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With Forewords by Prof. Olaf Weber and Sebastian Frisch

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The Centre for Sustainability Management (CSM) at Leuphana University Lüneburg is an internationally operating centre conducting research, teaching and continuous education in the fields of entrepreneurial sustainability management, corporate social responsibility (CSR) and social entrepreneurship. The Centre analyses causes, structures and processes of environmental, social and sustainability related problems applying concepts and methods of business management, entrepreneurial and environmental sciences.

In research, Leuphana plays a pioneering role within the field of sustainability science. In 2010, Leuphana established the first and only Faculty of Sustainability in Germany and Europe.

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Brief Summary (German)

Nach Jahrzehnten des Wirtschaftswachstums und des damit verbundenen Konsums werden die Grenzen dieser Wirtschaftstätigkeit deutlich. Zum einen, weil die natürlichen Ressourcen begrenzt sind, zum anderen, weil die Abfälle der bisherigen Konsumgüter die Umwelt und die Gesundheit der Menschen belasten. Die lineare Ökonomie ist an einem Wendepunkt angekommen und die Circular Economy (CE) kann Teil einer notwendigen Transformation darstellen. Der nachhaltige Umgang mit Materialien über ihren gesamten Lebenszyklus hinweg spielt unter anderem bei Plastik eine besonders wichtige Rolle. Insbesondere in Entwicklungsländern lassen sich die aktuellen Plastikmengen kaum noch bewältigen und enden oft auf illegalen Müllkippen. Dies führt u. a. zur Verschmutzung des Bodens, Verstopfung von Kanälen und letztlich zur Schädigung von Mensch und Natur. In Entwicklungsländern obliegt die Aufgabe des Abfallmanagements, dessen Finanzierung und somit der Umgang mit Plastikabfällen oft den Gemeinden. In Industrienationen existiert bereits die erweiterte Produzenten-Verantwortung (Extended Producer Responsibility = EPR), die die Produzenten gesetzlich verpflichtet, für die Entsorgung ihrer Produkte und deren Verpackungen auch finanziell aufzukommen. In Entwicklungsländern existiert EPR meist nur rudimentär. Vielmehr finden sich hier kleinere Projekte, für die Produzenten freiwillig zahlen, da sie selbst über ihren Unkostenbeitrag entscheiden können. Dies findet u. a. in der Form von Plastic Credits (PC) statt. Dabei handelt es sich um Offsetting Zertifikate für Plastikabfall, die durch Produzenten freiwillig erworben werden können und Plastiksammelprojekte in ausgewählten Ländern finanzieren. Diese Arbeit befasst sich mit der Frage ob, und wenn ja wie, PC als Brückenkonzept auf dem Weg zu einem EPR-System in Lusaka, Sambia einsetzbar sind. Die Relevanz dieser Fragestellung liegt in dem dringenden Lösungsbedarf zum Umgang mit dem kaum nach zu bewältigenden Plastikabfall in Sambia. Während PC kurzfristig einsetzbar sind, handelt es sich bei EPR-Systemen um langwierige Prozesse, die keine schnellen Auswirkungen erwarten lassen, jedoch langfristig Erfolg versprechen. Da beide Mechanismen ähnlichen Prinzipien folgen, besteht die Möglichkeit, dass PC genutzt werden können, um kurzfristige Optimierungen im Umgang mit Plastikabfall und der Einbeziehung von Produzenten zu schaffen und Grundlagen für EPR-Einführungen zu legen. Es wurden Mechanismen von EPR-Systemen und PC-Projekten anhand von Literaturrecherche analysiert. Zudem wurde das Abfallmanagement in Lusaka während einer Feldstudie untersucht. Basierend auf diesen Analysen und Beobachtungen konnte festgestellt werden, das PC als Brückenkonzept für das EPR-System in Lusaka anwendbar sind. Notwendige Aspekte für einen erfolgreichen Einsatz in Lusaka wurden erarbeitet und konkrete Umsetzungsmaßnahmen beschrieben.

Brief Summary (English)

After decades of economic growth and the associated consumption, the limits of this economic activity are becoming clear. On the one hand, because natural resources are limited, on the other hand, because the waste of previous consumer goods pollutes the environment and people's health. The linear economy has reached a turning point and the Circular Economy (CE) can be part of a necessary transformation. The sustainable use of materials throughout their entire life cycle plays a particularly important role in the case of plastics, among others. Especially in developing countries, the current plastic volumes can hardly be managed and often end up in illegal landfills. This leads to pollution of the soil, clogging of canals and ultimately damage to people and nature. In developing countries, the task of waste management, its financing and thus also the handling of plastic waste is often the responsibility of the municipalities. In industrialized countries, the Extended Producer Responsibility (EPR) already exists, which legally obligates the producers to be financially responsible for the disposal of their products and their packaging. In developing countries, EPR usually exists only in rudimentary form. Rather, smaller projects are found here, for which producers pay voluntarily, since they can decide themselves on their contribution to expenses. This also takes place in the form of Plastic Credits (PC). These are offsetting certificates for plastic waste, which can be acquired voluntarily by producers and finance plastic collection projects in selected countries. This paper addresses the question of whether, and if so, how PCs can be used as a bridging concept towards an EPR system in Lusaka, Zambia. The relevance of this question lies in the urgent need for a solution to deal with the almost unmanageable plastic waste in Zambia. While PCs are applicable in the short term, EPR systems are lengthy processes that are not expected to have a quick impact but promise success in the long term. Since both mechanisms follow similar principles, there is a possibility that PCs can be used to create short term optimizations in plastic waste management and producer engagement and lay foundations for EPR rollouts. Mechanisms of EPR systems and PC projects were first analyzed based on literature review. Furthermore, waste management in Lusaka was investigated during a field study. Based on these analyses and observations, it was found that PCs are applicable as a bridge concept for the EPR system in Lusaka. Necessary aspects for a successful application in Lusaka were elaborated and concrete implementation actions were described.

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Abbreviations

ACCP	African Clean Cities Platform
AFR	Alternative fuels and raw material
Approx.	Approximately
App	Application
BFS	BlackForest Solutions GmbH
CBE	Community Based Enterprises
CE	Circular Economy
cf.	Confer
CPR	Collective Producer Responsibility
CO_2	Carbon Dioxide
8NDP	The Eight National Development Plan
EC	European Commission
EDP	EPR Design Principles
EF	External Factor
e.g.	exempli gratia
EPR	Extended Producer Responsibility
Etc.	Et cetera
et al.	Et alia
EUR	Euro (Currency of Europe)
FMCG	Fast Moving Consumer Goods
Fig.	Figure
GDP	Gross domestic product
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GES	Green Earth Solutions
GTAI	Germany Trade and Invest

HDPE	High-density Polyethylene
ISO	International Organization for Standardization
ISWA	International Solid Wastes and Public Cleansing Association
Kg	Kilogram
LCC	Lusaka City Council
i. e.	id est
IPR	Individual Producer Responsibility
IJHSSE	International Journal of Humanities Social Sciences and Education
JICA	Japan International Cooperation Agency Institute for International Cooperation
LDPE	Low-density Polyethylene
M	Million
MGEE	Ministry of Green Economy
MLP	Multilayer plastic packaging
MLGRD	Ministry of Local Government and Rural Development
MLNR	Ministry of Lands and Natural Resources
MMMP	Multi-material multilayer plastic packaging
MoF	Ministry of Finance and National Planning
MoH	The Ministry of Health
MSW	Municipal Solid Waste
MWDS	Ministry of Water Development, Sanitation & Environmental Protection
NABU	Naturschutzbund Deutschland
NGO	Non-Governmental Organization
n. d.	no date
n. pag	no page number
OECD	Organization for Economic Co-operation and Development
PET	Polyethylene terephthalate
PE HD	Polyethylene High-density
PE LD	Polyethylene Low-density
PVC	Polyvinyl chloride
PC	Plastic Credits
PS	Polystyrene

PP	Polypropylene
PRO	Producer Responsibility Organization
RDF	Refuse-derived fuel
SADC	Southern African Development Community
SDG	Sustainable Development goals
SG	Strategic goal
SLR	Systematic literature review
SWM	Solid waste management
SWOT	Strengths, Weaknesses, Opportunities, Threats
SWMIP	Lusaka Solid Waste Management Improvement Plan
Tab	Table
T	Ton
UBA	Umweltbundesamt
UN	United Nation(s)
USD	United States dollar (Currency of US)
US EPA	United States Environmental Protection Agency
UV	Ultraviolet
WCEF	World Circular Economy Forum
WMU	Waste Management Unit
WMD	Waste Management Districts
WWF	World Wide Fund for Nature
ZEMA	The Zambia Environmental Management Agency
ZMW	Zambian Kwacha (Currency of Zambia)

Foreword

Plastics are one of the major environmental problems the world suffers from. The practical and easy-to-use material has become a significant problem in landfills and water bodies, such as oceans, rivers, and lakes. There are floating 'plastic islands' in the sea, and in some rivers, there is more plastic than fish. However, the good news is that we are aware of the problem. The bad news is that we do not really know how to address the problem. To get rid of the waste, many industrial countries ship it abroad. But this does not solve the problem; instead, it moves it from one continent to another.

Some legislations have introduced regulations to price or ban one-way plastic products, such as shopping bags. In Tanzania, for instance, one-way plastic shopping bags are banned. Another way to address environmental problems, however, are market-based solutions. Probably, the most famous market-based approach is pricing carbon emissions. To test such solutions, they are often introduced voluntarily.

The current publication addresses such an approach. It analyzed whether voluntary Plastic Credits (PC) can be used to reduce plastic waste. The publication addresses the problem from a theoretical and practical perspective. Based on a literature analysis, the research conducts document analyses and interviews in Lusaka, Zambia. The approach is particularly useful because it focuses on a developing country instead of an industrialized country in the North. Developing and emerging countries will grow economically but often do not have the financial opportunities or regulatory systems to address problems caused by economic growth. Therefore, the analysis contributes to our knowledge about how to address waste problems in developing countries.

Inga Skowranek suggests that a market-based solution, such as plastic credits, might be a way to address the waste problem, but that it needs to be designed carefully to have the desired effects. For instance, PC only works if there is a way to process the plastic waste. Often, it is argued that waste management or recycling facilities can be built with the PC income. However, usually, there is a lack of finance that leaves the problem unsolved.

The current publication delivers insights into PC use that are valuable for academics and practitioners. It shows both the opportunities and drawbacks of the approach. Hence, it is a must-read for everyone involved in managing plastic waste in developing countries.

Prof. Olaf Weber
CIBC Chair in Sustainable Finance,
Schulich School of Business

Preamble

At first the concept of so-called plastic credits seems promising. It stands for immediate financial support for collecting plastic waste that would pollute beaches and environment otherwise. Informal waste pickers receive money for their work from international brands to compensate their plastic waste footprint. Apps provide a digital coverage of the process. That process can be implemented without any burden of a time-consuming technical and legal process, which is required to establish a conventional circular economy that relies on the concept of a mandatory Extended Producer Responsibility (EPR). Especially countries located in the Global South still show a lack of awareness about waste management and EPR .

All good, let's go ahead with plastic credits?

Inga Skowranek's award winning master thesis shed more light on this question. In her thesis she analyzed that plastic credits can actually disturb and delay the process of circular economy and EPR implementation. Brands are using plastic credits as part of their corporate social responsibility budget, as a purely voluntary measure. The risk of greenwashing is high. Brands can pretend action with plastic credits whereas the structured, coordinated process of a mandatory EPR implementation is being neglected as substantial budget has to be pumped into the system. Plastic credits can cure the symptoms only on short sight but a mandatory EPR would cure the root cause of the global waste management crisis both sustainable and on long-term.

The impact of plastic credits based on quantities being collected is negligible on business models operating sustainable. The concept is rather used to promote brands, the (mostly European) start-ups behind the apps and attract investors to finance these start-ups but not the system on the ground.

Inga further suggests clear conditions that would support the co-existence of a mandatory EPR scheme and plastic credits (then being used in a different form from how they are operated now).

This master thesis is answering key questions raised in the community since the first upcoming of plastic credits in approx. 2018. It gives a new perspective on the opportunity of implementing EPR in the Global South exemplary based on beautiful Zambia where Inga travelled to collect first-hand data and information on site.

Sebastian Frisch

1 Introduction

1.1 Background

Despite the finite nature of resources, the global economic system is still geared to growth (cf. Obinger 2004: 13–20). Consumption is also linked to this permanent striving for growth regardless of whether they are industrialized or developing countries. This consumption is often accompanied by a careless use of products and resources (cf. Fellenberg 1997: 106–120). In addition, this type of growth promotes the quantities of different waste, because it creates more consumption and therefore more packaging or production waste (cf. Fellenberg 1997: 106–120). According to 2050 forecasts a doubling of waste worldwide is expected (cf. Muheirwe et al. 2022: 1). One type of waste that people are often confronted with in everyday life is the Municipal Solid Waste (MSW) which includes "(…) items such as packaging, food waste, grass clippings, (…). MSW does not include industrial, hazardous, or construction waste" (United Stated Environmental Protection Agency (US EPA) 2014: 2). The various components of MSW also pose challenges for its treatment. In particular, the high amount of plastic packaging pollutes the environment and contributes to high waste management costs (cf. World Wide Fund for Nature (WWF) n. d.). These high costs also explain the shipping of waste from industrialized nations to developing countries. There, the handling of waste is still usually cheaper due to weak laws and a lack of environmental protection measures. Often, the waste there is stored in wild dumps, incinerated or can be find everywhere in the environment (cf. Naturschutzbund Deutschland (NABU) n. d.). Even though there are various conventions to prevent this kind of illegal shipping, especially the Basel Convention from 1989, such shipments still take place (cf. Basel Convention 2019). But the amount of self-produced waste in developing continent such as Africa is far higher than the imported waste. The waste volume in the Sub-Saharan Africa including plastic waste (Details about plastic categorization see chapter 4.3.2) is estimated to 231 metric tons generated annually (cf. Muheirwe et al. 2022: 1). The interconnected world, the economic systems and also the dependencies on imports and exports lead to huge amounts of waste that are generated globally but often have to be dealt with locally. A high increase is expected in cities in developing countries in particular where they have hardly any possibilities to cope with these volumes of MSW. A major challenge for the cities or municipalities lies in the responsibility for governance, the operating and the funding of waste management which takes approx. 19 % of the municipal costs (cf. Taylor 2000: 408; Kaza et al. 2018: 102). Improving waste management in developing countries often fails due to lack of funds, infrastructure and insufficient capacities at the institutional level (cf. United Nations (UN) Habitat 2007: 5–40; Guerrero et al. 2013: 220–232).

Zambia, the third largest economy in southern Africa, is confronted with various environmental problems caused by "rapid urbanisation, unsustainable population growth and inadequate town planning" (UN Habitat 2007: 5). The environmental destruction also comes from the mismanagement of MSW. It is estimated that about 50 % of MSW from developing countries remains uncollected (cf. Muheirwe et al. 2022: 1). Especially the plastic waste has negative effects e. g., clogging drains and gutters. Due to the blockages from the drains, the water is unable to pass through and might become contaminated which is the cause of cholera. The residents of Lusaka have also already been affected by this in 2018 and 2022 (cf. ReliefWeb 2022 see Fig. 1:).

Fig. 1: Blocked sewer, Misisi, Lusaka, October 2022 (own image)

And even though the impacts are felt locally in the city and need to be resolved, it is also important to involve international and national actors and their requirements (cf. Taylor 2000: 408). Dealing with MSW is also addressed directly and indirectly in the international 17 United Nations (UN) Sustainable Development Goals (SDGs) e. g., in SDG 6: Clean water or sanitation or SDG 12: Responsible consumption and production (cf. UN in Zambia n. d.). To achieve the SDGs, global and local actions must be implemented. An overview of the concrete targets in Lusaka and their impact on the SDGs can be found in the Annexure 9). Also various national initiatives address this complex waste topic either through the objective of a sustainable economy: "Africa by 2063 will have been transformed such that natural resources will be sustainably managed and the integrity and diversity of Africa's ecosystems conserved" (African Union Commission 2015: 34) or directly as a defined goal "We, therefore, undertake to achieve (…) interconnected (…) Circular Economies that are sustainably developed (…)" (Southern African Development Community (SADC) 2020: 5).

Circular economy (CE) (see chapter 2) and the opportunities that arise from the reduction of linear material and energy flows can also contribute to the solution of the waste problem in Lusaka (cf. Eurostat n. d.). The Extended Producer Responsibility (EPR) (see chapter 2.3) is considered a tool for achieving CE. According to the Organization for Economic Cooperation and Development (OECD) the EPR describes "(…) an environmental policy approach in which a producer's responsibility for a product is extended to the post-consumer stage of a product's life cycle." (OECD 2016: 21). So EPR is consistent with the Polluter Pays Principle regarding the shifting of responsibility and all related costs for the products towards producers (cf. OECD 2016: 21). This responsibility includes the ecological impact of the products throughout their life cycle from product design up to the final disposal. By covering the entire lifecycle of products, it is not surprising that EPR implementation can be multi-faceted and time-consuming (see chapter 2.3). Zambia does not have a fully functional EPR system yet, even if legal drafts and regulations exist since several years (see chapter 4.2). Looking at the current situation in Lusaka (see chapter 4), the urgency of dealing with plastic waste becomes clear. Sustainable solutions and financing for the handling of plastic waste must be established in the short term. In order to promote infrastructure development, eliminate plastic waste, and lay foundations for a functioning waste management system and full-scale EPR systems, plastic credits (PC) might be used as a quasi-immediate solution (cf. Nguyen et al. 2022).

Conceptually, plastic credits are an offsetting certificate for plastic waste, its collection and, in some cases, treatment (see chapter 3). Producers can purchase this type of credit to offset the company's plastic footprint. The Polluter Pays Principle can also be seen here, although the purchase of PC takes place on a voluntary basis yet. The benefits for companies here include improving their brand image through the use of claims such as plastic neutral (cf. Johnson 2022: 12–18). PC projects can contribute to the removal and disposal of plastic waste from the environment in the short term and at the same time reduce the financial burden on the municipalities (cf. Prevent Waste Alliance n. d.).

Whether and how PC and EPR can be used together to address the plastic waste problem in Lusaka is highlighted throughout this paper.

1.2 Research field and problem statement

The developing country of Zambia, and the city of Lusaka in particular, is faced with a large amount of plastic waste that already poses health risks to the population (cf. ReliefWeb 2022; see chapter 4). Short- and long-term solutions for dealing with waste must be found and implemented. According to the national visions and strategy papers, the development of a CE is part of the desired long-term solution (cf. SADC 2020: 5). In order to implement the CE in Lusaka, an EPR system can be a useful, although rather long-term, solution. Since the introduction of such systems might take years, the question arises which actions can be done in short-term. PC might be a mandatory solution to reduce the current plastic waste. The question arises, however, as to whether PC will make a meaningful contribution to a future EPR system and the desired CE, or whether it could even disrupt it. If a meaningful synergy between PC and EPR is possible, it is also essential to identify the local specifics in Lusaka and the resulting requirements. The effect of PC on EPR has not yet been sufficiently investigated scientifically. So far, there are a few selected project reports, studies are not available on this topic. For this reason, the research question of this thesis is:

"To what extent Plastic Credits can be used as an EPR bridge concept in Lusaka, considering local specifics need, the costs and environmental impacts?"

To answer this question, the following sub-questions are also addressed in this thesis:

- Could PC be a relevant component for the implementation of an EPR system in Lusaka? If so, which criteria would need to be considered for implementation?
- How does the local waste management in Lusaka work?
- How can the strengths of PC be used and how can their weaknesses be compensated?

- What are the requirements of PC and the associated business models?
- What are realistic costs of PC in Lusaka?
- Would the implementation of mandatory PC be reasonable and feasible?
- What environmental and social impacts can be achieved through PC in Lusaka?

Waste management and also EPR systems are implemented differently due to their local conditions such as culture, financing system, institutional framework, technical and human capacities and waste types (cf. Muheirwe 2022: 3). PC projects are also subject to these local conditions. For this reason, this thesis focuses on the city of Lusaka, Zambia and its local requirements (see chapter 4). Since PCs and their mechanisms are an essential part of the work, the focus is on plastic waste. Other waste types, such as hazardous substances, are not considered in this thesis. For the cost calculation of PC, an explicit waste flow is assumed (see chapter 6.1). This flow includes the incineration of plastic waste in a cement plant and do not refer to any other plastic recycling process. The selection of this process is based on the assumption that it represents a realistic scenario and does not require any additional infrastructure on site. This paper addresses the local requirements for a plastic credit-based project or even business model in Lusaka. The business model itself is not part of the paper due to the defined scope.

1.3 Methodology

This thesis relates to the following main knowledge streams: the current impact of PC and their relevance to CE and EPR, and a consideration of local challenges and opportunities in an implementation of PC in Lusaka, Zambia. The following image (see Fig. 2:) shows the methodological approach by phases:

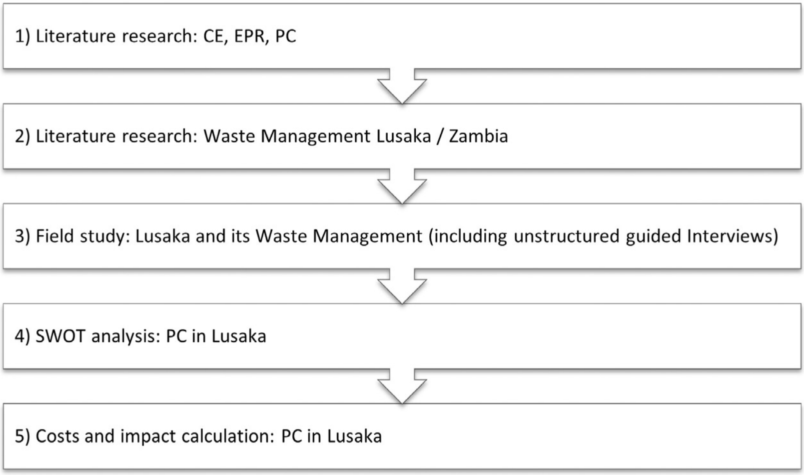

Fig. 2: Methodological approach (own illustration)

In order to understand the complex market of PC, their modes of action and concepts, and interrelationships with CE as well as EPR, literature research on this background information was first conducted (1). In parallel with the above basic research, a literature review was conducted on the development and current status of waste management in Zambia's capital city, Lusaka (2). Based on these literature reviews, initial assumptions could be made about potential issues in the implementation, which have been validated during a field study in Lusaka in October 2022. During the field study qualitative, unstructured guided interviews with experts as well as interviews with residents or waste pickers were conducted (3). Based on the literature review and field study the intersections between PC and EPR are identified. In addition, the strengths and weaknesses of PC are highlighted and aspects for its combination with EPR are described. In the SWOT analysis, the local specifics and the basic idea of the PC model, relevant aspects of a future EPR system are aligned and concrete recommendations for a future PC project or even business model are developed (4). In the next step the price of PC is calculated. Also, environmental, economic and social impacts of the implementation of PC are mentioned (5).

1.3.1 Literature research

The empirical research method of the literature research, is to be assigned to the qualitative research and covers the search and selection of publications, in order to answer the posed problem definition. Thereby, the methodology refers to already existing knowledge. While an unsystematic literature research is rather used to get an overview of a topic, the systematic literature research is advantageous if there is already a question to be answered and thus specific literature can be searched (cf. Brink 2013: 46–108). This paper is based on both approaches, whereas the unsystematic literature research is mainly used to delimit the task area. While the systematic literature research is applied directly to the task. The systematic literature search comprises five steps, as shown in the table (see Tab. 1:).

Tab. 1: Literature research (own illustration based on Kalina et al. 2003: 74–110)

Steps	Significance
Determine search terms	Includes the creation of lists of relevant synonyms, catchwords and keywords related to the assignment.
Perform literature research	Includes searching for literature using the lists of synonyms, headwords and keywords.
Skim search results	Includes cursory review of literature found for rough presorting of relevant literature to answer the assignment.
Make literature selection	Includes the selection and source mix of relevant and frequently cited literature to answer the assignment.
Prepare documentation	Includes the preparation of the paper, paying attention to proper citation.

