

**A Path to Formalization: Exploring the E-Waste Informal Sector's Integration Amid the
Transition to Circular Economy**

Dhyeya Pandya

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Institute of the Environment
Faculty of Social Sciences
University of Ottawa

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CE	Circular economy
EEE	Electronic and electrical equipment
E-Waste	Electronic waste
SDGs	Sustainable development goals
EPR	Extended producer responsibility
EMF	Ellen Macarthur Foundation
WEF	World Economic Forum
UNIDO	United Environment Programme
UNEP	United National Industrial Development Organization
ACEA	African Circular Economy Alliance
UNDP	United Nations Development Programme

IV. Abstract

The growing e-waste problem, fueled by high consumption of electronics and electrical equipment (EEE) and resource scarcity poses serious health, safety, and environmental risks. The circular economy (CE) is presented as a sustainable solution for these concerns, though some stakeholders may struggle with adapting to increased demands like supply chain transparency, materials traceability, and technological advancement. Operating predominantly in the Global South, informal workers manage significant amounts of e-waste, handling nearly 18 billion kg of e-waste in 2022. Current CE research often overlooks their impacts and fails to fully address the social implications of circularity. This gap prompts investigation in aligning CE principles with broader sustainability goals, especially regarding the role of the informal sector in the transition to CE. Formalization emerges as a potential strategy, involving regulation, collaboration, and capacity building to improve resource recovery, livelihoods, and mitigate associated risks while defining the role of the informal sector in circular e-waste management. A comprehensive literature review with seven semi-structured interviews were utilized to explore the formalization of the informal e-waste sector in the context of the global transition to circularity. The main findings reveal that formalization in e-waste management is a complex, multifaceted process requiring legal frameworks, regulatory enforcement, and integration strategies like capacity building and partnerships. The study underscores the importance of integrating informal workers into regulatory frameworks and CE policies to improve resource recovery, reduce environmental impacts, and enhance socio-economic outcomes. The study finds that including informal workers' perspectives may work to enhance effectiveness and adoption of formalization initiatives as part of a just transition to circularity in the EEE value chain and e-waste management.

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1.0 Introduction

The world is facing a growing e-waste problem stemming from high consumption of electronic and electrical equipment (EEE). Currently, electronic waste (e-waste) poses significant concerns for human and environmental health and safety, livelihood security, and wellbeing (Baldé et al., 2017; Bhagat-Ganguly, 2022; Wilson et al., 2013; Morais et al., 2022). Further, the rapid consumption of EEE coupled with growing resource scarcity have led to a scenario where mining e-waste for secondary resources will be a requirement to reduce the demand pressure on primary or raw materials extraction, as well as waste management systems (Forti et al., 2020; Baldé et al., 2024). Simultaneously, there is a growing body of literature suggesting that the collective shift taking place towards the circular economy (CE) is a viable and sustainable solution to addressing some of the issues presented by increasing EEE consumption, limited resources, and the ensuing e-waste (Baldé et al., 2017).

From reviewing recent literature and discourse on the CE, it is clear that EEE will remain a key sector as part of the initial stages of the transition to circularity (Platform for Accelerating the Circular Economy (PACE), 2019; Ellen Macarthur Foundation, 2020; European Commission, 2020). If the CE aims to be a sustainable solution for addressing the challenges posed by the increasing e-waste problem, this raises questions regarding how the transition will reflect the environmental, economic, and social aspects of sustainability. To add, a report by the International Labour Organization (ILO) states that currently, circular economy research fails to fully address the impacts on people in the Global South (ILO, 2023). Undoubtedly, the adoption of circular approaches and circular policies will impact workers in these sectors who will need to adapt to the new demands of this transition.

This is particularly the case for stakeholders that may be disproportionately impacted by calls for greater transparency, traceability, and partnerships. This consideration is pertinent for the informal sector which is estimated to employ 60% of the world's population and plays a substantial role in global e-waste management yet may encounter additional challenges in meeting the demands of a circularity in e-waste (Bhagat-Ganguly, 2022; Rizos & Bryhn, 2022; Tura et al., 2019; Kissling et al., 2013; Singh, 2021; Morais et al., 2022; ILO, 2023).

Further, with the growing focus on extracting value from e-waste to enhance circularity of resources, the increasing value of e-waste coupled with the expected decrease of recycling costs, will likely motivate more actors to participate in value capture from extracting resources from waste (Millington & Lawhon, 2019). For instance, the investment in technological advances to improve resource efficiency has huge implications for the informal sector, raising questions about whether mechanization of collection, sorting, and recycling of e-waste will integrate informal workers as contributors to the system, or create competition for them (Dias, 2016; Millington & Lawhon, 2019). Therefore, examining the potential impacts of circularity on the informal sector is imperative for integrating the implementation of CE into sustainability frameworks.

Informal e-waste workers are recognized as a marginalized, yet a resilient and widespread group of workers and informal coalitions which provide resource recovery services (Nzeadibe, 2013). Typically, the informal sector provides resource recovery services often employing rudimentary techniques, lacking education, access to personal protective equipment (PPE), safe working conditions, or proper awareness of health and environmental impacts on workers and communities (Rizos & Bryhn, 2022; Tura et al., 2019; Kissling et al., 2013; Singh, 2021; Morais et al., 2022). While there is lack of complete records, reports suggests that in 2022 an estimated 18 billion kg of e-waste was handled by the informal sector, typically in low and lower-middle

income nations lacking sufficient infrastructure to safely and sustainably manage e-waste (Baldé et al., 2024).

However, even if social sustainability is not the primary focus of circularity, engaging informal workers remains essential to enhancing circularity in e-waste due to their significant presence and substantial involvement in managing high volumes of e-waste (Baldé et al., 2024, p. 17, p 58-61). The concept of “formalization” emerges as a potential strategy to clarify the role of the informal sector in this context. Although its definition lacks general consensus, formalization involves standardizing processes and procedures, implementing regulations, establishing relative organization, developing best practices, and providing access to capital and resources (Bhagat-Ganguly, 2021; Arora et al., 2019; ILO, 2014).

Studies by Bhagat-Ganguly (2022), Wilson et al. (2013), and Morais et al. (2022) have suggested that there may be benefits of formalizing the informal sector’s involvement in waste management yielding improvements in resource recovery, livelihoods of workers, alleviating poverty, improving health risks, and improving environmental risks. Additionally, studies also indicate that there are negative impacts from their involvement, including environmental pollution, health risks, and rudimentary practices to name a few (Bhagat-Ganguly, 2022; Wilson et al., 2013; Morais et al., 2022). Yet, the consideration for the informal sector workers is largely absent within the circularity discussion and literature to date.

These questions regarding the informal sector’s involvement in a circular economy raise further questions regarding the link between the CE and the environmental, social, and economic pillars of sustainable development more broadly. Though some accounts suggests that the CE and sustainable development are two sides of the same coin, the CE literature largely focuses on environmental and economic markers for growth, and largely omits the social tenet of

sustainability (Suarez-Visbal et al., 2022). As a result, there is a growing body of literature questioning how well aligned the CE is with sustainability and sustainable development discussions. Given the ongoing discourse in the CE literature regarding the absence of socio-economic implications of such a transition, and the evident necessity of involving the informal sector in addressing contemporary e-waste challenges, it becomes crucial to investigate formalization of the informal sector.

This thesis paper will investigate various streams of literature and the experience of formalization in the e-waste context, exploring how these insights might inform circular policy and facilitate a circular transition in the EEE waste sector. To answer this question, a literature review and semi-structured expert interviews were conducted. The literature review contains two key components. The first component of the literature review is to build relevant context surrounding the CE, sustainable development discussions, the e-waste management problem including formal and informal sector practices, and the EEE value chain. The second component of the literature review is to draw knowledge from existing accounts of formalization efforts across regions and to observe whether any patterns emerge in terms of common strategies and challenges faced. The semi-structured interviews will then supplement this information as speaking with experts that have knowledge on or experience with formalization and circularity initiatives will provide additional insights to better understand what the process formalization entails in practice. In that regard, experts that have knowledge on the e-waste sector and circular economy and have experience with formalization of the informal sector were engaged.

This paper follows a structured approach, beginning with a comprehensive overview of methodologies employed. This is followed by an extensive literature review that draws from various scholarly disciplines including circular economy, the EEE value chain, waste management,

and sustainable development. Within this review, the transition to circularity, the burgeoning e-waste problem, linkages between circularity and sustainable development, and the concept of formalization are explored. The subsequent section presents findings from semi-structured interviews, organized around the key themes related to core elements of formalization, the broader landscape within which formalization takes place, and the implications for social sustainability. Furthermore, additional themes are discussed in the following chapter, acknowledging areas beyond the primary scope of the study. This study concludes with a summary of core findings, acknowledging limitations, and suggesting areas for further research.

2.0 Methodology

This thesis project depends upon a literature review and synthesis that is informed and supported by semi-structured interviews conducted with experts to obtain data. Given the emerging transition to circularity across the EEE value chain, the overarching goal of the thesis project is to improve knowledge on formalization of the informal e-waste sector, and how this might be important to enable a circular transition and inform circular policy.

2.1 Literature Review

The literature review and synthesis compile contemporary knowledge on the transition to circular economy within specific context of the EEE value chain and the growing e-waste issue. The literature review is organized in a thematic format in order to reflect the interdisciplinary nature of the environmental sustainability program. The key themes and areas of research explored include circular economy, the EEE value chain, waste management systems, and sustainable development. Within each theme, the literature review explores more broadly on important

concepts relevant to the research question. The literature review draws on scholarly sources, journal articles, and books, as well as grey literature including working papers, policy reports, and research reports from reputable, relevant, and leading industry organizations. The literature review synthesizes and links together different perspectives of the broader issue wherein the CE acts as a framework within which e-waste management and sustainable development concerns are being addressed.

Table 1: Literature Review Components

Themes	Relevant Concepts
Circular Economy	Addressing questions of how to align environment-economy questions along value chains, including improvements to resource efficiency and recovery in the face of scarcity.
EEE value chain and resource recovery	Understanding more about where materials found in e-waste are ending up, looking to concepts such as supply chain transparency and materials traceability.
Waste Management	Strengthening the knowledge on how e-waste management systems currently work, including our understanding of working relationships between the formal and informal sector, and any integration or partnership initiatives.
Sustainable Development	Acknowledging the integration of social tenets of sustainability into the environment-economy discussion, pointing to the sustainable consumption and production approach to global development and livelihood impacts.

2.2 Semi-Structured Interviews

The semi-structured interviews act as a qualitative tool to obtain more information from industry experts. These interviews help to inform the thesis project by providing supplementary insight on formalization in practice including some key elements of formalization, enablers of formalization, and the greater landscape within which formalization initiatives are taking place.

Interview respondents were sought by reaching out to notable scholars, some of whom were identified in the literature search, as well as connections formed with industry experts from

a number of organizations. There were some initial discussions with experts in the field of circular economy, sustainable development and e-waste from organizations including Chatham House, University of Lagos, United Nations Environment Programme (UNEP), International Environmental Technology Centre, African Development Bank, World Economic Forum, and United Nations Industrial Development Organization (UNIDO). The intended group of participants was policymakers and policy analysts, international development project and program leaders, leading academics, and NGO executives.

The initial discussions helped to identify potential interview participants who are leading or involved in recent formalization initiatives, experts in the circular economy and sustainability discourse, experts in e-waste management discourse, policymakers and researchers helping coordinate projects in Africa and India working to implement circular business strategies or have otherwise acted as key contacts to help facilitate further connections that are relevant to this project. In total, 7 semi-structured interviews were conducted which yielded a sufficient saturation of information and diverse viewpoints. These interviews produced data on a wide-range of perspectives and themes relevant to the research topic. The details of the final survey respondents are in section 2.3.

2.3 Participant Profiles

To a degree, most of these participants have expertise which is global in nature and have worked or researched in some capacity beyond the regions of expertise which are identified in Table 2. For the purposes of this research and to specifically understand what information they can offer about e-waste management and informality, the study has chosen to identify specific regions in which the participants have self-identified as having experience in e-waste, circular economy, or formalization. However, the study refrains from drawing significant conclusions about regional

contexts. Instead, it relies on insights from experts with diverse regional expertise to formulate high-level findings regarding formalization. Further, while many of these participants have and continue to conduct work across different spheres, for the purpose of this research study, the sector-specifications were attributed to each participant based on their work related to e-waste, formalization, and circularity. Where a region of expertise is not defined, it is because the work and context gathered from the participants revealed that they work in a global capacity. For example, Murthy does work as a consultant in regions like Egypt, India and Singapore – while others work within mainly one regional context and therefore are identified as experts in that region.

Table 2: Participant Profiles

Participant	Sector Experience	Regions of Expertise	Organization	Date of Interview (dd/mm/yyyy)
Dr. Deepali Sinha Khetriwal	Private (consulting)	India, Global (China, South Africa, etc.)	DSS+ Consulting (previously Sofie's India), E[co]work	08/06/2023
Venkatesha Murthy	Private (consulting)	Globally (Singapore, Egypt, India, China)	Vans Chemistry Pte Ltd	26/05/2023
Dr. Victor Odumuyiwa	Academia, Private	West Africa	University of Lagos, NitHub	12/05/2023
Dr. Innocent Onah	Policy and Programs	West Africa	African Development Bank	06/06/2023
Dr. Ruediger Kuehr	Academia, Policy and Programs	Global	UNITAR, SCYCLE Programme	05/06/2023
Bonmwa Fwangkwai	Policy and Programs	Sub-Saharan Africa (SSA)	African Development Bank, African Circular Economy Alliance	08/06/2023
Dr. Abdul Ganiy Adelopo	Academia	West Africa	University of Lagos	23/05/2023

2.4 Analysis of Interview Data

In this study, interview data analysis was conducted using two prominent software tools, Delve and NVivo. The study also used “Temi”, an online tool for transcription. The utilization of these software tools was imperative to ensure systematic analysis of the data collected through semi-structured interviews. This section describes the rationale behind the selections and the methodologies employed.

First, Temi was utilized as the primary transcription software for this study. Audio files were uploaded to Temi’s platform, where automatic transcription was performed, followed by manual review and correction of transcripts to ensure accuracy. Second, Delve and NVivo were employed for data analysis. Both tools are widely used and recognized for qualitative data analysis.

Delve was initially chosen with the intent of conducting in-depth analysis of the collected interview data. Completed transcripts generated and reviewed on Temi were uploaded to a dedicated project folder within Delve’s user interface. Delve’s “code” feature was utilized to systematically identify common themes and recurring patterns within the transcripts. The initial phase involved a thorough review of each transcript, where careful attention was paid to identifying themes, keywords, and recurring patterns in the responses. These elements were then systematically converted into “codes” by manual entry into the software’s coding feature which enabled categorization of relevant quotes from the transcripts. This tool facilitated organization of data and streamlined the analysis. As analysis progressed, codes were then refined and consolidated to ensure alignment and coherence. For instance, mentions of “personal protective equipment (PPE), facilities, and tools” were consolidated under the broader category of “equipment”.

While Delve facilitated the organization of data and the initial development of a coding guide, its limitations became apparent. Specifically, Delve's inability to generate visualizations or cross-referencing tables hindered the exploration of deeper insights within the data. This limitation prompted the exploration of other software tools to advance the analysis and gain a more comprehensive understanding of the interview data.

Following the initial coding process in Delve, NVivo was selected for its widely recognized ability for data organization, codebook creation, and data visualization. Building upon the groundwork laid in Delve, the analysis in NVivo was able to advance the codebook. Further review of transcripts was conducted with constant comparison between transcripts, resulting in the emergence of clear themes and subthemes. Thus, the final codebook presented in section 4.0 is integral to shaping a narrative rooted in participants' expertise and perspectives. NVivo's features including "text query", "word cloud" and "matrix framework" were instrumental in the analysis process. The "text query" tool facilitated systematic word search across all transcripts, aligning with keywords and phrases identified within the codebook. Executing these queries yielded relevant passages across transcripts, aiding in the assignment of data to appropriate codes and enabling further interpretation.

