

Municipal Solid Waste Management in Informal Settlements – A multiple-case study of challenges and possibilities in the favelas and informal sector of Rio de Janeiro city

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Sammandrag

Idag bor cirka en miljard människor i världen i informella bosättningar och saknar tillgång till avfalls- och sanitetstjänster samt stadsinfrastruktur. I Rio de Janeiro bor cirka 1,4 miljoner människor, en fjärdedel av stadsbefolkningen, i informella bosättningar, eller favelor som det heter i Brasilien. Bristerna i stadens avfallshanteringssystem manifesterar sig huvudsakligen genom ansamling av avfall i offentliga utrymmen i favelorna. En del av avfallshanteringen och materialåtervinningen utförs av avfallsplockare och återvinningskooperativ. Sedan 2010 fastställer brasiliansk lag systematisk integrering av dessa aktiviteter i avfallssystemet för att öka återvinning. Motsägelsefullt når återvinningsgraden endast 1-2% av det genererade avfallet i staden, som kan jämföras med städer i andra utvecklingsländer där siffran kan nå 20%.

Med anledning av detta analyseras i uppsatsen avfalls- och återvinningssystemet i de informella bosättningarna i Rio de Janeiro för att identifiera problem och föreslå möjliga angreppsmetoder för att minska inverkan på kringliggande miljö och förbättra social integration i systemet. Resultaten är baserade på en fallstudie med 10 deltagande samhällsorganisationer och kooperativ i 7 olika favelor. Data samlades in genom semistrukturerade intervjuer och fältobservationer.

Studien identifierade tillverkare, distributörer och importörer som en av de främsta orsakerna till den låga återvinningsgraden då de inte tar lagstadgat ansvar. Vägran till investeringar från dessa aktörer i systemet orsakar operativa svårigheter för återvinningskooperativen, och tillsammans med låga marknadspriser på materialet leder detta till hinder för social integration och inkomstgenerering för de mest marginaliserade i samhället. Vidare identifierade arbetet att en lägre utbildningsnivå bland invånarna, gamla vanor och för få insamlings-containerar bidrar till att avfall hamnar på gatorna och i naturen. Utöver detta påverkar både favelornas geografi och brottslighet insamling av avfallet.

Åtgärder för att i efterhand mildra eventuella miljöeffekter inkluderar clean-ups av avfall och förbättring av estetiken kring dessa områden. Andra metoder omfattar informell insamling av avfall för en områdesanpassad avgift, dörr-till-dörrinsamling av återvinningsbart material och skapandet av nätverk och partnerskap inom den informella sektorn. För en större systematisk förändring rekommenderas Pro-Poor Public Private Partnership konceptet, där kommunen anställer favela-invånare för att underlätta insamling av avfall samt finansiera kooperativ baserat individuella krav och integrera dessa aktörer i beslutsprocessen. Däremot, i perspektivet av den utbredda politiska och rättsliga korruptionen i Brasilien och den historiskt långsamma utvecklingen av avfallssystemet, uppmanas den informella sektorn att organisera sig för att förbättra situationen. Resultatets tillförlitlighet och giltighet hade ökat genom att ha mer strukturerade intervjuer och observationer och inkludera fler systemaktörer i studien. Framtida forskning bör fokusera på favela-specifik miljöförbättring, stärka kooperativ och resursåtervinning från organiskt avfall.

Nyckelord

avfallshantering, informell bosättning, favela, avfallsplockare, återvinningskooperativ, miljöpåverkan, social integration, Rio de Janeiro

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Abstract

Today, about one billion people in the world live in informal settlements and lack access to basic services and city infrastructure. In Rio de Janeiro, approximately 1,4 million people, one fourth of the city population, live in informal settlements, in Brazil called favelas. The insufficiency of the city's waste services mainly manifests itself through accumulation of waste in public spaces in the favelas. A part of the waste management and recycling is carried out by waste pickers and waste pickers' cooperatives. As of 2010, Brazilian law establishes systematic integration of their activities in the system to increase recycling. Contradictorily, the recycling rate only reaches about 1-2% of the generated waste in Rio de Janeiro, which can be compared to cities in other developing countries where this number is 15-20%.

Therefore, the municipal solid waste (MSW) management and recycling system in the informal settlements of Rio de Janeiro are analyzed to identify main issues and, from a systems' thinking perspective, suggest possible approaches to improve environmental protection and social inclusion in the system. The results are based on a multiple-case study with 10 participating community organizations and cooperatives in 7 different favelas. Data was gathered through semi-structured interviews and direct field observations.

The study identified non-compliance of manufacturers, distributors and importers as one of the main reasons for the low recycling rate. The withholding of investments from these actors causes operational difficulties for the cooperatives and, together with an oligopsony market with low prices, this leads to the impediment of social inclusion and loss of income for many urban poor. The study also identified that a lower educational level among the residents, bad habits and too few collection containers contribute to the large generation of waste in the streets. Above this, steep hills and criminality influence disposal and collection of waste. The biggest differences between the formal and informal parts of the city are the frequency and type of collection.

With the support from literature, approaches to mitigate the environmental effect after the accumulation of waste in the streets include clean-ups and improving the esthetics of the location. Approaches adapting to the circumstances of the current MSW and recycling system involve informal waste collection for community-adapted fees, door-to-door collection of recyclables in favelas and the creation of networks and partnerships within the informal sector. Pro-Poor Public-Private Partnership, where the local government employs favela residents to facilitate collection, fund cooperatives based on their specific needs and integrate them in the decision-making process, is recommended as approach for a larger systematic change. However, in the perspective of the widespread corruption in Brazil and slow development of the waste management system, the informal sector is urged to organize itself to join forces to improve the situation. The reliability and validity of the results could be increased by conducting more interviews, improving the interview and observation structures. Future research should focus on favela-specific improvement and the empowerment of cooperatives.

Keywords

municipal solid waste management, informal settlement, favela, waste picker, recycling cooperative, environmental protection, social inclusion, Rio de Janeiro

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Definition of terms

Catadore – The Brazilian word for waste picker or waste collector. A person who sorts, collects and sells material from waste to generate income.

CBO – Community based organization. CBO's are nonprofit groups typically staffed by local members of the community. They work to improve the lives of the residents of a community by addressing a big variety of issues such as affordable housing, environmental protection, youth homes and centers, humanitarian/disaster response et cetera.

COMLURB – Companhia Municipal de Limpeza Urbana. The municipal urban cleaning company of Rio de Janeiro city, responsible for the collection and treatment of all generated municipal solid waste in the city.

Cooperative – In the context of this study, a cooperative is a group of catadores, working together in a more or less organized way to collect and sell recyclable material from waste.

Favela – The Brazilian word for informal settlement. According to Catalytic Communities (CatComm) (2016a) the word favela is often wrongfully associated with the English word 'slum'. Each favela has unique history but is normally characterized by four common traits:

- They arise due to no affordable housing option in the formal city
- Built by the residents, brick by brick
- Not subjected to central regulation or oversight due to government neglect
- Low-cost, pedestrian-oriented street life, tight-knit communities and rich culture activities

Informal Settlement – According to United Nations Conference on Housing and Sustainable Urban Development (UNCHSUD) informal settlements are residential areas where:

“1) inhabitants have no security of tenure vis-à-vis the land or dwellings they inhabit, with modalities ranging from squatting to informal rental housing, 2) the neighborhoods usually lack, or are cut off from, basic services and city infrastructure and 3) the housing may not comply with current planning and building regulations, and is often situated in geographically and environmentally hazardous areas.” (UNCHSUD, 2015, p.1)

MSWM – Municipal Solid Waste Management.

Social Inclusion – According to UN (2016) social inclusion is the process of improving the terms on which people participate in society. For people who are disadvantaged due to their age, sex, disability, race, ethnicity, religion, origin, or economic or other status, this means enhancing opportunities, access to resources, voice and respect for rights.

1. Introduction

Today, informal settlements in the Global South are highly affected by severe environmental and public health issues originating from inadequate municipal solid waste management (MSWM) (Gutberlet, Kai, Nyakinya, Oloko, Zapata & Zapata Campos, 2017). Rapid population growth and urbanization are leading to rising waste generation rates around the world. By 2050, the generation rate is prognosed to have grown with 70% from 2.01 billion ton per year in 2016 to 3.4 billion ton per year. Therefore, MSWM is one of the biggest challenges of our time. Currently, about one billion people in the world live in informal settlements and lack access to basic services and city infrastructure (UN Habitat, 2018). One major issue in these areas is the absence of or inefficiency of solid waste management. Mismanagement of waste can have many adverse consequences such as soil and air contamination, surface water and groundwater pollution, marine litter and spread of vector-borne infectious diseases (Ferronato & Torretta, 2019). Proper waste management and recycling is of great importance for preservation of the environment and resources but also for the protection of human health (Ravindra, Kaur & Mor, 2015).

In 2010, the Federal Government of Brazil launched the National Solid Waste Policy (NSWP) (N°12,305/2010) to improve solid waste management and boost recycling and energy generation from waste. According to NSWP it is mandatory for municipalities to collect household waste through either municipal workers or outsourced to private companies and dispose in an 'environmentally sound way', such as in a sanitary landfill. In the city of Rio de Janeiro and its informal settlements, in Brazil called favelas, this collection service is provided by the municipal company COMLURB. Despite the seemingly proper collection service, waste is being disposed of in public spaces such as sidewalks, creeks, or open dumps, impacting the environment in the favelas but also water and nature around the city (Sanchez Garcia, 2018). As a result of the insufficient solid waste services in the favelas, several community-based organizations and initiatives have emerged to address the issue and, without any compensation, work with keeping the favelas clean and prevent the spread of diseases (CatComm, 2018a).

The NSWP establishes the systematic integration of waste pickers, in Brazil called catadores, and waste picker cooperatives in the MSWM and recycling system. Despite this, neither the Brazilian national policy (Brazil, 2010) nor the municipal waste plan of Rio de Janeiro has set quantitative goals for the recycling system (Municipal Secretary of Environment, 2016). The amount of recycled material in the city of Rio de Janeiro only reaches around 1-2% of the generated waste (Tirado-Soto & Zamberlan, 2013; Castro, 2019). This can be compared to cities in other developing countries where both collection services and resource recovery in terms of recycling greatly rely on informal workers, and where approximately 15-20% of the generated waste is collected, sorted and recycled by the informal sector (World Bank, 2019). Consequently, a development of municipal solid waste and recycling management in Rio de Janeiro is required.

1.1. Aim and research questions

The objective of the thesis is to examine the municipal solid waste management and recycling system in the informal settlements of Rio de Janeiro to identify main obstacles and challenges to its development. Furthermore, the study aims to suggest approaches that can give long term improvements of the management of solid waste in the perspective of social inclusion and environmental protection, at different entry points in the waste system.

To achieve the objectives the following research questions will be answered:

1. *How does the solid waste management system work in Rio de Janeiro in general and in the favelas in particular?*
2. *What problems and challenges do favelas around Rio de Janeiro encounter in terms of solid waste in their communities?*
3. *From the viewpoint of the informal sector, what are some of the main obstacles and challenges that hinder a more economically profitable and socially inclusive recycling system?*
4. *What are some possible approaches that could improve the solid waste management and recycling in terms of environmental protection and social inclusion?*

1.2. Scope and delimitations¹

The case study was geographically limited to the state of Rio de Janeiro, which includes the city (municipality) of Rio de Janeiro but also one neighboring municipality, Duque de Caxias. Though the majority of the field work and interviews were conducted in the city of Rio de Janeiro, Duque de Caxias was included since many cooperatives are located there.

Hereafter, unless otherwise stated, ‘Rio de Janeiro’ or simply ‘Rio’ refers to the city (municipality). If referring to the entire state of Rio de Janeiro, this will be explained.

¹ Delimitations are characteristics chosen by the researcher to define the boundaries of a study. The researcher makes inclusionary or exclusionary decisions of the delimitations while limitations normally are uncertain elements or weaknesses of a study which are beyond the researcher’s control (Simon, 2011).

2. Methodology

2.1. *Qualitative research and case study method*

The general aim of the thesis is to investigate, analyze and interpret - not to measure or rank - problems and mitigation possibilities around waste management in informal settlements. While quantitative research often aims to create usable statistics or numerical data, qualitative research seeks to interpret meaning from a variety of empirical data to describe, interpret and evaluate underlying reasons, opinions and motives for a targeted situation (Mohajan, 2018; Njie & Asimiran, 2014). For this reason, a qualitative research approach was considered to be most suited to answer the research questions. There are several methods through which one can conduct qualitative research; narrative study, grounded theory study, action research study, case study, phenomenological study, ethnography study, historical research, and content analysis (Mohajan, 2018).

Case study is a method which allows for the study of complex phenomena in their natural settings (Njie & Asimiran, 2014). It examines people, a place, event or phenomena to uncover hidden issues, find key themes and possibly predict future trends (University of Southern California, 2019). In comparison to the other types of methods, a case study is especially suitable when the aim of the study is to address descriptive or exploratory research questions, e.g. '*what is happening?*' and '*how and why is this happening?*' (Yin, 2011). Furthermore, the method is favorable when investigating a specific location, as it collects data directly related to the natural setting in a real-world context instead of using derived secondhand data (ibid). Since the mentioned aspects match the research questions and aim of this thesis well, the case study method was chosen as basis for the work.

The case study method can be used by studying one or several cases. Using multiple cases as basis for the results allows for a greater understanding of the cases as a unit or whole, by identifying similarities and differences between the individual cases (Heale & Twycross, 2018). The results and evidence from a multiple-case study is typically stronger and more reliable than that based on single case (ibid). With this as motivation, a multiple-case study was chosen as approach to reach the objective of this thesis. To conduct a multiple case study, there are six common used data collection approaches (Yin, 2011): Direct observations (researcher watches human (inter-)actions and/or physical environment), participant observation (under the name of 'a researcher' participate in the activities to be studied at the same time as observing), interviews (one or more depending on the case study), archival records (historical documents of the study subjects or environment), document studies (newspapers, articles, letters, emails etc), and physical artifacts (the collection or observation of materials, tools, instruments, work of art, or other physical evidence linked to the case). Depending on the relevance and nature of the case study, the researcher can use one or more of these data sources (Njie & Asimiran, 2014). The two main data sources chosen for the study was interviews and direct observations which are described more in detail down below.

2.2. Interview method

Interviewing as a data source was chosen for the study as it presents an opportunity to explore the experiences, opinions and knowledge of people with different relations to the solid waste management in the Rio de Janeiro's favelas. According to Seidman (2006) the purpose of interviewing is not to get answers to questions nor test hypotheses, but it is rather to understand and make meaning of other people's lived experiences. As he puts it (2006 p.14): "It is a powerful way to gain insight into ... issues through understanding the experience of the individuals whose lives reflect those issues". One can observe and register the actions of a person, group or occurrence, but interviewing allows for putting that behavior in context (ibid) and investigate things one cannot see (Wellington & Szczerbinski, 2007).

Research interviews are normally categorized as structured, semi-structured or unstructured. Structured interviews are typically used in surveys where the respondent answer close-ended questions and is instructed to not provide information outside what is specified (Brinkmann, 2013). One idea behind this standardized way of collection answers is to be able to compare between participants and possibly quantify the results (ibid). At the other end of the spectrum are unstructured interviews, which have little to no predetermined set of questions or structure. These interviews tend to be more free, spontaneous and guided by the respondent's answers. However, one weakness is the possible loss of reliability which might make it more difficult to find patterns and to draw conclusion from the responses (ibid). A semi-structured interview is a mix of the two mentioned types. Normally, the interviewer has a set of questions to guide the interview but is given more freedom to follow up on interesting angles or opinions raised by the interviewee. It also makes more use of information arising in dialogues apart from the questions. Compared to unstructured interviews, the researcher can more decisively focus the conversation around the issues which are important to the study to not get too much off topic (ibid).