In the first step, a systematic literature review (SLR) was conducted. First, search terms relevant to this work were defined. Broad research was first done using various criteria that feed into the research question and the following sub-questions:

- What is CE?
- How do waste management, CE and EPR interact?
- What are the criteria of EPR?

- What is the mode of operation of PC?
- Are there interrelated modes of action between PC and EPR?
- Who are stakeholders and participants in the PC market?
- What are the challenges to be considered in the implementation of PC?
- What are the opportunities and risks associated with PC?
- How does waste management work in Lusaka, Zambia?
- What are the challenges of waste management in Lusaka, Zambia?

In literature research, a distinction is made between primary and secondary literature. While primary literature comprises the original literature, secondary literature contains content that originates from another author. It is advantageous to focus on primary literature and to use secondary literature only in exceptional cases (cf. Kalina et al. 2003: 74 –110).

1.3.2 Field study & unstructured guided interviews

For the classification and possible evaluation of the results of the work, it is necessary to explain the methodologies used (cf. Gebhardt et al. 2011: 156). After the initial literature research, gaps became apparent with regard to local and, in particular, current conditions in Lusaka, Zambia. These gaps related in particular to the concrete design of waste management and its functioning as well as related price structures.

Thus, the objective of a ten-day field study was to close these information gaps. Owing to limited a priori information in advance, it seemed reasonable to approach it with the help of a qualitative methodology (cf. Gebhardt et al. 2011: 98). Specifically, this meant developing several guiding questions that were addressed in guided interviews with selected contacts (for structure guided interview, see Annexure 1). The most important issues are addressed and noted in bullet points. According to Lamnek this is not necessarily done in concrete wording. When and how the question was specifically asked is not fixed, but results from the course of the conversation (cf. Lamnek 2016: 515–607). This chosen method does not aim at a statistical forecast, but rather at gaining knowledge in order to approach the actual local challenges (cf. Gebhardt et al. 2007: 91–98).

The selection of interview partners (see Tab. 2:) was based on two criteria. Firstly, on the basis of the previously conducted literature research regarding possible stakeholders, and secondly on the basis of recommendations by the locally based Maluwa Foundation, Green Earth Solutions (GES) as well as the company BlackForest Solutions GmbH, which are active in the field of waste management (cf. Maluwa Foundation 2022; BlackForest Solutions 2018).

Tab. 2: Interview partner field study 2022 (own illustration)

Institute / Position	Date / Annexure
Aggregator Misisi	(15.10.22 / Annexure 2)
Waste Collector 1	(17.10.22 / Annexure 3)
Waste Collector 2	(19.10.22 / Annexure 4)
Recycler 1	(20.10.22 / Annexure 5)
Recycler 2	(21.10.22 / Annexure 6)
Lusaka City Council (LCC)	(17.10.22 / Annexure 7)
Waste Picker	(18.10.22 / Annexure 8)

In addition to the scheduled interviews, brief interviews were conducted as part of what is most closely described as participant observation. Participant observation here also includes participation in everyday life (cf. Gebhardt et al 2011: 157).

For the study in Lusaka, this included visits to illegal (Misisi) and legal landfills (Chunga) as well as interviews with concerned persons such as the aggregators, the waste collectors, the recyclers and the LCC (see Chapter 4). The aggregator and the waste collector were interviewed because the informal sector plays an important and supporting role in waste management in developing countries and thus also in Lusaka. Here, it was important to understand the informal structures and mechanisms. The registered waste collectors are subject to official structures, such as official requirements, price definitions and regulations. During the interviews, an understanding of the mechanisms and further insights into everyday problems could be gained. In addition, one small and one larger recycling company were selected for interviews to get an idea of the state of recycling in Lusaka and the possible quantities that can be processed. Admittedly, however, the willingness among recyclers for interviews was low. The interview with the LCC and the visit to the landfill were conducted in order to get an on-site picture of the waste problem and also to understand the official figures, structures and background.

It was disclosed to all conversation partners that the questions were asked in the context of a master's thesis. In general, the interview partners were open and helpful, especially in the participant observation. Logging the conversations, although originally planned, was not possible. Although all conversation partners knew the background of the interviews, a certain skepticism could be felt. However, in order to obtain the most valid statements possible, the author decided to record the interviews in writing only. This led on the one hand to a keyword-like transcript and a natural accompanying interpretation by the author. These were used as a basis for further interpretations and for closing any gaps in the research field. On-site and interview support was provided by a local Maluwa Foundation project manager. This helped to ensure that the interview partners were open and approachable and that language barriers have been overcome as well.

1.3.3 SWOT Analysis

SWOT analysis is used for strategic planning and management of companies. At its core is a positioning analysis by internal factors (strengths and weaknesses) and external factors (opportunities and risks). This analysis provides a comprehensive overview of the company's situation and lays the foundations for business models and company positioning (cf. Wollny and Paul 2015: 189). In this thesis the SWOT analysis is used for analyzing the idea of PC as a bridge concept towards EPR. For that reason, strengths and weaknesses of PC related to a future EPR system are contrasted to the local, external opportunities and risks. On the basis of this comparison, measures are then developed that must be taken into account when implementing a PC project or even a PC-based business model that is intended to contribute to EPR.

1.3.4 Costs and impact PC

The price for PC is calculated on the basis of a defined waste flow. This takes into account waste collection, transport, sorting and incineration in a cement plant. In addition, the administrative costs for the introduction of PC are calculated based on comparable projects. The data obtained from the field study and literature review form the basis for this price calculation. In addition, the possible impacts in the social, environmental and economic fields by using PC are mentioned.

2 Circular Economy and the Extended Producer Responsibility

This chapter describes the basic idea of the CE and the associated waste management challenges. In addition, basic factors influencing the implementation of EPR in developing countries are outlined. Finally, the status quo of EPR and accompanying strategic measures in Lusaka are described.

2.1 CE and waste management

The basic idea of CE is to create a circular approach to the production and consumption of products in order to reduce the environmental pollution, to protect resources and disconnect economic growth from resource depletion (cf. Gheewala et al. 2021: 35–53). The mechanism of CE is defined by closed production, consumption and recycling cycles in which all material is kept in circulation: "A circular economy aims to maintain the value of products, materials and resources for as long as possible by returning them into the product cycle at the end of their use, while minimizing the generation of waste." (cf. Eurostat n. d.). To achieve CE, each step of the product value chain must be considered and, if necessary, adapted. This system describes a regenerative and recovering handling of resources, reducing waste production and emission always trying to close open loops of the product cycle (cf. Prieto-Sandoval et al. 2018: 606–615). This includes the complete system from product design to use, repair, refurbish or disposal (cf. Prieto-Sandoval et al. 2018: 606–615). Even though all life phases of products in CE must be considered holistically, the focus of this thesis is on the waste management system. Especially in developing countries, the system has a significant role in the CE development process (cf. Ferronato et al. 2019: 366–378). Waste management in the CE includes the following aspects: "Nationwide collection systems, development of recycling infrastructure, recovery at a high-quality level, environmentally compatible disposal, service obligations of the market participants, information, education and awareness among all involved stakeholders" (Prevent Waste Alliance 2022a: 8). In order to introduce a new sustainable waste system, it is particularly important to consider the fundamentals waste collection, sorting and recycling within the value chain (see Fig. 3:). This is due to possible effects such as market changes (e.g., increase value of secondary, recycled material) or the change of mindset of the stakeholders involved towards CE (cf. Ferronato et al. 2019: 366–378).

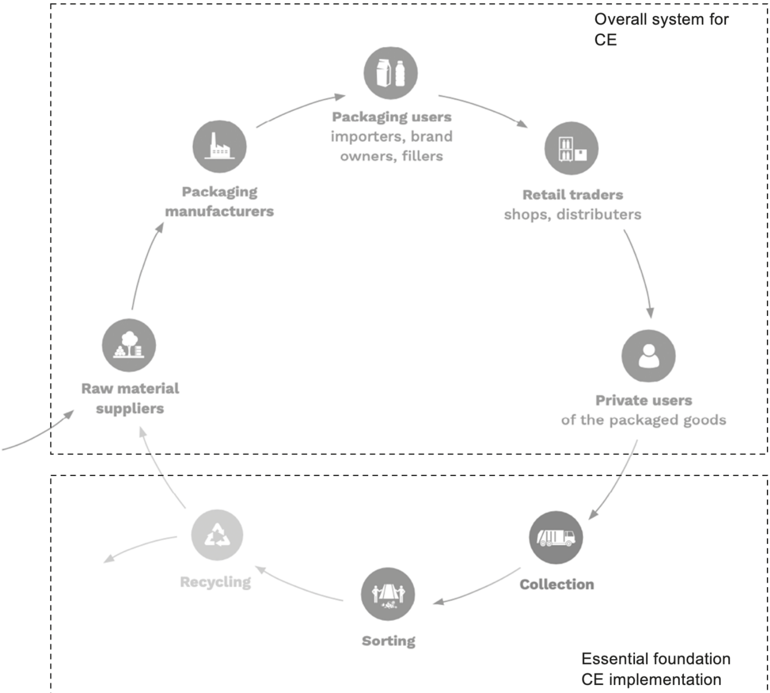

Fig. 3: Packaging value chain in CE (adapted illustration based on Prevent Waste Alliance 2022a: 7; Factsheet 00)

The City of Lusaka is addressing these fundamentals to implement CE through the Solid Waste Management Improvement Plan (SWMIP) 2022–2026. This can be seen, i. e., by the reference to the waste hierarchy (see Fig. 4:), which is a tool for ranking waste management options according to their environmental impact (cf. Lusaka City Council (LCC) 2022: 5). The basic principles of CE are also anchored here in preferred implementation: reduce waste generation, re-use, recycle and recover material and, as a last resort, final disposal of material (cf. Prevent Waste Alliance 2022a: 13).

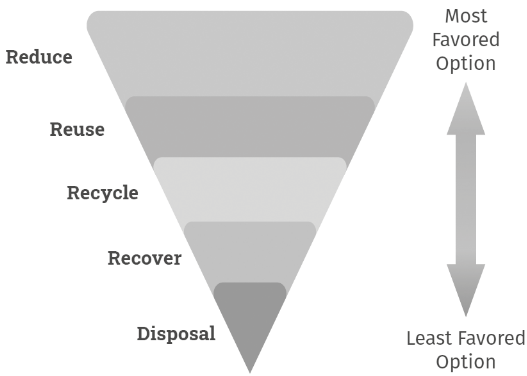

Fig. 4: Waste hierarchy (LCC 2022: 5)

2.2 Financing CE in developing countries

The challenges of CE are manifold, as it affects all areas from production to disposal as well as associated stakeholders. However, a particular difficulty is found in the financing of CE mechanism especially in developing countries (cf. Langsdorf and Duin 2022: 21). Ideally the CE results from the conduct of the market participants along the value chain. This would be a free-market economy-bases approach. Revenues are generated via trading of recycled materials and costs for using new resources are being avoided. However, not all steps of the value chain have proven to be cost-covering. Therefore, several instruments may provide financial support. Municipal fees or taxes can be used for waste services (e. g., collecting) or as specific funding. Private companies might provide voluntary financial support for specific projects, i. e., in the form of Plastic Credits (PC). A promising approach lies in financing via the mode of action of the EPR, which makes the producer liable for the treatment and disposal costs generated (cf. Prevent Waste Alliance 2022a: 8). Local circumstances ultimately define the type of funding. In the case of PC and EPR the money raised is allocated to the dedicated purpose of waste prevention and/or waste collection and recycling (or treatment in general) and should generate enough revenues (based on EPR fee, revenue out of recycled material and prices for PC) for operating the corresponding system. This distinguishes these constructs for example from municipal fees (cf. WWF 2020: 10–18). In the case of EPR, it is also recommended to initially work with simple, traceable fees and to detail these in the course of setting up the system. This should both adequately shape the initial monitoring and control effort and increase transparency (cf. WWF 2020: 10–18). Thus, all of these mentioned options can be used in parallel or only individual actions. Although some local actions are mentioned in this paper, the focus is on the interaction of EPR and PC.

2.3 Mechanism of EPR

According to the OECD the EPR is “as an environmental policy approach in which a producer’s responsibility for a product is extended to the post-consumer stage of a product’s life cycle.” (cf. OECD n. d.). So, the EPR policy is consistent with the Polluter Pays Principle regarding the shifting of costs towards producers reduces the burden on municipalities in terms of waste management (cf. OECD 2016: 21). Thus, through EPR, externalities, i. e., costs incurred in the consumption or production of a product and not yet included in the market price, are to be covered by the polluter (cf. Sturm and Vogt 2018: 17–40). This is intended to address market failures and encourage producers to act responsibly, efficiently, effectively and sustainably. An EPR system works in two directions within the value chain. Upstream, i. e., in terms of production methods and product design to reduce and/or change the use of materials, and downstream, i. e., in terms of recycling or recover processes and the reusability of materials (cf. Gupt and Sahay 2015: 595–611). The basic idea of an EPR system is promising and has already led to changes in production and waste handling in industrial nations like Germany. However, the implementation is also associated with many challenges within the waste management. EPR implementation may vary based on local conditions, defined objectives and context. Currently about 400 EPR individual schemes exist worldwide (cf. OECD 2005: 21; OECD 2021: 8). Nevertheless, all schemes base on the following principles: Context-specific implementation is one of the basic design principles of EPR (EDP). Accordingly, all local circumstances, be they legal, demographic, geographical, social or economic, must be taken into account (cf. OECD 2016: 40–45). Local conditions shape the implementation options and may require adjustments due to the lack of established waste systems or other cultural or structural factors in developing countries (cf. Akenji et al. 2011: 919–930). The other principles are target circularity, social inclusivity, co-operation and co-ordination, financial sustainability, transparency, monitoring & enforcement, clear definitions about covered materials, obliged companies and producer's responsibilities (cf. OECD 2016: 40–45; WWF Akademie n. d. b.). Target circularity describes the clear focus on the transformation to a circular economy by improving product design and waste management. Social inclusivity stands for the support and inclusion of all existing waste management actors (e. g., informal sector, small businesses) on fair terms. Co-operation and co-ordination emphasize the need of an open and trustful relation between the involved stakeholders to create a stable EPR environment. The financial sustainability describes the cost covering of the operational EPR system by revenues out of the recycled material as well through the producer's fee. Transparency, monitoring & enforcement are the basis to ensure that all producers contribute according to the defined goals. The clear definitions are setting the rules for the EPR scheme and provide clarity through the entire process (cf. OECD 2016: 40–45).

According to the final report "Development of Guidance on Extended Producer Responsibility (EPR)" of the European Commission (EC) 2014, several external factors (EF) shape the success, the costs as well as the design of implementation. These aspects are the existing waste management and treatment infrastructure, the willingness and awareness of communities and residents to participate, the value of recycled (secondary) material on the national market, the country geography and demographics, the existing waste policy instruments and the transparency on key activities within the waste management (cf. Monier et al. 2014: 76; OECD 2016: 53). EPR schemes aim to implement CE but specific objectives may vary depending on specific circumstances. Possible overall EPR goals are prevention of waste, organization of waste collection, organization of waste treatment, assure financing of waste collection & treatment, reduce use of virgin material and increase recycling, reduce negative environmental impact (please see mapping of external factors and possible EPR objectives affected by them in Fig. 5:).

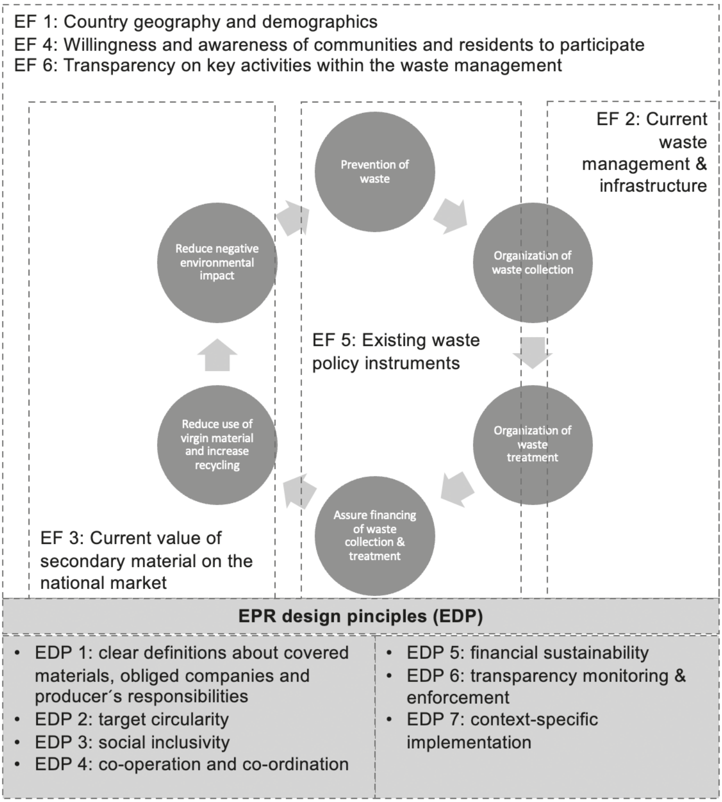

Fig. 5: Mapping of EF and possible EPR objectives affected by them.
(own illustration based on WWF Akademie n. d. b.)

To reach the concrete goals and sub-goals of EPR, the introduction of producer responsibility organization (PRO) or Pre-PRO is recommended. This is an organization or preliminary organization which performs administrative and contractual tasks which are part of an operational EPR System. This also includes monitoring and reporting on EPR processes for the involved producers and other stakeholders which requires a high transparency (e. g., through regular reports) and lays the foundation for a functioning co-operation. (cf. WWF Akademie n. d. b.). However, the tasks also include educational aspects for consumers. Thus, a PRO has high impact on the entire economic, social and environmental system as well as on its involved actors and stakeholders (cf. WWF 2020:10–28). Although these tasks can also be performed by each producer individually (individual producer responsibility (IPR), this is usually cost-intensive and not as effective as working collectively (Collective producer responsibility = CPR) (cf. WWF 2020: 16). The following diagram illustrates possible tasks of a PRO in the context of CPR (See Fig. 6:).

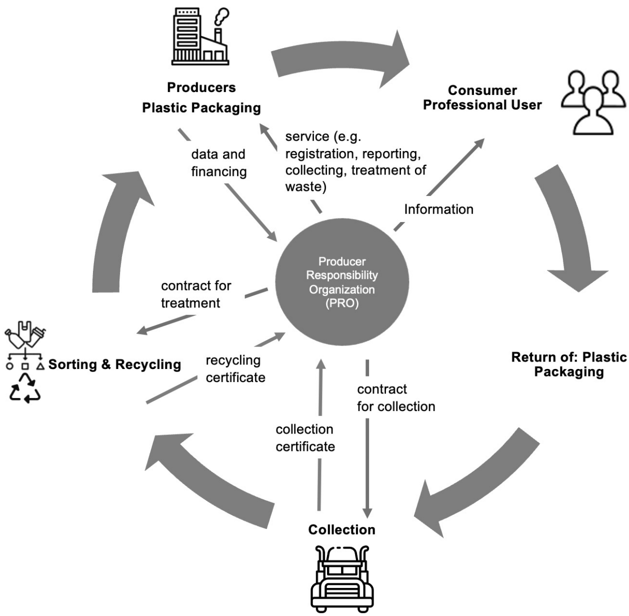

Fig. 6: Basic Flow CPR with PRO (own illustration based on OECD 2016; icon source iconfinder & flaticon; credits to Chanut-is-Industries; Freepik)

When implementing EPR systems, another independent control authority can be introduced, which collects data from stakeholders and controls compliance with regulations. This contributes to create transparency and also to build trust in the EPR system (cf. WWF Akademie n. d.c.). These tasks and required structure as well as the associated actions in the economic, environmental, legal and social areas might explain the long implementation times of EPR (the German EPR System is already 32 years in place and is still evolving) which can be a major obstacle for developing countries (cf. WCEF 2021; WWF Akademie n. d. a.). The EPR System is connected to existing waste management processes and structures. In developing countries, these are usually not in place and must be established which might happen via pilot projects (cf. WWF Akademie n. d. a.). Of course, the implementation of EPR can be done even if the waste management structure is not set up properly. Any concerns that products will become significantly more expensive due to EPR systems and the associated costs can be dismissed on the basis of previous experience. For example, product prices in Germany have often not increased by more than 2.2 % in the case of the introduction of EPR systems (Details see Annexure 10). This does not burden either the producers nor the consumers. Eventually, an increase in product sales is possible, as sustainability aspects have been proven to influence people's eating and shopping behavior (cf. Giz 2021; YouGov 2021). In addition, aspects of sustainability and a reliable implementation of these contribute to the improvement of the brand image and can thus promote the sale of products (cf. Esch et al. 2019).

2.4 EPR and waste initiatives in Zambia

Zambia is also considering the introduction of EPR and has already established the initial legal basis since 2018 (Statutory Instrument No. 65 of 2018). Since 2019 this means banning the use of plastic carrier bags and flat bags that are below 30 microns in thickness as well as the registration of packaging materials and conformity to the National Standard (cf. Zambia Environmental Management Agency (ZEMA) 2018). Currently, these regulations are only sporadically enforced. This is due, among other reasons, to a lack of capacity and the highly fragmented structures (see chapter 4). Detached from a clearly defined EPR system, various initiatives exist that are intended to contribute to improving waste management and therefore might lay the foundations for EPR. One of these initiatives is the Solid Waste Management Improvement Plan (SWMIP) which aims to contribute to the global SDG, the national Zambian Vision 2030 and local strategic goals (SG). While Zambia Vision 2030 targets overall conditions like "Institutional capacity development for LCC, provision of appropriate equipment and infrastructure as well as nationwide anti-litter awareness campaigns" the SG target concrete aspects of the waste management within the city (LCC 2022: 5; Republic of Zambia 2006: 1, see Tab. 3).

Tab. 3: SWMIP strategic goals (LCC 2022: 9)

STRATEGIC GOAL (SG)	
Strategic Goal 1	80 % collection and clean-up of municipal solid waste generated and transported to designated disposal sites.
Strategic Goal 2	80 % of all waste generators who are provided with door-to-door collection services pay an affordable tariff by 2026. All collectors of domestic waste must hold a license from the municipality.
Strategic Goal 3	80 % of the total collection and clean-up of MSW is handled by Private Sector Partners (PSPs) outsourced by LCC/SWMC.
Strategic Goal 4	Interim improved landfill at Chunga disposal site is achieved between 2022 and 2026, and a new modern sanitary landfill disposal site is fully operational and receives 100 % of MSW by 2026.
Strategic Goal 5	100 % of special non-hazardous waste handled by LCC/SWMC. Food and other consumables that require controlled disposal will be exclusively handled by LCC/SWMC.
Strategic Goal 6	80 % of MSW collection and disposal operational costs are covered by revenues (e. g., license fees, tipping fees, user charges, penalties, etc.) by 2026.
Strategic Goal 7	80 % of billings are efficiently collected to support cost recovery objectives.
Strategic Goal 8	30 % of suitable commodity materials are recycled by 2026 (i. e., hard plastic materials, paper, cardboard, metals).
Strategic Goal 9	All designated disposal sites are 80 % compliant with National Environmental Standards by 2030.

Even though Zambia currently has a rudimentary EPR system, these SGs could become part of future EPR target definitions. The following image illustrated a mapping of external factors and the SG affected by them (see Fig. 7:).