NVivo's "word cloud" featured played a role in visually representing the frequency of words or phrases relevant to identified codes. To expand, the "word cloud" tool facilitated the ease of overviewing recurring themes and patterns, highlighting the most prominent words surrounding a chosen term, and guiding analysis. In this regard, the "word cloud" tool was primarily used as a search instrument in developing a codebook representing the themes in the data. The final codebook was created through this search process, along with a review of transcripts and an

analysis of potential codes and themes which involved combining themes and refining where relevant.

Notably, one word cloud was employed to provide a visual representation of the discourse surrounding the “informal sector” and “informality” among participants. Parameters were manually set to visualize the 200 most frequently occurring terms within the 25 words surrounding “informal sector” and “informality” where they presented in the data. This visualization revealed key elements of the discussion pertaining to the discussions on the informal sector. This word cloud is found in section 4.0.

Finally, the “matrix framework” feature was employed. The feature served as a structured analysis tool to facilitate comparisons and exploration of the codes identified in the data. Specifically, the matrix framework allowed for side-by-side view of the different codes to reveal where there were common answers or relationship and intersection between codes. The matrix framework itself is not included in this paper due to its length. However, the observations from the matrix framework formed the basis of the findings as presented in section 4.0.

3.0 Literature Review

This chapter synthesizes insight from different bodies of literature to offer a comprehensive overview of the current understanding of formalization of the informal sector within an increasingly circular economy. The first section of this chapter discusses the transition to circularity and the ever growing e-waste issue, and includes sub-sections on contemporary policy, electronics consumption, and the transboundary movement of e-waste. The second section of this chapter reflects the current discussion on the linkages between sustainable development and circular economy, addressing the prominence of “capacity building” in sustainable development

literature, criticisms of sustainable development and circularity, and introduces the informal sector. The third section of the paper discusses formalization as an approach to address challenges relevant to a circular transition in e-waste.

The analysis of these streams of literature highlights several key findings. The CE is gaining significant traction globally, evidenced by the emergence of a growing body of literature, roadmaps, regulations and policy, and international commitments (Government of India MOEF, 2016; European Commission, 2020; EMF, 2013; UN, 2015; European Investment Bank Group, 2021; Geissdoerfer et al., 2017). With this increasing attention to CE, electronics and e-waste have emerged as a focal point, whereby consumption of EEE is increasing while the capacity for safe and sustainable e-waste management is not increasing at a similar rate (Forti et al., 2020). Concerns remain around the collection and recovery of resources from e-waste which is an essential component for achieving circularity. The literature also underscores the significance of enhancing transparency throughout supply chains and advancing materials traceability as pivotal components of the CE transition (Rizos & Bryhn, 2022; Tura et al., 2019; Kissling et al., 2013). Thus, CE strategies necessitate collaboration among stakeholders engaged in e-waste handling to achieve accurate tracking and traceability of material flows, thus enabling efficient resource recovery (Rizos & Bryhn, 2022).

Indeed, contemporary literature is moving beyond challenges of eliminating the informal sector and is actively developing insights on the extraction of value and materials from e-waste through formal engagement across sectors involved in e-waste management (Mbah et al., 2019; Millington & Lawhon, 2019). One of the advancing theories here is the concept of formalization. There is a growing body of literature supporting formalization between the informal and formal

waste management sectors to enable greater resource recovery and enable the CE (Mbah et al., 2019; International Labour Organization (ILO), 2014; Bhagat-Ganguly, 2021; Wilson et al., 2013; Millington & Lawhon, 2019; Murthy & Ramakrishna, 2022).

This raises questions regarding e-waste management given the significant involvement and dependence on informal sector labour (Bhagat-Ganguly, 2021, p. 18; Ryder, 2019; Masud et al., 2022). While there is a lack of complete data, some evidence strongly suggests that the informal sector manages a significant share of e-waste, prompting further concerns regarding various issues such as human health and safety risks, child labour, resource recovery efficiency, and environmental impacts, among others (Baldé et al., 2024; Bhagat-Ganguly, 2022; Rizos & Bryhn, 2022; Tura et al., 2019; Kissling et al., 2013; Singh, 2021; Morais et al., 2022).

In addition, comparing the literature on CE with sustainable development reveals a notable gap. The literature on CE has not addressed the social dimensions of sustainable development thus far, emphasizing primarily environmental and economic aspects (Suarez-Visbal et al., 2022; Pla-Julián & Guevara, 2019; Hobson & Lynch, 2016). There is a gap in understanding regarding how informal sector workers may be impacted by the formalization efforts suggested in the literature. Yet, there is a broad consensus in the literature that formalization is necessary (Baldé et al., 2024; Mbah et al., 2019; International Labour Organization (ILO), 2014; Bhagat-Ganguly, 2021; Wilson et al., 2013; Millington & Lawhon, 2019; Murthy & Ramakrishna, 2022).

Nevertheless, literature on formalization indicates that there is a lack of clarity on what formalization entails precisely. Multiple concerns are raised. First, untracked e-waste poses challenges for resource recovery and supply chain efficiency, crucial for advancing circularity (Panchal et al., 2023). Second, the financial implications of meeting transparency and traceability

standards in a circular economy may disproportionately affect informal sectors who lack the capacity to meet standards yet handle a significant portion of e-waste (Singh, 2021; Morais et al., 2022). Third, informal management of e-waste presents various hazards including occupational health risks, child labour, resource recovery inefficiencies, and environmental pollution due to rudimentary practices and limited resources (Bhagat-Ganguly, 2021).

Yet, there are also potential benefits that the informal sector provides including livelihood and resource recovery services in lieu of formal waste management (Chi et al., 2011; Scheinberg et al., 2010). Further, additional benefits may emerge through formalization, whereby providing informal sectors with access to equipment may improve resource recovery efficiency of informal operations while mitigating pollution and health and safety risks, thus aligning the CE in e-waste with the social dimension of sustainability in that the actors who face marginalization are valued as part of the transition. This potential should not be overlooked.

3.1 The Transition to Circular Economy and the Growing E-waste Issue

Circular Policy

The circular economy (CE) is primarily an economic model designed to reduce waste and promote sustainable resource utilization (Geissdoerfer et al., 2017; Pla-Julián & Guevara, 2019). The paradigm shift towards circularity has gained significant momentum in recent years, becoming increasingly visible across sectors including academic research, business and innovation, and policy (Brenner & Drdla, 2023; Rosa et al., 2019; Geissdoerfer et al., 2017).

Conceptually, while the CE as a model for the global economy is new and emerging, the foundational principles behind circularity, such as recycling, reusing materials, preserving value from resources and waste, and reducing waste, are not novel concepts (Ekins et al., 2019). The rise

of the CE and the discourse surrounding its practices are embedded within the broad discourse and collective efforts to achieve a sustainable future within a globalized world where cultures, economies, and people are more interconnected than ever before (Geissdoerfer et al., 2017).

While missing a universally accepted definition, the proliferation of the CE as a concept comes from an amalgamation of several existing theories. Each of these concepts addresses the interactions between human industrial systems of production and consumption, and their subsequent environmental impacts (Gallaud & Laperche, 2016). Pearce and Turner (1990) are often cited as the first to conceptualize the CE, although, the CE derives from a converging of different subjects and categories such as industrial ecology, environmental economics, and ecological economics, to name a few (Ghisellini et al., 2016, p 12-15; Geissdoerfer et al., 2017; Su et al., 2013).

As prominent environmental economists, Pearce and Turner theorized that natural resources such as air quality or water quality “influence the economy by providing inputs for production and consumption, as well as serving as a sink for outputs in the form of waste” (Geissdoerfer et al., 2017, p.759). In simple terms, Pearce and Turner conceptualized that the traditional economy drew resources from the environment and simultaneously treated the environment as a reservoir for waste. Pearce and Turner’s work on the CE borrows and builds on knowledge from ecological economist Boulding’s work calling on the need for a closed economic system, where the relationship between environment and economy must be balanced, aiming to operate like a natural ecosystem where materials are regenerated, reused, and recycled within the system itself (Su et al, 2013; Boulding, 1966).

Though the CE lacks one single definition, the Ellen MacArthur Foundation’s (EMF) definition of the CE is one of the more widely accepted definitions, as the organization has

remained actively involved in contemporary research on the adoption of circularity in practice. Further, some may argue that the EMF may be responsible for bringing more stability to the understanding of the CE, which may have been fragmented previously (Gallaud & Laperche, 2016). Created in 2010, the EMF defines the CE as an industrial system that is restorative or regenerative by intention and design (EMF, 2013). According to the EMF, the CE is underpinned by a transition to renewable energy and renewable materials, decoupling human economic activity from the consumption of finite resources and based ultimately on three key principles: (1) eliminate waste and pollution, (2) circulating products and materials at their highest value, and (3) regenerating nature (EMF-a, n.d.)

The first principle is to eliminate waste and pollution by adopting circular strategies that effectively design waste out of the economy by asking at a product or service's conception, "what will happen to these resources at the end of their life" (EMF-b, n.d.). The second principle is to keep resources in use for as long as possible, and to keep them in circulation (EMF-c, n.d.). According to the EMF, circulating materials occurs in two key cycles, technical or biological (EMF-c, n.d.). The technical cycle addresses the way products are designed to remain in use as long as possible, and how the resources used to make products are reused, repaired, remanufactured, recycled (EMF-c, n.d.). The biological cycle relates to the regenerative nature of our resources, where renewable materials are returned to the Earth (EMF-c, n.d.). The key element of the second principle of the circular economy is to circulate resources and products at their highest value to maximize the usage of materials that have been taken from the Earth for human use. The third principle is to support natural processes and to shift from an extraction-based economy to a regenerative one (EMF-d, n.d.). This principle aims to shift the relation between the

economy and the environment beyond preventative measures, instead looking to what practices can actively improve the environment (EMF-d, n.d.)

Notably, the transition to circularity has both “pull” and “push” factors. At a high-level, the pull-factors include economic opportunity and job creation, market demand for sustainable products, and regulatory incentives (EMF, 2013; Accenture, 2019). On the other hand, push factors include resource scarcity, pollution mitigation, and serious environmental degradation (EMF, 2013; European Environment Agency, 2016; World Economic Forum, 2021). Although this is not an exhaustive list, these pull-factors indicate that there are clear benefits in transitioning to circularity. However, the push-factors are significant as they demand urgency and highlight that disregarding the risks of not transitioning to a sustainable economic model of operating will have dire consequences for humans and the environment.

As a result of acknowledging the benefits and risks of circularity, various kinds of policy approaches and strategies are emerging. These include action plans, roadmaps, national regulation and legislation, international commitments, and funding initiatives for instance. A primary CE policy toolkit, Extended Producer Responsibility (EPR), makes use of economic instruments aiming to achieve circularity by placing the burden of responsibility to manage products through their use and end-of-life on producers (OECD, 2024). EPR efforts are supported by incentives for producers aimed at promoting material collection and recovery at the end of the product lifecycle (OECD, 2024). In essence, EPR strategy asserts that producers can mitigate the impact of their products by making improvements to product design and waste management practices through enabling policies.

Examples of the various policy approaches to CE include the European Union’s “Circular Economy Action Plan”; The EMF’s “Towards the Circular Economy” roadmap; India’s “E-waste

(Management) Rules, 2016” which serve as EPR legislation in India; the 2030 Agenda for Sustainable Development which identify sustainable production and consumption as a core element; or the European Investment Bank’s “Circular Economy Financing Initiative” which provides funding for circular business initiatives (Government of India MOEF, 2016; European Commission, 2020; EMF, 2013; UN, 2015; European Investment Bank Group, 2021).

Notably, the European Union (EU) has demonstrated a longstanding commitment to environmental protection, dating back to the 1980s (Knill & Kiefferink, 2021). While the 2015 Paris Summit is often recognized as the starting point for environmental policy in the EU, the union has progressively developed an environmental governance system in which policies are developed upon collaboration between various levels of government across nation-states to ensure a comprehensive approach to managing environmental issues (Jordan et al., 2021). Over time, EU policies have progressed from tackling pollution and conservation to embracing sustainability, and eventually leading to its current focus on the transition to a circular economy model (Knill & Kiefferink, 2021; Jordan et al., 2021). Key initiatives such as the Circular Economy Action Plan (CEAP) and the European Green Deal underscore the EU’s dedication to achieving climate neutrality, resource efficiency, and global competitiveness (Steurer, 2021).

Further, China is another notable example of how circular economy principles are being integrated into national policy. The concept of CE has been integrated into China’s national policies since the Hu-Wen administration (Pesce et al., 2020). China generates a national development plan every five years outlining a policy agency with goals for social and economic development and successive five-year plans since 2006 have dedicated a section to the CE (Pesce et al., 2020). The inclusion of CE into overarching social and economic goals indicates that CE is a fundamental part of their policy goals. The “Opinions on Accelerating CE Development” and

the “CE Promotion Law of 2008” provided a legal framework for CE implementation, focusing on the 3R approach of reduce, reuse, and recycle.

In some instances, despite the absence of specific roadmaps or frameworks, policymakers are actively engaged in encouraging and incentivizing the transition to circularity. Such is the case in Africa, where as a pathway to post-COVID resilient growth, largely driven by the private sector, the CE is gaining strong momentum (World Economic Forum, 2021). The African Circular Economy Alliance (ACEA) has presented a considerable commitment to increasing circularity through its various initiatives. In 2017, the ACEA was formed by Rwanda, Nigeria, and South Africa, with support from global entities like the World Economic Forum and the African Development Bank (World Economic Forum, 2021). A sector assessment conducted by ACEA identified five priority sectors for the circular transition: food systems, packaging, built environment, electronics, and textiles (World Economic Forum, 2021). Further, in Nigeria, Africa’s most populous country and largest economy, efforts are underway to develop a national CE roadmap through initiatives like the ACEA’s Nigeria CE Working Group, aiming to harmonize policies and guide the transition from a linear to a circular economy.

Furthermore, across the current landscape of circular policy work, there are key value chains which are repeatedly identified by policymakers, researchers, and industry alike as being the drivers of sustainable development, circularity, and innovation. Typically, plastics, renewable energy, textiles, agriculture, and electronics are identified as key value chains that should be prioritized in the circular economy movement (EMF, 2014). A widely supported perspective based on a review of the available literature shows that fostering circularity within these value chains may yield immediate or accelerated results in terms of achieving circularity globally, and thus ideally, enhancing sustainability via improved resource recovery, greater innovation,

collaboration, improved environmental outcomes, and economic prosperity. (World Economic Forum, 2021; EMF, 2018; EMF, 2020).

Consumption of Electronics and Electrical Equipment

While plastics, renewable energy, textiles, agriculture, and electronics are all identified as key value chains as part of the circular transition, the electronics value chain presents a particularly unique and pressing challenge. First, while consumption of electronics and electrical equipment (EEE) is increasing, the capacity to manage large volumes of e-waste safely and sustainably is not. In that regard, the Global E-waste Monitor is a groundbreaking report which publishes the quantities, flows, and the circular economy potential in e-waste (Forti et al., 2020; Baldé et al., 2024). As a defining report, the Global E-waste Monitor reveals that e-waste is one of the fastest-growing waste streams globally, discussing how e-waste management challenges align with international commitments to achieve the Sustainable Development Goals (SDGs), and how data and monitoring of e-waste flows can lead the collective towards a circular and sustainable future (Forti et al., 2020; Baldé et al., 2024).

