in SA?	Determining the effectiveness of current post-consumer metal	Research question 2
3	<i>How do you ensure data accuracy and transparency in your metal supply chain, especially regarding the sources of scrap metal and raw materials?</i>	Understanding the reliability of post-consumer metal packaging data acquisition and reporting	Research question 3
4	<i>How does your facility ensure compliance with EPR legislation and environmental regulations and standards in SA?</i>	Understanding the commitment to legislation and material circularity	Research question 4
5	<i>Are there alternative models to recover and process metal more effectively and more efficiently in SA?</i>	Understanding how re-modelling the metal recovery system can support job creation and transformation	Research question 5
6	<i>What waste management practices do you have in place to minimise the environmental impact of your operations?</i>	Establishing global best practices within the recycling sector	Research question 1
7	<i>Can you share information about any initiatives or technologies implemented to enhance energy efficiency in your metal recycling/foundry processes?</i>	Establishing global best practices within the recycling sector	Research question 1
8	<i>What initiatives or programs do you have in place to engage with and benefit the local community surrounding your facility?</i>	Understanding how re-modelling the packaging recovery system can support job creation and transformation	Research question 5