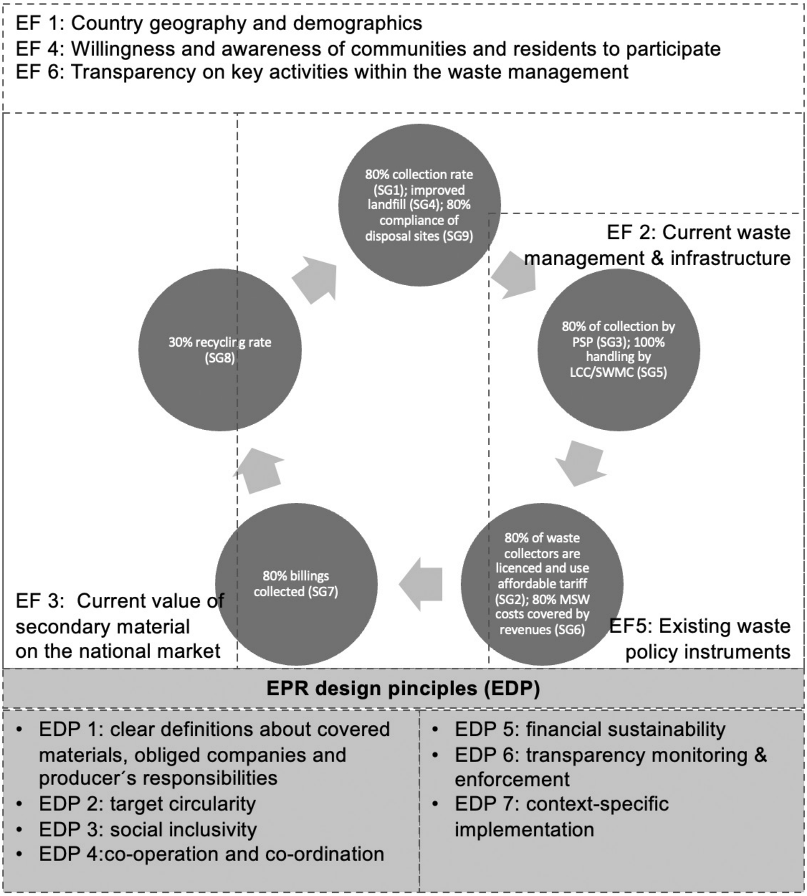

Fig. 7: Mapping of SG and external EPR factors (own illustration)

The SG and the allocation to external aspects suggest that waste management (SG3, SG5), associated legal regulations and their enforcement (SG7), as well as recycling processes (SG8) are weak in Lusaka. Be it the need for optimization at the landfills (SG4, SG9) and collection rate (SG1) clear allocation of waste collection to different actors (SG3, SG5) as well as financing needs of the various measures (SG2, SG6). For a more detailed analysis of waste management in Lusaka, see chapter 4. Even though current activities and objectives are aimed at an EPR system and CE, the question arises regarding the implementation period and the associated costs. There are also questions about enforcement, when already the plastic ban cannot be controlled and implemented. Since Lusaka already has to deal with high plastic waste volumes, both short- and long-term actions are required. As described in chapter 2.2 PCs might be useful in short term.

This chapter dealt with the relationship between CE and waste management. In addition, CE financing options were presented and the basic mechanisms and principles of EPR were outlined. The status quo of the EPR system and other waste initiatives in Zambia was also explained.

3 Plastic Credits and the relevance for EPR

The aim of the chapter is first to understand the mechanisms of PC, their strengths, and challenges in implementation. The second step is to identify the intersections with EPR and the risks as well as opportunities in using PC as a bridge concept. This is described on the basis of concrete challenges to the implementation of PC projects, as the interplay becomes particularly clear there.

3.1 PC general concept

The term PC is used for a transferable certificate representing the collection of specific amounts of plastic waste recovered and / or recycled that would have otherwise ended up in the natural environment (cf. King 2022; WWF n. d.: 2). Companies which are producing plastic waste thus voluntarily pay a specific amount of money to offset the company's plastic footprint. Additionally, they receive a certificate / claim like "plastic-neutral production" which can be used for reputation and marketing issues (cf. rePurpose n. d.; see Fig. 8:). The money raised by PC is used to finance the local collection and treatment of plastic waste done by local partners, i. e., governments or non-governmental organization (NGOs). Usually, one PC is representing a certain weight (e. g., 1 kg / 1 t) of plastic waste and is considered as a transferable, purchasable unit (cf. Prevent Waste Alliance 2022c:2; Nguyen 2022: 22–30). The price of one PC should cover at least the cost of collecting and treating the designated quantity of plastic waste. Treatment here describes recycling or energy recovery or even landfilling on a sanitary landfill. Optimally, sufficient money will also be raised to help finance future waste management infrastructure in the country where the PC project takes place (cf. Prevent Waste Alliance 2022c: 5). Using quality standards regarding social and environmental requirements can lead to diverse benefits (e.g., via "(…) creating socio-economic co-benefits by improving income opportunities for waste workers." (Prevent Waste Alliance 2022c: 2). Following this basis idea PC therefore address the Polluter Pays Principle by shifting the cost towards producers and promotes the internalization of negative externalities like the EPR system do (e.g., waste management costs) (cf. OECD 2016: 21; see also chapter 2.3).

Fig. 8: PC cash and certification flow (own adapted illustration based on TonToTon 2022; icon source iconfinder & flaticon; credits to Freepik; Eucalyp Studio)

Worldwide, PCs are currently offered by more than 60 providers like rePurpose Global (cf. rePurpose n.d.; ValuCred 2021: 5). The range of products offered by the various PC providers varies substantially, which can be explained by the lack of uniform and binding quality standards (cf. Johnson 2022: 12–18). The following graphic illustrates an ideal typical process and the challenge of executing PC-funded waste management projects (see Fig. 9:).

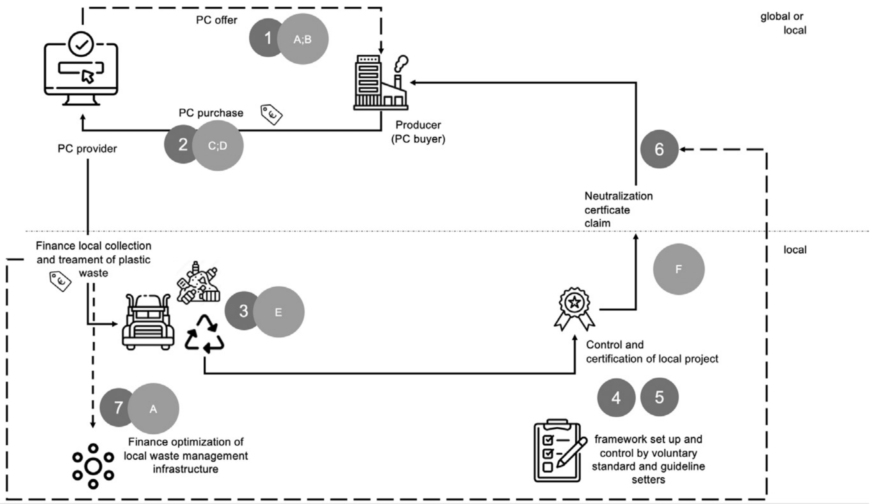

Fig. 9: Ideal typical process and challenge PC-funded projects
(own illustration; icon source iconfinder and flaticon; credits to Eucalyp Studio; Freepik; Gregor Cresnar; Chanut-is-Industries)

1) PC providers offer PC through digital platforms to get the attention of as many producers as possible **2)** Producers calculate their plastic footprint and buy the appropriate number of PC **3)** PC providers finance local collection and treatment of plastic waste (additionally take care about accompanying administrational tasks **4)** The control of the projects can take place through project participants or through external quality parties **5)** In the best case, certain guidelines and directives are also observed during implementation by standard and guideline setters **6)** After proving that plastic waste has been collected from nature and treated, a corresponding certificate is issued, which the producer, i. e. the buyer of the PC can use for his brand communication **7)** Ideally, PCs are already calculated in such a way that they also partly finance the optimization of the local waste management infrastructure. If the ideal type of PC is used, a wide range of positive impacts for various actors like recycling industry, producers, local communities and the informal waste pickers is achievable (cf. Lee 2020: 11; see Tab. 4:). Details on possible impact of PC in Lusaka are described in chapter 6.2).

Tab. 4: Exemplary impact of PC projects and benefits for selected actors (own illustration adapted Lee 2020:11; Nguyen 2022: 42–43)

Benefits for the recycling industry	**Benefits for the producer**	**Benefits for local communities**
Higher recyclability and better quality of plastics due to the revenue generated by PC, and the resulting development of infrastructure for recycling respectively CE	Increased interest in adopting recyclable material; reducing costs due to usage of recycled resources	Higher income per kg of recovered plastics due to better quality; stability in income
	Corporate endorsement for environmental and social impact in offsetting partial / total plastic footprint	Human rights-based employment and higher income for waste pickers; support local business
More stable and more reliable resource stream	Increased feasibility of sustainability goals for higher recycled material content	Cleaner local environment and tourism attractions; carbon reduction due to processes like Co-Processing
	Enhancement of company reputation	Optimization of waste management infrastructure (e. g., higher waste collection rates)

3.2 Strengths of PC and relevance for EPR

Considering the above-mentioned ideal typical process, the following main strengths of PC could be named.

3.2.1 Short term improvements and data collection

PC projects are compared to EPR more flexible to implement due to their independence from legal anchors and size. As a result, PC projects can bring about short-term improvements especially in developing countries (ValuCred 2021: 1–19). PC projects are flexibly applicable on different local conditions and can quickly achieve visible improvements, like cleaner landscapes (see Tab. 4:). Thus, it was possible that one PC project established "(…) a local collection system in Mexico with 85 independent collectors (…) and recovered 169,535 tons of plastic from ending up in the ocean or landfill." (Prevent Waste Alliance 2022b). Besides that, the informal recovery sector has been connected with the global market demand and evaluated environmental impact (cf. Prevent Waste Alliance 2022b). Viewing PC as an intermediate stage to EPR, these projects provide evidence of the success of producer engagement and demonstrate the opportunities of cost-covering CE approaches.

All the information that can be collected about the waste value chain is also of great importance. It can be used for monitoring and thus for creating strongly needed transparency in PC projects themselves. In addition, PC projects also provide information about waste quantities, types and quality, which is essential for the construction of EPR systems. Also, any gaps in the wasteflow can be identified for consideration in the design and within the goalsetting of EPR systems (cf. Prevent Waste Alliance 2022b: 1). Thus, PC projects can provide the basis for the EPR design principle (EDP1), the clear definition of materials, stakeholders and responsibilities. It also provides an inventory of external factors relevant to EPR, such as country geography and demography (EF1) or the current value of secondary material on the national market (EF3). PC projects can also be seen as pilot phases for EPR introductions, in which relevant data are collected, ideas are tested, and short-term improvements for people and nature are achieved (see chapter 2.3). Details on the current situation of waste management and the associated challenges in Lusaka can be found in chapter 4.

3.2.2 Enhancing waste management infrastructure

In addition to successful short-term improvement, however, PCs also offer the opportunity for long-term improvements regarding the waste management in total. In the best-case scenario, PC projects also provide funding for necessary infrastructure improvements (e.g., collection systems and construction of waste sorting stations and treatment facilities). According to the consortium ValuCred it is possible to use PC as "(…) financing mechanism to fund the environmental services of collection, transport, and treatment, and the set-up and operational costs of related infrastructure“ (ValuCred 2021: 19). ValuCred intends to introduce a quality standard to improve plastic credits. This takes into account social as well as technical aspects. The aim is to develop a standard process that enables transparent calculation, verification and validation of plastic credits (cf. ValuCred 2021: 1–19).

Thus, PC can provide a reliable, contextualized sustainable revenue stream (EDP5), providing the foundation for the required infrastructure to enable the implementation of EPR systems and target circularity (EDP2). However, in addition to funding, this also includes co-operating (EDP4) with relevant stakeholders and their willingness to improve the situation in short- and long-term (EF4). Context-specific implementation (EDP7) and transparency (EDP6) are of great importance here and also include consideration of the informal sector (EDP3).

3.2.3 Plastic pollution awareness and its relevance for the market

Another major strength is the possibility of generating attention through PC projects. The very existence of PC and the structures associated with it create awareness of plastic pollution and the assumption of responsibility by producers in general. In addition, producer awareness of PC can also help strengthen the market for secondary material. For example, active participation in a recycled plastic market can increase its liquidity (EF3). In addition, lobbying for an enabling local environment to support additional funding, such as through microfinance, could be facilitated. Taking responsibility for one’s own products and calculating the actual environmental costs can also lead to a rethinking by producers of their production processes, also referred to as “upstream” in EPR systems (cf. OECD 2016: 21–58; WWF Akademie n. d. a.). However, attention generation applies not only to producers but also to residents. Through visible projects and their impact, a new view and evaluation of plastic waste can be created, which can ultimately also contribute to waste prevention.

The intersections of PC with EPR principles and the relevance for external factors to EPR implementation are manifold. With an ideal-typical PC implementation adapted to the local characteristics, including the financing the optimization of the waste management structure, meaningful cornerstones for the long-term expansion of EPR systems and therefore also CE could be established (cf. Ocean Conservancy 2021: 10; OECD 2016: 21–58).

But the implementation of PC also faces many challenges that can ultimately have backlash effects on EPR systems. These are discussed in more detail below.

3.3 PC challenges and dependencies with EPR

The ideal-typical process shown (see Fig. 9:) is based on the assumption that all processes between all participants run smoothly and in a controlled environment. Of course, implementation in reality poses various challenges (A–F) which are described below. Each challenge is also highlighted in terms of potential dependencies towards EPR.

3.3.1 PC provider offers PC and finance local infrastructure (1)

Challenge A – Cost-covering PC price: As already mentioned, the costs of a PC should consist of the money required for the collection and treatment of the respective amount of plastic waste as well as money for the development of further waste infrastructure (cf. Prevent Waste Alliance 2022c: 5). In addition, the work of the PC provider and its margin must be taken into account. PC are offered globally and the PC projects take place locally in cooperation with local governments, non-governmental organization (NGOs) and other stakeholders. As established waste management systems are rarely available in developing countries, pricing may vary. Depending on the country and the available infrastructure, this can result in widely differing price ranges for PC (cf. WWF n. d.d.). The challenge, however, lies more in determining the price rather than the wide variance of prices. An approximation calculation of a PC price based on the current SWM in Lusaka is provided in chapter 6.

EPR & PC – Dependencies: Implementing EPR and PC and its costs based on the local context (EDP7, EF1), such as the waste management infrastructure or possible revenues from secondary material (EF3). PC projects are able to provide a senseful step towards transparency of infrastructures and required costs and revenues (cf. Johnson 2022: 12–45; Prevent Waste Alliance 2022a). A valid cost determination is a cornerstone for PC projects as well as for EPR systems. By striving for cost coverage and the highest possible sales of PCs, a high level of cost transparency (EDP 6) is desirable. In addition, PCs can also influence the market for secondary materials, which can ultimately also generate relevance for EPR.

Challenge B – Find Buyers: Since the purchase of PC is on a voluntary basis, it is necessary to find ways to ensure sales. After all, without sufficient buyers, PC's intended goals cannot be achieved (cf. Nguyen et al. 2022:13–20). In recent years, a market for PCs has emerged in which various suppliers compete with each other. Producers can therefore choose the supplier with the best cos t/benefit offer. This often leads to low-cost providers being chosen regardless of their quality standards (cf. Circular Action Hub 2020: 1–10).

In order to master this challenge, it is advisable both to establish quality standards for PC providers (see challenge F) to achieve comparability of the offerings, as well as to create clear added value for the potential buyers. These aspects subsequently need to be translated into clear brand communication, e. g., in the form of marketing (see also chapter 5). A further approach to solving this challenge would be to establish PC as mandatory element. This could clearly determine buyers and the PC quantities to be purchased. At the same time, however, care should be taken not to lose the flexibility of the PCs.

EPR & PC–Dependencies: Finding buyers is a challenge only for PCs because EPR systems are mandatory. Nevertheless, interactions between PC and EPR can arise here as well. If the approach of making PC mandatory is applied, the legal interaction between EPR and PC must be defined in particular. How this interaction might work, is described in chapter 5. The marketing carried out by the PC supplier can help to raise awareness among producers and consumers. Raising awareness among producers and consumers can lead to a change in mindset and thus a growing understanding of the need to take responsibility (EF4). Cost-covering PC projects and the prospect of a profitable recycling market can also increase the entrepreneurial interest of producers and their own initiative. In addition, this can foster collaboration and coordination among stakeholders and actors (EDP4).

3.3.2 Producers purchase PC (2)

Challenge C – Legal Binding: Purchasing PC is voluntary thus it is left open to producers to use them without any legal enforcement (cf. Prevent Waste Alliance 2022c). The lack of legal obligation yet is both an advantage and a disadvantage. On the one hand, PC projects are detached from complex regulations and can also be implemented at short-term (cf. Prevent Waste Alliance 2022a: 133–160). On the other hand, regulations can help to convince numerous producers to buy PCs and thus to take over the costs originally caused by them. This taking of responsibility as well as internalization of costs is a central point for both PC and EPR.

EPR & PC–Dependencies: The voluntary acquisition of PCs, i. e., the lack of a legal obligation, may also lead to problems with regard to EPR introductions in the medium term. Due to the voluntary decision to purchase a self-selected amount of PC, the producer can determine its own costs. Whereas implemented EPR systems set a higher cost frame corresponding to the product quantities (cf. Prevent Waste Alliance 2022a: 153). This can lead to resistance to the introduction of EPR systems as PC can save producers costs for CE-oriented conversion of production, which might be part within EPR implementations (cf. Prevent waste Alliance 2022c: 7). This problem should already be taken into account when setting the price of PCs. In addition, PC could be integrated into EPR schemes from the beginning (EF5) in order to exclude cannibalization and to enact sensible regulations and requirements in this regard (cf. Prevent Waste Alliance 2022c: 6). How this interaction exemplarily might work out is described in chapter 5.

Challenge D – Amount / Impact: The producers decide for themselves whether and also how many PCs they want to purchase. This can result in small quantities, which only benefit the producer's brand communication, but hardly lead to any significant impact in the countries affected (cf. Johnson 2022: 12–18). Since PC providers offer different projects and therefore also different types of plastic, producers can also do cherry-picking on the most valuable waste but ignoring less valuable waste e. g., light plastic bags (cf. Prevent Waste Alliance 2022a: 133–153). Different types of plastic require different treatments and also have different values. Producers are able to choose PC projects regardless of the country or plastic type. Consequently, producers can currently produce one specific type of plastic, but offset another easier recyclable one which distorts the idea of the offset certificate (cf. Prevent Waste Alliance 2022c). It is also important to consider the aspect of additionality which should "ensure that a project's positive environmental impacts are additional compared to the impact in the absence of the project" (CircularActionHub2020: 3). That means, that waste reducing activity for which the credit is given would not have occurred in the absence of the crediting mechanism but instead clearly occurred in response to (and after the development) of a crediting mechanism (cf. WWF n. d.d.). This additionality is intended to ensure that real added value and improvements are achieved. These challenges might be partly tackled through defined quality standards and accompanying transparency within the PC framework (see challenge F). A clear definition with regard to a material binding would also be conceivable. However, this is currently not part of the standard in PC projects (EDP1).

EPR & PC–Dependencies: In order to generate the most relevant impact possible, the aim must be to achieve not only a valid price but also the most efficient and sustainable implementation on site. This challenge might be partly tackled through defined quality standards and transparency (EDP6) of the PC projects (see challenge A and F). In particular, monitoring processes and results can lead to high impacts here. In the long term, these results can define benchmarks and minimum requirements for EPR systems. This includes looking at the market for secondary material (EF3) which has a strong impact on the success of EPR systems and PC projects.

3.3.3 PC providers finance local collection and treatment of plastic waste (3)

Challenge E–Local conditions: When considering waste collection and treatment, challenges are found due to local conditions in current waste management infrastructures, geography and country demographics (EDP7, EF1). Depending on structures, different requirements and possibilities may occur towards the implementation of PC projects (e. g., missing waste sorting infrastructure leads to a gap in the required value chain and might cause higher costs). At this point, reference should also be made to the administrative effort and the necessary structures. This applies both to the implementation of the projects and their control. The basic idea of PC is based on the assumption that with producers pay for previously externalized costs. For this purpose, it is necessary to consider the local as well as the material and organizational context to avoid shifting problems and reducing positive impacts (cf. WWF n. d.).

EPR & PC–Dependencies: PC projects can be used to quickly research local conditions. These can be the waste flow (EF2, EF6), relevant stakeholders (EF1, EF4), aspects of the market for secondary material (EF3) or legal aspects (EF5). All these aspects are highly relevant for both PC projects and EPR systems as local conditions define future EPR schemes and their chances of success (cf. Prevent Waste Alliance 2022a: 211). For this reason, documentation of PC projects is highly recommended, as these can already provide essential insight into EPR systems. The structures needed for implementation and also control (Challenge F) can also be taken over in the long term, if necessary, by the EPR structures such as PRO (see chapter 2). Thus, not only data and basics are collected in PC projects, but also already administrative structures for EPR systems are tested and optimized. Details about local conditions and their possible influences in Lusaka are described in chapter 4.

3.3.4 PC project control based on guidelines, issuing certificate (4,5,6)

Challenge F–Greenwashing: In addition to the local conditions, the control and quality assurance of the PC projects is a challenging task. Without verifiable standards and controls, slipping into greenwashing represents a potential risk. Greenwashing describes a feigned sustainable action by companies or organizations, which is usually based on marketing or individual actions (cf. Prevent Waste Alliance 2022c: 3). This risk permeates the basic idea of PC, since as described in challenge D, even with marginal investment, the benefits (usage of claims) for the producers remain unaffected. As a result, the claims like plastic-neutral might mislead the consumer, as it is rather a plastic-free products nor a sufficient financial compensation (cf. WWF, n. d.). As there is no uniform regulation the possibility of fraud is very high (cf. Johnson 2020; ValuCred 2021: 5). The certificates are not yet forgery-proof and the processes are not completely transparent and controllable. Thus, there are providers who just burn the waste, do not dispose any of it at all, sell the same quantities several times for different certificates or only send a certificate without carrying out any activity. A possible documentation of the collection is currently done via photo documentation. In order to be as forgery-proof as possible, some providers already use blockchain technology that documents the various collections or even further treatment (cf. Liu et al. 2021: 42–51). To meet this challenge, the introduction of overarching, global guidelines and quality standards as well as adequate tools are necessary. This includes uniform claims as well as inclusion of environmental and social criteria within PC projects (cf. ValuCred 2022: 19; Johnson 2020: 12–19).

EPR & PC – Dependencies: The introduction of standards and the control of their implementation is essential for successful PC (EDP5, EDP2). In order to benefit from this also in the long term in EPR systems, an alignment with EPR principles is senseful (cf. Prevent Waste Alliance 2022c: 2–7). Failure to do so creates the potential risk of mutually exclusive standards or even loopholes that enable greenwashing.

3.4 Interim conclusion

The aim of the chapter was to understand the mechanisms of PC, their strengths, and challenges in implementation. It also refers to risks and opportunities while using PC as a bridge concept towards EPR. In summary, many challenges and opportunities can be identified for PCs and their interaction with EPR systems. The challenges can be met by a wide variety of solutions and approaches that should be taken into account when designing PC projects. Due to the high flexibility of PC, they could serve the needs of fragmented waste management systems in developing countries and can be a useful bridge to EPR systems (cf. Prevent Waste Alliance 2022c: 2–7). The next chapter looks at the specific local challenges in Lusaka's waste management. In chapter 5, these results are combined with the risks and opportunities identified here to formulate concrete recommendations for the implementation of PC projects in Lusaka.

4 Lusaka and the handling of waste

The following chapter provides a general overview about Zambia and its capital Lusaka. In the following, some legal actors and relevant documents in the field of waste management are presented. In addition, the local conditions of waste management in Lusaka are explained on the basis of a field study conducted in October 2022. The results of this field study are examined with regard to their influence on PCs.