In qualitative studies, semi-structured is the most common format of data collection (Jamshed, 2014). This approach was also chosen for the interviews for this study. The reason for this rather than structured or unstructured was that this would help guide the interview to focus on the research questions but also permit for questions to be added, removed or modified during the interview to clarify or expand certain issues.

There is no general guideline on how many interviews one should conduct for a multi-case study because it all relates to the size and aim of the study. Together with my supervisor it was decided that the number of interviews should not be too many too lose depth but not too few to lose perceptions on the problem. It was estimated that 20 interviews would make the interviews too shallow and data processing too large in relation to the time frame. Around 10-15 interviews were decided to be a reasonable number.

2.3. Observation method

Observation was chosen as another method to gather data as it creates direct access to some of the research questions and is able to create permanent evidence or record of the studied phenomena. Observations can be conducted using several techniques. As described by Wellington and Szczerbinski (2007), one can classify observations as a combination of ‘degree of involvement’ and ‘degree of structure’. For example, an observation where the researcher is completely immersed in the context and the study is completely hidden from the observation subjects, is called complete participant (ibid). On the other extreme is the complete observer, which can be described as a researcher taking on the sole role of observing with a completely detached perspective of the situation. In between these sides lie the observations which are made by a researcher taking a more or less active role (ibid). The direct observation approach is normally less time consuming than participant observation as the researcher can choose sampled situations and leave less important happenings out. Participant observations can take months or years to conduct because the researcher has to be accepted in the natural setting of the study to fully observe as someone apart of the natural phenomena (Stake, 2010).

The other scale is structure. On the one side, the researcher can enter any situation without any preset questions or structured themes to study, thus making a completely open-ended and unstructured observation study. On the other side, a pre-determined and systematic observation means entering a situation knowing exactly what to look for and how many times (Wellington & Szczerbinski, 2007).

For this study, the direct observation approach was chosen as data could be gathered through the interviews or site visits without having to arrange my active participation in their activities. Furthermore, direct observation would also allow me to more easily collect photos and videos with a specific purpose. However, it is difficult to know ahead of time what situations might arise and therefore it has to be taken into consideration that some participation will likely be inevitable. Furthermore, a multiple-case study makes it even more difficult to arrange equal participation in all cases. The structure of the observations was planned to be semi-structured, like the interviews. This means to look for some aspects of the solid waste issues in particular but also to be open to new information.

2.4. Ethical considerations in research

In research that use real people as a part of data gathering, there are several ethical aspects to be considered. According to the Swedish Research Council (2002) there are four main principles that need to be met for such research.

The first one is the ‘requirement of information’ for the participants. This means that the researcher has to inform the participant about their role in the project and on which terms they are partaking. They shall also understand that the participation is completely voluntarily and that they can terminate their participation at any time (ibid). The second principle is about consent. To fulfill this rule, the researcher has to collect the participants consent to partake and that the participant independently can decide if, how long and on what terms they want to

participate. In the case they want to stop, there shall be no pressure to make them continue or any negative consequences afterwards (ibid). The third principle is the rule about confidentiality. This means that the researcher shall make it impossible for outsiders or unauthorized people to access information from the study and identify individuals. In particular is this true for data regarding ethical sensitive information. What is ethically sensitive varies between countries, groups of people and across time but the starting point should be what the participants could perceive as unpleasant or offensive (ibid). Finally, the fourth principle determines that all data or information gathered should not be used for any other purpose than that of the aim of the research (ibid).

Furthermore, the value of the research results shall always be assessed or compared with possible negative consequences for the participants if there are any aspects of these rules that are difficult or impossible to meet. For example, if it is impossible to make a participant completely anonymous in the study the contribution of this person should be assessed with possible negative personal consequences.

In this study, these principles have been followed by sending each participant an email or message explaining the aim of the research, why their participation would be interesting and what their role would be. Before starting the interview, the participant's rights in relation to the interview and the information they shared were explained. They were also given contact information if they if they would like to add or modify anything in the material afterwards. All information gathered was stored safely with password-only access. All participants in the study were decided to be anonymous according to the ethical principles.

2.5. Literature study

Beyond the case studies, a literature study was done to widen the perspective of solid waste issues to informal settlements around the world. The sources for the literature study were, to the biggest possible extent, limited to articles and reports published no later than 10 years ago, i.e. 2009, since the field of waste management has gotten more and more attention lately, and especially when it comes to informal settlements. However, exceptions were made for data that could not be found within this frame.

The literature study was conducted throughout the work with the thesis. Platforms used for the search of scientific articles were LUBsearch and Google Scholar. The search included, but was not limited to, combinations of following words: municipal solid waste (MSW), solid waste management, integrated solid waste management, recycling, waste picker, cooperative, social inclusion, environment, informal settlements, slum, squatter settlements. The literature study also includes legal documents mainly found on the national and local governments websites.

2.6. Systems Thinking

To analyze data gathered from case studies one can use a so-called analytic framework. This means that the information is processed through a theoretical lens which relates the information in a certain manner. In this study systems thinking was chosen as framework when analyzing data. The reason for this is that it facilitates the process of understanding how the different parts

of the waste management and recycling system in Rio de Janeiro and its favelas are interconnected and work. The better understanding one has for its systemic behavior and the roles different actors play, the easier it is to understand what could be improved and how it could be managed more efficiently.

Systems thinking theory has already proved useful when analyzing waste management and behavior (Babader et al., 2016), urban household waste (Mashayekhi, 1993), for waste policy in developing countries (Bala, 2012) and integrated solid waste management in developing countries (Marshall & Farahbakhsh, 2013). In a study by Kum et al. (2005) system theory approach was used when assessing the potential of waste recovery through local small-scale informal recycling and composting solutions.

Systems thinking is a holistic analytical approach to problem solving based on the idea that components of a system can be best understood by how they are interrelated through different processes. Systems thinking is applied to a wide range of fields and can be used to identify root causes of malfunctions or resistance to changes in a system (Gutberlet et al., 2017). A system can be defined as a collection of elements that are related so that they form an orderly whole (Nationalencyklopedin, 2019) or as described by Kim (1999) “any group of interacting, interrelated or interdependent parts that form a complex and unified whole that has a specific purpose”. A system can thus be many things: a car, the central nervous system in the human body or a waste management system.

According to systems thinking, reality can be seen as an “iceberg” which is made up of multiple levels of perspectives: events, patterns and systemic structures (Van der Merwe, 2008). Events are occurrences that one may notice or encounter on a daily basis. For example, you miss the bus to work in the morning, a fire breaks out or your car breaks down. As can be seen in Figure 1, events are at the “tip of the iceberg” as they usually are easy to see or discover while the reasons for the occurrences are more concealed. Patterns are essentially the summary or the accumulated memories of such events: you miss the bus to work every day you slept too little, there is a raise in frequency of fires in certain areas or your car tends to break down every time the weather gets colder. Systemic structures are the underlying causes which generate the patterns and events that we observe (Van der Merwe, 2008). The structure of a system shows how the included parts are organized and can be both physical structures such as the way your car is constructed, or more subtle such as the way you go about your morning before going to the bus.

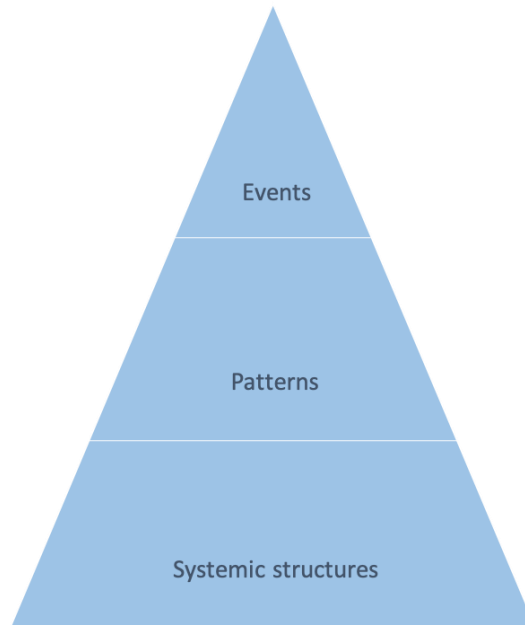


Figure 1 The "Iceberg". Systemic structures generate patterns which are manifested through the occurrences of events (Kim, 1999).

In order to make a lasting change in occurring events it is not enough to only react when an event already happened. For example, putting out a fire in one restricted area does not mean another fire will not break out some distance from that place. Making it to the bus by running does not help you to be on time the next day. Figure 2 shows the possibilities to alter events and patterns by acting according to different "action modes" which correlates to different levels of perspective (Kim, 1999). One can either act *in* the system, *on* the system or at a higher level which changes our view of the system in a bigger context. For example, if you look at the problem of missing the bus over a period of time you might notice a pattern, such as missing the bus on days you have a certain meeting.

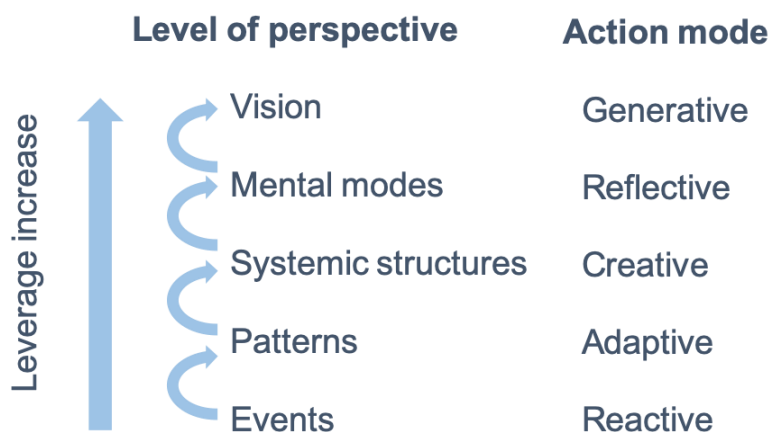


Figure 2. Depending on which level of perspective one decides to take action, the leverage one has on the impact of its outcome changes (Kim, 1999).

Taking adaptive actions in this case might e.g. mean that you adapt to that situation by making use of the time on the next bus. However, in order to not be late in the morning you might have to *create* a new or change your morning routine. Maybe the problem is not much about the routine but more about when you wake up, thus changing the system structure by putting the alarm earlier might be an appropriate creative action to decrease the probability of missing the bus. Yet, reflecting on whether an earlier alarm will actually make you reach the bus on time might be even more important. By rising above the systemic structure and e.g. posing questions such as “is the problem related to the fact that I do not like my job?” one can reach a higher perspective and *reflect* on a mental model level (Kim, 1999). On a vision perspective level, actions can be *generative*, i.e. bring something into being that did not exist before. In this case it could for example mean envisioning yourself having your dream job, realizing that in theory you do not even have to be restricted to a certain workplace or work hours – you can be your own boss. In summary, the further away from the system one takes action, the more leverage one has to change its outcome and influence future results (ibid).

In this study, systems thinking is used as an analytical framework to structure the outcomes from interviews, observations and literature study. This is necessary to distinct which mitigation approaches should be used when and which changes that are necessary to make a lasting improvement in the system.

3. Conducted work

3.1. Preparatory work

When conducting field work in Rio de Janeiro's favelas one has to take precautions about how, when and with whom one enters these areas due to safety reasons. Catalytic Communities (CatComm) is a non-governmental organization (NGO) that works for the empowerment of favelas in the areas of sustainable community development, human rights and urban planning, among others. CatComm has created and coordinates the *Sustainable Favela Network* (SFN) which includes many actors such as community leaders, community-based organizations (CBO), projects initiators or representatives. Through a collaboration with them I received all the help and knowledge needed to make necessary connections with participants and plan for a safe study.

When arriving in Rio I sat down with CatComm to decide the next steps to initiate my study. In accordance with their wish to focus on and prioritize CBO's and projects which were started and still run by residents who live in the same favela today, only such projects were contacted initially. However, as the case study continued and the role of actors that did not fall within this definition became increasingly clear and seemingly important, other projects and organizations were contacted.

Catcomm has guidelines for field work conducted by their collaborators and in accordance with them I always presented myself as a student or researcher (on Master's level) from Sweden who worked with Catcomm on waste related issues and recycling in favelas. In the emails sent out to possible participants I introduced my research topic more thoroughly and described why I was interested in meeting with them.

3.2. Observations

The observation studies carried out generally took place simultaneously as or in connection to the interviews. Due to increased risk of police raids or gang violence in the early morning hours or nights, interviews or observations took place no earlier than 9 am and no later than 5 pm. Observations were noted in text during visit and e.g. surroundings or interesting objects were recorded through photography. People were always asked before photographed. Prior to taking photos of the environment, I always asked the resident guiding me if it was permitted. In some cases where it was not allowed due to safety reasons, I received photos through WhatsApp afterwards. In these cases, it was naturally more difficult to control the content and quality of the pictures. To better remember impressions, situations or observations that neither could be captured through photography or by taking notes at a certain moment, I also recorded myself speaking about the visit directly after leaving. This was valuable as it gave me a good holistic reflection of the visit and also as certain details that could otherwise have been forgotten remained.

The length, type and comprehensiveness of the observations ranged all the way from 30 minutes to several hours depending on the availability of the person guiding me, the safety situation of the particular favela and how they would guide me. For example, in one favela I was only

allowed to “enter” with my guide, walk down one street to reach the place of the interview but not see anything else or talk to anyone else. Another visit I spent 4 hours in the community with the community leader, walking around taking photos of whatever I wanted, talked to whomever I wanted and was even invited to have barbeque and drinks with local residents on the street. Sometimes the guide would talk excitedly about the community, reflect on its current situation in context of other parts of Rio and history, others would be more passive and await questions from me. The nature of the observations is hence varying and inconsequent, although this fact is an interesting observation in itself.

3.3. Interviews

The interviews started with a brief introduction to my work and the purpose of the interview. I explained participant’s rights in relation to the interview and the information they shared. I reassured that they had my contact information if they would like to add or modify anything in the material afterwards, in accordance with the ethical principles established by the Swedish Research Council (2002). For 5 out of 11 interviews I used a translator. The first interview I did was without a translator as I thought the level of my Portuguese would be sufficient to hold a conversation about the subject. However, I decided to continue the rest of the interviews with a translator until I felt completely comfortable and confident that I could understand and express myself enough to allow a more giving and developed dialogue with the respondent. Every interview was recorded with a recording application on my phone. The questions for the interviews can be found in Appendix I and information about the interviewees can be seen in Appendix II. Some of the participants mentioned to have a sensitive relationship with the government. As I did not want to jeopardize that relationship, I decided to let all participants be anonymous, except COMLURB as this is a governmental body. The interviewees are in the thesis cited according to the number of the interview. For example, interview number 7 is cited (I7). Basic information about the interviews is found in Table 1.

How the interview was set up and took place differed between the cases. Usually I met with the person who was the president of an organization, in charge of a project or a respected community leader outside the favela to enter together. This happened on the request of me and CatComm as a safety precaution and this was always well received by the participant. In most cases the organization had a specific location or “headquarter” where we would go. The first visits I preferred walking around the community and organization location to get a better understanding and to avoid asking questions which would be better explained visually. However, I noticed that during these walks, a lot of information came up and many subjects were treated as we encountered interesting things. As I was not recording these conversations, data interesting for the study might have been compromised. This also led to some questions being removed from the interview to not waste the respondents time repeating him/herself and as a consequence of this all questions were not recorded the same way. When trying the opposite and doing the interview first I found, as suspected, that certain things that were best described in the field, e.g. in actual contact with daily activities such as sorting recyclables from waste, took longer to explain and to understand during the interview than it would have if I had started with observations. The areas in which the interviews and observations took place can be seen in Figure 3.

Table 1. Conducted interviews during the case study. Locations corresponding to the numbers can be seen in Figure 3.