Several factors fuel the growing e-waste problem, which can be primarily attributed to the rising consumption of electronics and electrical equipment (EEE) (Forti et al., 2020; Baldé et al., 2024). According to Forti et al. (2020), global consumption of EEE increases by 2.5 Mt per year, disregarding solar photovoltaic panels. In 2014, 44.4 Mt of e-waste was generated globally, in 2019, 53.6 Mt, and that figure is expected to reach 110 Mt in 2050 (Baldé et al., 2022, p.15; Parajuly et al., 2019). According to the most recent Global E-waste Monitor over 62.0 Mt of e-waste was generated in 2022 (Baldé et al., 2024). Although the amount of e-waste collected and recycled continues to improve, total e-waste generation itself continues to increase at a rising rate (Forti et al., 2020). The yearly increase in EEE consumption is greater than the current capacity to

manage the ensuing e-waste. In that respect, research shows that globally only 17.4% of e-waste that is generated is formally collected and recycled (Forti et al., 2020). In particular, only 22.3% of over 62.0 Mt of e-waste was documented as formally collected and recycled in 2022 (Baldé et al., 2024). Furthermore, between 2019 and 2023 the number of nations with e-waste legislation increased from 78 to 81 (Baldé et al., 2024, p. 13). Although that number seems to now be decelerating, this indicates that many nations are committed to tackling the e-waste issue (Baldé et al., 2024).

In addition, Forti et al. (2020) establish that there are some key determinants which link greater EEE consumption and increasing e-waste generation. Primarily, growing urbanization, industrialization in emerging economies, and increasing levels of disposable income across classes have led to an increase in consumption and demand for EEE (Forti et al., 2020, p.13). High consumption rates, low repair rates, and short product lifespans coupled with rapid technological innovation within a consumerist “throwaway” culture, render many EEE products as e-waste despite them being suitable for reuse, repair, recycling, or continued usage. (Forti et al., 2020; Fawole et al., 2023; Oraee et al., 2024; Baldé et al., 2024).

In addition, the complex materials composition of EEE products presents a significant challenge for circular economy adoption, specifically because of the complexities this creates for recycling. Moreover, safely dismantling and processing EEE products requires great capital and expertise. For instance, smartphones are a commonly cited example when discussing the complexity of e-waste given that they typically contain precious and important metals in their various components including lithium-ion in their batteries, gold, silver, and palladium on touch screens, and an array of polymers in their casing (Venditti, 2021; Jawaid & Khan, 2023). Indeed, the materials composition of a smartphone includes up to forty-nine elements (Roithner et al.,

2022). The example of the smartphone serves to indicate that recycling of EEE products requires disassembly and treatment of each of the different components. This is relevant to the circular economic transition in that in order to successfully recover materials for use as secondary feedstock, there must be further exploration on how to recycle EEE products in an economical and environmentally sound manner on a large-scale

Third, in focusing on the e-waste issue as part of the initial transition to circularity, there is a great economic opportunity to recover value from resources (Thiebaud et al., 2018; Panchal et al., 2023; PACE, 2019). While there is a high volume of e-waste, there is also a high volume of valuable resources found within e-waste products.

Further, this value of resources found within e-waste show immense potential for resource recovery. In fact, mining e-waste is an economic opportunity worth more than \$62.5 billion annually (PACE, 2019). For instance, e-cigarettes contribute significantly to e-waste due to their disposable nature, containing plastic, lithium-ion batteries, heating elements, and circuit boards, all of which are frequently discarded (Baldé et al., 2024). In 2022, the batteries of nearly 42 million kg of e-cigarettes contained approximately 130,000 kg of lithium, representing a significant missed economic opportunity (Baldé et al., 2024). As another example, in 2017 1.46 billion units of smartphones were sold, each containing electrical components worth more than \$100.49; in this case extracting raw material from smartphones that are no longer in-use could be worth up to \$11.5 billion (PACE, 2019). In another instance, at the current e-waste recycling rate of roughly 17.4%, approximately 4 million metric tons (Mt) of iron, aluminium, and copper can be extracted for use as secondary materials, with the value of roughly \$10 billion USD (Forti et al., 2020; Bhagat-Ganguly, 2021). The literature points to the untapped economic potential of resource recovery from e-waste. As scholars such as Thiebaud et al. (2018), and Panchal et al. (2023) assert, the

significant rise in the consumption of EEE will create substantial economic opportunities for resource recovery from e-waste, as these EEE products will eventually be discarded after initial use. This creates a compelling case for further examining the application of circularity by addressing and exploring the issues relevant to e-waste management.

Fourth, the latest available Global E-waste Monitor (2020) (GEM) finds that there are strong linkages between global development and EEE consumption (p. 13). To elaborate, the pursuit of development is a driver of increased dependence on EEE for improved living standards (Hossain, Al-Hamadani, Rahman, 2015; Kumar et al., 2017; Forti et al., 2020). For example, a case study on emerging markets revealed that the volume of e-waste generated has increased as a direct result of electronic “lifestyle improvement” products such as PCs and cell phones (Hossain, Al-Hamadani, Rahman, 2015). Additional research by Kumar et al. (2017) suggests that countries with high GDP are likely to have a higher e-waste generation, with the increase in e-waste generation being attributed to an increase in individual wealth of inhabitants (p. 34).

These linkages between greater EEE consumption and increasing waste generation produce sustainability concerns as well. These concerns are two fold. First, e-waste poses significant environmental and human health risks (Bhagat-Ganguly, 2021; Li et al., 2008; Guo et al., 2009). Second, as nations pursue development goals such as enhancing connectivity or transitioning to clean energy sources for example, there is a corresponding rise in EEE production and subsequently in e-waste (Forti et al., 2020; Baldé et al., 2024). This linkage underscores the connection between discussions on global development and efforts toward sustainable development. This relationship is illustrated well by the Sustainable Development Goals (SDGs). For example, SDG 9, which focuses on fostering sustainable industrialization and infrastructure improvements requires technological upgrades (United Nations, 2015). This topic is further

explored in section 3.2 of this paper. Hence, e-waste is both a matter of concern for sustainability as well as the circular transition and in this way, all three issues are highly interlinked.

Fifth, supply chain disruption, market fluctuation, and material scarcity have created a situation where the mining of secondary resources has become necessary to reduce pressures on primary materials extraction, waste management systems, and the environment (Smart Prosperity Institute, 2021, p. 19). Within context of the EEE value chain, mining secondary resources refers to the process of safely dismantling and extracting metals and minerals from e-waste. Ideally, these resources would then be re-used in a way that would retain their quality, function, and value. In general, it is likely that secondary materials extraction will be an absolute necessity to meet future demand for metals and minerals (World Bank, 2017; OECD, 2019). Murthy & Ramakrishna (2022) also indicate that the scarcity of metals and minerals required to meet the demand for EEE products will likely encourage the need for secondary production. The latest GEM asserts that in light of the growing amount of e-waste, resource recovery and efficiency efforts must improve, with the underlying goal to reduce the use of virgin materials (Forti et al., 2020). While projections by the OECD (2019) and World Bank (2017) indicate that reducing the use of virgin materials is a far-away possibility, mining resources from e-waste for re-use as secondary materials in EEE manufacturing is an economic opportunity that would supplement the extraction of raw materials providing additional environmental benefits as well (Forti et al., 2020; Bhagat-Ganguly, 2021, p. 30)

Overall, the literature reveals that e-waste is a rapidly growing waste stream that poses a number of challenges which are highly relevant to the application of circular economy. The increase in EEE consumption and the subsequent implications for sustainable development, the complexity of materials, the economic opportunities to recover value from resources, and the need

for secondary production to reduce reliance on virgin materials work to strengthen the case that increasing attention to circularity will inevitably lead to increasing attention to e-waste concerns given that the EEE value chain remains a pressing and core sector of interest as part of the transition.

Transboundary Movement of E-waste

While the growing amount of e-waste generation exacerbates the strain on waste management systems globally, transboundary movement of used EEE and e-waste presents a particular concern. Reports show that transboundary movement of e-waste makes up 7%-20% of total e-waste generated (Forti et al., 2020). For example, it is estimated that around 50%-90% of EEE that is diverted from landfill in the United States is actually exported to developing countries for reuse, despite the banning of trade on toxic waste streams (Needhidasan et al., 2014). Furthermore, 5.1 billion kg of e-waste moved across borders in 2019, with 3.3 billion kg of this total considered as “illicit” – the treatment of this e-waste is unclear and it is likely that it is not conducted in an environmental sound manner (Baldé et al., 2024).

While there are some policy measures in place to address transboundary e-waste movement, they are currently insufficient (Baldé et al., 2022). For example, the Basel Convention on the Control of Transboundary Movements of Hazardous Waste encompasses some EEE products given that they contain hazardous elements however, the treaty’s definition of “hazardous” makes it so that some e-waste products are currently unaccounted for (Baldé et al., 2022, p. 17). Seemingly, a sizeable amount of e-waste is exported illegally or under the guise of used EEE, which does not fall under jurisdiction of the Basel Convention (Forti et al., 2020).

In fact, differentiating between used EEE and e-waste is one of the main challenges in monitoring transboundary movements, where in some instances shipments can contain anywhere

between 30% to 77% of illicit items (Baldé et al., 2024; Odeyingbo et al., 2017). Another key challenge is the inadequacy of reliable data on e-waste flows. Inaccuracies in reporting are exacerbated by the significant presence of illicit e-waste movement (Baldé et al., 2024).

The export of used EEE and e-waste compounds the pressure on waste management systems already overwhelmed by domestic generation. In fact, the transboundary movement of used EEE and e-waste to areas that lack sufficient infrastructure, technical expertise, or policies in place can add further pressure to those waste management systems (Wang et al., 2016; Puckett et al., 2018; Parajuly et al., 2019). Moreover, the management of domestic and imported e-waste is particularly challenging for regions of the Global South that lack sufficient infrastructure for managing waste and where waste management systems are characterized by formal and informal waste management networks (Baldé et al., 2024).

Formal waste management systems encompass all the legally permitted and recorded activities relating to the collection, treatment, and disposal of waste materials. However, globally e-waste is predominantly managed by informal sector activities including collection, refurbishment, repair, and recycling using primarily rudimentary techniques (Bhagat-Ganguly, 2021, p. 18). It is estimated that around 80% of global e-waste is informally recycled (Ryder, 2019; Masud et al., 2022). For example, in India approximately 95% of e-waste is recycled by the informal sector (Dutta & Goel, 2021).

The informal waste management sector is characterized by a diverse range of individuals and groups conducting waste handling activities without legal mandates, operating in an unregulated and untaxed environment (Guibrunet, 2019; Bali Swain & Kambhampati, 2022). Williams (2023) states that the literature often portrays the informal sector in a negative light, describing a hierarchy where formal is the “norm” and informal is abnormal or inferior (p. 3).

Williams' (2023) definition of informal economy consists of "socially legitimate paid activities that are legal in all respects other than they are unregistered with, hidden from, and/or undeclared to the state for tax, social security, and/or labour law purposes when they should be registered, reported, and/or declared" (p. 6). While the informal sector functions differently depending on the region, the consensus is that informal solid waste management "comprises all the unregistered and unregulated activities of waste pickers, scrap dealers, itinerant waste buyers, informal collectors or cart pushers, middle-men and micro and small enterprises involved in solid waste management" (Nzeadibe, 2013; Baud et al., 2004; Medina, 2007; Scheinberg et al., 2010; Wilson et al., 2009).

However, there are additional complexities between the informal and formal sectors suggesting that they may not always operate independent of one another. In many cases, informal sector work is entwined and coexists with the broader formal economy, this is particular true where there are substantial networks of informal workers (Chi et al., 2011; Simaetele et al., 2017; Kawai et al., 2012; Hilburn, 2015; Millington & Lawhon, 2019; ILO, 2014; Wilson et al., 2006). It is estimated that there are 24 million waste pickers involved in informal sector activities, concentrated mainly in the Global South, often employing semi-skilled labourers including children (World Bank, 2022; Bhagat-Ganguly, 2021). Typically, it is challenging to assess the true number of waste pickers in a given municipality, or the volume of e-waste they handle (Buch et al., 2021). Data on the informal sector's involvement in waste management is scarce, largely due to their undocumented and relative unorganized nature (Buch et al., 2021, p. 41). This insufficiency of statistics on the true volume of waste collected and recycled by the informal sector makes it difficult for policymakers, development workers, and researcher to determine the true number of jobs, employment standards, and recovery rates of resources from the informal e-waste sector (Bhagat-Ganguly, 2021). In addition, the absence of accurate data affects the capacity to offer aid

or formulate a plan for engagement or policy support of the informal sector (Bhagat-Ganguly, 2021). Nevertheless, the informal waste sector is not a homogenous group and is characterized by varying levels of organization including unorganized individuals, organized collectives or unions, or contract laborers (Buch et al., 2021, p. 41).

Globally, e-waste management is increasingly being incorporated into national strategies, most prominently within the adoption of circular policies that promote reuse, recycling, and recovery (Murthy & Ramakrishna, 2022). This observation suggests that increasing emphasis on circular economy initiatives may influence a heightened focus on addressing relevant e-waste challenges such as resource scarcity, recovery, and enhanced recyclability. Further, increased awareness of the rising volume of e-waste may stimulate further interest in adopting circular practices. Hence, it is essential to investigate how the ongoing shift towards a CE across the EEE value chain and in e-waste management, aimed at influencing a sustainable future, could potentially generate economic, environmental, and social impacts. In particular, such a transition might impact the livelihood and wellbeing of key actors in the EEE value chain, particularly those engaged in the historically marginalized informal sector.

3.2 Towards a Sustainable Future: Capacity building, CE & the SDGs

Sustainable development is presented as a solution to global challenges of resource depletion, growing waste, biodiversity loss, and climate change (UNEP, 2015). The concept of sustainable development as a solution was first presented in the 1980s and has since evolved from exploring ecosystem carrying capacity to a complex concept which addresses how humanity can meet its current needs in a way that does not inhibit the ability of future generations to meet theirs (Pla-Julián & Guevara, 2019, p.68). Pla-Julián and Guevara (2019) write that “increasing population and consumption rates, inequality gaps, and [the] excessive environmental pressure

[are] putting human society at risk” (p.67). A commonly accepted perspective among scholars in sustainable development is that decoupling economic growth and human wellbeing from resource use and negative environmental impact is necessary (Pla-Julián & Guevara, 2019; UNEP, 2015). In that regard, sustainable development hinges on addressing three key tenets: economic, environmental, and social development (Mbah et al., 2019). As a result, “a fundamental restructuring of current systems of production, provision and consumption is required” (UNEP, 2015, p. 12).

Capacity Building in Sustainability Literature

“Capacity building” represents a significant area of discussion within the literature on sustainable development, representing the idea that human development is rooted in empowerment (United Nations Development Programme (UNDP), 2015). Capacity building is relevant for this study as it can serve as a tool to bridge the gap between the historically marginalized informal sector and stakeholders involved in advancing circularity and development initiatives.

Capacity building is a multifaceted concept utilizing a range of strategies and interventions aimed at development, such as enhancing training and education, ensuring access to resources and fundamental rights, and establishing institutions for economic and social empowerment of individuals, among others (UNDP, 2015). Eade (2007) asserts that capacity building cannot be viewed narrowly as a singular idea of providing services, nor can it be viewed as a broad catch-all for aid (p. 632). An earlier publication by Deborah Eade (1997) provides insight into the evolution of capacity building as a concept, which became prominent in the development sphere in the mid 1990s (p. 10). Eade (1997) shares that capacity building gradually became integral as a result of major criticisms of development theory. For example, scholars such as Ivan Illich, Paulo Freire, Mahmood Mamdani, and Amartya Sen critiqued development as being an imposition of Western

ideology on what is now deemed “the Global South” leading to determinantal impacts (Eade, 1997). These criticisms sparked discussions in the development literature, eventually leading to the emergency of what is now “capacity building”. Eade (1997) writes that “capacity-building is influenced by earlier ideas concerning participation, empowerment, civil society, and social movements” (p.10).

One example of these earlier ideas is the Capacities and Vulnerabilities Analysis (CVA) framework which emerged in the 1980s (Eade, 1997, p. 13). The CVA framework was developed to address the negative impacts of aid work, ultimately stating that “identifying and strengthening the capacities that people and organizations already have and tackling the cause of their weaknesses” will provide the right framework within which to make decisions about long- and short-term aid responses (Eade, 1997, p. 14). At the same time, Eade (1997) asserts that the emergency of neo-liberal policy led to a greater consensus on “people-centred development” (p. 14).