4.1 General data about Zambia and Lusaka

The presidential republic of Zambia with an area of 752.614 km^2 is considered one of the most politically stable countries in Africa, with a population of around 18,9 million and a population growth rate of 2,9 % in 2021 (cf. Germany Trade and Invest (GTAI) n.d). Zambia's population is very young, with 46,08 % of the population under the age of 14, and 66,08 % under the age of 24 (cf. Muller et al. 2017: 8). The population in the capital Lusaka is currently estimated at 2,5–3,5 mi (LCC 2022:1; LCC, personal interview, LCC, Chunga Landfill, Lusaka, 17.10.22, see Annexure 7). Even if Zambia's gross domestic product (GDP) is projected to be around USD 26,7 billion in 2022 Zambia is also considered one of the poorest and highly indebted countries in Africa (cf. Statista 2022). This is partly due to the fluctuating world market prices for copper, which is one major source of revenue. With the rapid population growth, a middle class is also currently emerging, and thus also good opportunities for the development of other sectors within the national economy (cf. Deutsche Gesellschaft für Internationale Zusammenarbeit (Giz) 2020). However, the development of new economic sectors and population growth in general are likely to have an impact on existing waste management systems (cf. Muller et al. 2017: 19). According to studies and assessments, there is currently only inadequate highly fragmented waste management in Lusaka which is not capable to handle the current quantities of waste (cf. Siame 2018: 3–16; details see chapter 4.3). This fragmentation can be found in the legislation (see 4.2) as well as in the operational waste management (see 4.3).

4.2 Institutional actors and regulations

In Lusaka the responsibility for legislation and regulation of waste management is highly fragmented which results in a complex legal framework. To give an impression of current important legal stakeholders and regulations, these are presented below.

National Level: Since waste management has overlapping impacts on the environment, people and the economy, the following ministries are national stakeholders regarding the waste management. The *Ministry of Water Development, Sanitation & Environmental* Protection *(MWDS)* which is responsible for the handling of water resources by providing clean water and sanitation (cf. MWDS n. d.). The *Ministry of Health* (MoH) is aiming for healthy and productive people within Zambia. According to waste management, the ministry is interested in effective and efficient waste management to ensure the health of the citizen (cf. MoH n. d.). *Ministry of Green Economy (MGEE)* "shall be responsible for coordinating and facilitating the development and implementation of policies, programmes and projects for the management and conservation of the environment in order to ensure sustainability." Besides the finance department is part of this ministry and "(…) is responsible for effective management and utilization of financial resources to facilitate implementation of programmes (MGEE n. d.). The *Ministry of Lands and Natural Resources (MLNR)* which is aiming for transparency in handling the natural resources and is responsible for implementation and control of policies regarding the environment including pollution control (cf. MLNR n. d.). The *Zambia Environmental Management Agency (ZEMA*) is a statutory agency which advises ministries and other authorities and provide several services according to their mandate: "To ensure sustainable management of natural resources, protection of the environment and prevent and control pollution." (ZEMA n. d. a.). Until a few years ago, ZEMA was also responsible for the registration and control of the MSW's private waste collectors, but now its remit is mainly hazardous waste (cf. LCC, personal interview, LCC, Chunga Landfill, Lusaka, 17.10.22, see Annexure 7).

Local Level: Operational waste management takes place at the local level and is strongly influenced by the *City or Municipal Council (Local Authority).* It is taking care about MSW in the related area. The Lusaka City Council (LCC) refers to the Waste Management Unit (WMU) whose task it is "to plan, organize, execute (directly or indirectly) and supervise waste management services in other selected areas in the city and the management of disposal site" (LCC n. d.). In addition to the LCC, the *Ministry of Local Government and Rural Development* (MLGRD) is involved which is assigned to the "refuse removal, refuse dumps and solid waste disposal". (MLGRD n. d.). The diverse stakeholders pursue certain goals and objectives which are defined in various documents addressing topics of sustainability, economic and ecological development, CE, EPR and waste management. As explained earlier in chapter 2, overall requirements at the international, national and local levels are required to solve the waste problem in the long term.

International and National: The Zambia Vision 2030 aims for a "A prosperous Middle-income Nation By 2030" (Republic of Zambia 2006: 1). To achieve this goal also in the area of waste management the document addresses several sectors: Public services have to become more efficient and effective (this also includes waste management) and it is aimed to reach 80 % of waste to be collected and transported (cf. Republic of Zambia 2006: 1). The agenda 2063 describes a blueprint for the transformation of "Africa into the global powerhouse of the future" which includes a sustainable economic growth (African Union n. d.). *The Eight National*

Development Plan (*8NDP*) 2022–2026 is one step in achieving the agenda 2063. It „(…) is the country's medium-term blueprint designed to unlock the country's potentials in all sectors of the economy for sustainable, holistic and inclusive national development." (Ministry of Finance and National Planning (MoF) 2022: 4). Within the document MSW is addressed directly, e. g., using MSW for improving sanitation services (cf. MoF 2022: 69). The 17 defined UN *Sustainable Development Goals* are also part of the declared policies. As Zambia is member of the UN these goals are obligatory (cf. UN in Zambia n. d.). *The SWIMP 2022*–2024 refers to the above-mentioned documents and defines concrete strategic goals aligning with the Zambian Vision and the UN Sustainability goals (cf. LCC 2022: 8; see Annexure 9); chapter 2). Besides these explicit documents also various framework conditions have further influence on the MSW, e. g., Statutory Instrument No. 65 of 2018 which enforce the principle of ERP by restricting light plastics (cf. Sishekanu 2018). Also, the *Solid Waste regulation & Management Act No 20 of 2018 (cf. Zambia Parliament 2018)* which provides a framework for sustainable waste management, *the public health Act Cap 295* (cf. Zambian Parliament 1995) which addresses aspects of health topics regarding the waste management and the *Statutory Instrument No 10 of 2018* (cf. Government of Zambia 2018) which includes several issues of waste management.

The diverse documents, frameworks, and actors reflect in excerpts the complexity of Zambian legislation. This can be attributed, on the one hand, to the fragmented system in Zambia and on the other hand to the close entanglement of CE, EPR, and operational waste management (see chapter 2). As the operational waste management in Lusaka shows strong deficiencies, it may be assumed that the implementation of and compliance with the various regulations does not take place sufficiently (see chapter 4.3.). This assumption could also be confirmed by experiences from other developing countries, which often suffer from a lack of enforcement capacity (cf. Banda et al. 2021: 5827). The lack of enforcement, and thus the lack of official pressure, puts the use of voluntary mechanisms like PC in a different light. In this way, a business-oriented dynamic can be created through voluntariness, which is currently not possible through legal regulations. At this point, reference should be made to the flexibility and independence of PC regarding legislation (see chapter 3.2.1). Even in fragmented systems, PC projects might be successfully implemented and lead to short-term improvements (cf. ValuCred 2021: 1–19).

4.3 Operational waste management

This sub-chapter presents the results of the field study of MSW management in Lusaka. These are highlighted in particular with regard to their significance for PC and EPR. Waste management describes a system for disposal, reduction, reuse and also prevention of waste, taking into account the local context such as infrastructures or also cultural characteristics (cf. Japan International Cooperation Agency Institute for International Cooperation (JICA) 2005: 9). The following graph (see Fig. 10) illustrates a simplified waste flow in Lusaka based in the conducted field study.

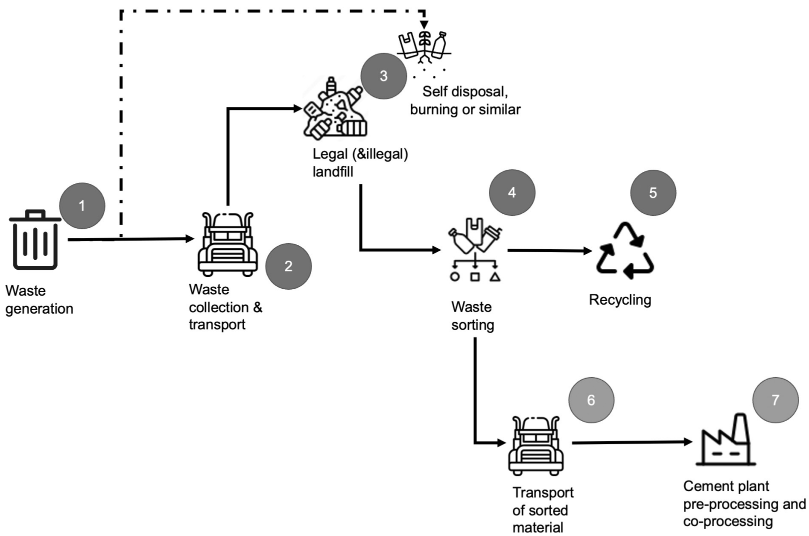

Fig. 10: Waste flow Lusaka (own illustration; icon source iconfinder and flaticon; credits to Eucalyp Studio; Freepik; Gregor Cresnar; Chanut-is-Industries)

This illustration gives an overview about the observed waste flow in Lusaka **(1–5)** as well as an outlook towards a possible integration of co-processing of low-valuable plastic waste within a cement plant **(6–7).** Starting point are the household where the **1)** generation of waste takes place. **2)** Different kinds of waste collection take place. So licensed private companies (or community based companied) collect the waste house-by-house and transport this waste directly to the **3)** legal landfill (even though a lot of waste is dumped at illegal landfills or ended up in self disposal). **4)** Regardless of whether the waste ends up on illegal or legal landfills, valuable materials are sorted there by waste pickers on site and is then sold to recycling companies. **5)** These recycling companies produce different materials or concrete products out of the plastic waste. **6)** Low-valuable plastics could be transported from the landfill towards **7)** cement plants for pre- and co-processing.

4.3.1 Waste Generation (1)

Description: The starting point of this waste flow is the generation of solid waste in the households of Lusaka, also called municipal waste. This automatically excludes other types of waste, like healthcare, construction, commercial, industrial or agriculture waste (cf. Zambian Parliament 2018: 22). During the field study, special focus was set on various plastic materials found in municipal waste due to their immense quantities and their negative effects (for details on plastic types see 4.3.2).

Despite personal contacts on site, it was not possible to obtain comprehensive and concrete data on the total amount of waste generated in the city of Lusaka. This can be attributed, to some extent, to the gaps in data collection process of the waste management itself. Nevertheless, it was possible to obtain approximate values and data on waste collection in individual districts (see chapter 4.3.3). With regard to per capita consumption, there are different numbers, ranging from **0,5 kg/day** to **0,75 kg/day** (cf. Nyirenda 2019: 71; LCC 2022: 2–8). The higher number of **0,75 kg/day** serves as basis for further calculations. This quantity per capita is multiplied by the current population of Lusaka, which numbers ranges between **2,5** and **3,5 m**i inhabitants (cf. Kuwema 2022; Chisala n. d.; LCC, personal interview, LCC, Chunga Landfill, Lusaka, 17.10.22, see Annexure 7). Approaching from 3.5 mi inhabitants, this leads to a potential waste quantity in the capital of **958.125 t/year.** It is estimated that **40 %** of the waste arriving in the biggest legal landfill in Chunga is plastic waste. The figure seems quite high, with values in South Africa at around 12 % (cf. Babayemi et al. 2019: 10). For the present study, however, the 40 % figure is assumed for the purpose of this study, and needs to be validated again in future projects. Applying this figure to total waste, the estimated amount of plastic waste is **383.250 t/year.** (cf. LCC, personal interview, LCC, Chunga Landfill, Lusaka, 17.10.22, see Annexure 7). At present, there is no mandatory involvement of plastic producers, even though they naturally have a share in waste generation.

Tab. 5: Overview waste generation Lusaka (based on field study data, see LCC, personal interview, LCC, Chunga Landfill, Lusaka, 17.10.22, see Annexure 7)

Description	Numbers / Calculation
Population Lusaka	3,5 m inhabitants
Estimated per capita waste generation per day	0,75 kg per person a day
Total amount of waste in t	958.125 t/year
Estimated amount of total plastic (year/t)	383.250 t/year

Reasons: With these figures, Lusaka's waste consumption is positioned in the middle range compared to other African cities like Maputo in Mozambique with 1,2 kg/day and Yaoundé in Cameroon with 0,4 kg/day (cf. African Clean Cities Platform (ACCP) 2019: 3–4). According to previous experience in other African countries, an increase in waste consumption is likely due to rising per capita income. This rise is expected due to the growing economy and the increasing size of the middle class in Zambia (cf. ACCP 2019: 3–4). As soon as more income is available, people consume more and also differently, which might also lead to a different composition of waste. Thus, the amounts of plastic waste increase, organics decrease (cf. The World Bank n. d.)

Challenges and possible solutions: The large, constantly growing volumes of waste pose a significant challenge. The existing structures can no longer serve this growth due to various aspects (details as follows). In addition to the quantities, the problem of the composition of the waste has also emerged, as the increasing quantities of plastic are unmanageable as seen on site (see Fig. 11:). These challenges are well known in Lusaka and are already partly addressed in the SWIMP by increasing the recycling rate (SG 8). Furthermore, it might be challenging to take producers into account for optimizing the waste management.

Fig. 11: Chunga landfill, Lusaka, October 2022 (own image)

Local aspects regarding PC and EPR: Based on the current figures, various requirements can be identified that go hand in hand with the waste prevention strategies reduce, reuse, recycle. It is necessary to remove the current plastic waste from the environment, establish new waste management infrastructures and generally reduce the increase in waste production. In the long term, these tasks could be solved by an EPR system and the introduction of CE. In the short term the following requirements for PC-projects are identified: Inclusion of producers via financing the reduction of current waste with the help of collections and subsequent treatment, education of the population to avoid waste. With regard to education, the following observations might be relevant. It was observed that even plastic waste with a higher material value (PET) is simply thrown out of the car window while driving. It can be assumed that there is a lack of awareness among a large part of the population considering the value of plastic waste. Generating this understanding could be a key for a necessary mindshift within the population and should be part of educational campaigns within PC projects (cf. Muheirwe 2022: 7).

4.3.2 Overview plastic types and recycling aspects of MLPP

There are different types of plastic, which differ greatly in production and properties and reusability. These properties ultimately also determine the reusability of the respective plastics. According to the International Organization for Standardization (ISO) 472 "(…) plastic is a material which contains as an essential ingredient a high polymer and which, at some stage in its processing into finished products, can be shaped by flow." (ISO n. d.). There are a wide range of polymers used in common plastics with different properties, which make them appropriate for different applications (see Tab. 6:).

Tab. 6: Seven Types of plastic (cf. Hardin 2021)

PET (1)	PE-HD (2)	PVC (3)	PE-LD (4)	PP (05)	PS (06)	O (7)
Polyethylene terephthalate	Polyethylene (High Density)	Polyvinyl chloride	Polyethylene (Low density)	Polypropylene	Polystyrene	Bisphenol A and others
e. g., Commercially sold water bottles	e. g., milk and juice bottles, grocery bags	e. g., plumbing pipes, vinyl flooring, blister packs	e. g., cleaning bags, bread bags, newspaper bags	e. g., yogurt containers, deli food containers	e. g., cups, plates, take-out containers	e. g., Cds baby bottles, headlight lens

An application is the usage within multilayer plastic packaging (MLP) or multi-material multilayer plastic packaging (MMMP) which is mainly used for fast moving consumer goods (FMCG) (cf. Távora et al. 2022: 1). They provide certain characteristic specific functions like oxygen and UV-light barrier layers. These special capabilities make MLP a popular material and lead to strong distribution. Unfortunately, this material is suboptimal from a CE perspective and poses an environmental threat, especially in developing countries (Távora et al. 2022: 1). Up to 56 % of plastic packaging in developing countries is consisting of 3–12 layers material (cf. Kaiser et al. 2018: 45–70; Plastics Technology n. d.). Compared to other plastics such as PET, recycling in the form of reusability is expensive and difficult and does not provide much material value after recycling (cf. Kaiser et al. 2018: 45–70). Since this type of plastic has a lower material value, smaller quantities are also collected and this plastic lingers in the environment for a long time and can harm people and the environment. Even though the industry is working on new forms of recycling for MLP, a mainstream solution is not expected for another 5–10 years (cf. Távora et al. 2022: 1). Even though it is reasonable and necessary to work on medium and long-term recycling solutions such as chemical recycling (Pyrolysis) or granlues into products, a short-term approach to MLP is necessary (cf. Shinde 2021, Távora et al. 2022: 1). Looking at the infrastructure in Lusaka, a partial short-term solution might be the co-processing within the cement production (see chapter 4.3.7).

At this point, reference is made to the importance of additionality (see chapter 3). The low value material remains in the environment if there are no dedicated projects for its removal. In contrast, other materials such as PET are collected from the environment and recycled even without dedicated projects, due to their material value.

4.3.3 Waste collection and transport (2)

The figures given below are based on observations made during the field study as well as estimates and explicable assumptions.

Description: Lusaka uses a district system which is tailored to the different needs and demographics of each district (cf. UN Habitat 2010: 66–67). The districts are handled by different operators which are managed by the WMU of the LCC (cf. Nawa 2017). There are between 16 and 24 waste management districts (WMD) which are managed by franchise contractors and 180 zones in peri-urban areas which are serviced by Community Based Enterprises (CBE). Currently, with the help of these actors, about 50 % of the total waste in Lusaka is transported to the Chunga landfill (cf. LCC, personal interview, LCC, Chunga Landfill, Lusaka, 17.10.22, see Annexure 7).

Besides these main actors, there are also illegal waste collectors and individual street waste pickers, which are presented in this chapter. According to the solid waste regulation and management act 2018 of Zambia, there should always be up to two official providers per district, so that the citizens always have the freedom of choice of providers (cf. Zambian Parliament 2018). Based on the available documents it was not possible to give neither an exact breakdown of the waste districts nor validating this two-provider approach. Nevertheless, the following map (see figure Fig. 12:) can be seen as a guide to the division.

Fig. 12: Lusaka city with exemplary WMD N, T, H, C (adapted image)

Franchise contractor: Based on official documents 16 franchise contractors are currently registered which are taking care of dedicate WMD. The main service of these companies is the collection of waste and its transport to the Chunga landfill. The collection is mostly done by private house-to-house services and takes place on average three times a month (see Fig. 13:). However, waste collection in low-income districts is more unreliable than in districts with higher average incomes (cf. Daka & Madimusta 2020: 532). Depending on the waste collector, different vehicles are available for collection. There are open and closed trucks as well as skip trucks. As observed, this can lead to a high loss of waste during transport. Additionally, collections are not always regularly due to broken or not sufficient equipment or bad roads (cf. Muller et al. 2017: 19).

Fig. 13: House-to-House collection Kabulonga, October 2022 (own image)

In order to offer the waste collection service, the waste collectors must be registered. This registration costs **15.000 ZMW/year** and is issued for a period of four years by the relevant official body which is currently not clearly defined. This licensing process also includes a quality control of the waste collector's equipment (cf. Waste Collector 1, personal interview, Lusaka, 17.10.22, see Annexure 3) In addition to waste collection and transport, waste collectors are also responsible for invoicing households, which have to pay a certain collection fee depending on the district (cf. UN Habitat 2010: 34). The waste fee is based on the district's distance from the Chunga Landfill as well as the district's economic strength and has a range of **50 ZMW/month – 250 ZMW/month** (cf. Daka, & Madimusta 2020: 532; LCC, personal interview, LCC, Chunga Landfill, Lusaka, 17.10.22, see Annexure 7) see Tab. 7:).

Tab. 7: Excerpt waste fee per district information (cf. LCC, personal interview, LCC, Chunga Landfill, Lusaka, 17.10.22, see Annexure 7) Waste Collector 2, personal interview Lusaka, 21.10.22, see Annexure 4)

WMD	Waste Collector	Type of Collection / Collection fee
C: Chudleigh, Kalundu, Olympia, Roma **H:** Handsworth, Kabulonga, Sunningdale	Waste Collector 2	House-to-House and specific contracts for houses, companies C: 160 ZMW/month H: 160 ZMW/month
N: Chilenje, Chilenje South, Burma Road area **T:** Part of woodland, Nyumba yanga, Leopard's hill area	Waste Collector 1	House-to-House and specific contracts for houses, companies N: 120 ZMW/month T: 150 ZMW/month

Waste collectors must document their collections and submit reports to the official body on a monthly basis.

CBE: The CBE are mainly collecting the waste in rural or unplanned areas in which almost 70 % of its population is living. There are about 130 registered CBEs of which about 80–100 are actively operating in Lusaka (cf. LCC, personal interview, LCC, Chunga Landfill, Lusaka, 17.10.22, see Annexure 7). The peri-urban areas are often characterized by poor roads and narrow development, so that waste collection must be carried out in two steps. First, with the help of wheelbarrows or similar tools to transport the waste than by truck to the landfill (cf. Chibinda 2016: 6).

Unregistered waste collectors: In addition to the officially registered waste collectors, illegal operators can also be found in Lusaka. This leads to problems, as it is not clear where the waste finally ends up. According to a study 30 % of households are served by estimated 20 unregistered collection services (cf. UN Habitat 2010: 34; Chibinda 2016: 6).

In addition to waste collectors, there are also individual street waste pickers in Lusaka. These are mentioned here for the purpose of completeness, but do not represent direct competition to waste collector companies as they only collect small amounts of waste (15–75 kg/day) from the streets (cf. Waste Picker, personal interview, Lusaka, 17.10.22, see Annexure 8). Although it was not possible to obtain total waste quantities for all WMD, it was possible to obtain approximate values from one waste collectors which is serving low-income districts (see Tab. 8:).

Tab. 8: Exemplary waste volumes per month (Waste Collector 1, personal interview, Lusaka, 17.10.22, see Annexure 3); Waste Collector 2, personal interview Lusaka, 21.10.22, see Annexure 4)

WMD	Waste collector	Waste volume
N: Chilenje, Chilenje South, Burma Road area **T:** Part of woodland, Nyumba yanga, Leopard's hill area	Waste Collector 1	Estimated 200–250 t/month, through waste Collector 1 in both districts together consisting of: 125 t plastic 62,5 t food 62,5 t boxes and sacks

Reasons: The available information reveals the complexity but also the fragmentation of the waste collection system. Although each waste collected by the waste collectors that is transported to the Chunga landfill is weighed and the waste collectors are required to submit monthly logs and reports to the LCC, only rough waste quantities are known. Various reasons can be assumed for this condition. The observation has shown that the amount of waste collected is mostly documented manually on paper. There seems to be no centralized data collection, which may be due to the vague definition of responsible bodies and the lack of digital infrastructure. It was also observed that the weight of the waste is determinant for documentation even if this indicator carries a certain degree of imprecision. Thus, the weight does not take into account the type of waste (plastic is lighter than organics) nor does it take into account weight changes that may occur, for example, due to weather conditions such as rain (wet waste has a higher weight).

During the conversations with the waste collectors, a reluctance to openly communicate their specific services to the interviewer was noted. Official reports were provided, but further details haven't been shared. However, the official reports are only of limited informational value and detailed monitoring of waste collection does not appear to be possible. Another important aspect of waste collection is the lack of waste separation. Most households only separate food waste from other types of waste, as these can be disposed or incinerated independently. Sorting of waste mostly takes place at illegal and legal dumps (see chapter 4.3.5). At this point, it is also worth mentioning the poor roads, which cause trucks to get stuck and waste collection to be cancelled, especially during rainy periods. In addition to such overarching gaps in the structures, problems were also found in the equipment of the waste collectors as trucks are frequently break down.

Challenges and possible solutions: Waste collection is a fundamental component of sustainable waste systems (see chapter 2.1). The current structure offers challenges and potential for optimization. Basically, reliability and also collection rates need to be increased. This objective is already addressed within the SWIMP by setting up the collection rates to 80 % (SG1). It seems to be reasonable to improve the monitoring of the services of the highly fragmented actors (franchise contractors and CBE) or, if necessary, to change the allocation of services. According to the SWIMP, Lusaka strives for a stronger collection allocation in the direction of the franchise contractors (SG2: 80 % of waste collectors should be licensed; SG3: 80 % of collections should be fulfilled by private sector partners). Licensing focuses on evaluating the reliability of the equipment, which should be improved in the medium-term Infrastructural improvements such as road extensions or the introduction of sorting stations could also be useful (cf. LCC, 2022: 5–10). For the optimization of monitoring, the introduction of centralized digital tools is conceivable. There are already initial projects such as the mobile application (App) Ebusaka (see Fig. 14:), which provides an idea of the digital possibilities for waste collection as well as PC (cf. Ebusaka 2022). The application provides a communication channel towards the waste collectors e. g., to get informed about delay in waste collection services or to order waste collection. Also, the payment of the waste fee for the residents is integrated. This might be interesting as according to a study from 2019 collecting the fees per household is difficult and the resulting finance flow is low (cf. Unido 2019: 7). However, there are other approaches, such as working with the electricity provider to collect the fee along with the electricity charges (cf. Unido 2019: 7).