Interview, type of organization (number of interviewees)	Date and location of interview or observation	Translator present?	Number on map
1. CBO (1)	March 14, 2019. Morro dos Prazeres	No	1
2. CBO (1)	March 29, 2019. Pavuna	Yes	2
3. Cooperative and community center	April 2, 2019. Observation at Vila Cruzeiro, Complexo do Alemão April 9, 2019. Interview close to Metro Uruguaiana	Yes (only interview)	3
4. Cooperative (2)	April 18, 2019. Maria da Graça	Yes	4
5. CBO (1)	April 30, 2019. Vila Kennedy	Yes	5
6. Cooperative and partner CBO (2)	May 20, 2019. Jardim Gramacho	Yes	6
7. CBO initiator and municipal environmental agent (1)	May 28, 2019. Vila Kennedy	No	5
8. Cooperative (2)	May 29, 2019. Jardim Gramacho	No	6
9. Residents' Association (1)	May 31, 2019. Asa Branca	No	7
10. CBO (3)	May 31, 2019. Complexo da Maré	No	8
11. COMLURB (1)	June 3, 2019. Irajá (not favela)	No	9

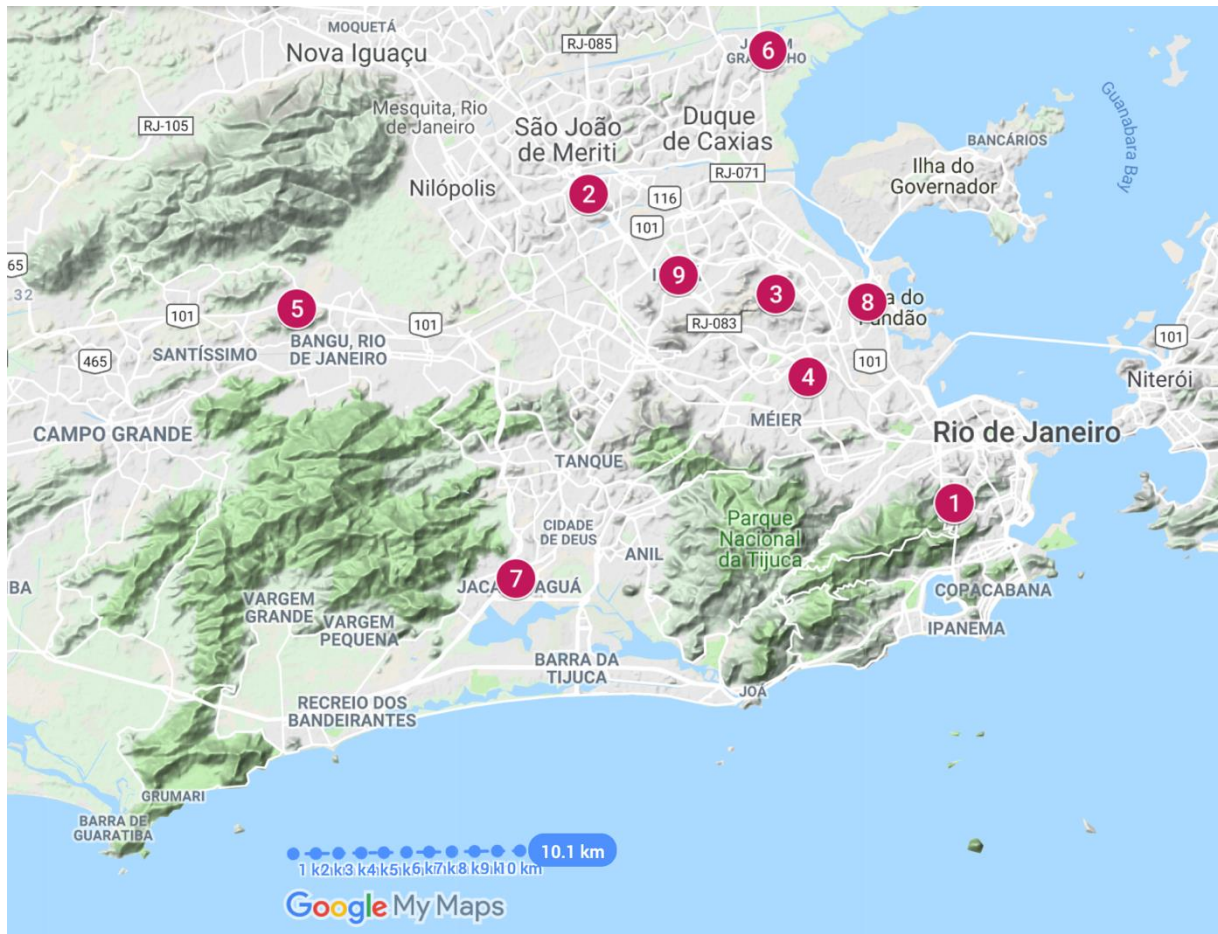


Figure 3 Locations of interviews and field observations. Source: Google Mymaps, 2019.

4. Background

4.1. *Rio de Janeiro and the history of favelas*

The state of Rio de Janeiro and its constituting 92 municipalities are home to approximately 17,2 million people according to the Brazilian Institute of Geography and Statistics (IBGE) (2019). The city (municipality) of Rio de Janeiro which, before the finalization of construction of Brasília in 1960, was the capital of Brazil, has around 6,7 million inhabitants (IBGE, 2018). It is also the city in Brazil with the most favela residents (CatComm, 2019a). In 2010, around 1,4 million people, one fourth of the city population (IBGE 2017), lived in the approximately 1000 (CatComm, 2019a) favelas dispersed around the city. The city is also home to the biggest favela in South America, Rocinha, see Figure 4. The population in Rio is a mix of the wealthiest people in Brazil and some of the poorest, living alongside each other. The city is divided into 5 zones, see Figure 5, and though there are several favelas in the more expensive south and central zones most of the urban poor live in the west and north zones, hours of commuting away from the city's wealthier zones. Favela residents usually work in the formal city with service professions such as in shops, restaurants, bars and cleaning (Al Jazeera, 2014) often to a minimum salary of BRL 998 (USD 240) (Ribeiro and Soares, 2019).



Figure 4 View over Rocinha from the top of the mountain Morro dois Irmãos. Rocinha is the biggest favela in South America. Photo: Emma Bergman 10/3/2019.

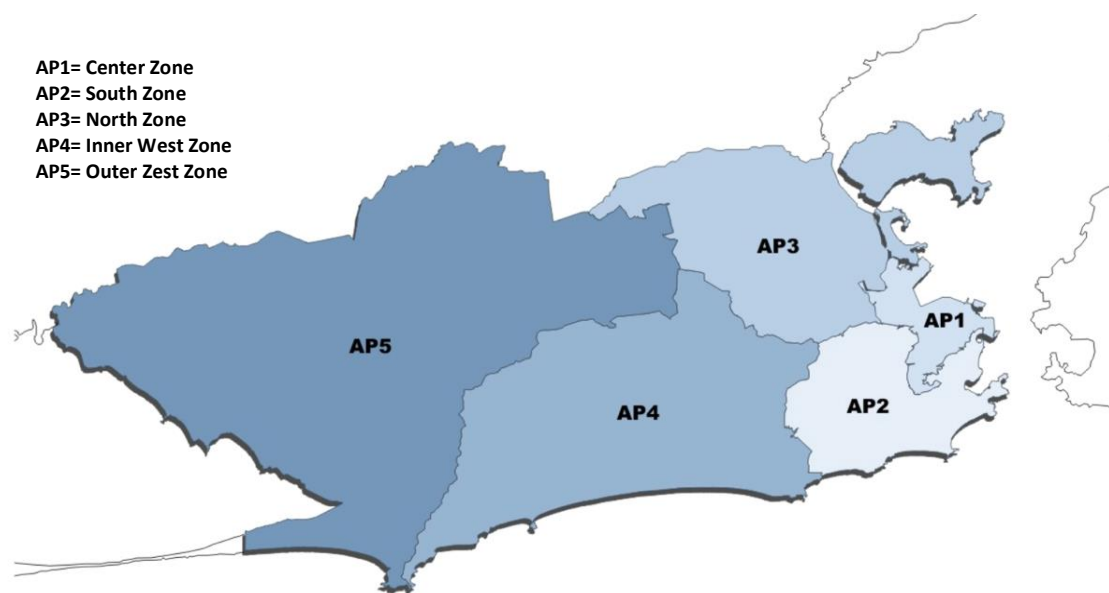


Figure 5. Rio de Janeiro municipality is divided in 5 planning areas (AP). Most of the urban poor living in favelas live in AP5 and AP4. Source: COMLURB (2019).

The word ‘favela’ originally comes from the name of a plant. After the Canudos War 1895-1896 in Bahia, soldiers migrated to Rio after promises of land in the capital (Valladares, 2006). The promises were broken, and they settled on a hillside next to the city instead. The place was named Morro da Favela (Hill of the Favela), after the plant which is common in Bahia. Today, the community is called Morro da Providência and is considered the first favela in Brazil (ibid).

As the industrialization grew bigger in Brazil at the end of the 19th century, more and more people moved to Rio in the search for work. This is one of the main causes of the large expansion of these urban areas (Pino, 1997). In the early 1980s, the country gradually transitioned from a military rule to a republic with numerous political changes (Skidmore, 2010). Due to housing crises and the shifting political environment, the favelas underwent further development as more of the urban poor were forced to move to the informal areas (Pino, 1997). The favelas were neglected by the state and government up until the 1940s when they began attracting national and local political attention. Politicians started to use poverty minimalization in their campaigns by e.g. providing modern public housing units as option to the informal settlements in favelas they believed generated diseases, crime and moral corruption (Skidmore, 2010). After the 1980s, as a result of increased drug trade, the situation in the favelas became increasingly complex. Violence between the police force and criminals increased, which exposed and still exposes many local civilians to danger. Though the environment in the favelas is different from most parts of the formal city, the local residents like it there. According to a survey conducted in 2013, 85% of the favela residents in Rio are happy about where they live and 70% would continue to live where they are, even if their income doubled (CatComm, 2019a).

Expansion of favelas occurs spontaneously and is considered unplanned (Al Jazeera, 2014). Houses and buildings are generally constructed and built by the residents themselves without

support from the government (Chokyu & Dias, 2018). Favelas have been increasingly debated during the past century and the image of them are often associated with words such as ‘violence’ and ‘social problems’. How they are portrayed by media, academics, politicians et cetera highly influence how they are perceived by the public. Up until the 1970s, little information about favelas can be found in historical documentation, revealing how neglected these areas have been (Pino, 1997).

Recently, favelas have started to be renowned for the vibrant, cultural and creative places they are. With increasing world urbanization, the qualities and values on which the favelas are developed have caught the attention of architects, city planners and sustainability experts around the globe (CatComm, 2019b). Due to limited financial resources favelas are built on collective action where residents work together to improve their living conditions. The pedestrian oriented infrastructure and creation of mixed-use buildings, e.g. shops on the floor level and home above, are sustainability aspects representing the favela better than the formal city. They are well developed city-like communities with their own arrangements of shops, schools, markets, playgrounds, public-transportation, clubs, bars etc. Moreover, the buildings in favelas are not unsteady shacks. A study conducted in 6 favelas found that 95% of favela homes are constructed with reinforced steel, brick and concrete. They have electricity, toilets and running water, even though the sewage system is not well developed (CatComm, 2019b). Figure 6 and Figure 7 show what streets and alleys can look like, this is in Asa Branca.



Figure 6 An alley in the favela Asa Branca. Photo: Emma Bergman 31/5/2019



Figure 7 A street in the favela Asa Branca. Photo: Emma Bergman 31/05/2019

In some areas where favelas have been built or grown tightly side by side, a so called ‘complex’ (‘complexo’ in Portuguese) has been formed. For example, Complexo da Maré in Rio’s north zone is made up of 16 favelas which are separated by the division of territories by drug cartels operating in the complex. In other areas the boarder can be made up from physical barriers such as forests, formal city neighborhoods etc. The geographical boarder is not always distinct to neither the residents nor people from outside the favela while complexes are more easily found on e.g. maps. This is also why the official numbers of favelas differ among sources. In 2010,

the City government reclassified favelas and established that there were at the moment 625 favelas in Rio instead of around 1000, in order to facilitate management (Osborn, 2013). Figure 8 shows a portion of Complexo do Alemão, and Figure 9 shows a collection point in the favela Cordovil, both located in Rio's north zone.



Figure 8 A portion of Complexo do Alemão in Rio's north zone. Photo: Emma Bergman 2/4/2019.

Today, 38 of the favelas have been pacified (CatComm, 2019a). This means that they have an established Pacifying Police Unit (UPP) in the base or entrance of the favela or complex with the aim of making the streets safer and removing visible manifestations of the drug business. The UPP program started in 2008 and since then the presence of these units has also come to represent forced occupation (ibid). Many favelas are also run by so called paramilitary gangs, in Portuguese ‘milícias’, which are groups of former and current professionals with the right to bear arms such as police officers, fire fighters or prison guards (The Brazilian Report, 2019). The militias are known for their organized criminal activities and violence and present a threat to public security by running favelas by their own set of rules. For example, they impose fees on the residents to “keep the streets safe”, provide internet or electricity. For the first time militias have been addressed as a target of the state in the anticrime plan presented by the Minister of Justice (ibid).



Figure 9 A waste collection point in favela Cordovil in Rio's north zone. Photo: CatComm (2016a).

4.2. Law and regulation in Brazil

4.2.1. National law

In 2010, the federal government of Brazil launched the NSWP (N°12,306) (Brazil, 2010) to improve waste management and boost recycling and energy generation from waste. The law consists of 15 goals to protect the environment and public health and simultaneously generate better results by developing sustainable actions through better services and social inclusion of waste pickers.

The process of passing the NSWP took over 21 years. Lack of consensus between government, civil society and the private sector regarding the model of the post-consumption responsibilities was one of the main reasons for the slow progression (da Silva & Bolson, 2018). Defining the responsibilities of the actors of the system such as manufacturers, importers, distributors, consumers and holder of public services was another (ibid).

The national solid waste policy is based on four ground pillars: shared responsibility, reverse logistics, sectoral agreements and inclusion of catadores and cooperatives, see Figure 10.



Figure 10. The National Solid Waste Policy in Brazil is based on four ground pillars.

Shared responsibility means that all actors in the system such as manufacturers, importers, distributors, marketers, consumers and holders of public urban cleaning services, have their specified responsibilities within the system. The responsibilities are concretized in the law through individualized and interconnected duties for respective actor. For example, municipals are obligated to provide waste collection services and treatment while it is the duty of the consumer to properly dispose of the products after use. The aim is for the actors take legal responsibility to enable a functioning and reliable waste management system to minimize the volume of generation of waste, reduce impact on human health and increase environmental protection (Art 30 – 36th).

‘Reverse logistics’ is the Brazilian term for a take-back system. According to Art 33rd of the NSWP, manufacturers, importers, distributors and marketers are required to structure and implement a reverse logistics system, independently of public service urban cleaning and solid waste management, for the following post-consumer products: pesticides, their residues and packaging, batteries, tires, lubricating oils, fluorescent bulbs, sodium and mercury vapor bulbs, and mixed-light bulbs as well as electrical and electronic products and their components.

Above this, due to the extensive impact on the environment and public health such reverse logistics systems shall also be extended to include plastic-, metal- and glass packaging, as well as other products and packaging with comparable negative impact (Art 33rd). The collection of products included in reverse logistics is in Brazil called “selective collection”. The manufacturers, importers, distributors and marketers are required to take all necessary measures to ensure the implementation and operationalization of such system. They are not only obligated to manage post-consumer material but also have responsibilities that encompass investment in the development, manufacturing and marketing of products restricted in volume and weight. They must also design products to be technically suitable for post-consumer reuse or recycling, reclaim these products after use for sound environmental disposal and, when required by or in accordance with the municipality, participation in actions established in the municipal integrated solid waste management plan (ISWMP) (Art 30-32nd). However, as concluded in Art 33rd §7 the utmost responsibility of the manufacturers, importers, distributors and

marketers is the “environmentally sound disposal” of the solid waste. This means that in the end, it is legal for these actors to dispose of the waste in sanitary landfill.