Capacity building literature also identifies NGOs as playing a key role, noting that both aid donor and aid recipient NGOs must share the risk and responsibilities of development, as well as be able to hold mutual accountability (Eade, 1997). NGOs have increasingly assumed the role of service providers, especially in the Global South, playing the role of advocates and collaborating with policymakers (Ulleberg, 2009). Finally, the literature cautions that while the role of NGOs is key, capacity building in development also requires involvement from governments, policymakers, private sector, and other stakeholders (Eade, 2007). Eade (2007) has gone on to raise a critical point that without a clear definition and well-defined parameters, determining what kind of development initiative is seen as “capacity building” and what does not fit under this umbrella is a daunting task. Thus, capacity building might be understood as a tool, comprised of

various strategies, aiming to enable the capabilities of people to represent and defend their own interests more effectively. In summary, development theory has evolved to include capacity building, recognizing it as a multifaceted concept and reflecting a shift toward inclusive and context-specific approaches to development, including sustainable development.

Sustainable Development and Circularity

As established, the discussion surrounding the CE is embedded in broader discussions regarding sustainable development (Geissdoerfer et al., 2017). Indeed, eliminating waste and pollution, circulating resources at their highest value, and regenerating nature are clear goals for restructuring the current linear system of production and consumption (EMF-a, n.d.). Thus, there are observable links between sustainable development and CE. However, while the two concepts have similarities, some scholars still identify notable gaps in literature.

A review of the literature shows that current discussions on CE place a strong emphasis on implementing the economic and environmental tenets of sustainability but there remains a lack of knowledge on the social factors (Suarez-Visbal et al., 2022; Pla-Julián & Guevara, 2019; Hobson & Lynch, 2016). Improving resource recovery and resource efficiency, and the implementation and adoption of CE will bring social and economic benefits including improvements in infrastructure, employment opportunities, and technological development (Bhagat-Ganguly, 2021, p. 6). Yet, Suarez-Visbal et al. (2022) underline that where available, most of the literature on the social sustainability dimension of the CE focuses largely on job creation from the application of circular business practices such as recovery, rental, repair, resale, remanufacturing, and recycling. Further, Pla-Julián & Guevara (2019) highlight that much of the CE discussion focuses on “value creation opportunities through a better management of material resources” but omits the social and human dimension of consumption and production processes, and socio-cultural transformations

(p. 69). Thus, while implementation and adoption of CE is expected to generate socio-economic benefits, there are some gaps in the literature regarding the socio-economic implications of CE beyond job creation, particularly concerning its broader social impact on communities, livelihood, cultures, and social equity, for instance.

This gap between CE and social sustainability is reflected in Kirchherr et al.'s (2017) definition of the CE as a multidimensional approach to addressing the challenges presented by a linear economy by aiming for economy prosperity that is primarily aligned with the environmental and economic tenets of sustainability. Hobson & Lynch (2016) affirm this distinction highlighting that the CE is rooted in the belief that the process of conserving and reusing resources and optimizing energy has economic benefits (p. 17). Though Hobson & Lynch (2016) suggest that CE has now shifted towards a political agenda of systemic and structural change, they maintain that the CE requires a more holistic reshaping of our economy where considerations are made for the broader socio-economic implications of circularity (p. 16). The perspectives found in these papers point to a central message, if promoting circularity is to contribute to sustainable development, then research and discourse on the CE should comprehensively address its economic, environmental, and social dimensions of the transition.

Critiques and Parallels

The criticisms directed at the CE echo similar critiques on sustainable development literature. Both bodies of literature have been faulted for their disproportionate emphasis on economic aspects of sustainability. Indeed, scholars assert that development discourse in general tends to prioritize economic growth (Hickel, 2019; Mbah et al., 2019; Arora-Jonsson, 2023). These criticisms are observed specifically in literature surrounding the Sustainable Development Goals, which often take centre stage in the development sphere. The Sustainable Development Goals

(SDGs) aim for this systemic restructuring by aiming to address the social, environmental, and economic pillars of sustainability and ensure that while ecological sustainability is enhanced that poverty and marginalization also reduce (Mbah et al., 2019). Yet, the criticisms surrounding the SDGs parallel similar critiques within the discussion on the CE.

Notably, Jason Hickel (2019) highlights the inherently contradictory nature of the SDGs, writing that while Goals 6, 12, 13, 14, and 15 appear to call for “harmony with nature” and reducing environmental degradation through a variety of indicators, that Goal 8 focuses solely on global economic growth measured in GDP. Hickel (2019) argues that while pursuing economic growth as a strategy to pursue poverty alleviation, hunger reduction, and environmental protection may be feasible in the Global South context, that GDP growth past a certain threshold has negative impacts (p. 880). Furthermore, Seema Arora-Jonsson (2023) writes that the SDGs are “grounded in a western and neoliberal ideology” (p. 1). Similar to Hickel, Arora-Jonsson (2023) finds that the SDGs focus heavily on economic growth, but also concludes that there are a number of implementation challenges present for the Goals, including “lack of scientific data for indicators, weakness in monitoring and evaluation mechanisms” and “problems around technology transfers and development aid” (p. 7). Despite these criticisms, the SDGs remain a key framework for gauging and measuring progress towards sustainable development through the 231 unique indicators. Evidently, as the transition towards greater circularity progresses, the discussion on CE remains intertwined within the broader discourse surrounding sustainability.

Linking Circular Economy, Social Sustainability, and SDGs

As the adoption of the CE and the surrounding body of literature continue to grow, there may be an opportunity to align the broader CE discussion with the adjacent discussion on sustainability by addressing the social and socio-economic aspects of such a transition. Of greater

significance, it is imperative to recognize the social and human costs of policies and initiatives aiming to enhance and enable circularity. The literature identifies a few key enablers to implementing circularity in the EEE value chain, stating that the transition necessitates greater regulatory measures, enhanced supply chain transparency, materials traceability, accountability, strengthened partnerships across the value chain, and technological advancements (Rizos & Bryhn, 2022; Millington & Lawhon, 2019; Dias, 2016; Santana & Ribeiro, 2022; Tong et al., 2018).

Based on these enablers, it can be inferred that formal recyclers and aggregators, manufactures and producers, governments and policymakers, NGOs, advocacy groups, informal workers and informal SMEs, consumers, businesses, technology innovators, and other e-waste sector workers will be impacted by the requirements of the CE (Rizos & Bryhn, 2022; Tura et al., 2019). Some scholars suggest that developing this area of research with sector-specific and interdisciplinary knowledge is needed (Rizos & Bryhn, 2022; Tura et al., 2019). This prompts further investigation into how these enablers can be considered from a social and socio-economic perspective.

To expand, some of these enablers of the CE such as greater traceability and transparency or technological advancements demand deeper consideration of social implications. Without improvements in transparency across supply chains and greater materials traceability, it would be impossible to close-the-loop on resources and ensure that materials are recovered and reused for their highest-value application (Rizos & Bryhn, 2022; Tura et al., 2019; Kissling et al., 2013). Alongside these improvements in supply chain transparency and materials traceability, enhancements will also take place in recycling infrastructure, technological advancements, circular policy adoption, and incentives to reduce recycling costs for businesses (EMF, 2013; Accenture, 2019; OECD, 2024; Dias, 2016; Millington & Lawhon, 2019). As such, the adoption and

enforcement of circular policy and scaling of circular business models raises concerns about worker's future livelihood status and working conditions (ILO, 2023).

In that regard, the literature points to the informal sector as a group that will face increased pressure by the changes brought on by increasing circularity (Rizos & Bryhn, 2022; Tura et al., 2019; Kissling et al., 2013; Singh, 2021; Morais et al., 2022). When reviewing the waste management literature in the Global South, there is extensive coverage on waste pickers and the informal sector, emphasizing their role in urban waste governance and their pervasive presence (Gregson & Crang, 2015). Typically, the informal waste sector lacks the capacity to meet existing compliance measures, legal licenses, and permits which may likely impact their ability to participate in an increasingly circular economy (Kissling et al., 2013). Some waste management scholars have even advocated for increased focus on the social, economic, and environmental significant of informal waste workers and their role in urban waste management (Medina, 2007, Millington & Lawhon, 2019, Wilson et al., 2006). Despite these findings, the informal waste sector continues to be overlooked in the broader CE literature and the CE agenda, with insufficient consideration regarding their activities which may well include reflect some aspects of circularity (ILO, 2023).

E-waste & the SDGs

Moreover, there are two overarching links between the SDGs and the e-waste issue which are relevant to the circular economic transition. First, the SDGs provide a method for measuring progress towards sustainable development in the EEE value chain, particularly in terms of addressing a number of aspects of the e-waste issue including health and well-being, decent work opportunities, sustainable communities and cities, and responsible consumption and production.

Table 3 below identifies SDG indicators relevant to the CE as laid out in Bhagat-Ganguly's (2021) book on e-waste management in India.

Table 3: SDG Indicators & Principles of Circularity

3.9 By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination
8.3 Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity, and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services
8.8 Protect labour rights and promote safe and secure working environments for all workers, including migrant workers, in particular women migrants, and those in precarious employment
11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management. 11.6.1 Proportion of municipal solid waste collected and managed in controlled facilities out of total municipal waste generated, by cities
12.4 By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment. 12.4.2 (a) Hazardous waste generated per capita; (b) production of hazardous waste treated, by type of treatment
12.5 By 2030, substantially reduce waste generation through prevention, reduction, recycling, and reuse. 12.5.1 National recycling rate, tons of material recycled.

Note. SDGs and E-waste Related Targets and Indicators retrieved from Bhagat-Ganguly, V. (2021). E-Waste Management: Challenges and Opportunities in India. Routledge India.

Second, the SDGs reflect the concept of sustainable consumption and production across value chains (SCP). Though Target 12 is mentioned in the point above, it is necessary to highlight the fundamental idea that SCP and CE are intricately connected, and potentially represent aspects of a shared concept. The SCP approach implies the need to change our current “take-make-use-waste” economy into one that respects our planetary boundaries, enabling economic growth while limiting negative environmental impact and factoring in human wellbeing. In that regard, the CE is presented as a systems solution and a method for addressing contemporary sustainability

challenges like climate change, waste, and biodiversity loss by decoupling economic growth from resource consumption (EMF-a, n.d.).

However, it is important to note that the literature identifies nuance in the informal sector's participation in e-waste management, which will be explored in the following section of this paper. Investigating the role of the informal sector in facilitating a circular transition or devising strategies to enhance its capacity presents an opportunity to address the social and human dimensions of sustainable development and circularity.

3.3 Formalization

Contemporary literature on waste management is shifting focus from the challenges of eliminating the informal sector, to exploring how value and materials can be reclaimed through formalization strategies which integrate the informal sector into the formal system (Mbah et al., 2019; Millington & Lawhon, 2019). Scholarship is increasingly supporting the idea that integrating the informal and formal waste management sectors can improve waste management efficiency and resource recovery, and thus integration may contribute to enabling a transition to circularity in e-waste (Baldé et al., 2024; Mbah et al., 2019; International Labour Organization (ILO), 2014; Bhagat-Ganguly, 2021; Wilson et al., 2013; Millington & Lawhon, 2019; Murthy & Ramakrishna, 2022; Gregson & Crang, 2015; Adama & Nzeadibe, 2017). Another perspective argues that there must be a nuanced understanding of the informal sector's role within the CE and the broader economy, suggesting that integration practices vary and should not be homogenous across all contexts (Bali Swain & Kambhampath, 2022).

The significance of formalization within this study is multi-pronged. First, untracked e-waste remains a complication for resource recovery and reverse supply chain logistics. If such a vast portion of these valuable resources contained in e-waste remain in the hands of the informal

sector, which evidently lacks the capacity to improve traceability, then this hinders large-scale resource recovery. It becomes an issue that must be addressed by the greater collective involved in solving this problem (Rohit Panchal et al., 2023).

Second, the costs associated with making the necessary changes to meet the requirements of a circular economy, such as higher accountability, transparency, and traceability will have disproportionate impact on informal sector actors that lack the skills, resources, and capacity to meet such requirements (Baldé et al., 2024; Singh, 2021; Morais et al., 2022). Rizos and Bryhn (2022) corroborate findings on transparency and traceability, writing that “specific processes such as implementing traceability across the supply chains of electronics or measuring the life cycle environmental impacts of operations can be too costly to implement” (p.7). As the latest GEM states, ““any substantial increase in the collection and recycling of e-waste will require significant cooperation between the formal and informal sectors” (Baldé et al., 2024). Thus, without integration, the informal sector cannot fully meet the demands of a circular economy and simultaneously, the formal system cannot effectively address e-waste challenges without accounting for the pervasiveness and role of informal workers (Singh, 2021, Morais et al., 2022, ILO, 2023, Baldé et al., 2024; Chi et al., 2011; Wang et al., 2012; Chaturvedi & Bhardwak, 2013; Lundgren, 2012; ILO, 2014). This references earlier discussions in this paper on the gaps in the broader discourse on CE concerning the socio-economic and social impacts of such a transition. With a sizable portion of global e-waste managed by the informal waste sector, a collective shift towards a circular economy across EEE value chains will require thinking about integration of the informal sector.

Therefore, there is a need to better understand if formalization could also serve as a crucial means to bridge the gap between economic, environmental, and social dimensions of sustainability

within the CE literature and practice. Further, there is a need to explore if formalization could facilitate the transition to CE in a manner that addresses concerns regarding unintended social impacts (Scheinberg et al., 2010.; Bhagat-Ganguly, 2021; Arora et al., 2019; Wilson et al., 2013). This entails research on informal workers and the formal system engaging collaboratively to enhance resource recovery from e-waste and achieve a closed-loop approach in waste management.

The ILO (2014) has articulated that to address working conditions of the informal sector, formalization will be required (p. 18). Methods cited as part of integration, partnership, and formalization efforts include forming and registering member based organizations of informal workers, strengthening capacities, providing technical specializations, and improving access to equipment (Bhagat-Ganguly, 2021; Arora et al., 2019; ILO, 2014). Further, it is crucial that integration efforts are conducted with knowledge on the specific dynamics and level of skill of the informal sector in any given region, implying that a one-size-fits-all approach is unlikely to be successful (ILO, 2014).

The International Solid Waste Association's (ISWA) latest report on the future of the waste management sector states that the informal sector has long been providing waste management and resource recovery services, having capitalized on the opportunity to recover materials from waste to fulfill their economic needs while filling a gap in the formal sector's ability to do so (ISWA, 2021). As stated in section 3.1, integration between both sectors is already established (Chi et al., 2011; Simaetele et al., 2017; Kawai et al., 2012; Hilburn, 2015; Millington & Lawhon, 2019; ILO, 2014; Wilson et al., 2006).

In addition, along with integration and partnership initiatives there are also existing high-level strategies to achieve a strong degree of formalization (Chaturvedi et al., 2010). Grant &

Onteng Ababio (2012) found that legitimate e-waste recycling businesses outsource and subcontract jobs to informal workers in parts of Accra, Ghana to the point where the formal urban e-waste economy relies on the informal sector to operate. Informal and formal sectors in China, Vietnam, Mexico, and South Africa have also documented instances of partnership between formal and informal waste management sectors (Chi et al., 2011; Simaetele et al., 2017; Kawai et al., 2012; Hilburn, 2015). Overall, the evidence suggests that where formal and informal waste collection services co-exist there can be benefits “where they both compete and complement each others’ activities, resulting in an overall more efficient and resilient urban waste management system” (Scheinberg et al., 2011; Guibrinet, 2019). Emerging literature proposes that such partnerships can work to align with broader sustainability goals by reducing pollution, improving resource efficiency, generating jobs, as well as providing social welfare benefits (Bhagat-Ganguly, 2021, p. 145).

Furthermore, a paper written by Aparcana (2017) identifies that there are multiple approaches to formalization. The paper establishes that informal waste workers organized into coalitions, community based organizations, micro and small enterprises, or contracted by the formal waste sector as individual workers are potential approaches to formalization (Aparcana, 2017). The common barriers to formalization within this paper are identified as policy, economic, institutional and organization arrangements, social acceptance, and operational barriers (Aparcana, 2017). The paper concludes that addressing barriers to formalization with interventions targeting each category of barriers, is a key approach to ensuring the success of formalization efforts, regardless of approach (Aparcana, 2017). The significance of this study lies in its establishment of a foundational understanding of formalization, highlighting the presence of multiple approaches to formalization.