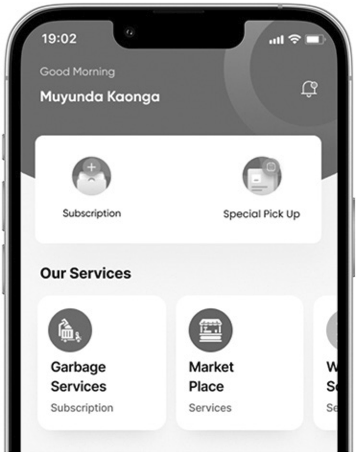

Fig. 14: Screenshot Ebusaka App (cf. Ebusaka 2022)

Local aspects regarding PC and EPR: The current waste collection process shows a high need for optimization. An EPR system could have a strong influence on legal requirements, such as licensing, and provide funds for infrastructure improvements. During the observation, however, it also became clear that a reliable database regarding waste volumes is not yet available. PC projects could help to compile this data. The digital documentation associated with PC projects can provide an essential foundation for traceable and centralized data. Of course, PC projects also offer the opportunity to finance newly required infrastructure, such as sorting stations (see chapter 3.1).

4.3.4 Legal and illegal landfill (3)

Legal and illegal landfills exist in Lusaka. The majority of franchise contractors transport their unsorted waste to Lusaka's largest landfill: Chunga landfill. The site covers an area of 24,53 hectare and it is controlled by the LCC (cf. Milimo et al. 2021: 571). It was built in 2004 and designed for 25 years but will be in place for the next 50 years (cf. Milimo et al. 2021: 571; LCC, personal interview, LCC, Chunga Landfill, Lusaka, 17.10.22, see Annexure 7). The Chunga site is not currently fenced in entirety due to the need to facilitate access because of weather conditions and the covid pandemic. At the landfill, work is done with simple-looking equipment (see Fig. 15:). There are clear ideas for the optimization of this landfill, such as the rebuilding of the fence, the construction of a new road within the landfill or even the closure of an old area (LCC, personal interview, LCC, Chunga Landfill, Lusaka, 17.10.22, see Annexure 7). Most of the people seen at the dump are waste pickers who make their living by sorting and selling waste (see 4.3.5). There are efforts to register these waste pickers and charge an entry fee of **2 ZMW/day**. However, both of these efforts are incomplete in reality due to implementation capacities and suitable tools (e. g., manual paper-based registration of waste pickers).

Fig. 15: Equipment Chunga landfill, Lusaka, October 2022 (own image)

In addition to this large landfill where about **50 %** of Lusaka's potential waste, there are also other collection points (see Fig. 16). At the Chunga landfill site, trucks with their loads are weighed at the entrance. The private waste collectors have to pay a fee of **50 ZMW/t** the CBE pay less e. g., **200 ZMW** for **16–20 t** (details see Tab. 9).

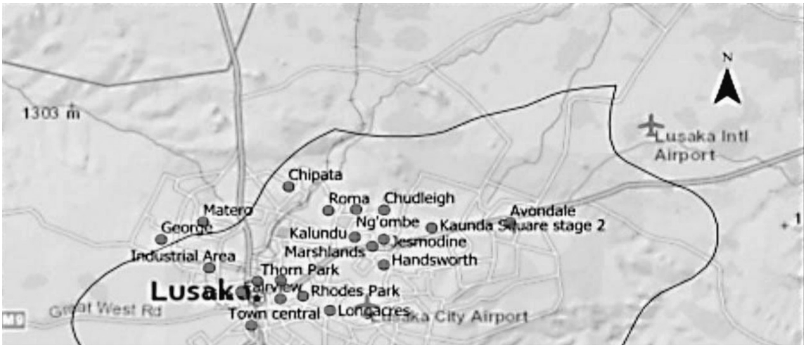

Fig. 16: Waste collection sites (dots) in Lusaka, Zambia (cf. Sambo et al. 2020: 43)

Tab. 9: Chunga landfill fee (based on LCC, personal interview, LCC, Chunga Landfill, Lusaka, 17.10.22, see Annexure 7)

Actor	Price / Fee
Private waste collectors	50Z MW/t
CBE	• 50 ZMW for 1–5 t • 100 ZMW for 6–10 t • 150 ZMW for 11–15 t • 200 ZMW for 16–20 t

Besides the landfills, 50 % of waste are disposed illegally or burned (cf. Muller et al. 2017: 19). The phenomenon of using illegal methods to dispose of household waste is also found in other cities in Zambia such as Ndola and Livingstone (cf. Edema et al. 2012; Chilinga, 2014). Illegal dumps can be found all over Lusaka and differ only in size. A large illegal waste dump could be observed in Misisi (see Fig. 17). Any kind of waste is dumped in this place free of charge. Waste pickers are also active there and are part of a similar sorting and sales structures as on Chunga landfill (see chapter 4.3.5). At this point, it is worth mentioning the better quality of waste at illegal landfills compared to Chunga Landfill (cf. Recycler 2, personal interview, Lusaka, 22.10.22 see Annexure 6). This difference in quality can be attributed to the length of time the waste has been lying around and thus to its contamination. The waste quality though has a high relevance for recyclers and waste pickers (see chapter 4.3.5).

Fig. 17: Misisi, Lusaka, October 2022 (own image)

As there is no control when dumping the waste, the quantities on the illegal dumps can only be estimated. To get an impression, the following sales figures of one waste seller (aggregator) in Misisi can be named (see Tab. 10). After observing Misisi, it can be assumed that there are about 15 aggregators selling similar amounts of plastic waste a day.

Tab. 10: Misisi landfill – Estimated amount of sold plastic each day by one aggregator (Based on Aggregator, personal interview, Misisi illegal landfill, Lusaka, 17.10.22, see Annexure 2)

Plastic Type	Estimated amount sold plastic waste a day
LDPE kg/day	500 kg – 1000 kg
HD kg/day	300 – 500 kg
PP kg/day	200 – 300 kg
PET kg/day	300 – 500 kg

Reasons: The need for landfills, whether illegal or legal, is high. The quantities of waste currently being generated in Lusaka are enormous. The dumping of waste at the illegal landfills can be explained on the one hand by the free disposal and possibly also by the proximity to residential areas. Additionally unreliable waste collection (see chapter 4.3.3) might also force residents to find other ways to handle their waste. This in combination with lack of knowledge around waste disposal can lead to higher illegal dumping (cf. Daka, & Madimusta 2020: 10). Another reason might be the fee which households have to pay which simply cannot be efforted by all residents.

Challenges: Current challenges are seen in the operation and control of such large landfills as well as the opening of new landfills with better technology. Both challenges are already addressed within the SWIMP (SG 4). However, the question arises where a new landfill could be reasonably planned and also how to handle any resistance from local residents (cf. OECD 2016: 191). When talking about better technology this also includes a CE approach so that the quality of the waste is good enough for recycling issues. This might pay on increasing the recycling rate (SG8). Furthermore, illegal dumping should be avoided to ensure proper disposal. Since this is strongly related to costs and also geographical distances, it is necessary to include both aspects in the planning and develop efficient and effective solutions. This could be, for example, the establishment of intermediate storage and sorting stations (see chapter 4.3.3).

Local aspects regarding PC and EPR: The challenges are manifold. The need to reduce waste in the long term and also disposing it properly remains a core task. This can be implemented by EPR systems at various levels. However, concrete tasks and opportunities can also be defined for the short-term possibilities offered by PC projects. Through a purposeful selection of locations for plastic waste collection and sorting (e. g., illegal landfills) relevant data on waste composition and its quality can be gathered. In addition, challenges of local conditions (e. g., road quality) can be documented. These data can help to i. e., identify reasonable locations for the construction of new landfills or required technology. The collection through PC projects can also lead to awareness among the population. In the best case, existing amounts of waste in illegal places can be visibly reduced and educational work can be carried out at the same time. PCs can also offer great added value if the revenue generated is invested in the expansion of these new landfills.

4.3.5 Waste Sorting (4)

The sorting of waste lays the foundations for the further processing of the materials and their circulation within the value chain (e. g., recycling).

Description: Although waste sorting can theoretically occur at different times (e. g., directly at households, at sorting stations along the road to landfill, at the landfill), sorting at legal and illegal landfills or within the city have been observed. At the moment, about **2.000** waste pickers are active on the Chunga landfill, the overall number in Lusaka might be much higher. **70 %** of the waste pickers are women (see also Tab. 11:). They sort the waste (including metal, paper, plastic) and take it to seller, also called aggregators, who are purchasing the waste. The aggregators pay the waste pickers according to the amount and type of waste. Afterwards the aggregators sell larger quantities to recycling companies. In some cases, dealers take over the sale and act as an intermediary (LCC, personal interview, LCC, Chunga Landfill, Lusaka, 17.10.22, see Annexure 7). Also the material might be consumed or used by the waste pickers themselves (cf. Chibinda 2016: 6). It is estimated that they are managing **15–20 %** of the waste generated and therefor playing an essential role for recycling the waste management system in Lusaka (cf. Muller et al. 2017: 18).

Tab. 11: Waste Pickers – Overview data (based on Aggregator, personal interview, Misisi illegal landfill, Lusaka, 17.10.22, see Annexure 2) LCC, personal interview, LCC, Chunga Landfill, Lusaka, 17.10.22, see Annexure 7) Waste Picker, personal interview, Lusaka, 17.10.22, see Annexure 8)

Description	
Waste Pickers at Chunga landfill Share of woman	Approx. 2000 70 %
Purchase price rage for material through aggregator and recycler	LDPE: 3–5 ZMW/ kg HD: 5–7 ZMW/ kg PET: 1–1,5 ZMW/ kg PP: 6–9 ZMW/ kg LD: 5 ZMW/ kg Mixed plastic: 1–1,5 ZMW/ kg White plastic: 5–6 ZMW/ kg
Estimated plastic waste sorted a day Waste Picker Chunga Landfill	25 kg/day
Estimated income / waste sorted a day Street Waste Picker in Lusaka	15–75 kg/day (all materials) 60–375 ZMW/day (Bases on different prices for material; 4/5 ZMW/ kg)
Access fee to Chunga landfill	2 ZMW/day

Reasons: Many people in Lusaka do not have a job and have to find a way for regular income. Waste picking is one of these possibilities, which has now been established. It could be observed that sales structures and business have emerged and contribute to the recycling market in Lusaka. This was also possible because the sorting of waste has not yet been anchored in a controlled waste management system. This also applies to the possibility of direct sorting in households or sorting by waste collectors. The reasons for this are complex, including the fact that the value of the waste is not clear, the effort is too great and there is also no space for sorting. In addition, it is difficult to demand sorting if the collection takes place without sorting (cf. Siame 2018: 10).

Challenges: In the area of waste sorting, one of the greatest challenges involves the integration and the protection of the informal sector. Shifting sorting to waste collectors or households for instance, would have an impact on the existing structures and actors, such as waste pickers and aggregators. As a result, these players must also be integrated in the best possible way in the event of system changes. Be it continuing in the same role with better social security or with new integrated tasks. The strategic goals address this issue only indirectly within the increase of the recycling rate (SG 8). A solution might be found in the Zambian city Chongwe where some waste pickers are already organized and working for a specific waste recycler who is also taking care about social standards (cf. Unido 2019: 8). In addition, a shift in sorting patterns would also give challenges to households and waste collectors. First of all, attention would have to be generated and benefits created for sorting in the household. In Taiwan, for example, this is done by offering free disposal of plastic waste (cf. WWF Akademie n. d. a). The infrastructural changes such as the introduction of sorting stations or the required changes within the waste collection (e. g., material-based collection) are a special challenge due to their complexity, which could certainly only be implemented step by step. Some of these steps are already addressed within SG 1,2,3 and 7.

Local aspects regarding PC and EPR: Sorting is essential for viable EPR systems and PC projects. Thus, the quality of the materials also determines their value and the possibilities of processing, which in turn generate necessary revenue. PC projects can be used here to leverage the knowledge of stakeholders, especially waste pickers, to understand current processes and define meaningful concepts for optimizing sorting systems. This not only considers local conditions but also ensures social inclusivity of the weakest market participants.

4.3.6 Recycling (5)

The recycling rates have been around 6 % in 2010, while 7 % out of it has been plastics (cf. UN Habitat 2010: 129). Based on observation, the rate is expected to remain low. During observations in Lusaka, gathering information on recycling proved challenging. It was obvious that a recycling market exists and that material is diverted from the illegal and legal landfills. However, the further flow of material could only be tracked incompletely.

Description: As mentioned above recyclable material is purchased from various aggregators and delivered to recyclers. Recyclers have to be registered and fulfil several quality aspects. Partial responsibility in the area of registration could be assigned to ZEMA. Based on some rare official data, there are 15 registered recycling companies in Lusaka (cf. LCC, personal interview, LCC, Chunga Landfill, Lusaka, 17.10.22, see Annexure 7). Another list which has been submitted is referring to 23 companies which are working in the field of plastic recycling. This discrepancy in statements probably also reflects gaps in registrations and monitoring. During observation the opportunity to talk to two different recyclers occurs. With the help of them following insights have been gathered. One of the recycling companies manufactures resistant sidewalk panels, buckets or even fences from any type of plastic. It is a small company with 3–5 employees but still requires 30–50 t/month of mixed plastic material (see Tab. 12:). The second recycler produce various plastic pellets, which are sold directly or are used for an own production for e. g., chairs (35 ZMW) and tables (48 ZMW). According to the process the recycler describes, that the delivery of these materials takes place between 7a.m.–5 p.m. Every ten minutes a truck with 500 kg–1 t per different material (e. g., HD, PP, LDPE) arrives. As soon as the truck arrives the material will be resorted and only the requested material will be paid. This resorting is done manually and takes again about ten minutes. For the recycling of 800t–1metric ton /month nightshifts had to be implemented (Not named recycle company, personal interview, Lusaka, 22.10.22 see Annexure 6). Both suppliers use plastic waste from smaller, illegal landfills due to a better quality than Chunga landfill. The prices they pay vary depending on the material (see Tab. 13).

Tab. 12: Exemplary recycler – Required material (Recycler 2, personal interview, Lusaka, 22.10.22 see Annexure 6) Recycler 1, personal interview, Lusaka, 22.10.22 see Annexure 5)

Amount of required material	**Recycler 1 (sidewalk panels)**	**Recycler 2 (pellets)**
Colored plastic	30–50 t/month	800 t–1 metric ton/ month

Tab. 13: Plastic materials – Price overview (Recycler 2, personal interview, Lusaka, 22.10.22 see Annexure 6) Recycler 1, Lusaka, personal interview, 22.10.22 see Annexure 5)

	Purchase price Recycler 1	**Selling pellets Recycler 1**	**Purchase price Recycler 1**	**Selling products Recycler 1**
LDPE	5.000 ZMW/t	15.000 ZMW/t	n. a.	e. g., fence pole 75Z MW
HD	6.500 ZMW/t	19.500 ZMW/t		
PP	9.000 ZMW/t	27.000 ZMW/t		
LD	5.000 ZMW/t	15.000 ZMW/t		
Colored plastic	1.000 ZMW/t	3.000 ZMW/t	1.500 ZMW/t	
White plastic			5.000 ZMW/t	

Reasons: The fragmentary data can be attributed to various aspects. First, the recycling market in Lusaka appears to be very fragmented and in the hands of many foreign investors which seems to be responsible for exporting material to China. Despite asking, some of them were not willing to give more information about the business. Conversations suggest that there is a black market in recycling that is not captured by the LCC or other institutions (Recycler 2, personal interview, Lusaka, 22.10.22 see Annexure 6). The different prices of materials are based on their recyclability and also available quantity. Pure plastics have a higher value in this context than mixed plastics, which can only be used for certain recycling processes (e. g., plastic sidewalks).

Challenges: Due to the rudimentary information, creating transparency is one of the biggest challenges. A step towards this transparency can be achieved by using digital solutions such as Ebusaka, Zaidi or Unwaste (cf. Ebusaka 2022; Zaidi Recyclers n. d.; Wastebase n. d.). With detailed information about the recycling market in Lusaka, other challenges could certainly be formulated. At this point, however, reference should be made to the challenges that still need to be addressed: The lack of transparency regarding responsibilities for registration and control. As well as the poor quality of the plastic waste at Chunga landfill. Additionally low value plastic material is only partly usable for some recycling procedures, so it is not returned to a waste value chain and remains in the environment. These challenges are only rudimentarily addressed in the strategic goals. In particular, SG8 addresses an increase in the recycling rate, which, however, focus on high value plastic.

Local aspects regarding PC and EPR: Revenues from recycling, along with EPR fees, are the financial foundation of the EPR system. However, to create such a stable system, transparency about current waste and recycling flows is first needed. As with sorting, PC projects here can help understand current pathways and identify stakeholders. Depending on the material available and the sorting and recycling infrastructure, future EPR systems could set different priorities and goals. For PC projects, it is important to be very careful about pricing and any competitive situations, and to include formal and informal stakeholders.

Now that the waste flow in Lusaka and its challenges have been outlined, the possibility of pre- and co-processing will be highlighted.

4.3.7 Transport sorted material (6) to cement plant for pre-and co-processing (7)

Description: For low value plastic waste that can no longer be recycled anywhere, thermal recovery in cement production offers an ecological solution. By using plastic waste, the cement industry can significantly reduce its consumption of fossil fuels such as coal. The usage of plastic waste in the co-processing of cement production is clearly superior to conventional incineration – because the high temperatures and long residence time in the rotary kiln destroy pollutants, fully utilize the heat content, and no ash or other residues remain that have to be disposed of in a landfill (cf. GIZ-LafargeHolcim 2020: 1–35; Holcim n. d.; European Union 2020). Although incineration is not the single solution to overall waste management, it provides a reasonable element to manage Lusaka's current waste (see Fig. 18).

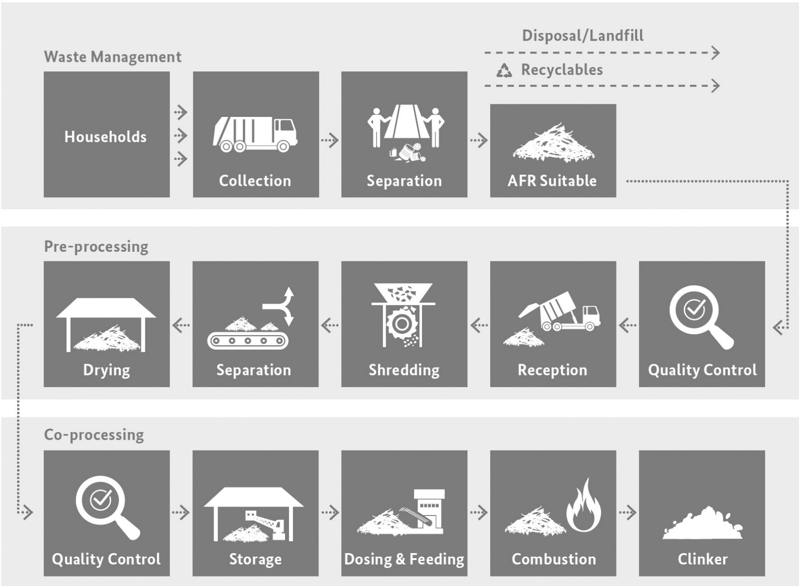

Fig. 18: Pre- and Co-processing within MSW management (cf. Holcim 2020: 29)

In order to be able to incinerate the waste, pre-processing is necessary. The waste is transformed from an unwanted, discarded material into alternative fuels and raw material (AFR) in regard with municipal waste also called refuse-derived fuel (RDF). Due to the objective of this thesis, there is no deeper critical discussion of this recycling technology.

Even though this type of incineration has been carried out in industrialized countries for 30 years, progress in developing countries has been slow. This is due on the one hand to a lack of know-how, but also to a "lack of legislative and institutional frameworks, as well as economic and financial uncertainties" (GIZ-LafargeHolcim 2020: 19) In Lusaka the Chilanga cement plant is located approx. 23 km away from the Chunga landfill. According to Chilanga company 2021 annual report, "… more than 2 million tons of plastic waste per year" used in co-processing (cf. Chilanga 2022: 30). However, these are overall figures and not only for Lusaka. Nevertheless, the relevance of MSW for co-processing is recognizable.

Challenges: For the future inclusion of the cement plant, challenges arise in terms of costs for pre-processing and co-processing as well as the structural anchoring. It shall not create competition with the existing formal and informal sector by using recyclable material which is than missing for recycle companies, small business or waste pickers. To avoid this type of competition, the waste hierarchy must be adhered to in order to create the right balance between recycling and co-utilization and the focus should lie on low-value plastic incineration.

Local aspects regarding PC and EPR: The incineration of plastic waste is a building block for the MSW. A challenge here is the cooperation and also the purchase of low-value plastic by the cement plant. PC projects can be used here as pilot projects to test efforts, costs and processes in order to enable the most sensible integration of cement plants. For long-term EPR systems, the integration of cement plants might also be conceivable.

4.4 Interim Conclusion

The following table (see Tab. 14) shows the interaction of local conditions and the resulting challenges or tasks for PCs. Even if PC projects can be carried out separately, the usefulness of a holistic approach to EPR might become clear. This starts with the involvement of producers, the consideration of all stakeholders (see 4.5) and the clear chance to obtain detailed data about the waste flow and its local conditions. The opportunities that may arise in Lusaka include the testing of new technologies and new infrastructures, with a view to extending them to future EPR systems. Due to the potential waste volumes, there is a strong recycling market and thus a potential revenue stream that can already be leveraged in the implementation of PC projects. In the long term, the financial potential for EPR systems can also be identified there. Aspects of raising awareness are just as relevant as the possible adaptation of waste management infrastructures. Further details about a possible implementation are described in chapter 5.

Tab. 14: Local requirements & dependencies PC (own illustration)

Local Challenge	**Dependencies PC / EPR and possible tasks**
Waste Generation • No mandatory involvement of producers • High volume of waste • Increasing problem due to population growth • Non-sufficient awareness in the population for need for waste management	*Waste Generation* • Inclusion of producers financing PC projects • Reducing waste generation (also forcing long-term changes in production chain) • Raising awareness
Collection and transport • Unreliable collection & transport due to insufficient equipment • No sorting; no storage, always directly to landfill • No transparency and monitoring (except very general reports) • Highly fragmented system • Also, high number of illegal waste collection	*Collection and transport* • Enable new projects (collection & recover) with monitoring & tracking under sustainable aspects; Integration of informal sector also to reduce illegal collection • Pilot projects to test other structures, e. g., on-site sorting, digital monitoring (e. g., App) • Generate stable financial stream to optimize equipment and infrastructure

Legal and illegal landfill, self-disposal • Hardly manageable legal landfill and associated poor waste quality • Only rough weighting at the landfill • No registration of waste pickers • Diverse illegal landfill • No digital data available, a lot of paperwork	*Legal and illegal landfill* • Enable pilot projects to optimize aspects of landfilling (e. g., weighting, handling of sorting) • Using campaigns to raise awareness in the population
Waste Sorting • Large informal sector dependent on waste collection and sorting • Sorting at landfill • No safeguarding for waste pickers	*Waste Sorting* • Enable new projects (sorting) with monitoring & tracking under sustainable aspects • Integration and safeguarding of informal sector (e. g., social secured sorting)
Recycling • Lack of transparency • Bad waste quality	*Waste Recycler* • Pilot projects to test other structures, e. g., on-site sorting and direct delivery to recyclers, digital monitoring (e. g., App) • Using financial stream to fund small local companies
Treatment / Cement Plant • Possibilities available, but no stable infrastructure or funding yet	*Treatment / Cement Plant* • Enable new projects (collection, transport, treatment and co-processing in cement plant) with monitoring & tracking under sustainable aspects and avoidance of competition with recycling industry or informal sector

4.5 Overview Stakeholder

This subchapter deals with an overview of the current stakeholders of MSW. The selection of stakeholders below is based on literature research as well as interviews conducted in Lusaka. The table below provides an overview of the stakeholders in MSW and integrated sustainable waste management, their roles and concerns (see also Tab. 15:). In addition to the stakeholders affected by the existing system, other relevant players who need to be taken into account in the context of the introduction of PCs are as follows: PC standard-setter, organizations providing certification services, program-, projects developers and operators as well as platforms, brokers, and marketplaces (cf. Nguyen 2022: 28; Johnson 2022:12–25).