One way of creating reverse logistics systems is through sectoral agreements, representing the fourth pillar. Sectoral agreements mean that representatives from different sectors such as manufacturers, importers, distributors and marketers enter into a contractual agreement with each other or government(s) at national, regional, state or municipal level. However, no municipal or state agreement can alter the obligations of these actors on a national level. For example, the law established that, if compensated accordingly, a municipal waste management company can offer services that otherwise fall upon these actors in the system. This means that the post-consumer products in the reverse logistics system and glass-, metal- and plastic packaging can all be collected and handled by the municipality instead (Art 36th). To promote sustainable development the federal government can grant financial aid to initiatives that help improve solid waste management according to certain prerequisites. (Art 42nd; Art 44th).

The fourth pillar, inclusion of catadores and cooperatives is recurrent throughout the NSWP. In programs, actions, arrangements or planned measures, catadores, cooperatives and associations of them should be included, or at least considered. For example, the holder of public urban cleaning and solid waste management services shall prioritize the engagement and support of the cooperatives in their service provision. This means including them in the establishment of state and municipal solid waste management plans, implementation of selective collection systems and sectoral agreements (Art 36th). As a result of the establishment integration of catadores and cooperatives in the solid waste management, many committees and programs were formed to facilitate the implementation the law. For example, the Pro Waste Picker Program was created to integrate and articulate the acts of the Federal Government and to support and promote the organization of waste pickers by improving working conditions, social and economic inclusion and thus enhance recycling activities (Government Secretariat, 2019a). By structuring cooperative and association networks, The Strong Waste Picker Program aims to enable integration of cooperatives in the recycling market and to add value in the solid waste chain (Government Secretariat, 2019b).

4.2.2. State and Municipal law

Using the NSWP as a basis, it is up to of each municipality to establish and implement a solid waste management plan. If a municipality would like access to resources from the federal government, the municipality has to implement an ISWMP (Ministry of the environment, 2019b). These plans can be developed at inter-municipal, state, micro-regional as well as metropolitan or urban levels to overcome barriers such as inadequate competence, knowledge or insufficient financial capacity if needed (Art 14th). The definition of integrated solid waste management is:

“Any set of actions directed towards the search for solutions for solid waste, to consider the political, economic, environmental, cultural and social factor, with social control and under the premise of sustainable development”

(Federal law 12,305/2010 Art 3rd - XI)

The ISWMP in Rio de Janeiro was established 2008 through the Municipal law n°4969 but updated in 2016 for the period of 2017-2020 (Municipal Secretary of Environment, 2016). Objectives of the plan, among others, are:

I – Incentivize selective collection, the reuse and the recycling, ensuring the reduction of the solid waste generation;

II – Define the role of the private sector and the civil society in the waste management and their responsibilities in the complying of the objectives of environmental policy of the city;

III – Generate social benefits and the pursuit of economic sustainability of the services connected to the waste management, moving the sustainable development;

IV – Create mechanisms of generation of employment and income, promoting the social inclusion of the scavengers of recyclables;

V – Incentivize government partnerships with organizations that allows optimization of the integrated management of solid waste;

(Municipal Secretary of Environment, 2016 p.6-7)

The plan seeks to explain and clarify the policies and actions implemented for reduction, reuse, selective collection and recycling of solid waste in the municipality. Here it is explained that the recyclables gathered by COMLURB in the Selective Collection System are distributed only to a few cooperatives or associations of catadores registered by the municipality. The program *Extension of the Selective Collection of the City* aims to expand the collection services to all 160 neighborhoods in the city, promoting the inclusion of catadores and increase recycling up to 5% of the generated recyclables. The program aims to create 6 sorting centers before 2020 with up to 200-300 catadores employed in each center. Each center would be managed by catadores trained by COMLURB through the program *Training and Support in the Self-Management of the new Cooperatives that will occupy the Sorting Centers* which is funded by the Brazilian Development Bank (ibid). The *Program of Solidarity Selective Collections* and the *Program of Expansion of the Selective Collection of the City* aim to increase the inclusion and representation of catadores, cooperatives and related associations in the decision process of projects related to solid waste and recycling. Programs and actions for favelas established in the ISWMP include developing the relationship between municipal management bodies and community leaders to minimize improper disposal of waste by increasing and improving access to collections points for the residents but also to facilitate for collections services. In a few favelas with Pacifying Police Units, the *Alternative Selective Collection Program* has been implemented. The program is a collaboration between municipal management and administration bodies, private companies, NGO's and favela residents which aims to increase separation and collection of recyclables through so called *Ecopoints*. This allows for generation of job opportunities and income for residents who engage in the collection and sale activities. Another initiative implemented through a collaboration between the municipal electricity company LIGHT and favelas is the *LIGHT Recycle Program* where favela residents can get a deduction in the electricity bill by giving away recyclable materials (Municipal Secretary of Environment, 2016).

Yet another plan is the *Release of the Selective Collection and Population Awareness* which conducts environmental educational campaigns directed towards the civil society such as school actions, actions for condominiums and residents' associations, information campaigns in public spaces such as buses, subways and trains, TV campaigns and events regarding solid waste. The ISWMP also proposed tax exemption for companies processing or reclaiming recyclables from the generated solid waste and other tax incentives to encourage the use of recycled material in the production chain (ibid). Other programs aiming to minimize waste in the street is the population awareness program *Zero Waste* by which littering is fined and the *Zero Coconut* program which specifically aims to recycle coconuts (Municipal Secretary of Environment, 2016).

Regarding the reversed logistics system mentioned in the NSWP, on November 1st 2018 State law N°8151 came into existence which establishes and clarifies the responsibilities of the actors involved in such a system (LegisWeb, 2018). The law applies to all packaging and products consumed in the territory of the State of Rio de Janeiro, regardless of materials used and where it was produced (Art 1st §1). The law states, just as in the NSWP, that the complete responsibility and financing of such a system fall on the producers, importers or retailers of packaging or packaged products (with the exemption of certain actors) and shall be carried out primarily in partnership with cooperatives and associations of catadores through actions, programs, investments, technical and institutional support (Art 3rd). Cooperatives or associations may receive, directly or indirectly, investments from the private sector. All actors involved in the system may enter into trade organizations, agreements, partnerships or contracts in order to facilitate compliance with the law (Art 10th). It is also the responsibility of mentioned actors to promote and finance environmental awareness campaigns to help consumers prevent waste and properly separate packaging after use. Provided that the municipal governments hire cooperatives or associations to provide the domestic collection services of recyclables, they may be financially compensated or benefit from investments in equipment, infrastructure, programs and projects that derive from the responsible actors (Art 12th).

Six months after the entrance of this law, i.e. May 2019, the companies or trade organizations had to present a *Goals and Investment Plan* which has to declare investments to be made every other year in the coming decade in: implementing Voluntary Delivery Stations (VDS) - locations for the reception, control and temporary storage of post-consumer waste delivered by consumers - and sorting centers; training, technical and operational support to cooperatives and associations; payments for the services provided by the same and processing and marketing of recyclables. The plan must also include the biannual targets for the collection of recyclables which shall increase with 10% biannually (Art 11th; 13th Art). However, besides the aim for the program '*Extension of the Selective Collection of the City*' to recycle 5% of generated waste, no quantitative goal has been found for the recycling rate in the city or state of Rio in this study.

Every year, responsible manufacturers, importers and distributors and/or trade organizations have to report and inform the public about the quantity of these material put on the market in the state of Rio de Janeiro and the percentage actually sent to the recycling industries. Within the frame of this study, no such reports have been found. Actors who are not participating in

accordance with their responsibilities can be reported to the State Secretary of Environment and the State Public Prosecution Service and be subject to sanctions (Art 5th §3).

4.3 Global aspects of MSWM in informal settlements

Today, informal settlements in the Global South are highly affected by severe environmental and public health issues originating from inadequate solid waste management (Gutberlet et al., 2017). Mismanagement leading to open dumping or open burning of municipal solid waste are recognized to have the following impacts in informal and formal areas in developing countries: visual impact, odors, greenhouse gas emissions, soil and air contamination, surface water and groundwater pollution, marine litter and spread of vector-borne infectious diseases and transmitting hazardous substances to humans (Ferronato & Torretta, 2019). When formal systems fail or fall short of providing basic services such as collection and removal of waste, communities begin to depend on CBO's, NGO's, microentrepreneurs, individual waste pickers or cooperatives to fill these gaps (Gutberlet et al., 2017). One reason for the insufficient waste management systems found in many developing countries is that it is one of the most costly urban services. Managing solid waste has been found to cost around US\$75 or more per capita per year (Brunner & Fellner, 2007; Wilson, Rodic & Scheinberg, 2012). It requires up to 1% of the GNP and around 20 - 40% (UN-Habitat, 2010a) or even 50% (World Bank, 2019) of a municipality's revenues go towards the waste management system, depending on the coverage and services provided. Logically, financing might be one of the biggest restraints for its improvement. In spite of the big capital spending on the system, large areas of cities remain without any type of collection. In developing countries, this leads to a big portion of the waste generated in urban areas being wrongfully disposed of in nature (ibid). However, even if a city has the financial capacity, improvement of the waste management system also relies on addressing other underlying issues relating to labor practices, accounting, management structures, contracting procedures and corruption. A clear and transparent institutional framework is fundamental for a successful solid waste governance (Wilson, Velis & Rodic, 2013).

In a study by UN Habitat (2010a) based on data collected from 20 cities in developing countries, it was found that recycling rates of 20-30% (weight) are achieved by the informal sector at no direct cost to the city or municipality. This presents an opportunity for all key stakeholders and is especially beneficial for the urban poor (ibid). In fact, by handling such quantities of recyclable material, that otherwise would have had to be collected by the city, the informal sector is in one way subsidizing the rest of the city. It has been shown that 20% or more of a city's waste management budget can be saved thanks to the activities of the informal sector (Scheinberg et al., 2010, 2011). The work of the informal sector is in line with the principles of circular economy as it directly contributes to the minimization of environmental pollution and recovery of materials (Ferronato & Torretta, 2019). Circular economy characteristics include recovering waste to avoid disposal to prevent the use of virgin material and generating income, along with other sustainable aspects. According to Ferronato and Torretta (2019) the inclusion of the informal sector is then a way to improve the circular economy models of a region and hence improve the social, environmental and economic stability. However, the work carried out by the informal sector is often labor intense with low profits in an unhealthy work environment.

Exploitation from middlemen and occupational health risks need therefore to be addressed to increase sustainability (ibid). The strategic inclusion, support and improvement of their rights in a city's waste management system presents a win-win situation with environmental, public health and social inclusion benefits on top of economic (Scheinberg et al., 2010; 2011).

In a city with informal settlements, changes or new initiatives in the waste management system should build upon the already existing practices performed by waste pickers, entrepreneurs, recyclers and CBO's in the communities, according to Gutberlet et al. (2017). Wilson, Velis and Rodic (2013) believe that the challenges of improving or further building upon these informal systems can be overcome but need persistency and a systematic approach. Though informal movements and community-based organizations are gradually acknowledged around the world, few governments include their role in waste policies, and even fewer actually realize what the policy says (Gutberlet, 2015; Zapata & Zapata Campos, 2015). In Brazil, the national solid waste policy does include the integration of waste pickers, but the reality rarely reflects this (Gutberlet, 2015). Not integrating the informal sector can seriously undermine the systems based on producer responsibility, i.e. the success of such a system can be connected to the failure or accomplishment of waste picker integration (OECD, 2016). It is also emphasized that a key aspect is early inclusion in the system instead of focusing on rescuing material downstream the waste chain (ibid).

Today, the formation of recycling cooperatives is more and more common. According to da Silva and Bolson (2018) it was found that catadores who work for themselves by themselves by picking material in the streets, benefitted from joining or starting a cooperative. The organization of the work the catadores do, profited the purchasing/gathering, recycling and selling of material. Not only did the catadores experience improved social and economic conditions, but also a stronger political position. For example, it was concluded that by joining movements that are concerned with the same work, they started to comprehend the essential role they have in protecting the environment and their rights (ibid). Yet, it was concluded that cooperatives have structural and technological restraints that limit the possibility to include more catadores. The cooperatives faced problems with paying rent, storage and working space, lack of equipment and maintenance, which, according to the author, could be improved by relationships built by public authorities (da Silva & Bolson, 2018).

In a study by Tirado-Soto and Zamberlan (2013), strengthening of cooperatives could be done by creating cooperative networks. This was shown through the work of the, at the time, only big cooperative network in Rio de Janeiro, REICLARIO. The network formation boosted interaction with public authorities, recognition by society and increased possibility of communication with actors in the private market and educational and financial institutions. For example, the network is able to directly negotiate joint sales of material to get better prices. Though, one challenge recognized in networks is the infrastructural and capital limitations of the cooperatives to deliver the amount of material necessary on a regular basis to enable joint sales. The authors promote funding of these cooperatives by the city government. As the cooperatives provide cleaning services and minimize the cost for landfill disposal, this can be completely justified from a budgetary point of view, according to the authors (ibid).

Though municipalities normally are legally responsible for the sound treatment of solid waste in cities, it is supported that they should seek the active participation of other stakeholders in its management (Wilson, Velis & Rodic, 2013). The priority of any waste management system should be to extend the collection service to cover the whole city. In cases where the municipal services lack the capacity to do so, inclusivity of other actors is an important option (ibid). One way to include other actors and create livelihood for the most marginalized in society is by adapting the concept of Pro-Poor Public-Private Partnerships (5P's), according to the Asian Development Bank (ADB) (2019). The approach is highly based on inclusivity and promotes the investment arrangements between the local government and the informal sector. It strengthens the rights of the informal sector and encourages micro- and small enterprises to provide needed services. In this way it is possible to address the issue of providing sufficient waste services to poorer communities in an effective and just way (ibid).

Using the 5P's approach means taking certain steps to ensure the best possible implementation of such partnerships between the local government and informal sector. It is e.g. important to collect data from low-income groups in the city's informal settlements about the preferences and current access to waste and recycling services. These data should then be used as a guideline, establishing targets and the baseline for progress measurement in these areas (ibid). A key aspect of the pro-poor partnerships (PPP) is that the operators, i.e. actors in the informal sector or micro-enterprises, do not have any responsibility of financing the operations or to invest in the system. This means that all resources, except specific expertise, shall come from the public sector and the organizations can make best use of these (ADB, 2019). Such resources include support for storage, equipment, removal and transport of recyclables from sorting points and the help to promote the collection services (Tirado-Soto & Zamberlan, 2013). In many developing countries, the informal recycling activities are completely dependent on the market value of the materials. This leaves them vulnerable and subject to fluctuating markets, affecting their livelihoods (Wilson, Velis & Rodic, 2013). The pricing structures of the PPP's must therefore be arranged in a way to guarantee that the local organizations can make profits (ADB, 2019).

One example of a successful pro-poor partnership is the one between the city of Mumbai, India, and three local organizations of waste pickers. The organizations are registered with and recognized by the city to issue identity cards to waste pickers and have by contractual arrangements been provided with vehicles for collection of recyclables and a space for recycling activities (Visvanathan, 2012). Another example is the city of Iloilo in The Philippines. Here, a pilot project which aimed at including the informal sector in transforming organic waste to an energy source in the form of biomass briquettes, was implemented. The project was between international NGO's and shows that integration of waste pickers can be an option to create renewable and cost-effective fuels (Romallosa & Kraft, 2017). Furthermore, in the municipality of Moshi in Tanzania several different models of service delivery have been tested through pilot projects. Today the waste services are run by both the local private sector as well and CBO's, which provide collection in the area's informal settlements (Wilson, Velis & Rodic, 2013). The city has a stakeholder platform on solid waste through which they create strategies and action

plans. Thanks to the collaboration of the stakeholders, Moshi has won the title of the cleanest city in Tanzania for many years. The success of the system is also much related to a wide commitment by the municipal council and citizens (ibid). According to Velis (2017) this type of door-to-door collection has been recognized as one of the best solutions to also increase recycling rates. Including the informal sector to deliver this service will bring essential environmental benefits as well as giving the workers a chance to be an agent of behavioral change (ibid).