Another study conducted by Dharna Tiwari et al. (2023) focuses on the challenges and opportunities in formalizing the informal e-waste sector in India. The study involved conducting interviews with e-waste recyclers, informal sector workers, and producers. The study found that the benefits of formalization can be accessed through the use of advanced technology in informal operations and capacity building, improving recycling infrastructure, improving outreach on e-waste laws, creating forums or platforms for the informal sector to voice their opinions, and providing access to land, finance, and technology for e-waste recycling to the informal sector.

Although the literature provides examples of integration and partnership between the informal and formal sectors, and there are some attempts to identify the process of formalization including barriers and interventions to barriers, some research gaps persist. First, there is a general consensus that formalization is necessary to address the impacts of the informal sector, but there is a lack of clarity on what formalization actually entails. The representation of the process of formalization within the literature produces a largely fragmented understanding. Questions remain such as

Table 4: Literature Review Outcomes: Research Gaps in Formalization

1. Is formalization primarily regulatory enforcement, taxation, or a multifaceted, multi-step approach?
2. Clarification of uncertainty regarding the specific steps or approaches involved in formalization, and whether integration is a fundamental aspect of formalization.
3. Whether there are universally applicable strategies that can be implemented across different regions to improve resource recovery, reduce environmental impact, and improve socio-economic outcomes for informal workers.

4. Which types of partnerships are most effective, including identifying key stakeholders involved in these partnerships.
5. How to bridge the gap in the literature concerning the broader socio-economic implications of formalization or integrating the informal and formal sectors, particularly in the context of the circular economy.

By addressing these gaps through further research and policy discussions, a greater understanding on formalization may emerge. As evidenced by this review, additional research is needed to explore how formalization can enhance resource efficiency and recovery rates amidst the shift to circularity. Additionally, research is needed to address the broader social impacts of transitioning to a CE on informal workers.

Challenges and Benefits of Informal E-waste Management

The informal management of e-waste produces additional challenges for sustainable development, resource recovery, environmental health, and human health (Bhagat-Ganguly, 2021; Wilson et al., 2006). While occupational risks are faced by those directly involved in handling e-waste, environmental health risks are faced by the surrounding community, including those not involved in handling e-waste (Bhagat-Ganguly, 2021). Improper handling and processing of e-waste can release toxic and hazardous substances, including polybrominated diphenyl ethers (PBDEs), mercury, poly vinyl chloride (PVC), and other organic pollutants and heavy metals (Bhagat-Ganguly, 2021). The release of hazardous substances directly causes contamination of air, soil, and water which can disrupt surrounding ecosystems, impact local food chains, and lead to bio-accumulation (Bhagat-Ganguly, 2021).

Occupational health risks are a direct result of the use of unsophisticated techniques which may cause respiratory illnesses, cancers, and infections for example and are exacerbated by the lack of access or use of protective equipment (Wilson et al., 2006; Cointreau, 2006). Rudimentary techniques to handle e-waste include the physical dismantling of e-waste using bare hands, hammers, and other manual tools, removing components from printed circuit boards over coal-fired grills, melting plastics without proper ventilation, burning cables to recover copper, and stripping metals in open-pit and acid baths to recover gold and other metals (Chi et al., 2011). Such informal and unregulated practices continue to contaminate local water, soil, and air, producing serious health risks for the surrounding ecosystem and human health.

Notably, several studies on the health and environmental impacts of informal e-waste handling have been conducted in Guiyu, China, a town whose population relies largely on e-waste processing as a major source of livelihood. For example, Li et al. (2008) conducted a study on newborn infants in Guiyu, a known informal e-waste recycling town in China. The study determined that environmental lead contamination from e-waste recycling had an impact on neurobehavioral development in newborn infants (Li et al., 2008). Similarly, a study conducted by Guo et al. (2009) evaluated the effect of e-waste recycling in Guiyu on surface water and sediments from the nearby Linjiang river system. The river and nearby ecosystem provide habitat for wildlife, breeding ground for fish and shrimp, and drinking water, along with having industrial fishery and agricultural uses for human consumption (Guo et al., 2009). The study found high concentrations of heavy metal from all samples, suggesting that environmental contamination from e-waste pollution and runoff poses negative outcomes for the surrounding ecosystem, wildlife, and subsequently, human health (Guo et al., 2009).

While the informal e-waste sector poses environmental and health challenges, the sector also provides benefits such as livelihood opportunities, as well as resource recovery services in lieu of formal waste management (Chi et al., 2011). There are a number of studies which support the role of the informal sector as part of waste management systems. For example, the informal sector can save a city 20%-30% of the city's waste management budget by providing informal collection and recovery services (Scheinberg et al., 2010, p. 60). Scheinberg et al. (2010) found that the informal sector provides resource recovery benefits in comparison to the formal sector, with collection, dismantling, and recycling efforts diverting e-waste from landfill. However, the efficiency of informal activities could be improved (Bhagat-Ganguly, 2021). Still, the EMF (2015) asserts that "the informal workforce could be a strength for labour-intense secondary markets" and suggests that "rather than destroying the livelihood of such workers, proposed policies could leverage this workforce" (p. 87).

As an example, Arora et al. (2019), supported by Bhagat-Ganguly (2022) write that providing informal actors with access to improved equipment might work to improve resource recovery efficiency of informal operations while maintaining income, mitigating environmental harms, and improving occupational health and safety standards. Essentially, the literature seems to imply that if informal actors are provided with support mechanisms that aim to reduce the negative environmental and human health risks, as well as improve their resource recovery efficiency through access to equipment and capacity-building, then the informal sector may be leveraged as part of a greater transition to circularity while aligning with the social dimensions of sustainability (Bhagat-Ganguly, 2022; Scheinberg et al., 2010; Arora et al., 2019; Adama,& Nzeadibe, 2017; Wilson et al., 2013; Murthy & Ramakrishna, 2022; Mbah et al., 2019).

4.0 Key Findings: Semi-Structured Interviews

Overall, the literature review suggests the need to gain a deeper understanding of formalization in e-waste sectors where there is a large and significant presence of informal sectors in handling e-waste. Therefore, this study aims to enhance the understanding of formalization at a high-level, considering the gaps highlighted in the literature, and furthering understanding of formalization as a potential catalyst for CE in e-waste. This chapter presents findings extracted from the semi-structured interviews. Within this context, the chapter will delve into the definitions of the circular economy and informal sector as derived from the interview data. Additionally, it will examine the insights regarding formalization, observable connections between circular economy and social aspects of sustainability, and potential areas for further study. As described in section *2.0 Methodology*, interviewees were experts in circular economy, sustainability, and e-waste discourse with experience ranging across formalization initiatives, developing and implementing circular business strategies, developing policy, and producing prominent and contemporary research or reports on e-waste and circular economy. Table 2, found in section 2.3 provides a detailed list of interview participants.

Given the gap in understanding of formalization highlighted in the literature, the objective of these interviews is to contribute to the understanding of formalization as a circular economy-enabling process within the domain of e-waste management. The following subsection outlines responses from participants on the transition to circular economy. This is followed by sections outlining insights on the role of the informal sector in a circular transition, and the process of formalization as defined by participants. Guiding questions for the interviews are in the Appendix.

4.1 Insights on CE

Participants were asked if establishing a circular economy is absolutely, somewhat, or not necessary for sustainable development and why. The overall sentiment was strongly positive, with four out of seven participants explicitly stating that the circular economy is “absolutely necessary” for sustainable development, one participant implying that the circular economy is absolutely necessary for sustainable development. The rationale provided by respondents in indicating that the circular economy is “absolutely necessary for sustainable development” encompassed the key points outlined in Table 5 below.

Table 5: Responses on Circular Economy and it's Necessity for Sustainable Development

1. Material flow management is essential for sustainability
2. Circularity optimizes resource use and waste reduction
3. Circular economy practices enhance resource efficiency and reduce environmental impact in production systems which is vital for sustainable development
4. Global resource efficiency requires a shift from unsustainable extraction rates, which the circular economy aims to address
5. Resource conservation is essential for sustainable development
6. More than half of the sustainable development goals emphasize a need to change patterns of production and consumption
7. Recovering resources, recycling, and putting them back into the supply chain I the only way to protect our natural resources
8. Circular economy is a holistic approach which addresses environmental, economic, and social challenges simultaneously
9. Circular economy can reduce the ecological footprint of human activities
10. Circular economy will develop jobs

Notably, one of the interviewees did not directly address circular economy but instead, the discussion revolved around the informal sector's resource recovery services, EPR, and recycling. Nevertheless, there were no viewpoints which directly opposed circular economy and there was an underlying sentiment of support. Further, one of the participants indicated (in the underlying sentiment or implication of their rationale) that the circular economy is “somewhat necessary” for

sustainable development. The respondent indicated a nuanced view on circular economy and its role in sustainable development, provided critique on the term “circular economy” for its economic emphasis, and emphasized the importance of holistic approaches including social, environmental, and cultural factors for achieving sustainable outcomes. There was also support among interviewees for the reduction of waste and need to loop materials back into the supply chain, but there were clear concerns around whether the circular economy fully embraces and aims for sustainable outcomes.

The responses displayed in Table 5 above suggest that the CE is likely crucial for sustainable development. The transition to circularity might work to address the need for sustainable production and consumption patterns emphasized in the sustainable development literature if the goal is to improve resource efficiency and minimize environmental impacts of production. Practices like recovering and recycling resources may be vital for protection natural resources and supplementing the extraction of primary materials. Moreover, CE could offer a holistic approach to addressing global challenges from social, environmental, and economic perspectives. Although, practical implementation of circular principles must be studied further to confirm CE’s role in sustainable development.

In addition, participants were asked to define the key parameters of the circular economy. The responses encompassed the following key points outlined in Table 6 below.

Table 6: Responses on Key Parameters of Circularity

1.	Elimination of waste from value chains
2.	Redesigning products and systems to minimize waste and environmental impact throughout the lifecycle, using techniques such as “eco-design” to intentionally create products and systems that reduce or eliminate waste and reduce environmental harm while accounting for overall resource efficiency
3.	Accounting for the principle of zero emissions so that the production, usage, and final disposal of goods does not result in the emission of harmful waste byproduct

4. Closing material loops through reuse and recycling of products and their material components
5. Developing recycling infrastructure to recycle at scale
6. Improving the durability of products and prolonging their usefulness through repair and reuse
7. Reducing the overall impact of human activity
8. Collaboration and consultation among stakeholders including governments
9. Restoring and regenerating natural ecosystems

There are several takeaways from respondents' questions on CE. The points displayed in table 5 above indicate that the concept of the CE extends beyond waste management to redesigning production and consumption processes and products, keeping materials in use through recycling and reuse, addressing the need and steps to achieve large-scale recycling, reducing the environmental footprint of human activity, going beyond reducing harm to actively restoring natural environments, and ensuring stakeholders collaborate in these efforts.

4.2 Insights on Formalization

In addition, participants were asked to define the informal waste sector and describe its key characteristics. Due to the semi-structured nature of the research interviews, the responses surrounding the characteristic of the informal sector were dispersed throughout the discussions on formalization. These responses have been consolidated and presented in Table 6 below.

Table 7: Responses on Informal Sector Characteristics

1. Lack of formal registration: they operate outside the purview of official oversight and regulations
2. Absence of monitoring and regulation: informal sector activities are not subject to monitoring or regulation
3. Low economic level operations: operate at the lowest economic level, typically, and can be in the form of individual, small-scale, or medium scale operations.
4. Lack of sophisticated technology: lack of tools and safety equipment, in their operations
5. Lack of taxation due to lack of formal registration

6. Varying organization levels: some informal operations exhibit a degree of structure while others function entirely outside of formal recognition and regulation. There may exist coalitions of informal workers and/or operations. In some regions, there can be a network of informal operations observed, even beyond the local capacity.

Notably, one participant identified the informal sector as “micro entrepreneurs” and emphasized their historical involvement in formal recycling operations and strong ability to recover resources through collection activities.

Using NVivo the project successfully identified recurring themes related to the concepts of “informality” and “informal sector” within the interview transcripts. Figure 1 below was created using the “word cloud” tool in NVivo. The word cloud in Figure 1 showcases the word frequency of the 200 most frequent words associated with “informal sector” and “informality”. The word cloud was configured to include 25 context words surrounding the terms “informal sector” and “informality”.

The presented word cloud offers valuable insight into the multifaceted understanding that experts possess regarding the informal sector. References to the informal sector are intertwined with discussions on collection methods, standards, EPR, involvement of recyclers, and policy considerations, among others. This suggests a nuanced and evolving comprehension among experts. These findings indicate an opportunity for further engagement and exploration of the discourses surrounding circularity in e-waste management regarding the integration of the informal sector such as inclusive policy frameworks or roadmaps, enhancing partnerships and collaboration between informal and formal actors, or improving regulatory standards.

50

Table 8: Codebook

Name	Description	References
social sustainability	The impacts of formalization, social benefits from formalization, formalization challenges, engagement, and linkages between sustainability and circular economy	20
training	Technical education on how to safely manage e-waste, including collection and dismantling, using tools and machinery, and using technology	20
EPR	Examining how Extended Producer Responsibility frameworks as part of circular policy play a role in shaping	11
stakeholders	Key actors relevant to formalization	10
resistance	Resistance to formalization from formal and informal entities	10
(dis)incentives	Incentives and disincentives to formalization	10
fear and marginalization	Resistance manifesting as fear from informal and formal entities in formalization	10
equipment and facilities	Equipment and facilities understood as resources	9
policy inclusion	engagement with the informal sector in policymaking discussions.	8
e-waste trade	Transboundary movement of e-waste	8
jobs	Employment in e-waste management	8
regulatory recognition	Recognition by governments through policy inclusion	7
cost burden	The time and financial commitments required to formalize for both informal and formal entities	7
interdependence	Mutual reliance between the informal and formal entities in e-waste management	6

Name	Description	References
capacity building	equipping the informal sector with the skills, awareness, and resources needed to comply with regulations, reduce risks, and integrate into mainstream economic systems	6
partnerships	Collaboration between formal and informal entities	5
awareness	Developing knowledge on environmental impacts of mishandling e-waste	5
global disparity	Discussions surrounding inequality and disparity in e-waste trade and standards	4
standards	Regulatory standards surrounding e-waste management	4
equality and justice	Equality between the global north and global south	3
infrastructure	Facilities for dismantling, recycling plants	3
business registration	informal operations registering with local authorities as tax paying businesses. In some cases, also refers to obtaining licenses or permits to operate.	3
political will	The role of political will in creating resistance to formalization	2
education	Developing knowledge on environmental impacts of mishandling e-waste	2
taxation	taxation of businesses and measuring contribution to GDP	1

The following sections identify where these key themes relate back to the existing literature and provide further discussion and interpretation. The codes identified in Table 8 above were framed into several core themes: pillars of formalization, surrounding landscape of formalization, and social sustainability. Table 9 below illustrates how the codes are mapped into core themes and additional themes accompanied by brief explanations of their alignment into these themes.