Residents are key players and stakeholders. In particular, residents in low-income areas in Lusaka are confronted with high amounts of waste due to, among other things, overly expensive and/or irregular waste collection. This has an impact on the quality of life and health of the residents (see also chapter 1). Waste management is the responsibility of the local authorities, in Lusaka the LCC and WMU. Regardless of whether they solve this task themselves or with other partners. The tasks include setting up a suitable infrastructure, taking into account informal and formal structures. As well as the creation of organizational foundations, including legislation topics and their compliance. Additionally, the overview and monitoring of the waste flow. Furthermore, it is always necessary to make sensible use of the financial framework conditions and to build up a resilient, economic system. Different ministries have a share and tasks in waste management. Depending on the ministry, the tasks here lie in health, social, ecological or economic aspects. The private formal sector is currently contributing strongly to waste management in Lusaka. The overarching concerns are both involvement in building new infrastructure and ensuring economic success. Depending on the sector, different aspects are relevant here. These can be legal or financial aspects that have a direct or indirect impact on business (e.g., taxation, operational requirements). Ultimately, this also applies to the providers of PCs, which should of course also be understood as a business. The private informal sector is often dependent on the MSW. Meaningful integration and strengthening their situation economically as well as socially are the main tasks. It is interesting to note here that the private companies involved in waste management should be considered as well as the producers of plastic waste. For producers, growth and a stable business are also necessary, but even more focus needs to be on producer responsibility. NGOs occupy an important place in developing countries. They often provide a link between local authorities and the informal sector. Goals are usually strong social inclusion and improvement of living standards, whether social, environmental or economic. City planners can play a vital role in waste management and should be involved in decision-making processes from the beginning, as they create long-term structures. For long-term change, it is also important to influence the mindset. Teachers and other educational institutions play a role in this. Since waste management is a complex system, there are other stakeholders who must be considered separately depending on the subarea. Basically, various stakeholders are already involved in Lusaka. As a basic principle, it should be pointed out that the high number of stakeholders involved can also lead to competing interests. This must be taken into account during implementation. Ultimately, sustainable development can only be implemented if personal needs are taken into account, as well as environmental protection, the sensible use of natural resources, the creation of economic growth and the creation of jobs (cf. Joseph and Nangendran, 2007:1).

Tab. 15: Overview stakeholder waste management Lusaka (cf. LCC 2022:ii; Joseph 2006: 866; Künster 2014: 15)

Stakeholder	**Role / concern**	**Opportunities plastic credits to pay on concern on stakeholders**
Residents	• Health • Reduction of waste • Reliable waste collection & waste management • Affordable waste fee	• Short-Term optimization due to concrete local projects (Collection), direct impact of health through reduction of waste • Raising awareness • Optimization local infrastructure
Local authorities: LCC and WMU	• Provide waste services • Implement legislation and prosecution • Enable participation of all stakeholders	• Provide overview auf current waste services • Enable new projects with monitoring & tracking under sustainable aspects; e. g., on-site sorting, digital monitoring (e. g., App) • Include several stakeholders, including informal sector • Generate stable financial stream to optimize equipment and infrastructure
Several Ministries (see also chapter 4.2)	• Ensure health of the residents • Achievement of national and international targets • Setting environmental regulations • Taking international issues in the area of waste management into account	• Provide overview and numbers of current system and track success (e. g., for reaching SDGs) • Improved health due to reduced waste load and better disposal

Private formal sector: waste collectors, recyclers, people / institutions involved in treatment, producer, PC provider	• Expansion and protection of business • Cooperation with local authorities • Infrastructural, organizational and legal aspects, depending on the specific business	• Optimize economics and • Introduce and stabilize the secondary material market • Involvement in new projects and structures; clear stakeholder management
Private informal sector: Waste Pickers	• Protection of income • Strengthening and safeguarding the social position and health	• Safeguarding and strengthening social position due to involvement in future infrastructure
NGOs / Social Workers	• Bridge between local authorities and the informal sector; Voice for unheard stakeholders • Raising money • Promoting cooperation between different organizations with the same objective	• Integration of NGO and social workers in projects to guarantee social oriented PC projects and/or waste management • Provide financial stream for local projects
City Planner	• Developing future-oriented city plans according to the goals of waste management	• Provide data for further city development, considering the MSW
Teacher / Educational institutions	• Influence on mindset regarding waste and waste management	• Provide financial aid for educational topics & projects

This chapter provided an overview of Zambia and waste management in the capital Lusaka. In addition to legal actors and documents, the results of the field study on waste management were presented. Current challenges of waste management and dependencies to PC and EPR were elaborated. Furthermore, an overview of the relevant actors was given.

5 SWOT Analysis

The following chapter serves as a basic overview of the external and internal drivers for the implementation of PC in Lusaka. In particular, the focus is on considering an introduction of PC with regard to a subsequent introduction of an EPR system.

5.1 Methodology

In the following chapter the SWOT analysis (see Fig. 19:) is not used for a concrete company but for the idea of PC used as bridge concept towards EPR. The strengths and weaknesses of PC in combination with EPR are compared to the local, external opportunities and threats. The goal is to obtain an overview that is as holistic as possible and might serve as basis for a practical approach of a PC project in Lusaka or even as basis for a business model for a PC provider.

external factors

Plastic Credits and their possibilites with regard to EPR in Lusaka	OPPORTUNITIES	RISKS
	• Political support internationally, nationally and locally • First EPR efforts but still under construction and possibility to integrate PC as instrument • Strong middle class and emerging, albeit poor, stable country • International interest (recycling market) • High volume of waste also secures resources for recycling • Basic infrastructure for optimization is in place; future-oriented infrastruture is possible • Approaches for digital solutions available	• Weak involvement of producers so far • No consideration of PC as a fertile concept to EPR • Highly fragmented system and high non-manageable amount of waste • Lack of reliable numbers and transparency (a.o. due to paper-based documentation) • Informal sector dependent on waste collecting and sorting, no safe-guarding so far • High and increasing costs • Bad waste quality due to missing sorting structure • No sustainable view of the system • No support from politics and lack of policy implemenation; no enforcement of legals • Non-sufficient awarness in the population
STRENGTH • Detached from complex legal integration • Can be legally anchored as a tool in an EPR system • Support market for secondary material and therefore circular economy • Raise awareness for plastic topic • Financing mechanism to fund required waste management aspects and future infrastructure • Adaptations to local and geographic specificities • Involvement and transfer of responsibility to producer and therefor relief of municipalities • Collect local data and infrastructure • Visible success through monitored projects (environmental, social, economic)	• Expanding legal opportunities for easy integration of PC as a tool to meet national and international goals • Design of the PC under the premise of later integration into an EPR system • Raise awareness among the population: communication of impact and value (e.g. campaign, App) • Engage producers under advantage communication for emerging country regarding tourism, recycling topics or other economic aspects • Provide incentives for producers also regarding the long-term EPR goal • Introduction monitoring process and tools • Develop system with local & geographic specifities (e.g. informal sector integration, Using local App providers)	• Engage producers under advantage communication for emerging country regarding recycling topics or other economic aspects • Provide incentives for producers also regarding the long-term EPR goal; Establish strong producer involvement • Use fragmented system to run pilot projects with PCs and lay basis for centralized solution (EPR) • Continuous data collection for price specification (e.g. Digital solution/App) • Develop system with local & geographic specifities (e.g. informal sector integration, Using local App providers; enhance waste quality) • Definition of sustainability factors to be considered in the implementation of PC / Using standard setters • Expanding legal opportunities for easy integration of PC as a tool to meet national and international goals • Raise awareness among the population: communication of impact and value (e.g. campaign)
WEAKNESS • Detached from complex legal integration, voluntary • Realistic PC price • Sale of PC/ No buyer • Only low impact due to amount and quality of service • Danger of greenwashing / misleading claims • Missing quality standard (not sustainable) • Missing additionality • Competing structure with EPR	• Expanding legal opportunities for easy integration of PC as a tool to meet national and international goals • Engage producers under advantage communication for emerging country regarding recycling topics or other economic aspects (e.g. campaigning) • Provide incentives for producers also regarding the long-term EPR goal • Continuous data collection for price specification (e.g. Digital solution/App) • Definition of sustainability factors to be considered in the implementation of PC / Using standard setters • Design of the PC under the premise of later integration into an EPR system	• Design of the PC under the premise of later integration into an EPR system • Engage producers under advantage communication for emerging country regarding recycling topics or other economic aspects • Provide incentives for producers also regarding the long-term EPR goal; Establish strong producer involvement • Expanding legal opportunities for easy integration of PC as a tool to meet national and international goals • Introduction monitoring process and tools • Continuous data collection for price specification (e.g. Digital solution/App) • Definition of sustainability factors to be considered in the implementation of PC / Using standard setters

Internal factors

Fig. 19: SWOT Analysis (own illustration; see also Annexure 11)

5.2 Opportunities of PC in Lusaka

In order to make the best possible use of local opportunities, it is essential to exploit the strengths and weaknesses of PC (see also chapter 3). PC are initially disconnected from complex legal integration but might be used as a bridging tool for future EPR systems. To ensure this, it is necessary to work together with political stakeholders on simple and meaningful integration. To do so, current legal aspects and future goals must be taken into account (for details see action 2). This implies the consideration of PC as component of a future EPR system (see action 1 and 2). Zambia is considered one of the most politically stable countries with an emerging middle class (cf. GIZ 2020). Various economic sectors show growth including recycling industries. Already now international companies seem to be active in the recycling market . At this point, PC can contribute to the development and strengthening of the market for secondary materials as and also lays the basis for constant revenue stream within an EPR-System (cf. Lee 2020: 11; Nguyen 2022: 42–43) (see action 2). Since the basic infrastructure is already in place, it can be built up gradually, taking into account local and geographical specifics (see action 3). Since certain components of the infrastructure already exist, money from the PC system can be used well and wisely to expand future infrastructure. One of the greatest strengths is the involvement of producers to reduce costs for the public sector and citizens (cf. Prevent Waste Alliance n. d.). Since this, of course, involves costs, it is necessary to convince producers of the usefulness and to create various measures for voluntary participation in the system PC to counteract the weakness of voluntariness. (cf. Johnson 2022: 12–18). Be it through the help of incentives, or e. g., co-design rights in EPR systems (see action 4,5). Nevertheless, the lack of the realistic price as well as uniform quality standards for PCs are a major challenge (cf. Prevent Waste Alliance 2022a: 8). This can lead to various consequences such as greenwashing or low positive impact. The lack of a price for PC is also based on the incomplete data situation regarding the waste flow. Detailed recording would therefore not only lead to greater transparency, but also provide the basis for a cost-covering PC price (see action 9). This data can also create a baseline for further developments from an EPR system and create visibility of successful projects (cf. Prevent Waste Alliance 2022b: 1). In Lusaka too, there are already digital solutions which can be used to collect data and thus create transparency (cf. Ebusaka 2022; see action 7). The weakness of greenwashing, missing impact or also a poor or unsustainable implementation can be mitigated and possibly even prevented by quality assurance, such as PC standards (see action 10). These standards are not only important for the projects and the implementation of sustainable solutions but also to enhance the life of the residents and the informal sector (cf. Prevent Waste Alliance 2022c: 2). Considering the residents, they also have a high share in the overall waste issue. PC can be used here to create awareness around the handling and value of waste (see action 6).

5.3 Risks of PC in Lusaka

Of course, the introduction of PC also involves risks that need to be considered and avoided. If the involvement of producers is not successful, there will be a lack of support and a lack of financial basis for using PC as a component of EPR system development (cf. Prevent Waste Alliance 2022a: 8; see action 4,5). Here it is also necessary to ensure realistic pricing and benefit argumentation with regard to the producers (action 9). Unless PCs are thought of from the outset as a tool for implementing EPR systems, there are risks which might block the introduction of an EPR system (cf. Prevent Waste Alliance 2022a: 153). One risk may occur due to a low-cost implementation of PC. Producers could invoke PC and refuse a more costly EPR implementation. However, this can be reduced by involving producers at an early stage. The fragmented system in Lusaka could be a problem, as EPR systems are about holistic solutions. Nevertheless, PC projects can become important components of a large solution (see Action 8). The lack of reliable data is a risk but can be minimized through (digital) data collection in PC projects (action 9). The risk associated with the involvement of the informal sector lies particularly in the need to secure people and their income. At the same time, it is necessary to build a reliable system which also serves the aspects of additionality and fulfil quality standards. To ensure that PCs and the associated financial resources are used sustainably and do not threaten livelihoods, the implementation of sustainable solutions is required (see action 10). Other risks include a lack of awareness among stakeholders (including residents and producers) and a lack of political support, particularly in the area of enforcement of regulations. Building awareness can be achieved through various campaigns (see action 6). The lack of policy support or simply the lack of implementation options can be addressed by bringing together local, national, and international goals. This can lead, for example, to an increase in human resources and also to a stricter pursuit of defined regulations (see action 1). Poor waste quality poses a risk to the recycling market, as recyclable resources cannot be used due to poor quality (see chapter 4). This risk can be minimized by optimizing waste management and implementing an infrastructure adapted to local conditions (see action 3). PC and its systematics can be used to reduce the high costs of waste management in the long term. Digital tools can also be used for this purpose (see action 9).

5.4 Actions Overview

The following actions serve to outline exemplary tasks in the implementation of PC as a bridge concept towards EPR systems. These actions do not claim to be complete and serve as a rough framework for the development of PC projects or even a future business model for a PC provider.

1) Expanding legal opportunities for easy integration of PC as a tool to meet national and international goals:

In Lusaka, there are already initial efforts to implement an EPR system standard (cf. Zambia Environmental Management Agency (ZEMA) 2018; see chapter 2.4). However, this is still in its early stages and will take several years (cf. WCEF 2021; WWF Akademie n. d. a.; see chapter 2.3). The opportunity that PC offers is the immediate implementation taking into account the already formulated local (for example, the increase of the recycling rate to 30 %) as well as the national and international goals (including SDG). In the future, these can also represent the clear definition and targets required by EPR Design Principles (EDP1) and thus be understood as a step towards CE and EPR. (LCC 2022: 5–10). It would be desirable if legal foundations and regulations would promote the participation in PC projects or, if possible, temporarily declare it as an obligatory action, e. g., on the local level. This must be in line with the higher legal framework and should involve relevant stakeholders, such as producers, from the very beginning. This means that already during the implementation and planning of PC projects, representatives for a future EPR system are present or, if these persons do not yet exist, the PC providers take over the advisory role with regard to this task. Possible realization options:

- Kickoff Meeting with relevant stakeholders while planning and implementing PC Project (initiated through PC Provider or external advisory role).
- Conducting regular appointments and reports to document PC projects.
- Regular communication regarding legal possibilities and changes (e. g., through LCC).
- Evaluation and documentation to share insights from the projects for further legal adaptations.

2) Design of the PC under the premise of later integration into an EPR system

The focus on national and international goals defined under action 1 is also reflected in the basic design of PC projects. Through the involvement of relevant stakeholders, the flexibility of PC can be exploited and options for the EPR system can be created at the same time. This means both the integration of political developments, economic trends and the definition of long-term goals. Through this anchoring, a risk of collision with future EPR systems can be avoided. Also involved stakeholders on different levels can be addressed and integrated in order to obtain the most comprehensive support possible on all levels. Important aspects here are the implementation of PC projects in compliance with the EPR principles (see 2.3). Co-ordination and collaboration between stakeholders such as the LCC, ministries, producers, waste collectors, recyclers, residents and the informal sector must be strengthened and should already take place in the PC projects (EDP4, EDP3) (cf. WWF Akademie n.d.b.). One main aspect of these projects, which also goes along with the international goals in Zambia, is to focus on CE (EDP2). In addition to the locally adapted project design (see action 3), PC must then also be communicated as part of a higher-level EPR solution. This communication is directed at the stakeholders, but is particularly relevant with regard to the producers. Through this connection, the linking of future benefits or incentives with the costs incurred today is conceivable. Possible realization options:

- Kickoff Meeting with relevant stakeholders while planning and implementing PC Project (initiated through PC Provider or external advisory role)
- Development of communication campaign to explain link and its possibilities between PC Projects and future EPR
- Documentation and reporting on producers' participation for future EPR actions.

3) Develop system with local & geographic specifies (e.g., informal sector integration, using local digital App providers, enhance waste quality)
The local reference is highly relevant and can be well covered by PC. The understanding of the existing system and its adaptation can lead to the development of a well-tailored system that takes into account the different requirements (EDP 7) (cf. WWF Akademie n.d.b.). In Lusaka, this could concern the integration of the informal sector as well as the cooperation with local providers regarding digital solutions or the development of sorting stations. Possible realization options:

- Setting up and implementing a PC pilot project with all stakeholders and define clear objective to collect and dispose of a certain area (e.g., sub-area of the illegal waste dump Misisi).
- Composition of the appropriate project team, including producers, waste pickers, aggregators, waste collectors, recyclers or the cement plant. In addition, project coordinators (e.g., NGO or LCC

representative), digital tracking App provider like Ebusaka, Zaidi (Tanzania), Unwaste (Mosambique) (cf. Ebusaka 2022; Zaidi Recyclers n. d.; Wastebase n. d.) and third parties to control the results (e. g., LCC representative or external consultants). These structures might be used for future PRO.

- Implementation of the project and subsequent evaluation, also with regard to overriding national and international goals like SDGs or the Zambian Vision (cf. LCC 2022: 5; Republic of Zambia 2006: 1).

The sustainable integration of waste pickers through registration, secured income and social security also deserves special mention. Registration via App would be conceivable, so that it would also be possible to make contact outside the PC project. It is also important to involve the aggregators and other stakeholders in a meaningful way so that these small businesses are protected. This could be achieved, for example, through the paid use of aggregator stands as collection points for PC projects.

4) Engage producers under advantage communication for emerging country regarding, recycling topics or other economic aspects

The initial challenge of PC projects remains the sale of PCs to producers which should guarantee the financial sustainability (EDP5). If it is possible to use PC projects as a bridge concept, new opportunities will also arise in the argumentation of advantages (see action 2). Possible realization options:

- Development of communication campaign to explain link and its possibilities between PC Projects and future EPR (provide potential future benefits for current PC purchases (see action 5).
- Implementation of the campaign at national and international congresses or events.
- Conducting face-to-face marketing within Lusaka (through PC providers and municipality representatives).

5) Provide incentives for producers also regarding the long-term EPR goal
PC projects are voluntary so far. However, if they can be perceived as a pilot phase of EPR projects and thus as part of an overall system, various opportunities for the use of incentives will arise which can also promote cooperation (EDP4). Possible realization options:

- Financial compensation e.g., reduction of taxes or usage of new infrastructure to reduced costs (further possibilities see Tab. 16:).
- Provision of reports and results of the pilot projects with relevant reference to the own business (e.g., waste flow, waste quality).
- Offer of an external consulting service with regard to CE (especially for smaller business).
- Involvement in the determination of future infrastructure improvements.
- Assistance in the preparation of marketing materials about the funded PC projects.

Most of these incentives can be financed by the PC system itself, but some of the external services are additional and must either be added to the PC costs or calculated as part of the introduction of EPR systems.

Tab. 16: Policy instruments under the EPR Umbrella (adapted from Widmer et al. 2005: 436–458; Nnorom and Osibanjo, 2008: 489–501.)

Category	Examples
Regulatory instruments	Take-Back programs (mandatory or voluntary), including the provision of infrastructure; reuse and recycling targets; minimum product standards; prohibitions of certain hazardous materials or products; disposal bans; mandated recovery/recycling obligations
Economic instruments	Product taxes, inpu t/material levies, virgin material taxes, collection fees, disposal fees, deposit-refund schemes, subsidies, tax/subsidy combinations
Information instruments	Environmental reports; information provision to consumers, collectors, recyclers, etc. through education and awareness raisin campaigns.

6) Raise awareness among the population: communication of impact and value (e.g., campaign, App)

Another task is to educate the public on how to manage waste. The initial focus here should be on raising awareness of sustainable waste management, thus also explaining the need for CE (EDP2). Possible realization options:

- Communication campaigns in schools and kindergartens regarding the value of waste its avoidance and its recycling.
- Communication campaigns via relevant digital media (social networks or also Ebusaka App) including providing incentives (e.g., bonus points for waste sorting in the household).
- Increased use of waste separation in public buildings to make people aware of its usefulness and necessity.

7) Introduction monitoring process and tools

It is reasonable that all changes and expansion stages in waste management are monitored (EDP7). This includes PC projects, EPR actions and other initiatives. The key to this is a data-based adaptation of the structures in order to improve the waste management situation as efficiently as possible, but also verifiably. With the help of a valid secure database, important insights may be gained which are for instance beneficial for setting priorities in the expansion of the infrastructure. In addition, data acquisition also serves to monitor and control PC projects and can thus prevent fraud and greenwashing (cf. Liu et al. 2021: 42–51). Possible realization options:

- Use of a central tool for recording waste flow (e.g., Ebusaka App).
- Regular evaluation of data, to develop a baseline for future EPR systems (through external instance).
- Introduction of monitoring processes by neutral parties, e.g., external consultants or local authorities.

8) Use fragmented system to run pilot projects with PCs and lay basis for centralized solution (EPR)

Locally in Lusaka, there are diverse providers, solutions, startups and opportunities to address the waste problem. A centralized solution is not yet possible, but the fragmented system can be used to test small and medium projects and their success. The implementation of pilot projects is promising, as they can gradually contribute to the improvement of the system (see also action 3). Possible realization options:

- Definition of pilot projects including objectives and questions, e. g., implementation of pilot project with introduction of sorting stations to answer the question about the improvement of waste quality.
- Providing results for the further development of waste management structures and possible EPR implementation.

9) Continuous data collection for price specification (e. g., digital solution/App)

Digital data capture as a tool for price calculation is useful and a prerequisite for the implementation of a PC project. Manual data entry is still conceivable, but also susceptible to fraud. A secure digital solution would be useful here. The evaluation of the data should take place regularly (e. g., every three months) and be communicated transparently to all stakeholders. In this way, the results can also be used for future EPR development and realistic pricing. This also promotes transparency and cooperation between all stakeholders and builds trust. Possible realization options:

- Introduction of digital data collection.
- Evaluation and transparency about data and possible price adjustments.

10) Definition of sustainability factors to be considered in the implementation of PC / Using standard setters

There are a number of certification providers. These can be used to ultimately build up the system in a sustainable and traceable manner and thus also pay into the EPR. When implementing PC projects, certain aspects must be taken into account, which are already being pursued by some standard setters such as ValuCred (cf. ValuCred 2022). It is advisable to work together with these standard setters. Possible realization options:

- Building a PC team, taking into account the standard setters that are particularly suited to the country and its goals (e. g., relevance for SDG goals).

5.5 Interim conclusion

This chapter dealt with the SWOT analysis and the resulting actions are showing opportunities for PC as a bridge concept to an EPR system. The basic prerequisites, such as the quantities of waste available, rudimentary expandable waste management as well as national and international targets for CE, are in place in Lusaka.