Though waste collection services can be carried out by a variety of actors, the problem of improperly disposed waste continues to be a big problem in the informal settlements around the world (UN-Habitat, 2010a). There are ways to combat this problem which do not necessarily involve a heavier demand on the formal collection system. Fitchett (2014) studied the upgrading of a street in an informal settlement in Johannesburg, South Africa. The project resulted in some parts of the street being paved with recycled bricks, toilet structures painted and repaired, cleaning streets from litter and the installation of a new, painted waste bin. The outcome of the study supports the theory that people take pride in what is beautiful and help keep it in good condition. The study also suggests that residents of informal settlements use recycled material in an effective and efficient way by exploring the specific features of a material, rather than being hindered by a mentally predefined idea about the outcome (Fitchett, 2014). This is supported in a study conducted in Kisumu, Kenya, where it was found that an important part of the income generated by recyclable material was through the processing of this material into new, sellable goods through handicraft (Gutberlet et al 2017). For example, VCR tapes and polyethylene were made into handbags, beer caps turned into earring and paper to necklaces. When implementing a re-use or recycling project in informal settlements, Fitchett (2014) highlights a process that defines the problem along the way together with the local residents, rather than a predetermined outcome. This is done by exploring available material and techniques, experiment with a pilot project, revise and then expand gradually, always adapting to challenges and new opportunities.

Another way to combat improperly disposed waste in a community is through clean-ups. Clean-ups are in many informal settlements a way to improve the direct environmental conditions and in some of the poorest communities, clean-ups might even be the only existing initiative to keep the accumulation of waste to a minimum (Gutbertlet et at., 2017). A clean-up is normally arranged by members of the community, CBO's or NGO's and is a collaborative and joint effort by residents and volunteers. However, the participation and engagement of residents can be small unless there has been political campaigning, or if there is no other incentive for the partakers such as refreshment or gifts (ibid). In some informal settlements, there is no need for such clean ups even if there is no formal collection system. For example, in the city of Bamako in Mali, over 120 micro- and small enterprises provide primary collection of solid waste for a community-adapted fee, and is an invaluable part of the service system, accounting for the collection from approximately 57% of the households (UN-Habitat, 2010a).

The access to similar services provided by groups or organizations outside the formal system differ for various reasons. Tukahirwa, Mol and Oosterveer (2011) studied how socio-economic

and perception factors as well as social and spatial proximity to NGO's or CBO's influenced access to sanitation and solid waste services in 12 informal settlements in Kampala, Uganda. The result showed that the parameter of trust as social proximity is the most important aspect for access, i.e. the higher trust one has for the CBO, the more likely it is to access the solid waste service. According to the authors, this might be because the use of a service requires some degree of trust in the ability of the provider to do a good job. The perceived competence of the CBO proved to be another key factor, meaning that a household is more prone to use the service if it thinks the CBO possesses sufficient competence. The cost of the service had a negative effect on the access, which can argue that households in the informal settlement with higher income will have better access (ibid).

In settlements where there is a frequent collection, but the service might not be sufficient or cover all areas, accumulation of waste in nature can be addressed differently. For example, the city can hire community waste pickers to be responsible for keeping the area around container or collection points clean (UN-Habitat, 2019). Having discussions with the residents about where to place collection containers to best suit their needs or providing spaces where waste pickers can sort materials without being harassed, could also help minimize the scattered waste (ibid). It has been shown that communities that face issues with waste do not understand why there is no collection or why the collection is so irregular or untidy. It is therefore important that local governments are transparent when it comes to the reasons why a certain area is more affected than others (Gutbertlet et al., 2017). Improperly disposed waste can also be a result of the miscommunications between the local government and residents. The lack of understanding from the government on where to best place containers in the community can lead to the residents not participating in the desired way (UN-Habitat, 2010b). Reasons for residents not participating in the desired way include too long walking distances, difficulties reaching the container, e.g. a container placed on the other side of a busy street, and the general dirtiness of the community which makes the local residents not caring about where they place the waste (ibid).

To conclude, improving solid waste management is a major challenge for developing countries, and particularly in informal settlements. A key aspect is to integrate the informal workers in the formal system, focusing on systematic, early inclusion instead of rescuing material downstream the waste chain. However, there is no exact universal answer to the problems. Rather, solutions should be developed in a local context tailored to the needs and conditions of the specific place.

5. Results

5.1. *MSWM and recycling in Rio de Janeiro city*

This chapter aims to answer the first research question:

1. How does the solid waste management system work in Rio de Janeiro in general and in the favelas in particular?

It is divided into two parts to facilitate the description of the system: mixed waste and recycling.

5.1.1. **Mixed waste**

The Municipal Urban Cleaning Company COMLURB (Companhia Municipal de Limpeza Urbana) is responsible for the collection and treatment of solid waste in all areas of the city of Rio de Janeiro, meaning the formal city as well as in the favelas. Though COMLURB legally is only responsible for everything that does not fall into the category of hazardous waste or producer responsibility, they end up collecting essentially all type of generated waste if needed, in an effort to keep the city as clean as possible. Ideally, the mixed household waste should only include things that are neither hazardous nor that go into the selective collection system. However, as neither of those systems are well developed the waste originating from households includes a variety of such products.

Approximately 10 000 ton solid waste, including recyclables, is generated in the city of Rio de Janeiro every day. The formal city has domestic collection pick-up three times a week. Collection takes place Mondays, Wednesday and Fridays or Tuesdays, Thursdays and Saturdays, depending on the neighborhood. Public spaces such as parks, roads and beaches are cleaned daily. Some residential buildings place the waste in containers, but it is common that waste is placed directly on the curb in black plastic bags. The law does not obligate waste generators to put waste in containers while waiting for the pick-up service (I11), neither in the formal city nor the favelas. As can be seen in Figure 11 waste is sometimes even be put on the curb without any bag. In the favelas, collection instead occurs every day or even twice a day. This is because waste ends up on the streets due to residents not keeping the waste inside the house until it is the selected day of pick-up (I11).

The collection of waste in the favelas is similar to that of the formal city, the difference is the equipment used and the frequency. Usually, the roads in the favelas are smaller and more difficult to navigate than the roads in the formal city. This means that the trucks cannot always enter the favelas, resulting in collection being conducted through smaller equipment such as mini-trucks, vans, motorcycles or cycle-cars. These vehicles circulate the favelas and pick up waste at specific collection points in e.g. smaller plastic waste containers but also in a more unorganized manner where they stop along streets to pick up waste where it is necessary. On roads with more businesses and movement larger open containers are also placed so people can throw their waste instead of leaving it on the street (I11). In contrast to the formal city, COMLURB does not normally use planned routes when picking up the waste in many favelas, unless they are urbanized and flat, like Complexo da Maré (I11). In most of them that have narrow and informal alleys (alleys without name), no maps exist (I11).



Figure 11 Household waste from a residential building put on the street for pick-up by COMLURB, Copacabana. Photo: Emma Bergman 23/5/2019

In the outskirts of each favela there is one or several bigger containers. COMLURB collects waste around the favela and puts it in the bigger containers. When this one is full, a truck comes to pick it up and put a new, empty one there. Collecting larger amounts of waste before removal saves both money and fuel. Some favelas – but far from a majority – are equipped with a compacting container that compact the waste to further minimize the transportation costs. The container is then transported to one of the five transfer points in Rio where it is repacked and finally transferred to the sanitary landfill in the state of Seropédica.

All residential buildings in the formal city pay a yearly tax which include the collection of waste. As favelas are not a part of the formal city they do not pay this tax, according to COMLURB. However, other organizations and CBO's claim they do have to pay this tax. Residences or businesses that produce less than 100 liters waste per day, including recyclables. Anyone who produces more than 100 liters per day is categorized as a big generator, such as supermarkets, restaurants, hotels, stores and other large businesses. Big generators are obligated to contract another company to handle their waste. These companies have to be accredited by COMLURB to guarantee that they have sufficient skills for the task, that their trucks are in good working condition and do not pollute the environment in an unacceptable manner. There are currently 15 companies accredited by COMLURB and the service they provide is collecting

the waste and transporting it the landfill. All mixed waste generated in Rio, or rejected waste after informal recycling activities, ends up in the sanitary landfill in the municipality of Seropédica, north west of the city. The landfill is located 60 km (linear distance) away from the furthest point in the city, Copacabana. However, due to large forests and mountains, the driving distance is approximately 100 km.

In the favelas there is no difference in regular or big generators, everyone puts the waste on the street and/or collection points where COMLURB will provide the collection service. In Figure 12 one can see an area where residents have dumped waste in Vila Cruzeiro in Complexo do Alemão. Random piles like this one are common throughout almost any favela. Some favelas have invented their own system to decrease the risk of street dogs or other animals raiding the bags to find food. Such system has for example been implemented in Vila Kennedy where the residents put the waste in a small metal bucket on top of a bar about 1 meter from the ground, as can be seen in Figure 13.



Figure 12 Accumulation of waste on a street corner in Vila Cruzeiro, Complexo do Alemão. Photo: Emma Bergman 2/4/2019.



Figure 13 In a part of the favela Vila Kennedy, household waste is collected in small buckets 1 meter from the ground to avoid street dogs and other animals from raiding the bags. Photo: Emma Bergman 28/5/2019.

The clean favela program

COMLURB have tried to conduct several programs to improve the local environment and waste collection in the favelas. One of the biggest and most successful ones was the “Clean Favela” (Favela Limpa) program. In 1995 the program was initiated with the objective of improving the cleanliness in the favelas (Alves de Oliveira Pinto, 2002). Many different methods were investigated and tried but about 10 years ago the most successful concept was reached. COMLURB contracted the residents’ associations of the favelas which in turn were obligated to employ current residents of the favela. COMLURB then trained and paid the employees to collect waste throughout the favela. “No one better to protect than who lives there”, as an employee describes it (I11). The residents were given COMLURB uniforms, they were taught which routes to take and at which collection points to leave the waste. They were also given tools to facilitate collection but did not have any moving equipment such as vehicle or collection bins. They could collect however they saw fit. Many collected by hand in plastic bags (I11).

All financial costs were covered by COMLURB and 10% of the contract with the residents' associations went to the association for the administration of employment et cetera. Above this they gave technical support and supervised the activities. Some years they would organize competitions of the cleanest favela where the winning residents' association would receive money as price.

The program was both environmentally and socially beneficial as it not only decreased the amount of improperly discarded waste throughout the favela but it also created new jobs, generated income through which the residents were helped to get proper identification papers, a bank account, (debit) card and proof of employment. At most the program was implemented in 30 complexes with 2500 employed residents (I11). Some years after the program was implemented some residents' associations were overtaken and run by criminals. Some employees took advantage of the uniform to distribute and sell drugs, a phenomenon which eventually put a stop to almost the entire program. Today the program only lives on in 3 – 4 favelas.

5.1.2. Recycling

The recycling system in Rio de Janeiro is very complex. It includes a variety of actors who are intertwined through formal and informal collaborations. The formal system only handles a smaller share of the recyclables that is generated and collected every day. The majority takes place in the informal sector where catadores, cooperatives, non-profit and for-profit organizations play different roles.

The backbone of the system are the catadores that manually pick and/or sort recyclables from the mixed household waste, in waste bins or garbage on the street. They work both in the formal city and the favelas and can act either independently or as a member of a recycling cooperative or an organization with other interests above selling material. They play a vital part in the recycling system as much of the material would remain in the mixed waste and end up at the landfill if it was not for their activities. The income is generated when selling the materials to cooperatives, scrap dealers, or other middlemen of varying levels of formality, who process this material and sell to larger enterprises. A cooperative is a more organized group of catadores, normally working with larger volumes and structured collection of solid waste to sort. The market for recyclables in Rio de Janeiro and in Brazil in general is an oligopsony (da Silva & Bolson, 2018; Rutkowski & Rutkowski, 2017; Tirado-Soto & Zamberlan, 2013). This means that there are many sellers and very few buyers of a product. The imbalance in the market leads to few buyers with little competition who can set beneficial market prices. According to COMLUR, the companies exploit the cooperatives and catadores by doing exactly this, only buying at very low prices (I11).

The recyclables collected by catadores are usually material they find on the streets or by opening bags or containers with mixed material, i.e. they do not have any formal contracts with the generators of the material. This means that they take whatever they can find and however they can find it. In Figure 14 one can see that some catadores “specializes” in certain materials such as aluminum cans or PET bottles while others collect all types of recyclable goods.



Figure 14 A man working as a catadore who specializes in collecting aluminum cans, here walking along Copacabana beach. Photo: Emma Bergman 8/4/2019.

Another part of the informal system is private pick-up services for residential buildings or businesses. This function is made possible with households or businesses who are familiar with sorting recyclables in-house, meaning that these households can provide a continuous flow of recyclable material to the collectors. These households are normally located in the formal city in the AP2 zone (south zone) in Figure 5, which is the area with the highest amount of recyclables per weight generated waste (I11). Cooperatives or private companies buy the material and provide the collection service in return for the material kept aside from the mixed waste that COMLURB collects. COMLURB collects recyclables but in very small amounts, which is explained further down below. Some cooperatives are able to start collaborations or partnerships with businesses that leave waste at their operational space. However, it is not very common. As the majority of the system is based on curbside collection, material can also be stolen on the street. Figure 15 shows a cooperative collecting recyclable material from a residential building. By doing so before the contracted company or COMLURB comes to pick it up they can gather material more efficiently than going through mixed waste. Whatever is left after catadores, cooperatives and contracted companies have passed by, is then taken care of by COMLURB. The cooperatives then sort and compress the materials into larger packages and sell to enterprises like Rio Recycling Center or RMJ Recycling Company (I11). There are also cooperatives which use mixed waste as a source when sorting recyclables materials. Some

use literally all material found in the waste, including things that normally goes to the landfill such as kitchen and hygienic papers (used toilet paper), smaller electronics and low-quality plastic. Figure 16 shows used toilet paper which is sorted and sold by a cooperative in Jardim Gramacho.



Figure 15 Recycling cooperative collecting material on the curb of a residential building in Copacabana. Photo: Emma Bergman 27/5/2019.



Figure 16 Some cooperatives use mixed waste as their source for recyclable material. Here, used toilet paper have been separated and mixed with writing paper, sold for unknown use. Photo: Emma Bergman 29/05/2019

Many cooperatives have been established as a result of the closure of the old landfill at Jardim Gramacho. The cooperatives are located in the municipality Duque de Caixas, just north of the boarder of Rio de Janeiro municipality. Many of these cooperatives have different arrangements when it comes to obtaining waste to sort and recycle. Some have trucks which they use to do the mentioned domestic pick-ups and others have contracts with transporting companies which deliver waste to them. What materials they sort and how the sorting and separation is carried out differ from cooperative to cooperative. In Figure 18 one can see the working station for a worker in the cooperative (I6) and Figure 17 shows the workplace for another cooperative in the neighborhood. Just like this cooperative, some have or have had more or less advanced electronic equipment to help the separation process. This specific machine helped to put the waste bags on the tables but as it is not working anymore the workers have to manually place the bags on the table.

The formal recycling system is considered the services provided by COMLURB. Even though COMLURB does not have any type of recycling activities themselves they collaborate with the 4 largest cooperatives in Rio de Janeiro which are located in the areas of Irajá, Bangu, Cajú and Jacarepaguá as well as a few medium sized cooperatives. One day a week, COMLURB picks up the leftover recyclables from the curbside with a special truck for this specific purpose and

drops it off to these cooperatives who then receive material to sort, assemble and sell. On their website COMLURB informs that the materials they collect are the following:

Newspapers, magazines, notebook sheets, computer forms, boxes, envelopes and paper shavings, PET, cleaning and hygiene packaging, margarine jars, natural and mate guarana cups, aluminum, iron, cables, beverage cans, oil and food cans, milk powder packaging, bottles, glasses and containers in general. (Rio City Council, 2018)



Figure 17 Separation process of another cooperative in Jardim Gramacho. They used to have rolling bands which would drop the waste on to the tables but since it broke the workers lift the waste bags onto the tables to sort. Photo: Emma Bergman 20/5/2019.