Table 9: Framework of Codes

Core Theme 1 - Pillars of formalization		
Category Code	Sub-Category Codes	Reasoning
Capacity Building	Awareness	Each of the relevant codes involves empowerment of the informal sector in some regard, thus enhancing their skills, knowledge, and capacity to effectively improve their operations, livelihood, and wellbeing as part of the process of formalization
	Education	
	Training	
	Access to Resources	
	Equipment and Facilities	
Partnership	Interdependence	Each of the relevant codes describes the collaboration required towards the shared goal of formalization, leveraging different strengths, identifying key stakeholders, and achieving outcomes that are unattainable individually
	Stakeholders	
Regulatory Recognition	Policy Inclusion	Each of the relevant codes involve legitimizing informal operations within existing legal frameworks, which can further enable formalization
	Business Registration	
	Taxation	
Core Theme 2 - Surrounding Landscape of Formalization		
EPR		EPR remains a core policy tool in the CE, meaning formalization initiatives will likely need to navigate and/or comply with EPR policy frameworks
Resistance	Fear and Marginalization	Each of the relevant codes create barriers for both informal and formal systems, impacting the perceived risks, support, or
	Political Will	
	(Dis)incentives	
	Cost Burden	

		financial constraints associated with the process formalization
Core Theme 3 - Social Sustainability		
Social Sustainability	Jobs and Infrastructure	Job creation and infrastructure development will affect the livelihood outcomes of circularity on informal and formal workers
Additional Theme		
Global Disparity	E-waste Trade	Each of the relevant codes highlight the unequal burden and benefits of e-waste, regulatory inconsistencies, and imbalances in resources and environmental impact between nations
	Equality and Justice	
	Standards	

First, the pillars of formalization encapsulate various dimensions that make up an essential part of the process of formalization. *Capacity building* emerges as a fundamental element of formalization. Capacity building encompasses *awareness, education, and training*. Further, *access to resources* is identified as a factor which influences capacity building. The resources include education and training, and *equipment and facilities*. Notably, education and training were identified to be relevant to both capacity building and access to resources. *Partnership* is the second element to this core theme, encompassing *interdependence*, and key *stakeholders*. The third element of this theme is *regulatory recognition*, which consists of *policy inclusion, business registration, and taxation*. Through these core themes, the interviews highlight the multi-dimensional yet interlinked nature of the process of formalization. While these findings offer valuable insights into the contemporary understanding of formalization, it's important to note that

they are broad in scope and may not apply to all regions, nor do they comprehensively describe the process of formalization.

Second, the surrounding landscape offers insight into the context surrounding formalization. The first aspect is *EPR* policies, examining how EPR plays a role in shaping the discussion on informal sector integration. The second aspect is *resistance* against formalization, encompassing *fears and marginalization*, *political will*, and *disincentives/incentives*. *Cost burden* emerges as a significant disincentive.

Third, *social sustainability* was identified as an important additional core theme for this study. This core theme provides insight into respondents' sentiment surrounding the linkages between circular economy and social sustainability, and how that relates to formalization as a process. Included within the discourse on social sustainability is *jobs and infrastructure*, discussing perspectives on the livelihood implications for informal workers amid a CE transition.

Several other themes were identified – however they did not fall under the primary themes identified regarding formalization. Instead, they offer additional insights on *global disparity*, encompassing *e-waste trade*, *equality and justice*, and *standards*. These topics will be discussed further in the following chapter.

Pillars of Formalization

Interviews reveal that formalization relies on three key pillars of capacity building, partnerships, and regulatory recognition. These elements, though distinct, are intricately connected. For instance, partnerships facilitate capacity building in the informal sector, while regulations can support such partnerships and capacity-building efforts. Strategies like roadmaps and framework approaches for the CE can encourage formal and private sector actors to engage with the informal sector. Understanding the interplay between these aspects is crucial for

furthering understanding of formalization processes and guiding future research or policy discussions.

Capacity Building

Participants commented on capacity building as the process of enhancing skills, knowledge, and abilities in context of waste management. All seven participants underlined the importance of capacity building initiatives that encompass education and awareness, and technical training, discussing also related concepts of infrastructure, the role of NGOs as mediators, livelihood security, and the creation of hubs and common facilities. Participants emphasized the necessity for structured training and capacity building, recognizing it as a key factor for the successful integration of informal workers into advanced circular economic practices.

Four out of seven participants highlighted the significance of access to resources in discussions about capacity building and formal recognition within the informal sector. The overall sentiment of the interview data includes the idea that the informal sector does not adhere to adequate environmental or health and safety standards. The implication from the interview data is that meeting these standards necessitates capacity building and recognition. The point of emphasis is that capacity building and recognition are dependent on having access to resources. In the context of the semi-structured interviews, resources tended to refer to personal protective equipment (PPE), secure and safe e-waste facilities including collection depots and dismantling facilities, basic tools like screwdrivers, and technology.

In discussing training and capacity building, one participant mentioned the importance of centralized spaces or facilities which are equipped with adequate technology for e-waste dismantling, such as dust filtration systems. The participant suggested that there is an emerging trend in the formalization space to create these centralized spaces, or “hubs”, where informal sector

workers are able to conduct their operations in a safe facility. Participants highlighted the significance of developing awareness among the informal sector on the presence of toxins and safe dismantling.

Participants also revealed that challenges around consolidating the informal sectors indicated the need for targeted efforts in providing training and incentives for integration into the mainstream. One participant mentioned that formal recyclers should play a crucial role in facilitating technical knowledge transfer to the informal sector, given that the formal recyclers have technical knowledge on e-waste processing at scale. Participants also mentioned that NGOs and PROs might play a role as mediators between the informal sector and the formal sector, helping to connect both sectors with regards to knowledge dissemination and training.

Participants revealed the importance of not only providing training, but also ensuring adequate access to resources such as facilities, PPE, and tools for informal workers. One participant from the policy and programs sector suggests that a move towards formalization involves training and supplying basic tools and equipment like screwdrivers and safety gloves. The emphasis accordingly was on recognizing that capacity building involves education, awareness, and training. All elements are important to the process of capacity building. Providing tools necessitates explaining the proper use, and the participant underscored that providing knowledge on correct dismantling or handling of e-waste is more effective when accompanied by the availability of tools and facilities. The recurring theme of “access” is highlighted, emphasizing the sector’s need for consistent access to these resources as a step towards formalization.

One participant directly connects the need for formalization to emphasizing the importance of providing training, awareness, and PPE to ensure the well-being of informal workers. Another participant advocated for a “soft approach” to formalization, emphasizing the providing of

training, PPE, and access to resources and facilities for operations. However, a third participant argued that training alone is insufficient without sustained access to the physical space, tools, or PPE, highlighting the crucial role of access to resources as part of capacity building. Advanced technology was mentioned by another participant as a means for integration. Additionally, government-led incentives to empower informal workers to procure equipment were also suggested. Notably, one participant highlighted that advanced skills do exist within the informal sector. In some cases, informal workers can assess the potential value of extracted materials from e-waste to such an extent that they set the price for the formal sector, due to their control over a sizeable portion of the e-waste available. In these cases, the participant recalls, the ability of the informal sector to determine value often surpasses that of the formal sector. This participant also suggested that access to resources in some cases could extend to facilitating access to markets and providing support in the process of selling collected e-waste or resources extracted from e-waste could work to legitimize the sector.

Participants mentioned that common challenges for providing training and awareness to informal workers included cost pressures, lack of initiatives from either government or formal recyclers, difficulties in maintaining effectiveness of training, absence of a conducive atmosphere for training and formalization, complexity in collaboration, and the absence of clear standards. Some of the suggested routes for training and capacity building involved establishing or supporting training “hubs”, involving recyclers and leveraging their technical knowledge, engaging NGOs as mediators given their reach in under-served communities, setting training standards, structured training programs which also teach good housekeeping and documentation or record keeping for traceability purposes, establishing collaborative initiatives across sectors, utilizing existing associations such as the Lagos State Recycling Association for training programs, and exploring

the idea of leveraging EPR frameworks to connect informal workers to the formal sector. Each of these is mentioned by participants as a path to improving capacity among the informal sectors. The underlying sentiment among participants was that capacity building goes hand-in-hand with access to resources. This further highlights the importance of partnerships in securing the necessary resources.

Partnerships

Participants often included partnerships or collaboration between different stakeholders relevant to e-waste management when discussing adjacent concepts of regulatory recognition and capacity building. Participants acknowledged various stakeholders involved in collaborating with the informal sector. Certain stakeholders were noted for their existing engagement, such as Lagos State Recycling Association, while others were seen as a potential avenue for integration, such as formal recycling companies. Typically, participants mentioned the local governing body for recycling or ministry of environment as a key stakeholder. Other notable entities included PROs, major electronic producers, NGOs, formal recyclers, and international policy organizations that may influence the trajectory of e-waste management.

Multiple participants commented on the notion that small informal players play a crucial role as aggregators for large formal players in e-waste, noting that while the informal sector is largely unorganized, that there are still actors within this sector who possess expertise and skills in collection, dismantling, and processing despite having little to no access to sophisticated equipment, PPE, or facilities.

The interview data also highlights the potential role of “integration” as a component of formalization. Participants identified integration opportunities, such as skill-matching programs, establishing guidelines for collaboration between formal recyclers and informal workers,

subcontracting informal workers for collection of e-waste, using NGOs as intermediaries, and recyclers providing training and PPE for the informal sector. Multiple participants mentioned that despite the formal system heavily depending on the informal sector for essential tasks like waste collection and processing, this reliance is frequently overlooked in policy considerations on the future of e-waste management.

As highlighted, participants also mentioned the idea of NGOs acting as mediators between the informal sector and other key stakeholders such as recycling companies and government-led initiatives. One participant proposed that NGOs could initiate formalization by consolidating and organizing informal workers in a gradual process that would pave the way for subsequent intervention by other actors including government, recyclers, or PROs. This participant underscored the role of NGOs, highlighting that they may already be involved in capacity-building within marginalized communities. As a result, NGOs could play a crucial role in facilitating and organizing knowledge transfer and capacity building for the informal sector.

Another participant also noted the presence of unions or coalitions within the informal sector, recognizing them as key stakeholders due to their relative organization and advocacy capabilities. However, it is essential to acknowledge that the interests of “unions” among informal workers may not universally represent or align with the needs of all individuals within that sector¹.

Notably, participants shared common perspectives on the importance of partnerships but identified different key stakeholders. Few participants highlighted the influence of EPR, proposing collaboration between PROs, major electronics producers, and the informal sector for end-of-life responsibilities. Conversely, others emphasized the significance of partnering with formal

¹*Traditional trade unions are typically characterized by formal recognition and legal status and as such, the participant’s use of this term may not align with the formal definition of “trade unions” and instead, be referring to informal worker collectives.*

recyclers, citing their expertise in providing technical training for e-waste processing. The participant suggested that formal recyclers should seek out informal sector actors to work as “downstream vendors” on behalf of the company and suggested that these partnerships should be recognized or baked in regulatory frameworks provided by the local government authorities involved in enforcing environmental and recycling standards. Similarly, another participant mentioned that informal actors can be engaged as “subcontractors” for the formal system. A third participant asserted that formal recyclers have both an incentive and responsibility to build capacity among informal workers in order to improve resource recovery and recycling. The common thread between participant responses was the idea that collaboration and partnership are essential components for facilitating regulatory recognition and capacity building – which work together to improve formality in the informal sector.

The interview data on partnerships and collaboration also revealed a trend among participants in discussing the idea of “interdependence”. In this case, interdependence refers to the relationship between formal and informal sectors among e-waste management ecosystems, particularly in the Global South, where each relies on the others’ contributions and expertise. Indeed, participant responses revealed that there is a symbiotic relationship between the informal sector and formal actors.

Another key element highlighted by participants is that when there is a degree of organization among informal actors – whether that is facilitated by an external entity or any existing groups within the informal sector – it serves as a fundamental step for any subsequent integration, capacity building, or recognition. The rationale provided by participants is that formal intervention or assistance by government, NGOs, or other entities becomes feasible in cases where there is some

form of organization among informal actors. This organization enables the identification of groups needing assistance and allows for planned assistance, in lieu of data.

Finally, participants mentioned that formal sector actors could seek out explicit partnerships with the informal sector in order to improve efficiencies in e-waste management systems or leverage the collection services that they provide. The participants clearly highlight that while the informal sector provides benefits to the e-waste management system, explicit collaboration and partnerships can work to improve capacity building, access to resources, and recognition. Overall, partnerships constitute a fundamental aspect of both capacity building and regulatory recognition, collectively forming what can be identified as the core pillars of formalization.

Regulatory recognition

Participants commented on the idea of “official recognition” or formal acknowledgement and acceptance by government authorities on the existence and contributions of the informal sector, particularly in the context of a circular economy. Based on the participants’ responses, formal acknowledgement typically referred to registration of operations, licenses to conduct operations, consolidating the informal sector into cooperatives or coalitions, and including them in policy frameworks.

Five out of seven participants commented on regulatory recognition. The participant responses revealed that regulators play a role in the process of formalization in a number of ways, including the ability to dictate and delegate authority as well as guide the process of formalization based on principles. However, one participant mentioned that often regulators and policymakers evade discussing the process of formalization and instead focus on eradicating the negative impacts of informality such as pollution or worker exploitation. Still, the concept of “regulatory recognition” refers to the process of acknowledging the existence of the informal sector, whether through official policy or by policymakers.

Respondents also mentioned that the informal sector could be recognized via consolidation into groups and partnering with formal recycling operations. One participant encouraged thinking on how regulations can help or hinder circularity – in context of formalization. Specifically, the participant suggested that regulatory tools and measures can be a useful tool in enabling the informal sector to conduct resource recovery – particularly in terms of the value they add to e-waste collection. While the informal sector’s activities span across collection, dismantling, and processing, the participant suggests that regulatory measures can be a useful tool in enabling the sector where they add value to the circular economy and to hinder the sector where it creates negative impacts. Door-to-door collection is an example of where the informal sector is able to access more e-waste than the formal sector. Thus, regulatory measures which prohibit the informal dismantling and processing of e-waste while permitted and facilitating the collection of e-waste by informal actors, is suggested as a means to build regulatory recognition of the informal sector’s role in resource recovery.

Four out of the five participants that commented directly on regulatory recognition mentioned that the informal sector must be seen as stakeholders in the process of policy formulation. They argue that regulations are more effective when developed with the informal sector rather than imposed on them, as understanding the sector’s culture and engaging them in discussions leads to better outcomes in terms of uptake. In essence, there is a difference between aiming to eradicate the informal sector through standardization versus aiming to both support the informal sector as well as leverage their abilities for resource recovery through regulatory measures. In both cases, the goal remains to achieve environmental, health, and economic outcomes, but through a participatory, consultative, and iterative process rather than stringent regulations.

One respondent suggested that in the context of a circular transition in e-waste, a roadmap which directly recognizes the informal sector by name, and potentially consults actors as part of this sector, would be beneficial given that the informal sector will be impacted by any high-level policies. Responses on policy inclusion, taxation, and business registration also fell under the regulatory recognition category, given that each of these involves the principle of governance.

Participants highlighted that it would be unrealistic to eradicate the informal sector via regulatory approaches. One participant pointed out that when an informal operation is shut down due to lack of standards, it is easily replaced by another informal operation. The data also revealed that there is an apparent lack of representation for the informal sector, and that engagement and understanding of the informal sector is crucial before attempting to regulate them. Indeed, the underlying sentiment among participants who discussed regulatory recognition and policy inclusion, was that regulating the informal sector is often not successful because regulation attempts to eradicate a sector which is vast, pervasive, and is easy to set up. Respondents emphasize that policy must be designed in a way which addresses the kinds of impacts it will have on the people it may impact – including sectors that are considered informal by nature but are pervasively involved in e-waste management.

Occasionally, respondents suggested that formalization and recognition can be achieved through registering operations as formal businesses and consolidating operations or individuals into cooperatives and coalitions. Notably, one participant pointed out that there can be a lack of legal frameworks guiding waste collection, or waste dismantling. Often, this is the responsibility of local governments. One participant notes that within the Indian context, the only legal framework available on this matter simply dictates that the local authorities are responsible for waste management, while in reality there are vast amounts of waste handled by the informal sector.

The absence of these regulatory structures brings into question this idea of “registering operations” for the informal sector. It becomes difficult to do so when there is no clear legal framework available.

Surrounding Landscape of Formalization

When considering how or whether formalization might work to facilitate circularity, it is important to consider factors within which formalization is taking place. The data reveals that EPR policies and resistance factors are worth consideration. The interview data reveals questions and comments on the relationship between EPR policies and formalization of the informal sector. Further, resistance to formalization manifests distinctively for several key stakeholders including the informal sector. Understanding the root of resistance to formalization can work to inform further research on how integration of the informal sector or engagement approaches can achieve successful outcomes of improved efficiency, resource recovery, or reduction in environmental impacts, for example.