Since the EPR system is only rudimentary, there is a good possibility that PCs provide relevant data for its concrete future design. In contrast, a future EPR system can include PC as a relevant tool and thus enable the set of actions regarding cooperation with producers, e. g., through long-term incentive actions. Here, however, it is always necessary to find the right balance between the flexibility of PC projects and more rigid EPR systems. This balance can certainly only be tested and limits defined during concrete implementations.

The basic fragmented structure in Lusaka offers the possibility to explore the effects of PC in the form of pilot projects and to collect data for an EPR system. For this purpose, it makes sense to understand the monitoring and its evaluation not only as a documentation tool for the PC projects, but also to examine the data for higher-level goals. Also, the existence of the digital app, can be understood here as an advantage and opportunity for PC and EPR systems. Clear communication campaigns can also help define and shape a future overall system. In order to actually be able to use this bridging function, it is important, that basic quality standards are met and that, in the best case, rules and specifications for EPR systems can also result from this. If the balancing act between short-term PC projects and medium- and long-term goals can now be mastered, Lusaka could be the first city to use PC as an actual bridging concept.

6 Costs and impact Plastic Credits

In this chapter, approximate costs for one PC per ton in Lusaka are calculated. Furthermore, possible effects in the economic, social and economic area are described.

6.1 Plastic Credit Price

The transferable unit PC is intended to cover costs incurred within the scope of the collection and proper disposal of plastic waste. This includes the administrative and organizational costs of the PC provider, as well as the guarantee of basic environmental and social standards (cf. ValuCred 2022: 29–30). In order to achieve the full benefits, the costs for the expansion of the current waste infrastructure (e. g., sorting stations) must also be included in the calculation. In addition, benefits or margins must be taken into account for all actors involved. The waste flow in Lusaka has various branches, but for the determination of the PC price per ton, the focus is placed on the following flow. The waste flow depicted here shows a component of the existing waste flow in Lusaka (see chapter 4). Due to the likelihood of implementation and the fastest possible improvement of the situation using the current infrastructure, the following process is considered in detail and serves as basis for a cost-calculation (see Fig. 20:).

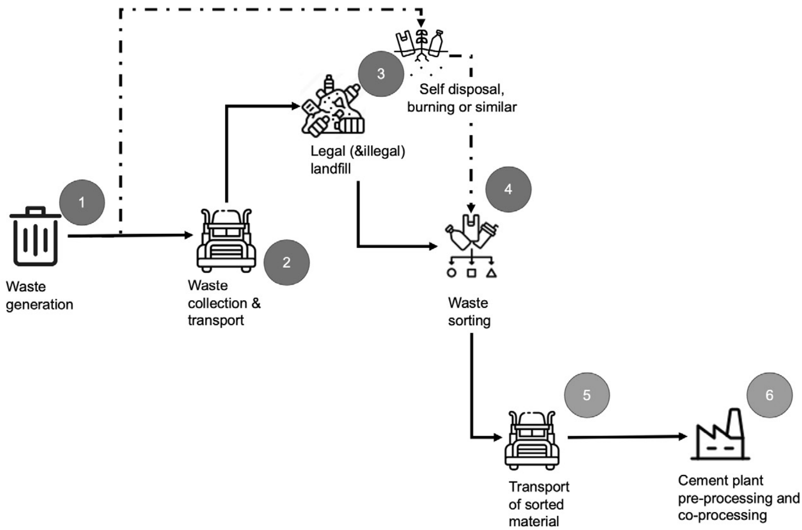

Fig. 20: Excerpt waste flow (own illustration; icon source iconfinder and flaticon; credits to Eucalyp Studio, Freepik, Gregor Cresnar; Chanut-is-Industries)

The basis of the calculation is the amount of expected plastic waste, generated in each household in Lusaka **(1)**. This waste is collected door-to-door by waste collectors. From there the waste is driven directly to the legal landfill named Chunga landfill. **(2)**. The waste is dumped in its entire quantity unsorted on this disposal site **(3)**. Waste Pickers then sort this waste and sell it to collections points, the aggregators **(4)**. From the aggregators, the waste is then transported according to its destination **(5)**. The waste is then transported to the cement plant, which uses the waste as additional material for the cement production process (named as pre- and co-processing) **(6)**. For the calculation, additional administrative costs are also considered. The margins, e. g., for the waste collectors, are not yet included.

The figures used in the following are based on data from the literature research as well as the field study. All prices are in Zambian Kwacha (ZMW) which is the country specific currency. The Euro (EUR) values are based on a currency conversion factor of 0,049 (Status 27.01.23). In some cases, there is only an insufficient data basis, so grounded estimates were used. The source of the figures used is always noted.

6.1.1 Waste generation (1)

The baseline amount of waste is based on Lusaka's population and estimated per capita consumption (see Tab. 17:). There are two calculations below that differ only in the amount of capita. This is based on data relating to an overall development in Zambia (cf. Nyirenda 2019:71; LCC 2022: 2–8). The deviations that may arise in reality must be taken into account in the course of the calculation through any surcharges.

Tab. 17: Estimated amount of waste / plastic waste (based on Kuwema 2022; Chisala n. d.; Nyirenda 2019:71; LCC, personal interview, LCC, Chunga Landfill, Lusaka, 17.10.22, see Annexure 7)

Waste Generation (1)		
Residents (millions)	3,5	3,5
Estimated capita generation (person per day in kg)	0,50 kg/day	0,75 kg/day
Total quantity (day in t)	1.750t	2.625t
Total quantity (year in t)	638.750t	958.125t
40 % of this waste is estimated as plastic waste (year in t)	255.500t	383.250t

6.1.2 Costs waste collection (2)

During the field study, it was observed that the waste ends up in illegal dumps, burned or is collected during door-to-door collections. This is done by waste collectors who drive the waste directly to the legal dumpsite. The waste collection costs, are made up of various cost items (cf. ValuCred 2022: 29–30; see Tab. 18:). The following calculation is based on:

- **Wages for the waste collectors:** The main collection work is done by the waste collectors who ride on the trucks. It is assumed that there are **4 people** on one truck. Each of these permanent employees earns **1.500 ZMW/month**. These employees are assumed to work **20 working** days per month, **12 months** per year. In this model the vacations are assumed as included within the 20 working days (cf. Waste Collector 1, personal interview, Lusaka, 17.10.22, see Annexure 3).

- **Transport costs:** The largest landfill, Chunga Landfill, is assumed as the destination for the following calculations. The assumed distance between Chunga Landfill and other waste districts **is 30 km and** serves as a one-way route, **60 km** for one round-trip (cf. Google Maps 2023a: Chunga Landfill – Silver Rest). For the calculation **1** tour per truck per day is calculated (cf. Waste Collector 2, personal interview Lusaka, 21.10.22, see Annexure 4).
- **Truck sizes and petrol consumption:** As noted in the field study, different truck sizes are in use. For the further calculation, an average capacity of **15 t** per truck was assumed, based on the rounded up (**14.8 → 15 t**) average value of the following truck sizes: 25 t, 20 t, 7,5 t and 7 t. The average gasoline consumption was determined to be **24 l/100 km**, based on average values of different truck sizes. The inaccuracies resulting from this are acceptable for approximating a PC price (cf. Bridgestone Mobility Solutions B.V. n. d.). The price of petrol amounts to **26,16 ZMW/l** as observed during the field study.
- **Repair and maintenance costs:** The necessary repair and maintenance costs are taken into account by 100 % surcharge. The assumption here is as follows: the mileage rate 50 % and 50 % maintenance inclusive fee and insurance.

Tab. 18: Waste collection costs (own calculation)

Waste collection costs (2)			
Petrol cost / zmw / liter	26,16	zmw	Waste collection
Average petrol consumption l / 100 km	24	l	
Petrol cost per 100 km	627,84	zmw	
Maintenance			
Extra charge for transport maintenance in %	100	%	
Transport maintenance / 100 km	627,84	zmw	
Distance and truck capacity			
Average distance to landfill oneway	30	km	
Average distance to landfill return	60	km	
Average capacity per load in tons	15	tons	
Average tours per truck / day	1	truck	
Distance return landfill / year in km	14.400	km	
Capacity per average truck per year in tons	3.600	tons	
Wages			
Working days per month	20	days	
Wage employee per month / zmw	1.500,00	zmw	
People working per truck	4	pax	
Wage persons per ton in zmw	5,00	zmw	
Wage per person and year in zmw	18.000,00	zmw	
Wage persons per truck and year in zmw	72.000,00	zmw	
Results			
Petrol / maintenance / wages / per year / truck	252.817,92	zmw	
Capacity truck / year (capacity / day * workdays / month)*12	3.600	tons	
Subtotal			
Cost collection / transport per ton (cost 1)	**70,23**	zmw	

This results in collection costs of **70,23 ZMW/t** which results in **3,44 EUR/t**.

6.1.3 Disposal costs legal landfill (3)

Landfill maintenance is the responsibility of the LCC. The maintenance costs base on various aspects: Size of the landfill and its geographic conditions, waste quantity, infrastructure (e.g., roads) as well as the general landfill strategy. Based on figures from Ghana and other comparable numbers, maintenance costs are assumed to be around 560 ZMW/t (approx. 30 USD/t) (cf. Kusi et al. 2016: 19–28).

For the further calculation it is assumed that the waste collectors' contribution to the costs of maintaining the landfill is covered by this license fee and the additional costs of 50 ZMW/per delivered ton (cf. LCC, personal interview, LCC, Chunga Landfill, Lusaka, 17.10.22 see Annexure 7; Waste Collector 2, personal interview Lusaka, 21.10.22, see Annexure 4) see Tab. 19:).

- **License fees for the waste collectors:** Waste collectors must register for official waste collection and pay **15.000 ZMW/year**. For the further calculation it is assumed that every truck has to pay a license, because also smaller companies are active in Lusaka.
- **Landfill fee waste collectors:** Besides the license fee, the waste collectors have to pay **50 ZMW/t** for unloading the waste at the legal landfill.
- **Capacity:** Additionally, the average capacity of **15 t** for a truck is used for further calculations. From this, assuming the above working days and number of daily trips to the landfill, the capacity is **3.600 t/year** delivered by one truck.

Tab. 19: Landfill costs (own calculation)

Landfill costs (3)			
License fee fix per truck / year	15.000,00	zmw	Landfill costs
License fee fix per truck / month	1.250,00	zmw	
Capacity truck / year (capacity / day * workdays / month)*12	3.600	tons	
License fee fix per ton (fee year fix / cap truck year)	4,17	zmw	
License fee variable per ton	50,00	zmw	
Subtotal			
License fix ton + variable per ton (cost 2)	**54,17**	zmw	

If the license fee and the landfill fee are now calculated on the basis of the estimated capacity, the result is a price of **54,17 ZMW/t** (which results in **2,65 EUR/t**) for landfill and license costs.

6.1.4 Costs waste sorting (4)

Waste sorting is currently performed by a large number of waste pickers. At the Chunga landfill alone, there are about 2000 waste pickers. It is important to secure these people from the informal sector by working in PC social projects and also to offer them financial security. In order to approach a valid price for waste sorting, collected waste quantities, sales prices and revenues from sales are considered (see Tab. 20:).

Amount of sorted waste: It is assumed that on average 80 kg can be collected by a waste picker per day. However, since this figure includes metals and other heavy materials, an average collection weight for plastic waste of **25 kg** is assumed for the following calculation (cf. Shunsuke and Tetsuya 2014: 474–480).

Prices: The prices received by the waste pickers vary from 1,5 ZMW/ kg up to 7 ZMW/ kg for plastics, depending on the material. As plastic with a low quality is considered for the incineration and the following calculation, a price of **1,5 ZMW/ kg** can be assumed (cf. Aggregator, personal interview, Misisi illegal landfill, Lusaka, 17.10.22, see Annexure 2).

Revenue: Recycling or even selling to a cement plant generates revenues from the material (estimated 500 ZMW/t). For the following calculation, this is set at approx. 33,33 % of the costs. This profit is directly offset against expenses and results in a price of **1.000 ZMW/t** on average.

Tab. 20: Waste sorting costs (own illustration)

Waste sorting costs (4)			
Average amount of sorted waste per day per waste pickers	25	kg	Waste sorting
Average purchase price for low–value plastic	1,50	zmw	
Estimated revenue from material per t	500,00	zmw	
Cost per ton minus revenue	1.000,00	zmw	

This results in an average sorting price per ton of **1.000 ZMW/t** (**49 EUR/t**).

6.1.5 Transport (5) and pre-and co-processing (6)

For calculation purposes, it is assumed that waste from Chunga landfill must be transported to the cement plant after it has been sorted. In the next step, the waste is forwarded to pre-processing and co-processing (see Fig. 18; see Tab. 21:).

Transport: The one-way distance from Chunga to the Lafarge Holcim is **23 km** for a single trip (cf. Google Maps 2023b). It can be assumed that only **2 persons** are required on the truck.

Pre-and Co-Processing: The cost of pre-treatment and co-processing depends on the type of waste, its quality and the technology chosen. According to Lafarge Holcim, which also operates the cement plant in Lusaka, the operational costs for handling MSW amount to an average of **205,42 ZMW/t** (which results in **10,06 EUR/t**) (cf. Holcim 2020: 44–59).

Tab. 21: Overview costs transport & pre- and co-processing (own illustration)

Transport landfill to cement plant (5)			
Average distance to cement plant oneway	23	km	Transport to cement plant
Average distance to cement plant return	46	km	
Average capacity per load in tons	15	tons	
Average tours per truck / day	1	truck	
Distance return landfill / year in km	11.040	km	
Capacity per average truck per year in tons	3.600	tons	
Wages			
Working days per month	20	days	
Wage employee per zmw / month	1.500,00	zmw	
People working per truck	2	pax	
Wage persons per ton in zmw	5,00	zmw	
Wage per person and year in zmw	18.000,00	zmw	
Wage persons per truck and year in zmw	36.000,00	zmw	
Results			
Petrol / maintenance / wages / per year / truck	174.627,07	zmw	
Capacity truck / year (capacity / day * workdays / month)*12	3.600	tons	
Cost transport / transport per ton (cost 5)	48,51	zmw	
Subtotal			
Cost per ton (petrol / maintainance / License) including sorting / picking / transport to landfill (cost 6)	1.172,90	zmw	
Pre- and co-processing (6)			
Cost per ton cement plant pre- and /co-processing	205,42	zmw	Pre- and co-processing
Cost transport cement plus processing in t (cost 7)	**253,93**	zmw	

This results in a price of **253,93 ZMW/t** (which results in **12,44 EUR/t**) for transport and pre- and co-processing.

6.1.6 PC administrative costs & infrastructure optimization

In addition to the costs for waste management, the costs for handling the plastic credits must also be taken into account (see Tab. 22:).

- For the development of infrastructure, educational campaigns, but also administrative costs, about 20 % can be added to the other costs incurred (cf. Plastic Credit Exchange 2021; Plastic Credit Exchange 2022).

Tab. 22: Overview costs organization plastic credit projects (own illustration)

Administrative costs			
Total costs (collection, transport, sorting, treatment) per t	1.378,32	zmw	Admin costs
Added costs for infrastructure, education and administration in %	20	%	
PC administrative costs & infrastructure optimization per t (cost 9)	**275,66**	zmw	

This leads to a total amount of **275,66 ZMW/t** (**13,51 EUR/t**)

6.1.7 Conclusion

Considering all individual positions, the complexity as well as the uncertainty in determining a valid price becomes clear. All aspects from collection, sorting, transport and pre- as well as co-processing in the cement plant leads to a total price of one PC for **1.653,99 ZMW/t** (**81,05 EUR/t**). Margins are not included yet.

During the determination of the price, it was often necessary to work with average values and assumptions, as some of the figures could not be validated. It would be desirable if the figures were validated already, but this might also happen during a first pilot project. The concrete project design is of high relevance. Aspects like the number of employees, duration of the project, concrete areas and materials determine the costs as well as the revenues.

For the above price the following uncertainties can be named:

- Concrete revenue from the cement plant for MSW.
- Concrete amount of waste and the amount of potential plastic waste.
- Lost material during the process is not taking into account yet.
- Concrete amount of required money for waste pickers as well as for employees and their wages.
- Concrete margin of the waste collectors.

Nevertheless, this price offers a guideline that a future PC provider could gradually concretize and validate depending on the implementation.

6.2 Estimated environmental, social and economic impacts

In addition to the price calculation for PCs, a consideration of the potential social, environmental and economic impacts is required.

There are several areas that can contribute to improvement at the site. Even though PC projects are business-oriented projects, it is important to consider the possible impacts, both negative and positive. Considering the environmental impacts, one can mention the reduction of waste in nature and the consequent conservation of the soil. The negative impacts can result from different aspects. In the area of collection, it is important to establish sensible, environmentally friendly collection and transport systems. The use of MSW in the cement plant also saves fossil primary energy sources and the associated amount of CO_2. The exact figures depend heavily on the technologies and the composition of the waste. If the money from PC projects is used to expand controlled waste incineration, high CO_2 savings are expected. The social impacts are in job creation, awareness generation, and small business development which are possible through the creation of a reliable income stream. Economically, it can lead to a strengthening of the recycling market, which in turn helps cover the necessary costs or even generates profits that benefit the MSW. Especially with the social and economic components, it is important to create meaningful and locally adapted solutions that do not destroy existing structures and livelihoods, but integrate them. Based on comparable projects, the following impacts (see Tab. 23:) can be defined:

Tab. 23: Overview positive and negative impact (own illustration)

Possible impact		
Impact	Potential positive impact	Potential negative impact
Environmental impact		
Reduction amount of plastic in environment: e. g., through one time collection: **18,5 t/day** **Door-to-Door-Collection:** e. g., by 8 persons **0,2 t plastic/week** (cf. Nguyen 2022: 44)		Negative impacts may be found in transportation costs, but these can be kept low through efficient planning of routes.
Primary fossil fuels: Depending on the availability of materials and their calorific values, primary fossil fuels can be avoided for processing in the cement plant. Typically, **15–20 %** of primary fossil can be replaced by RFD (based of MSW) (cf. Bharadwaj 2016:3).		
Reduction of CO_2 emissions in cement plant: The processing of MSW in the cement plant leads to a reduction of CO_2 emissions compared to fossil fuels. The actual number of reductions varies depending on techniques and composition of the waste and its calorific value. A study from Korea refers to a value of **106,9 kg/CO_2** in one ton of cement which can be saved (cf. Kim and Phae 2022: 1).		Efforts and energy incurred in the course of pre- and co-processing must also be taken into account.
Reduction of CO_2 emission in landfill: The use of waste for waste to energy also offers high CO_2 saving potential between **200–800 kg CO_2** that can be saved per ton if waste to energy replaces landfilling (cf. Clerens and Thuau 2018: 29)		To get these savings, waste to energy plants must be built, which also contributes to emissions.
Protection of soils: By reducing the amount of trash in legal and illegal dumpsites, soils can be protected from pollution.		

Social impact	
Creation of jobs: Depending on the PC project design, the generation of new jobs, especially for waste pickers, is likely. Reliable income enables the promotion of smaller businesses, e. g., small recycling facilities. An improvement in social standing can also be assumed (cf. Chileshe and Moonga 2017: 40–51).	Depending on the project design, individual aspects must be taken into account. In particular, it is important to avoid destabilizing the current structures but to integrate them in a meaningful way.
Economic	
Create revenue and optimize infrastructure and education: It is possible to generate relevant revenue from the materials. When considering a possible sale to the cement plant, it is assumed that at least the costs of collection and transport will be covered and a sufficient amount can be invested in the expansion of infrastructure and education. (cf. Nguyen 2022: 43).	In this area, too, local structures must be taken into account and integrated in the best possible way.

This chapter was about deriving the price of a PC in Lusaka. The calculated price is **1.653,99 ZMW/t (81,05 EUR/t)**. Even if this price should be validated with further figures, it still provides a comprehensible benchmark. Furthermore, possible economic, social and economic impacts are mentioned.

7 Summarizing review and outlook

The master thesis aimed to discuss the opportunities and challenges for the implementation of plastic offsetting certificates (plastic credits = PC) in Lusaka, Zambia with the use of a field study. This paper addresses the question to what extent PC can be used as a bridge concept towards EPR System in Lusaka.

The importance of this question lies in the high relevance of waste management in the context of CE. A functioning waste management system is part of CE, which aims to keep materials in circulation as long as possible. EPR systems are frameworks that pay into CE, but are mainly long-term solutions. However, as a short-term solution for dealing with plastic waste has to be created, especially in developing countries, PCs can be of great importance. Due to their flexibility and short-term implementation period, PCs in developing countries can fill gaps in waste management until or during the implementation of EPR systems (see chapter 1).

In order to identify the mode of action of EPR and also its possible gaps, the second chapter (see chapter 2) focuses on the interaction of CE and EPR systems in terms of waste management. In the best case of CE only necessary materials are used (including packaging materials) and kept within the circulation as long as possible, e. g., via recycling. The implementation of this CE is associated with costs that must be covered by municipalities in the area of waste management, especially in developing countries. Due to the rudimentary infrastructure (e. g., lack of sorting facilities), optimizations in the infrastructure often have to be made as a first step. In doing so, it is necessary to ensure constant cash flows so that waste management can be built up in the long term. One possible system is EPR, which forces producers of plastic waste to internalize the actual costs of their products, including their disposal. The implementation of these EPR systems is usually a lengthy process that requires, among other things, adjustments to legislation. In countries such as Germany, EPR has been in place for 32 years and is still being developed. EPR systems and their design are based on local conditions and yet follow all the basic principles: social inclusion, circular economy, co-operation and co-ordination, financial sustainability, transparency, monitoring and enforcement, context-specific implementation, clear definitions of the materials covered, the companies obliged and the responsibility of the producers. In Lusaka, the first EPR laws are in place, but they mainly relate to a ban on plastic bags. In addition, there is a set of measures for waste management in Lusaka, the SWIMP, which is also based on CE and has overlaps with the EPR principles (e. g., SG8: increase recycling rate).

Chapter 3 (see chapter 3) deals with the systematics of PCs and their strengths and challenges. PCs are a compensation certificate for plastic waste that can be purchased voluntarily by producers. This money is used to finance the collection of plastic waste from the natural environment and its proper disposal. PC is a voluntary system that, like EPR, complies with the Polluter Pays Principle and can thus contribute to financial relief for municipalities. Unlike EPR schemes, PC projects are more flexible as they are not tied to lengthy legislative developments. However, their voluntary nature can lead to low impact and greenwashing. PC and its relevance to EPR is found in both flexibility and short-term implementation. In particular, the strengths of short-term improvement through on-site waste collection, parallel data collection on waste streams, and improvement of waste management infrastructure using collected funds and revenues from recycling can be closely linked to EPR systems. Thus, PC projects can be understood as pilot projects that are equivalent to a fundamental analysis for future EPR systems. However, this only makes sense if the EPR principles are followed from the beginning, but without adopting their long-term processes. This flexibility allows PCs to take effect in local contexts and serve actual local needs. Risks such as a lack of quality assurance and transparency of PC projects, or the lack of sales of voluntary PCs and thus a missing sustainable financial flow, can be reduced by appropriate actions such as campaigns or monitoring tools. However, it remains important that PCs are understood as one step towards EPR in order not to threaten future EPR schemes. This might happen if i. e., producers boycott EPR schemes because of cheaper PC solutions. Since the design of EPR systems and PCs are based on local conditions, chapter 4 (see chapter 4) focuses on local challenges in Lusaka. During a field study in October 2022 in Lusaka, sub-areas of waste management were examined. Lusaka has a very fragmented waste management system legally as well as operational. Legally several ministries, e. g., MoH and local authorities like the LCC are involved. It is not always clear though who is entrusted with which tasks and responsibilities. From the operational side franchise waste collectors and community-based companies are responsible for waste collection. Temporary storage or sorting stations for waste are not available as standard. The waste that is collected at the houses is mostly driven directly to landfills, where it is sorted and sold by socially unprotected waste pickers. The recycling of materials does take place, but a valid database could not be determined. In general, there is a great deficit in the validation of data, so that the basic functioning of waste management could be traced, but actual verifiable figures are not available in the long term. Waste collection is insufficient, so that so far only about 50 % of the waste arrives at legal landfills. This not only poses a threat to the environment and human health, but also wastes valuable recyclable material. The volume of waste is expected to further increase and with it the problems of handling the waste, but also a reliable flow of recyclable material. Lack of controls, lack of waste sorting, and a poor funding model are just some of the current challenges. Poor equipment and overcrowded areas also prevent waste collection and encourage illegal disposal. PC projects can help identify gaps in collection infrastructure through the use of digital solutions, introduce small-scale value chains, and raise awareness of waste as a recyclable material. In addition, the informal sector can be supported by providing it with better social security. Be it through a higher income or by being able to work in newly planned waste disposal stations, for example. In addition to recycling, the incineration of materials in cement plants can also be an important temporary building block for managing waste volumes. There is already a high amount of low-value waste that would be excessively costly to recycle. This waste could still be uses as an essential part of the co-processing process. The field study identified some gaps in waste management that can be closed with the help of PC or EPR. Basically, it is important to hold producers accountable for their products and use this money to optimize waste management. PC projects can create great added value in Lusaka by collecting and documenting data on waste flow, quantities and types. This data is both relevant for future infrastructure design and can define long-term EPR goals. The introduction of digital tools as control and transparency tools for PC projects can also help to get a better overview of waste flows in the long term and improve the quality of work of the different actors involved. This can also help local authorities to control more easily and also to sanction non-compliance. The integration of the informal sector and its safeguarding are also part of PC projects and are also very important in Lusaka.