Figure 18 Separation of materials at a cooperative in Jardim Gramacho. Photo: Emma Bergman 20/5/2019

On average, COMLURB collects about 1600 tons of recyclables every month and only operate in the formal city in 115 out of 156 neighborhoods (Rio City Council, 2018). The amount of potentially recyclable material generated in the city is estimated to be about 40% of the 10 000 tons MSW per day, i.e. approximately 120 000 tons per month (I11). The formal recycling system thus only collects and recycles approximately 1,3 % of all generated recyclable material. Other cooperatives and catadores in the informal system collect around 2300 ton recyclables per month, managing about 1,9 % of the generated recyclables in the city (ibid). According to these numbers, only 1,3% of the total amount of generated MSW per year, is recycled by the formal and informal system together. This can be compared to cities in other developing countries such as Lima, Lusaka and Quezon City where 20 (0% formal), 9 (6% formal) and 26 (3% formal) is recycled respectively (UN Habitat, 2010a).

One of the cooperatives with whom COMLURB collaborate is the Recyclable Materials Central Triage (Central de Triagem de Materiais Recicláveis) which was started by COMLURB in 2014 through a corporate sponsorship from Coca Cola Brazil (CocaCola Brasil, 2014). Today, the center functions without any management from COMLURB or sponsorship and is run by the 200 employed catadores who previously worked on the street or small cooperatives. What differentiate this cooperative from others is it's large capacity of processing 20 tons separated waste per day (CocaCola Brasil, 2014), which is a result of the automated process of compactors and industrial lines of manual separation. However, the center operates far below this capacity due to the limited number of recyclables collected by COMLURB (I11).

COMLURB provide the collection service for free to the houses in the formal city that choose to separate recyclables from mixed waste as the ultimate goal of the company is to prolong the lifetime of the landfill. Consequently, it also lies in their interest to divert material from it as much as possible. The planned lifetime of the landfill is 25 years with a possible extension of another 25 years. Basically, COMLURB picks up any recyclables from the curb as long as they are put in transparent plastic bags, whether they are generated by normal or big generators. However, there is no such service in the favelas. Even if the recyclables were separated and placed correctly on the curb, COMLURB does not provide vehicles for collecting this material. Yet, if the residents choose to carry the recyclables out of the favela and leave it at the closest formal neighborhood, COMLURB would take care of it separately (I11).

To conclude, it goes without doubt that the solid waste and recycling system in Rio de Janeiro is complex with various actors operating at different informal and formal levels. The informal settlements are indeed included in the formal collection services of mixed waste but not recyclables. Figure 19 summarizes the basic structure for the waste management system and Table 2 compiles COMLURB’s operational differences in the city compared to the favelas.

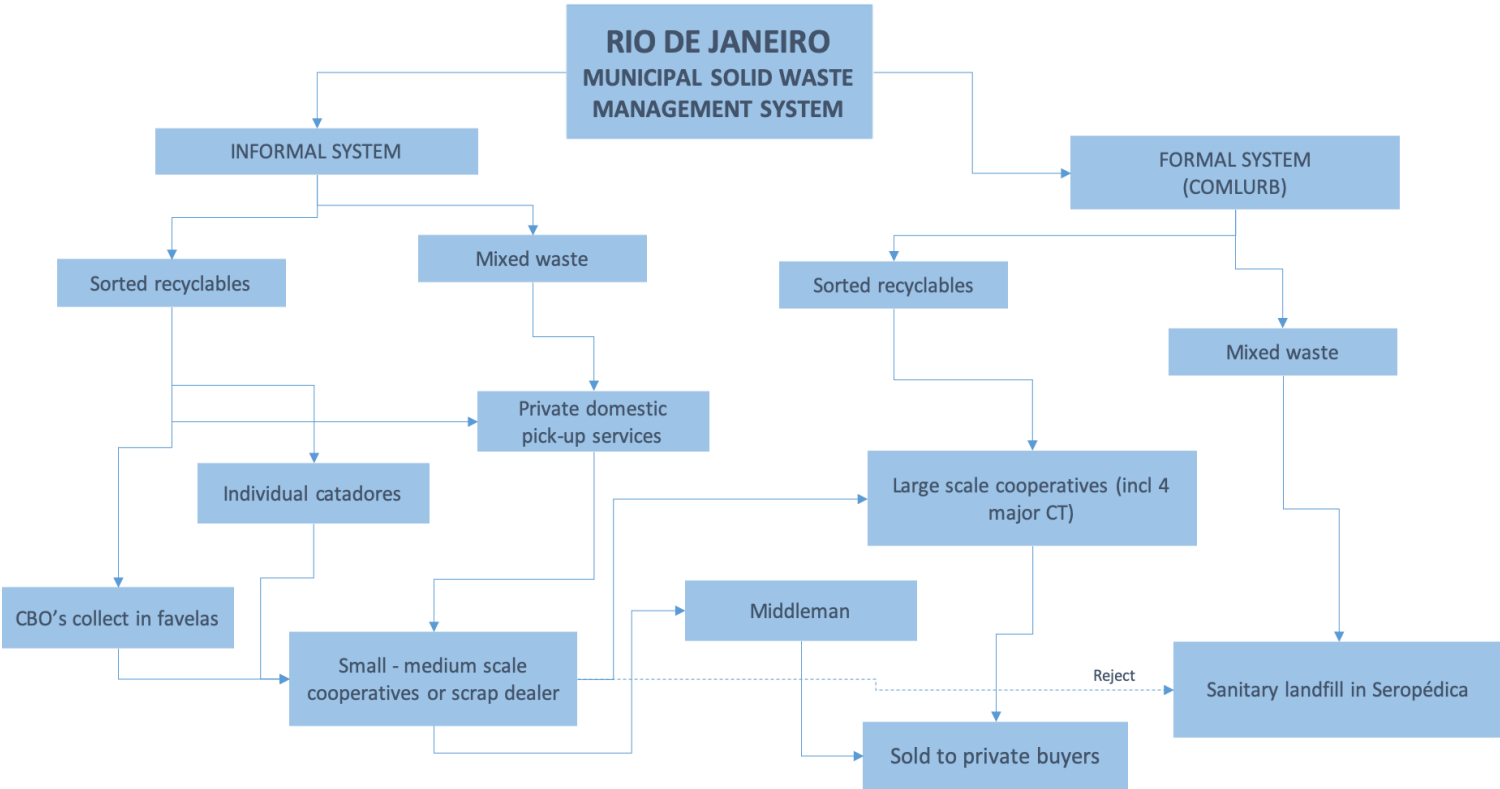


Figure 19 Basic structure of the solid waste management and recycling system in the city of Rio de Janeiro.

Table 2. Identified differences in the solid waste management system between the formal city and favelas.

	Formal city	Favelas
Fee for collection	Yes	No
Collection method	Trucks	Mini-trucks, Vans, Motorcycles or cycle-cars
Frequency	Every other day (except Sunday)	Every day
Separate collection of recyclables	Yes	No
Organized routes	Yes	Sometimes. Normally circulating favelas without route

5.2. Solid waste issues and recycling challenges

This part of the results aims to answer the second and third research questions:

2. What problems and challenges do favelas around Rio de Janeiro encounter in terms of solid waste in their communities?
3. From the viewpoint of the informal sector what are some of the main obstacles and challenges that hinders a more economically profitable and socially inclusive recycling system?

Each section describes issues that emerged from the interviews and observations.

5.2.1. Compliance and oligopsony market

One of the things quickly discovered in the study was the participants frustration over the buyers of the recyclable material and also the producers, manufacturers and importers of certain products. Though the state law N°8151 was implemented November 2018, there has been no or very few efforts to improve the collection and recycling system for the catadores who work to recycle their products. All of the cooperatives or organizations supporting catadores in the study mentioned the buyers and producers as the main causes for the bad profits of the material they sell.

Also, the NSWP, which establishes producer responsibility for certain products since 2010, is still not abided by the responsible actors. For example, tires go under producer responsibility, but the producers simply do not do what they should. COMLURB (I11) explains that due to high transportation costs the producers do not collect tires from car workshops or other resellers. To avoid the tires ending up at the landfill COMLURB collects them for a minor cost and leave them to the producers who turn them into grains and sell them for incineration. This means the producers make money from their own waste without paying for its collection, even though they are obligated to implement a completely separate system for this. There is no legal consequence for them not abiding the law, and thus the problems remain (I11).

The market for recyclable material in Brazil is an oligopsony. The few buyers on the market are very powerful and can demand almost whatever price they want (I4). The companies only buy in very large volumes which is almost impossible for small or medium sized cooperatives to produce. To solve this some cooperatives have previously tried to join forces and sell the

material together and in this way demanding higher payment. One of the reasons why this did not work was that the companies simply stopped buying from them as they could find many other alternatives. Another reason for the difficulty for cooperatives to sell their material is the administrative challenge of coordinating the sales. The payment from the industry takes about 30 days to reach the workers and as they usually are paid per week this becomes a management challenge (I4). Individual catadores, small or even medium sized cooperatives stand without choice, they have to sell to a middleman, who normally get the biggest profit (I11). Every participant who were engaged in recycling activities accused the buyers of paying them less than what is a reasonable price. Several efforts have been made to negotiate the prices with the companies, especially among the group of cooperatives in Jardim Gramacho, but they are not open to discuss it or simply do not meet their demands.

(I4) also confirms the picture of a government that does not support catadores, cooperatives or associations as they should. They do not receive any type of funding from the local government or other companies who, according to the law or municipal plan, are obligated to do so. Due to the high operational costs such as buying machines and maintenance, they are not able to run the business and pay the workers with only the money they make from selling the recyclable material. As a result of this they have to seek other activities or missions such as renting out staff to companies, working at events or trying to get jobs from private companies. However, recycling electronic equipment have resulted in an increased profit from the recycling activities (I11). Cooperative (I6) also believes that the government should do more now than what they are doing. Located in Jardim Gramacho, the cooperative started as a result of the closure of the former active landfill in the area. The catadores working with picking recyclable material from the landfill were promised compensation and support to start cooperatives in the area. The help differed widely among the catadores and some did not receive anything at all. Many residents are very disappointed in the broken promises by the government. In some cases, the government kept their promise initially and helped legalize the cooperatives by facilitating the process of getting the needed papers and licenses. They organized spaces for some of the cooperatives to work and paid one year's rent. Some cooperatives were given trucks and machines to help the recycling activities. However, today, one of the main challenges for them and other cooperatives at the site for (I6) is that they cannot afford the high rent and the cost of fuel and maintaining the trucks. Without the trucks they cannot operate and if one breaks down (which is common as they are old and in poor condition), income might have to be taken from the workers to repair it. Some months they have to deliberately not pay the rent so that the workers can have their salaries and feed their families.

What is needed to increase the welfare of the cooperatives and neighborhood of Jardim Gramacho, is public presence. They want the government to do their part in ensuring the continuation of the recycling system. According to (I7) the secretary of environment in Rio de Janeiro do have staff working full time with fulfilling their part of the integrated solid waste management plan environmental, for example through education in favelas. For example, they work with educating residents through spreading correct and understandable information, supporting environmentally oriented projects or organizations with knowledge or ideas. Another way the city supports the favelas is by hosting workshops to educate catadores on how

to increase the value of the material they sell and encourage them to work together as cooperatives. Specifically, in Vila Kennedy, catadores have been able to increase the value of the material they sell with five times the initial after these workshops. The environmental agents also work together with schools to improve the handling of organic waste and educate them on how to include children in projects of creating gardens with soil from composted food scraps (I7). However, these activities are scarce and not sufficient to meet the demands of such a large favela population, according to some participants.

5.2.2. Collection points and containers

Almost all interviewees enter the subject of having to few or overflowing waste collection containers or bins in their neighborhoods. Few collection points mean that the residents have to walk a longer distance to reach one. If it is too far, they simply do not have time or prioritize walking the whole way and thus dump the waste on the streets (I7). According to (I1), one challenge in communities is exactly this, residents dumping waste all over the streets and nature partly due to the long distance to a container or bin. (I4) agrees that Rio de Janeiro in general is very dirty due to the very few containers, not only in favelas but even in the formal city as well. According to them people do not keep the waste in their pockets but rather throw it on the ground if there is no bin around. Beyond a tight budget, COMLURB states that the reason for not having as many collection points as they could is because those that exist are not always used and for that reason it is not always reasonable to invest (I11). They have to circulate the favelas in any case. The large generation of waste in comparison to the volume of collection containers can be seen in Figure 20, a collection point in Complexo do Alemão.



Figure 20. Too small collection containers is one reason for the generation of waste in the streets in the favelas. Complexo do Alemão. Photo: Emma Bergman 2/4/2019.

In Maré for example, collection points have been removed due to criminal activity. This leads to residents having to walk longer distances to reach a container or waste bin. Sometimes the residents do not even know where these collections points are because they are scarce (I10). Too few containers also lead to overflow of waste in those that remain. Even favelas where amount of collection points and thus walking distance have not been identified as an issue, the total volume in the containers or bins are not sufficient for the generated waste (I9). This can be seen in Figure 21, which shows a collection point in the favela Asa Branca. Here, waste spill over to the sides of the bins and falls down in the little river on the side.

In Vila Cruzeiro in Complexo do Alemão, the problem with too few or overflowing or non-existing waste bins is massive. As seen in Figure 22, either people throw waste on the side of the container, or the container has just been emptied by COMLURB who then apparently did not pick up the waste on the ground. In Vila Kennedy, collection points easily overflow due to the heavy generation of waste but also because they are not well adapted to the type of waste generated. Here, it was specifically pointed out that many sofas end up on the streets as a result of renovating or changing the interior of the households. The sofas can end up staying in the place for a long time due to the prioritization of COMLURB to collect other waste. This was also seen in Vila Cruzeiro where a sofa had been placed right on the street and stayed there for weeks on end. The accumulation of waste around containers and bins are however not always caused by the limiting volume but is also a consequence of people throwing waste by the side and not inside the container ((I9), (I10), (I1), (I3), (I2)).



Figure 21. Overflowing bins or containers is a common issue in favelas. Here at a collection point located right next to a river in Asa Branca. Photo: Emma Bergman 31/5/2019.



Figure 22. A collection point in Vila Cruzeiro in Complexo do Alemão. Either the container has just been emptied by COMLURB who did not pick up the rest of the waste on the ground, or residents have thrown the waste on the side of the container, or a combination of both. Photo: Emma Bergman 2/4/2019.

5.2.3. Expensive transportation

The problem of expensive transportation became increasingly clear throughout the interviews and field observations. For COMLURB the transportation of recyclables are more than 4 times more expensive than mixed waste (I11). This is because the recyclable material should not be compacted before reaching the cooperatives as this makes the separation more difficult and material dirtier. The transportation cost of recyclables is therefore one of the major challenges for the actors in the recycling system. However, it is a cost difficult to escape. Many of the cooperatives need to gather large amount of materials to be able to make a reasonable profit. (I1) explained that due to the high transportation cost of the first contractor, they had to change to a smaller middleman who charges less for the transportation and in return of receiving a discount in the material he buys. One of the main focuses for (I3) at this moment is to either create partnership with a company who can leave recyclable material or waste at the cooperative or expand their business enough to get their own truck and collect material in a bigger area than what is possible by feet. The last option is not only challenging due to the price of a truck but also the cost of fuel. A partnership where the entire cost lies on the other party would most

likely be financially beneficial, but at the same time the organization would depend on another actor to keep their business going. However, having a few collaborations with donations of different types of material would make the risk of suddenly losing the material inflow lower (I3). (I2) mentions transportation as a part of their major costs but also one invaluable aspect to being able to collect the amount of material they need to keep the recycling business going. For (I4) the transportation is an important part of the operational costs and lowering them would increase the profits and thus benefit the employees. For (I6) in Jardim Gramacho the transportation is the second biggest challenge after paying for rent of the space. When starting the cooperative the local government gave them a truck and payed the fuel for the first year of operation, now they pay both for fuel and reparation of the truck when it breaks down. It is too expensive to keep it maintained regularly so therefore operations almost always stop as a result of the sudden break down. As they only have two trucks, they might lose half of the material influx that day. The truck is getting rather old and breaks down more frequently, and so they lose a substantial part of their income. Paying for fuel is also a heavy cost for the everyday operations.