Extended Producer Responsibility (EPR)

Five out of seven participants reference EPR, identifying it as a core policy approach to advancing the circular economy. As discussed in the literature review, EPR is a key policy tool used to incentivize the CE in many regions, with policies varying by region. EPR aims to increase the collection of waste and improve the management of waste at the end of the value chain, thus aiming to establish a “closed loop” system whereby waste is reintegrated back into the economy as secondary resources. Therefore, EPR policies directly influence the types and volumes of e-waste managed by formal and informal sector workers, as these policies mandate specific requirements.

The overall sentiment surrounding EPR was somewhat mixed, but generally more positive than negative. In addition, one participant mentioned that there are ongoing discussions about extending the scope of the producer pays principle further up the value chain, to the mining industry which is responsible for extracting resources.

Further, there was some mention that efforts towards implementation and enforcement are an important and necessary component for EPR. One participant mentioned that the implementation of EPR in Singapore has been particularly successful and is strictly enforced. The producer responsibility scheme is appointed by the government and has the responsibility to ensure compliance with regulations set by the National Environmental Agency. However, another participant highlighted challenges and concerns regarding the role of the informal sector and their involvement, as well as the need for traceability improvements. One participant mentions that informal sectors are not officially recognized under new EPR regulations, although recyclers may still be engaging with informal sectors given their ability to collect and supply e-waste. A third participant mentioned that there is generally poor enforcement and implementation of EPR.

Participants also mentioned the importance of traceability suggesting that traceability improvements are necessary for recyclers and producers, but this also extends to the informal sector which, to a considerable extent, is currently unable to record transactions or document operational activities. In addition, one participant also raised the concern that funding for EPR programs only reaches the informal sector once it has been filtered through many layers of middlemen, adding considerable transactions costs, and reducing the available resources for informal workers to access in closing the loop.

On the same note, there were some discussions surrounding EPR in India and how the informal sector might be able to play a role. The participant describes that within the Indian

context, EPR funding does trickle down to the informal sector eventually due to the heavy involvement of the informal sector in collection. Thus, recyclers, PROs, and producers facilitate collection and logistics, but the informal sector is unofficially involved in collecting e-waste and providing supply to this system. The respondent shares that anecdotally, the informal sector in India collects somewhere between 70-90% of e-waste. So, the fact that they get the bulk of e-waste means that the money injected from EPR fees will reach them eventually. However, the underlying point of this discussion is that the money that does reach the informal sector is filtered through many layers of middle-men and transaction costs. Thus, informal workers do not widely benefit from the EPR framework in India currently, despite playing a role in resource recovery.

The same participant goes on to refer to the informal sector as “microentrepreneurs” signifying that they are able and willing to conduct business but states that they need support and advocacy in the marketplace to receive a fair cut for what they bring to the circular supply chain.

Regarding EPR, one respondent brings attention to the challenges faced by informal sectors with the West African context amid the introduction of EPR, and other e-waste regulations. The participant points out that officially, these sectors lack a defined role in most EPR frameworks. Instead, there are guidelines stipulating collaboration among producers and recyclers with an aim to close the loop and ensure that end-of-life products are adequately managed. The participant hints at the possibility that recyclers may informally acquire materials from informal sectors on behalf of producers. However, this activity lacks clear measurement given its informal nature.

Resistance

Six out of seven participants delve into the recurring theme of “resistance” in their discussions surrounding formalization. This resistance can be observed from both the informal sector and the formal system. Key aspects for the informal sector included lack of support and

recognition, historical marginalization, lack of engagement for policy formulation, and financial barriers. Key aspects for the formal sector included fear due to regulation and financial barriers. The concept of “resistance” is implicit throughout discussions surrounding capacity building, regulatory recognition, and other foundational elements of formalization. At a broad level, responses suggest that relying exclusively on regulatory approaches to formalize the informal sector can build resistance among both informal and formal stakeholders, fostering a climate of “fear”. Indeed, fear is a recurring theme affecting formalization. Additionally, one participant highlights the necessity for waste reduction strategies to address production practices, underscoring the interconnectedness between production and waste generation.

The resistance of the informal sector to formalization manifests due to a number of factors, including financial constraints, lack of engagement, lack of ownership in policy formulation, and fear of repercussions. Participants highlight that without adequate support, such as capacity building measuring like technical training or record-keeping for example, the informal sector can be hesitant to formalize. In addition, respondents discuss that the lack of clear articulation regarding the benefits of formalization may instill fear among informal actors, particularly concerning taxation. The discussions highlight that historical marginalization adds to the informal sector’s concerns, as they have reason to believe that they will not receive support in improving their operations to meet e-waste management standards. The historical marginalization coupled with the fear of taxation, creates a disincentive for formalization.

Distinct, but interconnected, is the idea of articulating the benefits of formalization to the sector. Multiple participants mention the need to articulate the benefits of formalization to the sector – but one participant states the importance, suggesting that engaging the sector deeply to determine the needs of the sector or their “perceived benefits” is a key part to addressing resistance.

Another respondent points out that formal entities often dictate the roles and requirements for the informal sector without considering their perspective. This further exacerbates their resistance. Despite their contributions to resource recovery, the informal sector finds their needs, or their role, inadequately reflected in policy frameworks. This underscores the importance of regulatory recognition.

Four out of seven participants frequently mentioned that time and financial costs are significant barriers to capacity building. The “cost burden” can be analyzed from both the perspective of the informal sector and the formal sector. For the informal sector, the cost of compliance is a notable issue. Informal workers face a perceived and real financial burden associated with obtaining necessary equipment to meet safety standards consistently. The perceived burden derives from the belief that obtaining resources may not lead to significant improvements in their livelihoods. Expenses such as purchasing PPE, acquiring tools, enrolling in paid-training sessions, or renting facilities are often not feasible for informal workers who may be relying on a “daily income” only. The inflated costs associated with these capacity building elements create a challenge for informal workers in improving the safety, efficiency, or sustainability of their operations. Participants emphasized that the regulatory landscape is burdensome and costly for the informal sector. Time delays associated with registering businesses contribute to the lack of desire to register. The bureaucratic hurdles involved in registering a business and the prospect of paying taxes when daily income is low or scarce are identified as barriers.

On the other hand, those engaging with the informal sector also face funding challenges. Acquiring the necessary funding for formalization initiatives is difficult. One participant explained that attempts to secure funding to develop a “hub” concept for informal workers has remained

challenging. Providing training and basic education to informal workers is difficult to sustain without prolonged and adequate funding. The implication here is that formalization will require prolonged and continuous support.

Furthermore, one participant revealed that the informal sector can have unique pricing abilities in some cases due to their low operational costs and extensive network. In the Indian context for instance, one respondent points out that informal actors wield some control over pricing of resources extracted from e-waste. Though undocumented, the vast network of informal actors in this region has some level of organization and interconnectivity. As a result, they are able to set and agree on the price of resources extracted from e-waste, and formal entities will typically meet this same price. Consequently, this creates a disincentive to formalization which compounds on the other elements of their resistance to formalize.

There is a resistance to engage with formalization efforts by actors a part of the formal system, due to regulatory bans. One participant states that the Basel Convention and related bans on hazardous imports have led to some setbacks in terms of providing support or engaging with the informal sector. Specifically, references to the “The Basel Convention Ban Amendment” were made. This amendment to the Basel Convention prohibits the exports of hazardous waste from developed to developing countries for disposal, recycling, or recovery (The Basel Convention Ban Amendment, 1994). The amendment aims to prevent environmental and human health risks associated with the trade of toxic waste to countries with a lack of infrastructure and regulations to manage waste sustainably (The Basel Convention Ban Amendment, 1994).

Particularly, the “Basel Ban” creates some complexities in terms of motivation to engage with the informal sector. Specifically, discussions highlight that there continues to be an underlying sentiment which indicates that the informal sector must be “eradicated” – there exists an

underlying notion that the informal sector ought to not be engaged or supported, as it is perceived as part of the problem that the ban aims to prevent or protect against. As a result, this impacts the formal system's willingness to engage with the informal sector. Indeed, one response highlights that even though there are NGOs in the waste sphere, there are hardly any which directly and openly engage with the informal sector despite their clear involvement in handling e-waste.

In addition, financial barriers contribute to resistance of the formal system. Specifically, participants mentioned that due to the regulatory atmosphere, there is a lack of funding and support for initiatives which aim to engage the informal sector. Multiple participants mentioned that they faced challenge in securing funding for engaging the informal sector in training or capacity building. Thus, formal actors who wish to engage with the informal sector must secure funding to be able to sustain their initiatives.

Additionally, one participant discusses the need for a strong business case for formalization. Particularly, the discussions reveal that there has to be a strong economic incentive to engage with the informal sector, providing training and capacity building for engaging with the informal sector must render some value. Participants mention that there needs to be an economic case on why companies should use recycled products, which in the African context hinges on affordability and availability of feedstock, and the ability to operate at scale. The participant suggests that regulatory measures which facilitate the movement of secondary stock within countries and across regions in Africa, could help businesses to enhance their access to recycled materials, making it more financially viable and attractive compared to using virgin materials. This may relate back to formalization given the informal sector's ability to collect resources from e-waste.

Social Sustainability

The data also revealed sentiment and thoughts on sustainability in an aim to understand the linkages between circular economy and the social aspect of sustainability. Five out of seven participants discussed or made links to social sustainability. Three out of the five participants make direct commentary on the relationship between “sustainability” and “circularity”. One participant expresses dislike for the term “circular economy” suggesting that it promotes economic thinking. Instead, they suggest “sustainable cycles” is a more appropriate term which encompasses the social and environmental considerations as well as economic aspects. Another participant states that attempting to differentiate the two terms usually ends in explaining the same concept with different language. The third respondent asserts that closing the loop achieves sustainable development. This participant also highlights that solely focusing on environmental sustainability is also inadequate, as the term “sustainability” itself encompasses three core elements, each of which need to be considered to form a comprehensive understanding. The discussion here emphasizes the need for all three pillars of sustainability to be represented in this transition to circularity which is repeatedly referred to in this paper.

Furthermore, participants address social sustainability by delving into the challenges associated with formalization. One participant acknowledges the negative perceptions and obstacles faced by the informal sector. The discussion reveals the perception that informality or lack of acknowledgement within formal systems labels informal sectors as “illegal” by definition, and therefore lends to a kind of negative stigma which further marginalizes them. Alternatively, this can foster a perception that the informal sector does not contribute value, thus creating a form of resistance to formalization.

Similarly, another participant raises questions about attaching a social benefit to the collection services provided by informal workers, to incentivize their involvement in resource recovery. The participant suggests that incentives are a tool to increase participation in the circular economy. For the informal sector, the participant suggests that this would safeguard their livelihood but also enhance their viability as key stakeholders in the resource recovery and subsequently, material recycling processes. The participant expresses concerns about a circular economy which may improve circulation of resources but widen the gap of social inequality by ignoring the impacts or roles of key stakeholders. The underlying sentiment is that without social benefits for those involved in the value chain, circularity efforts may fail to achieve intended outcomes of fostering harmony between people and the environment, and while material recovery and recycling might increase, more can be done to apply circular economy within the principles of sustainability.

Additionally, one participant addresses the difficulties associated with communicating the benefits of formalization to informal sectors. The discussion reveals one key question of “how do we get the informal workers interested in formalization?” Multiple participants emphasize the importance of engaging with informal workers with the specific intention to understand their needs, thus clarifying what they might perceive as benefits as part of formalization. This information is valuable in conveying the benefits of formalization to them from an inclusive perspective. In a related manner, discussions reveal some of the perceived social benefits from formalization. Another participant mentions that partnerships with formal entities can lead to the provision of social safety nets for informal workers, allowing access to key things like health insurance, education, and healthcare.

Finally, another participant suggests that simply the emergence of circular economy frameworks, particularly in the African context, has provided a perspective shift towards providing

economic, social, environmental, social, climate, and resource efficiency benefits on a policy level. This is a crucial aspect that is typically missing from circular economy literature and discussions; where it is essential to consider how the entire system can consider the potential impacts of circular economy as part of this transition or leverage the transition to achieve improved outcomes across all pillars of sustainability.

Jobs and Infrastructure:

Three out of seven participant made some connection between e-waste management and jobs and infrastructure development. The general sentiment is that improper treatment at end-of-life for e-waste is mainly happening in countries lacking the infrastructure and expertise for e-waste management, suggesting that infrastructure plays a key role in improving conditions. The observations and discussion around jobs and infrastructure indicate that there are concerns and thoughts surrounding the transition to circularity and how it could pose a risk of job loss in the informal sector, thereby impacting the livelihoods and social security of workers. Interviews revealed diverse opinions, with some respondents suggesting that significant job creation in the CE is not realistic, while others suggest areas where the informal sector can play a role within the CE.

As stated, one participant states that “job creation is not realistic” to the degree which it is emphasized in current circular economy discussions, drawing parallels between the presence of robotics in waste management industries in Europe, which mostly started with manual labour in collecting, sorting, and processing. However, the participant mentions that there is still value for the informal sector in jobs for collection of e-waste. Similarly, another participant underscores that the informal sector demonstrates skill in e-waste collection because their operations are more mobile and thus, able to reach more waste. One example is through door-to-door collection. In

addition, a third respondent emphasizes that many small and medium-sized enterprises and individuals operate at a mostly informal basis, and participation in the informal sector is high. The point they make is that informal sectors contribute much to job creation – though on an unofficial basis. Finally, one participant mentions the links between regulatory changes and social implications, especially in regions with extreme poverty and youth unemployment rates. Despite doubts about job creation in waste management, catalyzing the informal sector's capacity could lead to more advanced circular economic businesses in the future.

5.0 Additional Theme

In addition to the core themes discussed, another significant point of discussion was around *global disparity*. This theme encompasses concerns surrounding *e-waste trade*, *standards*, and consideration of *equality and justice*. Although these topics were found to be beyond the primary scope of this study on the process of formalization, comments concerning regulatory disparities in e-waste trade are noteworthy. These comments are particularly relevant under these codes because e-waste is often exported to regions lacking capacity to manage it, with significant flows occurring from the Global North to the Global South.

Global Disparity

Five out of seven participants raised concerns about the disparity in global e-waste regulation, and in e-waste trade, particularly between the Global North and Global South.

For instance, discussing the equality and justice aspect of disparity, one participant voiced concerns regarding a perceived double standard, questioning why regulations are not uniform despite the environmental impact being global in scale.

Further, when discussing e-waste trade and e-waste management standards, another participant mentions that while e-waste may lead to local pollution when improperly managed, its environmental impact can extend far beyond local impact. The discussions surrounding e-waste trade encompass numerous viewpoints including the export of e-waste from the Global North to the Global South. Participants raise questions about how soon after used electronic products arrive in the Global South do they become obsolete, or how many products arrive for the purpose of reuse but are never reused. Another aspect mentioned is the importation of EEE driven by demand in the Global South, indicating the policies like Basel Convention or NESREA may not be enforced to their full effect. Yet, another perspective when discussing e-waste trade was on the export of e-waste from the Global South. One respondent notes that the Global South may benefit from developing infrastructure to process e-waste at scale, leveraging the massive quantities of e-waste imported and generated locally.

Moreover, the interviews revealed an overlap between EPR policy frameworks and concerns around equality and justice. Although EPR remains a core policy tool for enabling the CE, participants noted that variation in EPR policy frameworks and their enforcement on a global scale contributes to what respondents believe might be an unequal division among nations in managing the burden of e-waste. Furthermore, concerns were raised about the potential reluctance of nations to enforce environmental regulations on producers, fearing the loss of investment from those unwilling to operate where the responsibility for waste management costs falls on them. This insight is notable especially considering that EPR is not strictly enforced in certain regions, in certain areas. Consequently, producers may opt to conduct their operations in these locations where such regulatory measures are lacking, and the option remains available to them. One participant highlighted that producers may benefit from the differences in regulations and enforcement levels

worldwide. In particular, this participant notes that in Asia, producers may be able to sidestep environmental protection costs in regions where there may be less rigorous or inconsistent regulatory enforcement.