The field study also showed how diverse the stakeholders involved in waste management are as well as in PC projects (see chapter 4.5). For example, residents are strongly affected by the topic, as they already have to live with waste in their city and may perceive rapid local improvements through PC projects. Local governments are tasked with improving waste management and can benefit from valid data and reliable funding with PC. Through PC, ministries can also document data and achievements at the international level (SDGs) and work on overarching visions for Africa. The informal sector has the opportunity to secure itself financially, but also socially. The formal sector, like producers, can optimize its business and transform it into a sustainable structure. NGOs can accompany projects and support the informal sector socially, as these projects are financially secured by PC. Teachers may have financial opportunities to develop educational campaigns on waste. City planners have the opportunity to plan better streets and neighborhoods based on the data collected, thus improving the waste situation in the long term.

Chapter 5 addresses a concretization of the situation and uses the SWOT analysis to define concrete actions that enable PC as a bridge concept for EPR systems (see chapter 5). In the SWOT analysis, the external factors surrounding waste management in Luska were related to the strengths and weaknesses of PC and its ability to act as a bridge concept. The resulting actions, such as setting up explicit pilot projects which are referring to local and geographic specifies. The data should be collected using explicit monitoring processes and tools, as these can define the baseline for EPR systems in the long term. The collected data than serves as a basis for providing the introduction of PC with a positive impact on EPR systems. Furthermore, it is recommended to integrate PC as a tool within the EPR framework for Lusaka also via expanding legal opportunities for an easy legal integration. A key point is to involve producers in the whole process so that they can not only pay in the short term but also benefit from any incentives in the long term and thus also make lucrative and sustainable business decisions. Generating attention with the help of campaigns is also a building block for the success of PC as a bridge concept for EPR and can gain high relevance through strong communicative messages. Compliance with certain quality standards and sustainability requirements, must also be observed and can be understood as the basis for the success of PC in general. All this results/actions can be used to develop new PC projects, business models or optimize them. Since PC prices are a key factor, chapter 6 deals with a price approximation and the elaboration of further impact. The focus is on a simplified waste flow and the associated costs amount to **1.653,99 ZMW/t (81,05 EUR/t)**. With regard to further impacts, the removal of waste from the environment, reduction of CO_2 and or social security for waste pickers can be predicted.

Based on the present results, it can be assumed that PCs can be used as a bridge concept for an EPRS system in Lusaka under certain conditions. However, these conditions are essential and should be gradually integrated into PC projects. Although this involves more effort, it can lead to faster successes on the ground and promote the long-term development of waste management in Lusaka. Despite the field study, this work and the derivations from it are theoretical in nature. So far, there is no practical project that actually proves this interaction of PC and EPR. This would be desirable in the course of further research. Challenges will certainly lie in local specifics and initial results from the field, could create new opportunities for PCs and other supporting systems on the path to CE. In principle, Lusaka and possibly even the whole of Zambia seem to have all the prerequisites for such a practical consideration. The results of this work can help to focus on the most important aspects during a possible PC implementation in Lusaka.

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Annexures

Annexure 1) Interview guide for different stakeholders and actors

Interviews

General

Name, Position, Role, Context

Where are you living, how is waste handled there?

Waste Generation and disposal, collection (PRIVATE PERSONS)

How much waste is generated in your household ?

Which kind of waste?

Do you sort waste?

Do you recycle waste?

Where do you carry your waste?

What are you doing with your waste?

How often the waste is collected?

What are your main issues with the waste?

How would you describe the waste situation and why is it like it is?

Collection and transport (OFFICAL COMPANIES)

Do you have general data about the amount of waste? Which type of waste ?

In which areas/districts is your company working? How many districts exist?

How many people are working in your company? How is your equipment? How many trucks?

How do you collect waste? Kerbside House-to-House General Container?

How many containers do you place in each district? Where? Why did you place them there? How big are the containers?

How often do you collect waste? On which days?

How much waste do you collect? Per District?

What are you doing with the waste? How much will be recycled? How much Landfill?

Which kind of waste? (MultiplayerPlastic how much?)

How much costs your services? Waste fees

How much do you pay for the licence?

How do the licence process work?

How long is your contract? What was the tender award budget?

Do you have any storage rooms for the collected waste? Where? How long is the waste stored there?

How much is the maximum transport distance from generators to landfills?

What are the main issues regarding the Waste Collection? (e.g. Streets, time, etc.)

How much money do you pay for petrol? How much money for repair? How much money for cleaning?

How much money for your employee?

Do you also work with informal waste pickers?

Storage (OFFICAL COMPANIES)

How many storage places for collection of waste exist?

Where are these places? How high is the rent? Is security required? How long? How high are personal costs?

How much other costs, e.g. electricity?

How much waste can be stored?

Does any treatment or sorting takes place there? Or at any other place?

Treatment (OFFICAL COMPANIES)

Treatment in sense of sorting? Who is doing what where?

How much are the personal costs?

How much time for which amount of waste?

Sell / Incineration (OFFICAL COMPANIES)

How much waste is sold for recycling? To whom?

Which is waste is recycled?

How often the MLP can be delivered?

Where are the cement plans?

Self disposal (OFFICAL COMPANIES)

How much waste is self-disposed via burning? How much waste is self-disposed via buried? How much waste is self-disposed via dropping wild?

Education (OFFICAL COMPANIES)

How much money required for education for inhabitiants?

Disposal (OFFICAL COMPANIES)

How much is the maximum transport distance from generators to landfills?

Gate fee? If any fee for waste disposal at landfills per ton?

How much waste on the landfill? Which kind of waste? How much regarding the collected waste?

What happens with the waste?

How many Waste Pickers? What do they need?

Fig. 21: Interview guideline (own illustration)

Annexure 2) Aggregator / Interview transcript

- 16.10.2022 / Informal waste collector / aggregator
- Aggregator in Missis (illegal landfill)
- The waste is weighed because it is paid by kg.
- The waste that comes also comes from “richer areas”.
- Approx. 2–3 trucks are filled per day.
- These belong to different waste companies.
- They are the main supplier of recyclable material.
- All 7 days a week.
- They collect and sell different types of plastic at different prices.
- Working day: 8–17h.

Sum / day	**Selling**	**Buying**
LDPE: 500 kg–1t	LDPE: 3 ZMW/ kg	LDPE: 5 ZMW/ kg
HD: 300–500 kg	HD: 7 ZMW/ kg	HD: 5 ZMW/ kg
PP: 200–300 kg	PET: 1,5 ZMW/ kg	PET: 1 ZMW/ kg
PET: 300–500 kg	PP: 6 ZMW/ kg	PP: 8 ZMW/ kg

Annexure 3) Waste collector 1 / Interview transcript

- 17.10.2022 / Waste Collector (only collection)
- 2 districts (Low income)
- Collection once a week
- N: Chilenje, Chilenje South, Burma road area: Fee 120 ZMW/month
- T: Part of woodland, Nyumba yanga, Leopards hill area: Fee 150 ZMW/month
- House-to-House; and specific contracts for houses, companies
- Chunga Landfill / Landfill fee: 50 ZMW/t
- LICENCE 15.000 per distric t/year
- Licence 4 years valid
- 13 Employees; loan between 1.500–4.500 ZMW/month
- 5 Trucks (2 more to come); 2* 15 t; 2*5 t; 1*10 t
- Trucks are doing 2 trips in a day
- 200 to 250 t of waste per month (both districts together)
    - 2/4 plastic, 1/4 food and 1/4 boxes+sacks

Annexure 4) Waste collector 2 / interview transcript

- 21.10.22 / Waste collector (only collection).
- 2 districts (upper income).
- Collection once a week.
- C: Chudleigh, Kalundu, Olympia, Roma : Fee 160 ZMW/month.
- H: Handsworth, Kabulonga, Sunningdale: Fee 160 ZMW/month.
- House-to-House and specific contracts for houses, companies.
- Chunga Landfill / Landfill fee: 50 ZMW/t.
- LICENCE 15.000 per distric t/year.
- Licence 4 years valid.
- 50 Employees / 30 collectors; loan between 3.000–8.000 ZMW/month.
- 5 Trucks: 2* Skiptruck; 3*25 t.
- Trucks are doing 1–2 trips in a day.
- Skiptrucks once a day.

Top 3 aspects to be changed in Lusaka waste management:

- Payment for waste.
- Education/Awareness.
- Illegals stopping.

Annexure 5) Recycler 1 / Interview transcript

- 22.10.22 / A company that produces, among other things, plastic sidewalk stones. As a basis can be used different types of plastic.
- Uses 300 kg/day minimum up to 1 t per day (LDPE, PP, HDPE).
- Goal: 30–50 t/month.
- Buy it for the average of 2,6 ZMW/Kg.
- Colored plastics costs (LDPE): 1,5 ZMW/ kg.
- White plastics: 5 ZMW/ kg.
- 2 employees.
- Possible to sell i. e., fence poles for 75 ZMW instead of 200 ZMW for steal ones.
- However, there is still a lot of convincing to be done in both sales and waste handling.

Annexure 6) Recycler 2 / Interview transcript

- 22.10.22 / Recycler produces pellets and products (chairs (35 ZMW) and tables (48 ZMW).
- Delivery: between 7a.m.–5 p.m. Every ten minutes a truck with 500 kg – 1 t per different material (e. g., HD, PP, LDPE) arrives.
- Truck arrives, material will be sorted and only the requested material will be paid / takes ten minutes.
- Colored plastic required: 800 t–1 metric ton/month.
- Use plastic waste from smaller, illegal landfills due to a better quality.

Prices:

- LDPE: 3–5 ZMW/ kg
- HD: 5–7 ZMW/ kg
- PET: 1–1,5 ZMW/ kg
- PP: 6–9 ZMW/ kg
- LD: 5 ZMW/ kg
- Mixed plastic: 1–1,5 ZMW/ kg
- White plastic: 5–6 ZMW/ kg

Selling pellets:

- LDPE: 15.000 ZMW/t
- HD: 19.500 ZMW/t
- PP: 27.000 ZMW/t
- LD: 15.000 ZMW/t
- Colored plastic: 3.000 ZMW/t

Annexure 7) LCC / Interview transcript / visit at Chunga Landfill

- 17.10.22
- There are Franchise Contractor and CBE Services (approx. 182 registered companies).
- Usually 2 ZMW/day for waste pickers but at the moment no one is controlling due to broken fence.
- Tried to register waste pickers, approx. 2.000 waste pickers. 70 % waste pickers, 30 % aggregators.
- 2.000 waste pickers; 1.500 of them woman; 70 % Pickers, 30 % Aggregators. There is a handwritten list of some of them (183) but no one really cares. In the list before also the type of waste is displayed.
- 2 ZMW a day, but at the moment due to missing fence, no one is taking the money. Usually, the money should be used for the waste pickers and their conditions.
- Top 3 to change: A news fence; road Inside the landfill; closing an old cell.

- Only 50 % collected. Inhabitants Lusaka: 3,5 m.
- 20 % of the collected is Recyclable (plastic, paper, etc.).
- 650.000–1.200.000 kg/d; 550.000–650.000 kg/d.
- Only 50 % of the complete waste arrives at Chunga; 0,5 kg/day/person.
- 15 registered recyclers, but more informal.
- Fee: Franchise: 50 ZMW/t; CBE: 1–5 t = 50 ZMW; 6–10 t = 100 ZMW; 11–15 t = 150 ZMW; 16–20 t = 200 ZMW.
- Recycle Dealer: 4 Companies arriving daily; 2–3 trips every day.
- ZEMA is now responsible for hazardous waste.

Daily

- PET: 32 bags
- LDPE: 5–10 bags
- PP: 5–10 bags
- HD 5–10 bags

Sell

- HD: 7 ZMW/ kg
- PP: 9 ZMW/ kg
- LDPE: 5 ZMW/ kg
- PET: 5–6 ZMW/ kg

Annexure 8) Waste picker / Interview transcript

- 17.10.22
- Collecting in the streets, mainly HD.
- Between 15 kg/day up to 75 kg/day.
- Receiving different prices between 4–5 ZMW depending on material and dealers.
- Works 8–16 h.

Annexure 9) Contribution SWIMP to SDG

Tab. 24: Contribution SWIMP to SDG (LCC 2022: 31)

SDG	SWIMP Contribution
SDG 1 End poverty in all its forms everywhere SDG 2 End hunger, achieve food security and improved nutrition and promote sustainable agriculture	• Increase economic opportunities in the waste value chains; contribute to jobs, livelihood improvement, and business development. • Contribute to a cleaner, greener, and healthy environment. • Reduce vulnerability and exposure of marginalised groups to floods due to drainages blocked by waste. • Contribute to the maintenance of ecosystems, protection of soil quality and strengthened capacity for climate change adaptation.
SDG 3 Ensure healthy lives and promote well-being for all at all ages	• Contribute to the reduction of illnesses from contamination and pollution due to the safe disposal of waste. • Contribute to a clean, green, and healthy living environment.
SDG 4 Ensure inclusive and equitable quality education and promote life-long learning opportunities for all	• Contribute to a safe, clean, green, and healthy environment for conducive learning in schools and communities. • Support improved access to education through increased economic opportunities for households and income derived from participation in waste value chains to support access to education. • Increased community empowerment and ability to lever education and awareness for advocacy.
SDG 5 Achieve gender equality and empower all women and girls	• Increased economic opportunities for women in waste value chains. • Increased awareness among community members on the Human Rights Based Approach and the importance of inclusiveness, accountability, and empowerment. • Increased opportunities for women to effectively participate in leadership & decision-making positions in community structures.

SDG 6 Ensure availability and sustainable management of water and sanitation for all	• Improve water quality by reducing pollution, eliminating dumping, and minimizing release of hazardous chemicals and materials. • Promote principles of a circular economy and reduce solid waste threats to sanitation systems. • Contribute to the protection of water related ecosystems. • Support and strengthen the participation of local communities in improving sanitation management through the waste value chains and working with WDC's.
SDG 7 Ensure access to affordable, reliable, sustainable, and modern energy for all	• Promote waste to energy technologies, especially for industry, as part of circular economy principles creating economic opportunities in the waste value chain.
SDG 8	• Create business opportunities in waste value chains, including Creating Shared Value (CSV) models with big businesses and communities. • Promote entrepreneurship, job creation and livelihoods, creativity and innovation in management of waste, especially amongst youth and women Facilitate formalization and growth of micro-, small- and medium-sized enterprises in waste value chains.
SDG 9 Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	• Develop climate proof solid waste management infrastructure. • Increase access to financial services targeted to small-scale industries, community based enterprises (CBEs) and other small businesses working in waste value chains and related markets.
SDG 10 Reduce inequality within and among countries	• Effectively implement LCC resolution adopting the Human Rights Based Approach deepening empowerment, non-discrimination, and accountability. • Effectively implement LCC's Social Inclusion and Gender Policy. • Strengthen local governance through empowering WDCs and improving Local Area Planning to increase the control and prevention of unconducive waste generation and disposal practices.

SDG 11 Make cities and human settlements inclusive, safe, resilient, and sustainable	Reduce environmental impact of waste on the living conditions of people, especially the most vulnerable (women, children, persons with disabilities and the poor). Contribute to a cleaner, greener, and healthy environment for enhanced human development. Promote principles of circular economy for resource efficiency and city resilience. Increase awareness on the link between waste management and local governance in achieving a sustainable healthy city.
SDG 12 Ensure sustainable consumption and production patterns	Promote principles of circular economy and reduce waste generation through prevention, reduction, recycling, and reuse. Increased awareness on economic potential in waste value chains amongst communities and policy makers.
SDG 13 Take urgent action to combat climate change and its impacts	Strengthen adaptive capacity at local level through contribution to improved local governance. Reduce emission of greenhouse gases (GHG) from waste through effective waste management practices. Disaster risk reduction (floods and epidemics) through inclusive, effective, and efficient management of waste. Increase awareness on role of waste in climate change mitigation and adaptation.
SDG 14 Conserve and sustainably use the oceans, seas, and marine resources for sustainable development	Reduce pollution of water bodies by waste to prevent it from ending up in and polluting oceans and seas. Increase awareness on the link between land-based waste management and the health of oceans and seas.

SDG 15 Protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	Contribute to the protection of ecosystems through reduced levels of waste polluting the environment. Contribute to restoration of degraded land and soil through the removal of waste pollutants from the environment. Increase awareness on the link between integrated planning, improved local governance, and waste management in maintaining healthy terrestrial ecosystems.
SDG 16 Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable, and inclusive institutions at all levels	Contribute to implementation of the Human Rights Based Approach deepening empowerment, non-discrimination, and accountability. Promotes inclusive, participatory and representative decision making through the use of different governance structures i. e. WDC's. Contribute to effective development and implementation of Local Area Plans to underpin community and political support for waste management.
SDG 17 Strengthen the means of implementation and revitalize the global partnership for sustainable development	Promote multi-stakeholder partnerships and collaboration among private sector, public sector, civil society organisations and community structures. Build collective leadership and mutual accountability, e. g. LCC leadership under Lusaka Water Security Initiative (LuWSI). Promote environmentally sound technologies and sustainable financing mechanisms for waste management. Advocate for policy and institutional coherence and coordination for effective waste management.

Annexure 10) Examples of calculation under EPR

Products	Fill size	Price in €	Packaging material	g per pack	License price (ct. per kg)	License costs (ct. per pack)	License price in % of product price
Toothpaste	125 ml	1.39	Plastic tube with screw cap	21.8	54	1.18	0.85
Toilet paper	8 roles	2.15	Plastic bags	14.6	54	0.79	0.37
			Cardboard core	4.3	7	0.03	0.01
			Total	18.9		0.82	0.38
Handkerchiefs	30 Packets	2.75	Plastic bags	8.4	54	0.45	0.16
			Plastic bags	0.6	54	0.03	0.01
			Total	9		0.48	0.17
Grated cheese	200 g	1.89	Plastic bags	5.9	54	0.32	0.17
Flour	1,000	0.39	Paper bags	8.4	7	0.06	0.15
Sugar	1,000	0.75	Paper bags	7.5	7	0.05	0.07
Salt	500 g	0.19	Cardboard folding box	16.8	7	0.12	0.62
Cream, fresh	200 g	0.39	Plastic cups	6.1	54	0.33	0.84
			Aluminum lid	0.4	52.50	0.02	0.06
			Total	6.5		0.35	0.90
Fresh milk	1,000	0.71	Liquid carton	29.3	52	1.53	2.15
			Plastic closure	1.0	54	0.05	0.08
			Total	30.3		1.58	2.23
Canned cucumber	530 ml	0.79	Preserving jar	239.9	3.5	0.84	1.06
			Tinplate lid	13.7	49	0.67	0.85
			Total	253.6		1.51	1.91
Instant coffee	200 g	3.49	Preserving jar	408.9	3.50	1.43	0.41
			Screw cap	16.3	54	0.88	0.25
			Total	425.2		2.31	0.66

Fig. 22: Examples of calculation under EPR based on Umweltbundesamt (UBA 2019) (Giz 2021: 28)

Annexure 11) SWOT Analysis

Plastic Credits and their possibilites with regard to EPR in Lusaka	external factors: OPPORTUNITIES	external factors: RISKS
	• Political support internationally, nationally and locally • First EPR efforts but still under construction and possibility to integrate PC as instrument • Strong middle class and emerging, albeit poor, stable country • International interest (recycling market) • High volume of waste also secures resources for recycling • Basic infrastructure for optimization is in place; future-oriented infrastruture is possible • Approaches for digital solutions available	• Weak involvement of producers so far • No consideration of PC as a fertile concept to EPR • Highly fragmented system and high non-manageable amount of waste • Lack of reliable numbers and transparency (a.o. due to paper-based documentation) • Informal sector dependent on waste collecting and sorting, no safe-guarding so far • High and increasing costs • Bad waste quality due to missing sorting structure • No sustainable view of the system • No support from politics and lack of policy implemenation; no enforcement of legals • Non-sufficient awarness in the population
Internal factors: **STRENGTH** • Detached from complex legal integration • Can be legally anchored as a tool in an EPR system • Support market for secondary material and therefore circular economy • Raise awareness for plastic topic • Financing mechanism to fund required waste management aspects and future infrastructure • Adaptations to local and geographic specificities • Involvement and transfer of responsibility to producer and therefor relief of municipalities • Collect local data and infrastructure • Visible success through monitored projects (environmental, social, economic)	• Expanding legal opportunities for easy integration of PC as a tool to meet national and international goals • Design of the PC under the premise of later integration into an EPR system • Raise awareness among the population: communication of impact and value (e.g. campaign, App) • Engage producers under advantage communication for emerging country regarding tourism, recycling topics or other economic aspects • Provide incentives for producers also regarding the long-term EPR goal • Introduction monitoring process and tools • Develop system with local & geographic specifities (e.g. informal sector integration, Using local App providers)	• Engage producers under advantage communication for emerging country regarding recycling topics or other economic aspects • Provide incentives for producers also regarding the long-term EPR goal; Establish strong producer involvement • Use fragmented system to run pilot projects with PCs and lay basis for centralized solution (EPR) • Continuous data collection for price specification (e.g. Digital solution/App) • Develop system with local & geographic specifities (e.g. informal sector integration, Using local App providers; enhance waste quality) • Definition of sustainability factors to be considered in the implementation of PC / Using standard setters • Expanding legal opportunities for easy integration of PC as a tool to meet national and international goals • Raise awareness among the population: communication of impact and value (e.g. campaign)
Internal factors: **WEAKNESS** • Detached from complex legal integration, voluntary • Realistic PC price • Sale of PC/ No buyer • Only low impact due to amount and quality of service • Danger of greenwashing / misleading claims • Missing quality standard (not sustainable) • Missing additionality • Competing structure with EPR	• Expanding legal opportunities for easy integration of PC as a tool to meet national and international goals • Engage producers under advantage communication for emerging country regarding recycling topics or other economic aspects (e.g. campaigning) • Provide incentives for producers also regarding the long-term EPR goal • Continuous data collection for price specification (e.g. Digital solution/App) • Definition of sustainability factors to be considered in the implementation of PC / Using standard setters • Design of the PC under the premise of later integration into an EPR system	• Design of the PC under the premise of later integration into an EPR system • Engage producers under advantage communication for emerging country regarding recycling topics or other economic aspects • Provide incentives for producers also regarding the long-term EPR goal; Establish strong producer involvement • Expanding legal opportunities for easy integration of PC as a tool to meet national and international goals • Introduction monitoring process and tools • Continuous data collection for price specification (e.g. Digital solution/App) • Definition of sustainability factors to be considered in the implementation of PC / Using standard setters

Fig. 23: SWOT Analysis (own illustration)