Another cooperative (I8) says that collaboration with private companies that deliver their waste is one of the best ways for them to get material. However, this is not very common and depends on the workers relation to external businesses and residences for example. Most cooperatives in the area do not receive material but have to collect it themselves.

Big recycling programs in Rio, e.g. one which composted food and other organic waste to generate organic fertilizer had to stop due to the high transportation costs (I11). COMLURB explained that even though they were able to collect enough material to compost, there were no buyers for the product. Most plantations are located far outside the city and no buyers were interested in purchasing expensive organic fertilizers along with a long transportation stretch (I11). They prefer cheap chemical alternatives. Even when they tried to donate the fertilizers for only the cost of transportation no one would buy. In the end they used some of the product for reforestation projects in the city, but the program does no longer have any greater impact. Expensive transportation is, as mentioned above, also the reason for producers not taking responsibility of their post-consumer products.

If there was any company or cooperative that would like to take over the door-to-door collection of recyclables from COMLURB they would very much welcome it, but due to the costs, there is none at the moment (I11).

5.2.4. Geography

Another factor playing a part in the solid waste management system in the favelas is the geography. The geography affects COMLURB's accessibility to the affected areas and makes it more difficult for residents to reach collection points etc. Waste that is left uncollected can have severe effects on the environment and the community. For example, the favela Morro dos Prazeres is located on a hillside with barely any flat areas except on the very top (I1). This makes it impossible for COMLURB to enter with vehicles and as they can only access the very outskirts of the favela the residents have to walk quite long distances to reach the collection

points. However, waste does not always reach this point, it is both thrown on the hillsides or at the streets (I1). In 2010 the favela was hit by a landslide of waste from the hill caused by heavy rains (Freire, 2010). The waste had been incorrectly disposed of for decades, over time becoming a part of the surrounding environment, to a point where it was left to sit there and not dealt with properly (ibid). To combat and prevent further dangers and environmental impact from improper displacement of waste, some community members took the problem in to their own hands and started an organization with the purpose of environmental education and recycling (I1). In Figure 23 one can see COMLURB cleaning up waste that from a hill in the favela and Figure 24 shows that COMLURB has to transport the waste by dragging it due to the undeveloped roads and steep hills.



Figure 23. In Morro dos Prazeres which has a very steep geography, waste is sometimes thrown down the hill side by residents. Here COMLURB is trying to remove the waste. Photo: (I1) 2017



Figure 24. COMLURB has to use improvised methods of removing waste in locations with steep hills or tiny or inaccessible roads. Here in Morro dos Prazeres. Photo: (I1) 2017.

In Complexo do Alemão, insufficient collection due to inaccessibility is one of the problems (I3). Normally, the further up one goes, the smaller vehicles COMLURB has to use which makes it more work intense to remove the waste. (I2) also points out the problem for COMLURB to collect waste further up on the mountain as there are fewer and smaller streets. This is also problematic for the organization as the catadores working with collecting and sorting waste must climb steep areas and the truck used for collection cannot enter everywhere. There are however areas where the geography is not a problem such as Asa Branca or Maré where the grounds are flat and where there are only a few or no hills at all. In Vila Kennedy, the geography affects the collection of some of the southern areas close to the hill but not the entire favela.

There are many mountains and hills around Rio de Janeiro, and this is also a very common location for favelas, meaning that the issue around adequate waste collection is more likely to be present in these communities. In Figure 25 one can see that a large portion of the favelas (red areas) are located around or close to hillsides (dark green areas) (CatComm, 2018b). COMLURB (I11) confirms that they indeed have difficulties navigating and entering favelas with steep geography, leaving most of the responsibility of the waste collection to the residents.

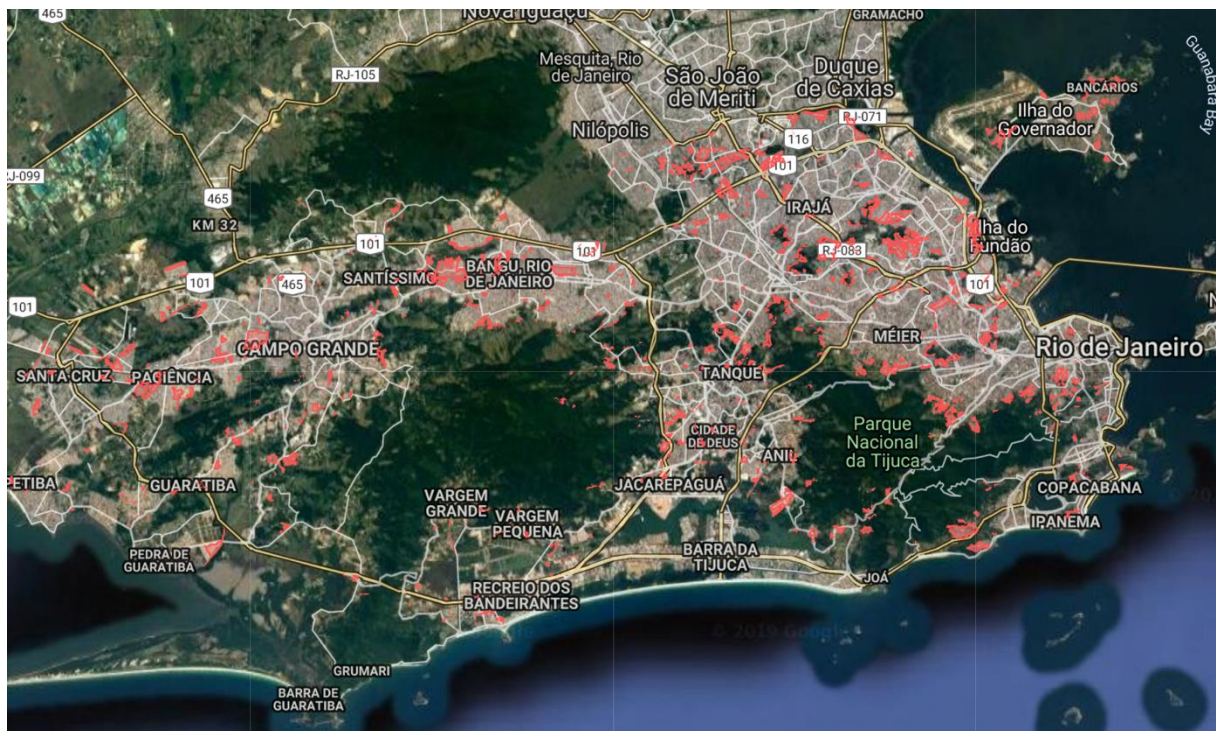


Figure 25. It is common that favelas (red areas) are located near mountains or hills (green areas), making them extra vulnerable when it comes to collection of waste as the steep geography might limit COMLURB's accessibility. Source: CatComm 2018b.

5.2.5. Criminal activity and violence

Violence and criminality have a direct and indirect negative impact on the waste management system in the favelas. In particular is the collection service vulnerable as it is an activity carried out by real people and takes place out in the open on the streets. If the 'Head of the favela' decides that COMLURB cannot enter on a given day, COMLURB simply do not enter (I11). This results in waste accumulating during the day or days until they are allowed back in. As mentioned in chapter 4.1, only 38 favelas are pacified, meaning that a large majority of them are run by drug cartels or militias.

In Complexo da Maré the violence between cartels in different favelas sometimes pose a direct threat to the workers of COMLURB. Sometimes it is difficult to know if and when there will be a shoot-off and as a result of this the collection service is not always provided on some streets (I10). At a street with a particularly big entrance to the Complex, both metal and plastic containers have been removed as a preventive measure to decrease gun violence. The containers were being used by cartel members as shields during shoot-off and blockages for the police trying to enter the favela. (I10) has to inform the members of the cartels when they plan to conduct any cleaning actions or events in public spaces, especially if there will be children at the event.

The waste management and recycling system is indirectly affected as some of the cooperatives have been claimed to be under the management of cartels (I11). Due to this, collaborations are

difficult to establish. If the cooperatives would reach out to COMLURB they could train and educate the people as well as give technical guidance (I11), however, the cartels do not want municipal workers close to their criminal activities and therefore COMLURB is very rarely contacted, according to (I11). In Complexo do Alemão criminal activity is not uncommon. The headquarters of (I3) is located in an abandoned house and in a crossing next to the facility a lot of waste accumulates. Due to this continuous stream of disposed waste, this has become a location where catadores can work to separate recyclables. According to (I3), the rejected waste which is left after catadores sort the material can stay in this place up to two weeks. This is a big issue as it attracts many different animals, including mosquitos. Many of the residents in this area suffer from vector borne diseases, and this was one of the main reasons for the start of the organization (I3). In Figure 26, one can see pigs raiding around but both dogs and birds go through the waste looking for food as well. When COMLURB was asked why the waste in this place is not collected with higher frequency the answer was simply due to the criminal activity in the area (I11). They cannot or do not want to enter there. From a visit with the organization it became clear that this was something that had not been communicated to the residents. They simply did not understand why the waste was there for such a long time. COMLURB (I11) explained that they believe many of the cooperatives (not only in Complexo do Alemão) are run by criminals and therefore they do not initiate contact. This inevitably affects the cooperatives who are running legit businesses as this makes it harder to establish a good relationship with the local government, thus decreasing the chance of getting support or funding.



Figure 26. Waste ends up in many locations around the favelas. Here in Vila Cruzeiro in Complexo do Alemão the waste cannot be removed due to claimed criminal activity (by COMLURB). The waste normally also causes different types of animals raiding the waste for food. Photo: Ilaci Oliveira 2019

5.2.6. Lack of education, habits and attitude

The lack of information on how to properly dispose different types of waste as well as lack of care for the environment and education, are some of the issues most frequently mentioned by participants. COMLURB states that one of the major issues they have is the incorrect disposal

of waste and frequent generation of waste in the streets (I11). It is the responsibility of the residents to know which day they should bring the waste out to the curb or collection point, but, as COMLURB claims, it is the lack of education, care and understanding of why they should do so that results in the daily generation of waste (I11). (I10) testify to the same problem. Residents of the community do not have sufficient knowledge or access to knowledge about how and where they should dispose of the waste correctly. For example, it is difficult to find out the adequate place to discard batteries, cooking oil and other products in the favela. Also, participants believe that old habits and patterns conquer over the common sense of putting waste at the right place. Empty public spaces quickly become a place where people throw their waste as these locations are not the responsibility of someone particular and it is an accessible and convenient place for by-passers (I10). According to (I5), the people who do not keep the waste in the house create big problems, even though they believe it is not a majority of the residents. “Only if one person throws a waste bag at a location, soon you will see a large pile there”, says (I5). For example, a man was seen throwing two bags of waste in an area which had just been cleaned by (I7) and volunteers. They went to talk to him and the answer to why he was throwing waste there was because “he wanted to” and because COMLURB “do not take care of the trees in the location anyway”. COMLURB describes the problem this way:

“Usually they [the favela residents] leave the house and throw the waste at the first corner or even throw it out the window of their own shack [house]”. (I11)

(I2) believes that people do not understand the true value of the waste they generate, or they would handle it differently. The will to do what is right by nature and your neighbor is not strong enough in our society, says one interviewee. For example, the problem will not be solved by trying to obligate people to separate recyclables and give away to someone else to make money from it (I2). As a consequence of this perception, (I2) thinks people need another, more advantageous motive to improve their waste handling.

Even though collection points are located close by, people chose not to use them out of habit or laziness (I9). Inhabitants of Rio de Janeiro are not used to recycling, and breaking this habit is also one of the biggest challenges we are facing, according to COMLURB (I11). This is also brought to attention by (I1), (I8), (I9) who describes that a big challenge is that environmental education has to be done every day. Deconstructing old ideas and habits to create a new consciousness among the residents is a continuous process; people forget and need to be reminded on a daily basis. (I1) invest much time and energy into spreading knowledge through social networks and media like WhatsApp, Facebook and Instagram. They also collaborate with other actors to spread knowledge about the issue and information about the organization such as churches, cafés, restaurants et cetera. To increase the consciousness in the neighborhood, (I10) uses social media to get messages across to the community residents but above this they go door to door to inform residents about their organization and activities they are doing. They conduct surveys where they ask the residents how they are affected by the waste and what changes they would like to see.

(I8) means that education is not only intended to enlighten people on certain subjects. It is intended to educate them enough for them to understand their importance in the community and that the environment is imperative for the survival of humanity. For the catadores, education might be particularly important to make them understand the difference they make and why they should be proud of the work they do. Often, the work they do goes unrecognized or is even frowned upon and education is also a tool to combat this marginalization. (I10) concludes that educating catadores about their value to the community is vital for each of them on a personal level. Furthermore, teaching catadores how to use waste and turn it into something they can sell is another important aspect of education that can generate income (I10). (I2) thinks that people do not understand the true value of the catadores and that they unfortunately are looked down upon, which is supported by all interview participants. The catadores working with (I2) clearly stated that they want to get recognition and respect for the work they do. After spending many years on the streets and being on one of the lowest ranks in society, being treated with respect and dignity is one of their highest wishes. (I3) agrees and highlights the importance of getting their organization recognized from people both inside and outside the community, not only to be able to create partnerships but for the catadores to be seen and appreciated for their work and to feel important and motivated.

According to (I6) in Jardim Gramacho waste management and recycling need to go hand in hand with education. As a support to their collection of recyclable material, they partner with a CBO which arrange public events to show the work they do, advocate for needed services in the neighborhood and protest government neglect. They believe that the favela residents do have the consciousness of knowing what the right thing is to do but lack the supporting system to do it. Therefore, the cooperative and the CBO started a system to include favela households in collection of recyclable material (I6). A WhatsApp group was created to spread information about the collection to residents and in this group interested households could register for the cooperative to pick up sorted material. Though this collection is not the fundamental part of the incoming material to the cooperative, it helps the cooperative as well as minimizes the waste ending up in the streets. In the neighboring area, which is part of the formal city, a similar project was implemented a few years ago. However, the residents did not sort their waste and even though the fraction of recyclable material in their waste theoretically is larger than in the favelas, the project was deemed unprofitable and ended. This shows that even areas with higher concentrations of organic material, such as informal settlements, can be more suited for collection of recyclable material than the formal city (I6). Furthermore, (I8) acknowledges the lack of environmental education as a direct risk to their business. It would be more time consuming and thus less profitable if more of the material arrived completely mixed, meaning that education is important as it e.g. can make people separate their waste in-house.

(I1) has an idea that you need to teach the citizens that they have the right to a life of dignity, breath fresh air, live in a clean environment, have good health care and feel purpose in life. However, the duties and responsibilities they have towards their neighbor and as a citizen of their community and of the world, also need to be taught. For example, they (I1) do not give money to people who separate material and help them in the recycling activities because they want people to understand that they should do it for the benefit of themselves and the

community, and not because they are obligated to. For (I3), education is the foundation of their organization and activities. The educational efforts are not solely focusing on environmental awareness or protection as there is still a more basic need among the residents to learn to read and write. If the residents cannot read or write, all other environmental campaigns or information will not be useful. It is also common that illiterate people are catadores due to the lack of other options.

