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.

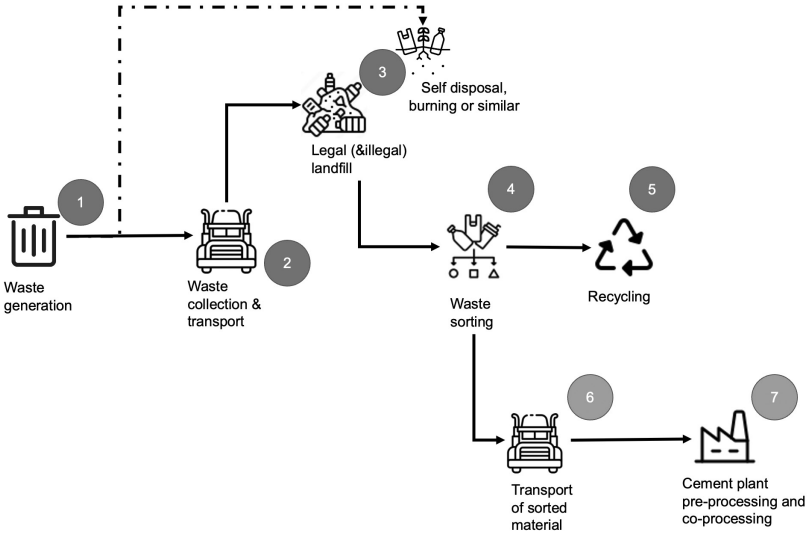

Fig. 10: Waste flow Lusaka (own illustration; icon source iconfinder and flaticon; credits to Eucalyp Studio; Freepik; Gregor Cresnar; Chanut-is-Industries)

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; Chisa-

la 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 reduc-

tion 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).

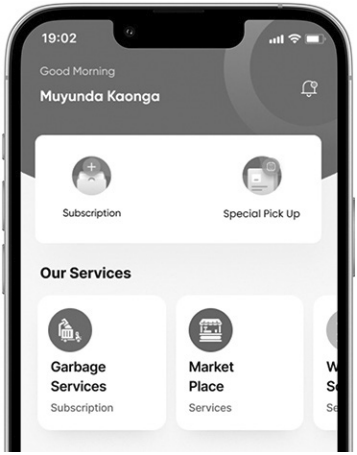

Fig. 14: Screenshot Ebusaka App (cf. Ebusaka 2022)

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).

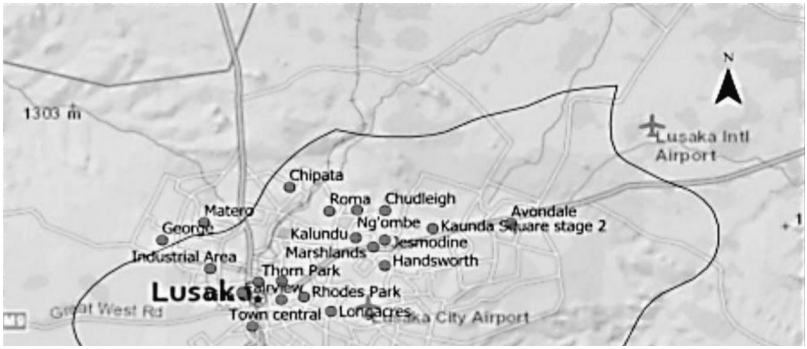

Fig. 16: Waste collection sites (dots) in Lusaka, Zambia (cf. Sambo et al. 2020: 43)

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 plas-

tic 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).

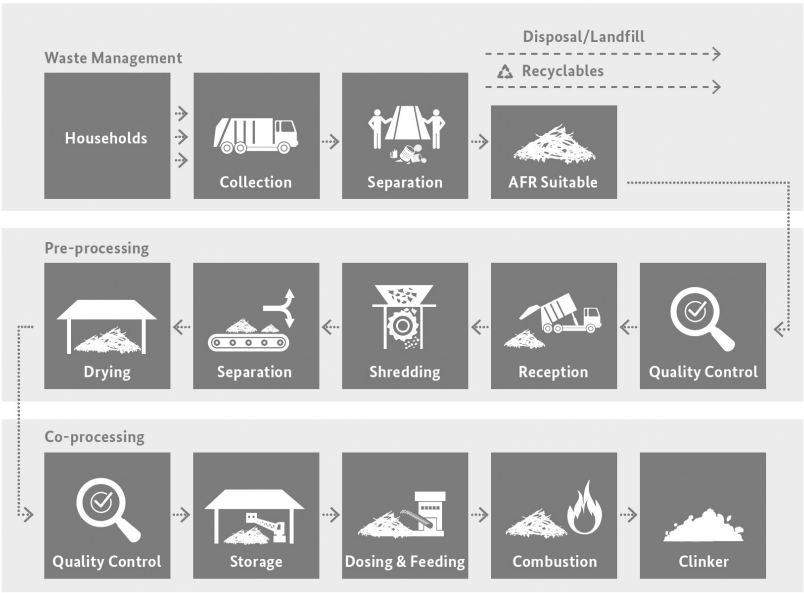

Fig. 18: Pre- and Co-processing within MSW management (cf. Holcim 2020: 29)

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.