6.0 Conclusion

Ultimately, the study explores various streams of literature and the experience of formalization in the e-waste context, investigating how these insights might inform circular policy and facilitate a circular transition in the EEE waste sector. Using a literature review and semi-structured interview approach, the study bridges gaps identified in the literature as described in Table 4, providing insights into the core themes surrounding formalization in e-waste.

First, the core findings of the literature reveal that the growth of EEE consumption has led to a concerning rise in e-waste worldwide, posing significant challenges to human health and the environment (Baldé et al., 2017; Bhagat-Ganguly, 2022; Wilson et al., 2013; Morais et al., 2022). As a response, there's been a notable shift towards embracing the principles of the circular economy to mitigate these challenges. However, while the CE emphasizes environmental and economic aspect, it often overlooks the critical role of the informal sector in managing e-waste (ILO, 2023; Baldé et al., 2024; (Bhagat-Ganguly, 2022; Rizos & Bryhn, 2022)). In comparing the CE literature to sustainable development literature, the study finds a gap in addressing some of the social outcomes of such a transition (ILO, 2023). This gap leaves some uncertainties about the role of the informal sector and their role in the emerging circular economy in EEE and e-waste.

In addition, the outcomes of the semi-structured interview indicate four key findings around formalization. First, it is imperative to capture the viewpoints of informal workers as part of the process of formalization. The inclusion of informal workers not only formal benefits the

system in addressing global concerns around sustainable e-waste management and implementing principles of circularity, but also accounts for the needs, livelihoods, and wellbeing of workers. Further, the literature establishes at several points that formalization is a crucial point of interest for the transition to circularity in e-waste management, thus, if the presence and involvement of informal workers must be acknowledged in order to address e-waste management, then it should be done so in a manner which is inclusive. Second, formalization must be cooperative, involving multiple stakeholders including formal and informal actors, NGOs, governments and policymakers, multi-national organizations, and researchers. Third, social components and impacts of a CE are essential to address in shaping policy, programs and initiatives. When understood as a pathway to achieving greater sustainability, the adoption of the CE must reflect the economic, environmental, and social aspects of a transition. Without this consideration, the overarching goals of a CE may not be achieved to their full potential, as a systemic shift involves that key stakeholders are accounted for, are able, willing, and have the capacity to facilitate such a shift. Fourth, formalization could work to improve resource recovery, but research is required on defining formalization and its characteristics clearly, investigating regulatory and policy support of formalization, and examining the closely-intertwined networks of formal and informal workers to determine whether a hybrid system is feasible, whereby “formalization” reflects improvements in resource recovery, health and safety, value-extraction from waste, environmental impact, and livelihood outcomes without full integration of informal actors within formal systems.

Overall, the literature as well as interview data suggest that formalization could improve e-waste management efficiency and address socio-economic implications often neglected in the CE discourse. The literature on formalization highlights that there are challenges with engaging the informal sector and potential benefits of their participation in closing-the-loop on resources.

Nonetheless, there seems to be no clear model or process for formalization. In investigating these streams of literature, the study helps to shed light on what a transition to a CE in e-waste may entail for informal workers, and what implementation of formalization could entail in practice. In addition, the interview data suggest that formalization will require attention to capacity building, partnerships, access to resources, regulatory recognition, the application of EPR policies, addressing cost burdens and resistance to formalization, and ensuring that formalization efforts bring about social benefits to formal workers while acknowledge their unique contributions to resource recovery. The matrix framework in Table 10 below offers an overview of how the research gaps identified in table 4 align with core interview findings. The first row represents the literature review outcomes as seen in Table 4, while the first column reflects the core interview findings. Additional insights are provided following Table 10.

Table 10: Outcomes Matrix: literature review and interview outcomes

	Approaches to Formalization	Integration as a Core Step	Universally Applicable Strategies	Effective Partnerships and Stakeholders	Socio-Economic Implications in the CE
Incorporating the informal workers' viewpoints in formalization is crucial for effective integration. The informal sector is a key stakeholder in future e-waste management. This bottom-up approach benefits the waste management system and addressing concerns around sustainable and efficiency e-waste management, but also respects their right to livelihood and well-being.	The idea of formalization from the bottom up suggests that formalization is not merely regulatory enforcement or taxation but involves a multi-step approach that considers the perspectives and needs of informal workers. It implies a process that goes beyond legal frameworks to include integrating informal workers into formal systems while addressing their concerns and desires.	The integration of informal workers' viewpoints into formalization efforts is important. This aligns with the need for clarity on specific steps and approaches involved in formalization, highlighting that integration is indeed a fundamental aspect. It suggests that successful formalization should incorporate the input and participation of informal workers to bridge the gap between informal and formal sectors effectively.	By emphasizing the need to capture informal workers' viewpoints, the statement indirectly addresses the search for universally applicable strategies. It implies that understanding and incorporating these viewpoints could lead to strategies that are more effective across different regions, improving resource recovery, reducing environmental impact, and enhancing socio-economic outcomes for informal workers.	Involving informal workers in formalization efforts requires identifying them as key stakeholders and establishing partnerships that are inclusive of their perspectives. This is needed for implementing formalization strategies that are accepted and supported by the stakeholders involved.	Emphasis on addressing the needs and including the viewpoints of informal workers relates to bridging the gap in the literature concerning broader socio-economic implications. It suggests that integrating informal workers into the informal economy, particularly in the context of the circular economy, requires understanding and mitigating the socio-economic implications of formalization on these workers.

A cooperative approach to formalization involves multiple stakeholders: formal and informal actors such as NGOs, governments, multinational organizations, researchers, informal workers and coalitions	The cooperative approach suggests that formalization is seen as a multifaceted, multi-step approach involving various stakeholders working together, implying a broader strategy that goes beyond enforcement to include collaboration, capacity building, and policy development.	The involvement of these multiple stakeholders indicates a collaborative effort towards formalization, which can help clarify uncertainties about specific steps and approaches to formalization. Integration between informal and formal sectors appears a fundamental aspect in the approach to formalization.	Collaboration among stakeholders can lead to the development of strategies that address environmental impact, resource recovery, and socio-economic outcomes across different regions. Further research is needed in this regard, but identifying best practices or widely-applicable strategies to formalization and effective waste management likely involves collaboration and discourse among key stakeholders, including the informal sector.	Partnerships involving government and policymakers, multinational organizations, researchers, NGOs, and informal workers could be considered effective. It is unclear on which types of partnerships are most effective, but this is likely context-specific and region-specific. However, effective partnerships for formalization may actively involve the informal sector.	A cooperative approach to formalization aligns with the understanding of formalization as a multi-dimension process which considers the broader socio-economic implications of formalization strategies.
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Addressing the social impacts of a CE is essential when shaping policy and programs. A CE is a pathway for greater sustainability, which entails that addressing the economic, environmental, and social components of a transition is a core part of the adoption and success of the CE. The full achievement of CE goals could be hindered without this consideration, as transitioning systems involves capacity, ability to adapt, and willingness - especially of key stakeholders	Formalization requires consideration of economic, environmental, and social components of strategies. The approach to formalization must include social considerations such as capacity building alongside regulatory and economic measures.	There is uncertainty and complexity involved in formalization in noting that transitioning a linear system requires capacity building, adaptation, and willingness or ability of key stakeholders. This suggests that formalization is a multi-step process which requires engagement with the informal sector.	Formalization approaches should be adaptable and consideration of local socio-economic contexts across different regions. The common element being the inclusion and consideration of informal workers and their role within a given waste management system.	Effective partnerships with the informal sector are a direct reflection of addressing the socio-economic impacts of a transition to CE. Further inclusion of informal sector in the development of policies and programs that address e-waste concerns and reflect circular principles is needed.	Bridging the gap in the literature around the broader socio-economic implications of formalization involves recognition of the impacts of integration of informal workers without which the full achievement of the goals of CE could potentially be hindered. If the informal workers are required to participate in formalization for improvements in e-waste management, then acknowledgement and engagement are crucial for future research and initiatives.
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The overarching findings indicate that formalization is a multi-faceted, multi-step process involving regulatory recognition and integrating workers into legal frameworks and waste management systems. This process includes strategies such as capacity building, developing partnerships, stakeholder collaboration, and addressing the economic, environmental, and social components of the transition to a CE.

Additionally, a structured approach to integration is required in addressing the uncertainties surrounding the process of formalization. Formalization remains a collaborative effort, requiring stakeholder alignment, training for informal workers, health and environmental awareness, education, and access to resources and support. Effective integration necessitates partnerships that provide capacity building and resource access.

Moreover, while universal formalization strategies may not exist, there are a few core elements of formalization which are core element to the process of formalization. Regardless of regional contexts, the inclusion of informal workers' perspectives is essential to designing formalization strategies which are effective. The inclusion is essential to improve resource recovery in e-waste, reducing environmental impact, and potentially enhancing the socio-economic outcomes for workers involved. In addition, effective e-waste management should be adapted to local socio-economic contexts and requires collaboration among stakeholders. This adaptability ensures that the approaches to formalization, while likely different based on regional context, will incorporate the needs and role of the informal sector. While the research did not identify which partnerships are the most effective for formalization, it is clear that effective partnerships typically involve policymakers, multinational organizations such as ACEA, researchers, NGO, PROs, workers, formal recyclers and waste management, and informal actors.

Furthermore, dialogue among stakeholders to develop, address, and implement formalization are crucial to improving resource circularity in e-waste management. Policies and programs should reflect the realities of e-waste management systems in pursuit of a CE. Bridging the literature gap on the socio-economic implications of formalization requires a comprehensive approach. Thus, understanding and including informal workers in regulatory frameworks and CE policy discussions on e-waste is needed as sidelining them can undermine the goals of a CE given their significant involvement in handling e-waste. Recognizing their role in e-waste management and the CE discourse is essential for informing practices and supporting a sustainable, just transition to circularity.

6.1 Limitations

While the study shed light on the process and characteristics of formalization, there were certain limitations which shaped the scope of analysis. First, the study was limited to a high-level scope on formalization. As a result, the perspective shared in this paper do not encompass the full complexity of formalization processes or account for all regional nuances. Additionally, the study's findings were restricted by the limited participation of only seven interviewees. Second, the study lacked any direct input from informal workers and a deeper exploration of projects involving their engagement. Understanding the perspectives of informal workers, who either seek to benefit from or are primarily impacted by formalization, is essential for determining the optimal approach to formalization, whether from project and programs viewpoint or from a policy development standpoint. Further research into these aspects is highly recommended. Third, while the study aimed to provide insights on how we can use the understanding of formalization to inform circular policy, there are broader implications and connections that extend beyond the study's scope regarding governance in circular economy.

Kovacac et al.'s (2019) paper on circular economy in Europe sheds some light on emerging criticisms suggesting that the term circular economy itself is too vague, with policies often narrowly focusing on waste management targets rather than addressing the broader systemic change the concept implies. This discrepancy between the conceptual understanding of circularity as a holistic systemic change and the practical implementation of circularity centred around waste management policy and economic growth was beyond the scope of this study but is notable and should be considered in further research. In that regard, the study scope also did not extend to literature critiquing CE policies on a deeper level, yet it is essential to acknowledge existing critiques outlined in the literature. For a starting point to address these limitations, researchers can examine Kovacic et al.'s (2019) critique on the gap between circularity as a concept versus circular policy in practice as well as the idea of a “biophysical” impossibility of closing-the-loop, Naustdalslid's (2014) analysis of governance challenges in the Chinese CE, and Valenzuela's (2017) critique of sustainable economic growth and “green growth” concepts.

6.2 Future Studies

Further research is needed on developing a widely accepted, standard definition of formalization and its key characteristics. In addition, research is needed on investigating regulatory and policy support of formalization, including which policy approaches and tools can work to enable or incentivize formalization and integration in e-waste. Also, research is needed to examine and observe the closely intertwined networks of formal and informal workers in waste management systems in the Global South, further exploring whether a “hybrid” system is feasible in managing e-waste. A hybrid approach to formalization might potentially improve resource recovery, health and safety outcomes for workers and surrounding communities, value extraction from e-waste, overall environmental impacts, and livelihood outcomes. Future research could

explore whether avoiding full integration of informal actors while leveraging their benefits through effective partnerships and capacity building is a viable strategy to address global e-waste concerns in context of a growing circular economy.

In addition, the research unveiled a strong area for future case studies or research on formalization in practice. One participant is a founder for a cooperative project titled “E[co]work” which aims to empower informal micro entrepreneurs by providing solutions for safe and inclusive e-waste management. E[co]work aims to function as a bridge between the regulatory requirements of e-waste management and informal sectors by providing a physical facility for safe dismantling of e-waste, as well as providing training and education, better access to markets, and covering certain costs of operations. This project could serve as a valuable case study on formalization because it aims to take a comprehensive approach on formalization addressing key factors such as partnerships and collaboration, access to resources, and capacity building.

E[co]work began as part of a Swiss-funded project focusing on e-waste management in India, China, and South Africa, following research revealing the significant role of the informal sector in waste collection, prompting discussions about formalization. E[co]work now aims to provide informal workers with safe and environmentally responsible infrastructure, tools, and training. It offers workspaces with shredding and filtration systems and provides training on practices like record-keeping to informal workers. Through a pay-as-you-go model, workers can use the space without paperwork, encouraging formalized practices while maintaining their autonomy as entrepreneurs. The initiative also aims to address hazardous waste disposal through EPR funding, ensuring covered disposal costs. More details are available on their website <https://www.ecowork.international/participatory-design>. The recommendation is to engage E[co]work to investigate further how formalization looks in practice, particularly what challenges

are faced in engaging the informal sector, what measurable benefits are achieved in terms of resource recovery, environmental impact, health outcomes, or livelihoods.

7.0 References

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Appendix: Interview Guide

Semi-Structured Interview Guide

Integration and Partnerships in E-waste Management: Formalization and a Just Circular Transition

note: please answer questions to the best of your ability, there are no wrong answers, your expert opinions are welcome

Screening

1. Do you understand the purpose of this interview, and that the information provided will be used for a master's student research project? Please be advised that you may withdraw freely from participation or pass questions at any time without any consequences.
2. Do you consent for audio-recording and identification so that the student may retain the knowledge gained and present findings with quotes for the purpose of completing their research project?

Guiding Questions (in no particular order)

1. What would you say are some major environmental concerns regarding e-waste?
2. Would you say that establishing the circular economy is absolutely necessary, somewhat necessary, or not necessary for sustainable development – and why?
3. Can you please define what you would describe as “the circular economy”, what are the key parameters and qualities.
4. If you were asked to define the informal waste sector, how might you define it? What are the key characteristics?
5. What role might the informal waste or e-waste sector play in a circular economy, if at all? In enhancing sustainability?
6. In your understanding, what does formalization of the informal e-waste sector look like? What actions might be included or understood as “formalization” practices?
7. Could formalization of the informal sector alternatively lead to negative outcomes?
8. Some scholars believe that formalization of informal workers might lead to benefits such as improved environmental outcomes, livelihood and security, and health. Can you speak to this or share some comments on this notion?
9. Can you provide a brief overview of any projects, programs, or initiatives that you, your organization, or external peers have implemented regarding waste management and reduction or other circular economy outcomes?
10. Can you describe what kind of engagement took place between different actors involved in managing waste or e-waste?
11. Additionally, can you speak to any existing collaboration, partnerships, or tensions between any of these actors in the projects you have been involved in, or are otherwise aware of? (policymakers, waste worker associations, SMEs, etc.)
12. As part of any projects or initiatives, did your organization work to facilitate partnerships between different actors involved in waste or e-waste management? If so, in what ways
13. In your experience, are there current or developing formalization or CE policy measures that address, impact, or are otherwise relevant to informal waste workers? If yes, how would you describe the relation of said policies to informal workers? (ex: indirect, direct, etc.)

14. Can you share your perspective on the following statement: “contemporary research suggests that the implementation and adoption of CE will bring social and economic benefits including job creation, improvements in infrastructure, and technological innovation”?