5.2.7. Operational difficulties for cooperatives

Another challenge that arose from the study was the difficulty for the organizations to expand or intensify their recycling operations or activities. Almost all interviewees mentioned that they do not have the space or equipment to enhance their activities. For example, (I1) do not have neither a space for the activities, nor a compressing machine. This means that they are dependent of the weather to do the separation of material and once the material is separated it has to be sold as they cannot store larger volumes. Neither do they have a vehicle to transport the bags of collected material in the favela and so they carry them by hand, which is a tough task and cannot be done by anyone. As can be seen in Figure 27, (I3) also have all the recycling activities outside. They lack a facility to work in and a storage room. The catadores are therefore dependent on decent weather to work and the material is both subject to UV-light and theft. Due to lack of infrastructure and possibility to collect more material (no truck) they are at the moment stuck to work under these conditions.

In Jardim Gramacho, many of the cooperatives have machines as a result of help received from the government after the closing of the old landfill site (I8). However, after many years a big percentage of the machines stopped to function, and the cooperatives cannot afford the maintenance costs. However, it should be stated that in this area, where many of the residents live off of recycling activities, the reason for the continued activity for cooperatives is the initial support received by the government.

According to (I4), there are many challenges one has to overcome to be able to run a cooperative. Many cooperatives get no funding from the government or companies and the number of recyclables they have to sort to be able to make a profit is large. Even equipped with compression machines they cannot always reach these amounts. That is also why the middlemen often end up with the bigger profit, says (I4). If they were able to change their logistics and manage the system differently, they would most likely be able to get bigger profits. But changing how things work while the business is running is very difficult. (I4) explains: “the



Figure 27. One of the operational challenges for small cooperatives is that they do not have any facility to work in or store the material. The workers are therefore dependent of decent weather to work and the material is both subject to UV-light and theft. Photo: Emma Bergman 2/7/2019.

car is already driving, and we have to change the wheel”. To stop the operations and start from the beginning is impossible as the employees are surviving of the weekly sold material, so they have to improve it the best way possible by adapting as they go.

(I5) also explained difficulties maintaining a working and profitable recycling business. They started a project to empower the women of the community by collecting and sorting solid waste to sell the recyclable material. The project was only up and running for a shorter time as the women would prefer to do other things to generate income. Instead of sorting all types of waste they started to focus on using certain types of material for handicraft and in this way create products they could sell. An example of such products is shown in Figure 28. Though waste is a big issue in the favela, there is not enough reasons to start recycling activities on such a small scale due to low profits (I5). However, (I5) have collected and sold used cooking oil for years and will according to the director always do that. The residents separate the oil in the house and bring to their headquarters. The reason for this was initially to avoid clogging of the pipes in the household. As the oil can easily be stored in plastic bottles, they keep it until they reach enough to sell to a middleman, and with this money they can benefit other activities or pay bills. (I5) have the past two years been in dept for not being able to pay the tax of the building they use. This dept worries the director of the organization but there is nothing they can do at the moment. Not only do they not receive any funding or support from any company, organization

or the government but the City authorities actually use their space to conduct and carry out their own projects. This is without paying (I5) anything.

(I6) clearly states that the biggest challenge in the day to day operations is the rent of the space where they sort and compact material. As the operations grow bigger and they are able to collect more and more material, the space they use also needs to increase in size. This means that not only would the rent get more expensive as the operations grow larger but there might not be any rentable spaces available and thus it is difficult to increase the recycling rate. Today, the stored material almost fill the entire space before being sold and this makes it difficult for the workers to have a decent space to stand while sorting, see Figure 29. Also, the compressors they have are borrowed, and many of them are not running due to too expensive maintenance costs. Not paying rent could be a way to keep the machines working and thus liberating space by compacting all stored material as well as selling more material per volume. To be able to have this freedom the government need to do their part in the system and provide basic support in terms of maintenance and paying the rent. (I8) shares the view of the difficulties in paying rent and keeping up with all other operational costs. A decent workspace is vital for a cooperative and its workers. Support from the government or other private actors is very important to overcome these issues (I8).



Figure 28. A woman who has created a basket from recycled paper at a handicraft workshop for the empowering of women at the headquarter for 15. Photo: Emma Bergman 30/4/2019. Photo approved to use by woman.



Figure 29. Operational space for the cooperative Recicla Verde. The sorted and compacted materials take up almost all space in the location before being sold, making it difficult to move around the space. Photo: Emma Bergman 20/5/2019.

6. Analysis of mitigation approaches

All challenges identified through the interview study are linked one way or another and affect the solid waste management in the favelas. Figure 30 represents a schematic overview of how the phenomena are linked. The main event manifesting the malfunctioning solid waste and recycling system can be seen in the red circle: generation of waste in the streets in the favelas. The underlying patterns creating these events are shown in the green circles, which in turn arise from systemic structures represented in the orange circles.

From a systems' thinking perspective, one can divide the phenomena in different levels. For example, education/attitude issues or habits can be seen as a systematic structure problem of the city of Rio de Janeiro, or even Brazil. These structures then give rise to residents discarding waste improperly or not conducting inhouse separation of recyclables, which are patterns manifested through waste ending up in the streets. Figure 31 demonstrates how the findings in the case studies can be divided into the levels in "the iceberg" mentioned in chapter 2.6. To be able to mitigate these issues, one can tackle the challenges on different levels and according to systems thinking, the higher up or further out one goes from the occurring events, the higher leverage one has to change the outcome of the system.

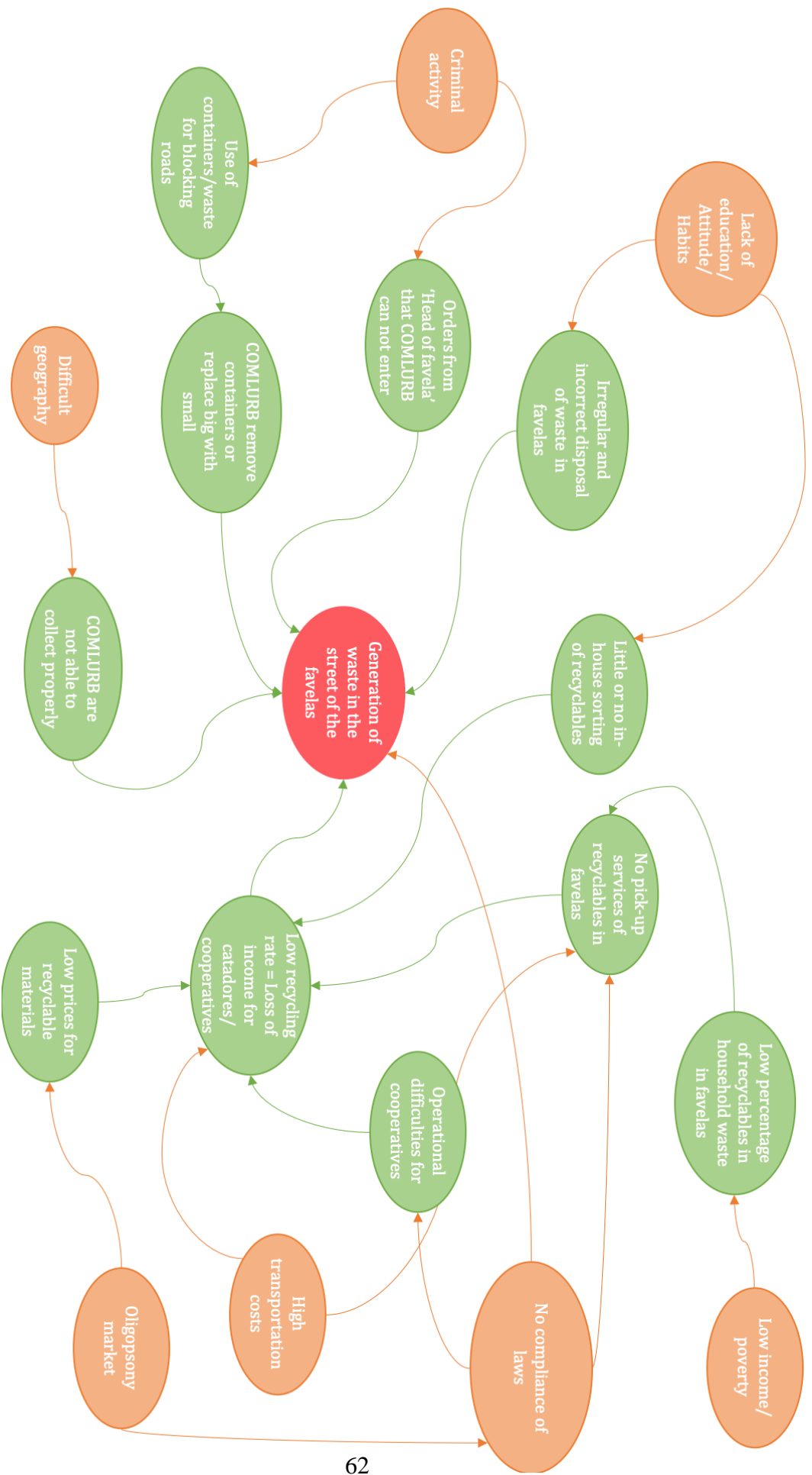


Figure 30. Schematic view of how identified issues in the case study are interconnected.



Figure 31. Identified phenomena in the case study divided into three levels, according to systems thinking.

6.1. Reactive

In the context of this study, a reactive approach is essentially a method to address the issue of the accumulation of waste in the streets and nature of favelas, once it is already generated. From the interviews and observations in this study, two such reactive approaches were identified. Clean-ups and painting and/or making the space esthetically pleasant with plant or flowers (I1, I2, I5, I10). Clean-ups have for example been organized by CBO's, NGO's, residents' associations, collaborations between cooperatives and mentioned actors and COMLURB etc. The results differ from clean-up to clean-up but one thing that stands out is the result of the clean-ups that accompanies other types of activities such as planting flowers or painting a wall to make the space prettier (I1, I10). In the literature this is supported by studies demonstrating that people take care and pride of what is beautiful (Fitchett, 2014). However, the success of a clean-up also depends on if the organizers manage to inform the residents on what is happening and why, and thus on how many that join (Gutbertlet et al., 2017). To manage this problem, it can be recommended for the organizers to seek sponsorship in form of gifts or food for the event (ibid). COMLURB has explicitly expressed in the study that they are willing to help with clean-ups for free. As they do not normally go in and clean spaces in certain areas without knowing it is safe, they can be contacted in order to participate (I11). It can therefore be encouraged that residents organize themselves and with the support from COMLURB conduct clean-ups to alleviate environmental and public health effects of waste accumulation in their community. Based on results seen in favelas from (I1), (I10) it is of great importance to have

an extra activity such as inviting children to paint or plant flowers, or for example invite artists or graffiti painters to paint the surrounding area, to increase the chances of keeping the space clean for a longer time.

6.2. Adaptive

In summary, patterns identified in this study were: the difficulty for COMLURB to collect all waste, too few or too small containers, irregular and incorrect disposal by the residents, no pick-up services of recyclables in favelas, little or no in-house separation of recyclables, operational difficulties for cooperatives, low prices of the recyclable material and lower percentage of recyclable material in favela waste are identified as reasons for the low recycling rate. To address these patterns and alleviate environmental and social inclusion challenges, adaptive approaches can be used. In the context of this study an adaptive approach is a way to tackle a problem by turning the challenges to opportunities and using the negative effects of the waste system to one's advantage. In other words, using the opportunities presented in the current situation to generate wanted results instead of changing how the entire waste management system works. Several different adaptive approaches were identified in the case study as well as the literature study.

Though COMLURB is legally responsible for the collection and removal of waste from the favelas, it is supported in literature that they seek the active participation of other stakeholders, e.g. the residents (Wilson, Velis & Rodic, 2013). Where the system fails to reach its aim of regularly collecting all waste, inclusivity of other actors is an important alternative (ibid). As seen earlier, wrongfully discarded waste and overflowing waste containers are two big problems in the favelas. Literature supports the method of hiring local residents to care for and protect certain areas from this (UN-Habitat, 2019). This is an example of a 5P's method and could in the favelas lead to the creation of livelihood for marginalized people. For the present study this could mean that the workers could for example be responsible for keeping certain areas or collection points clean or making waste available for pick-up by removing it from challenging areas such as hills. In the interview, COMLURB used the argument that people do not necessarily use the containers, could now provide containers with the knowledge that it is someone's specific duty to put the waste there. This concept is similar to the program 'Clean Favela' which was successful before it was taken over by the drug cartels. To avoid the same thing happening again, this approach would not mean that the worker would go to each household to collect waste but would rather be working in the streets to help residents place the waste in the right place as well as moving waste that still ends up on the street. As COMLURB stated, they are willing to come and remove piles of waste when they are contacted. It could therefore also be the responsibility of the worker to report to them any piles that need to be removed. This type of collaboration could further be motivated by the successful examples described in the literature such as the case of Mumbai, India (Visvanathan, 2012). It is also a way to increase the social benefits and government partnerships described in the goals of the integrated solid waste management plan of Rio de Janeiro.

With inspiration from the case of Bamako, Mali (UN-Habitat, 2010a), the streets in Rio's favelas could be kept clean even without the help of the local government. According to the

study, poorer households also value having a clean environment and are willing to pay a community adapted fee for it (ibid). In favelas in Rio de Janeiro, organizations such as residents' associations, cooperatives, CBO or NGO, or micro-entrepreneurs could establish a system where the local residents pay a fee for someone to be responsible for keeping the streets clean and removing wrongfully disposed waste. The system could be based on door-to-door collection or simply picking the waste off the streets and putting it in the right container. However, the acceptance and willingness to pay for such services are much influenced by trust to the service provider (Tukahirwa, Mol and Oosterveer, 2011), and it is therefore important to establish this first.

The low recycling rate and generally very low income in the informal recycling sector in Rio de Janeiro leads to more waste ending up in the streets as well as the impediment of social inclusion. There are a few approaches catadores and cooperatives could use when trying to enhance their activities and generate more income. Starting with a ground-up perspective, it has been supported that door-to-door collection is a possible approach to increase recycling rates (Velis 2017). In this study, this method was shown successful for a cooperative in Jardim Gramacho which collects pre-separated recyclables from favela households (I6). This shows that it can be an option to conduct recycling collection in informal settlements despite lower percentage of recyclable material in the waste. The cooperative in (I6) has received support from a local CBO to increase the direct communication with residents to explain the financial and environmental value of this service and to convince them to join the movement. This supports the idea that households in informal settlements too are willing to separate their waste if presented information and an opportunity to do so, in spite of a generally lower education level. Another community-based approach identified in this case study is one that is built on a so called 'green value award' system. In the community from (I2) local residents bring recyclable material to the small group of catadores working alongside the CBO. As a thank you, the person receives a ticket which is worth an amount of money that can be used in local restaurants or transportation within the community. This basically creates a small-scale get-paid-to-recycle system within the favela. However, it should be noted that this method increases the recycling rate but does not necessarily mean a higher income for the catadores. In this case they are able to collect old electric cords and sell the metal inside, which is a large portion of their income (I2).

In the favela of (I1) the collection system is based on the idea that favela residents do not have rights, but also obligations. The interviewee means that favela residents should not be a part of the improvement of the waste or recycling system only if it benefits them, they should be engaged because it is the right thing to do for the environment and the favela community. Therefore, the organization urges residents to help catadores with the recycling activities by sorting material and putting them in large bags spread out in the favela, not because they will profit from it but because of the understanding that it is good for the environment (I1).

Another approach adapting to the current problems and generating extra income for favela resident and informal sector workers and is e.g. by transforming waste to completely new products through handicraft. Waste that normally would have been thrown away can be used to

create value in the form of completely different merchandises. Three of the organizations and cooperatives in the case study conducted this type of work together with, usually, marginalized members of the community ((I2), (I3), (I5)). The work creates an opportunity to empower the involved residents as they can sell the products they make and at the same time increase social inclusion in the favela as they are included in a context where they meet people in their situation. This exploratory way of creating value from waste material has also been recognized in literature, demonstrating the usefulness of this approach (Gutberlet et al 2017).

Catadore- and cooperative movements in Brazil and Rio de Janeiro have shown two ways to improve the economic, social and political position of those workers (da Silva and Bolson, 2018). Therefore, the organization of self-working catadores into cooperatives is one important step for the favela catadores. After this, creating networks of cooperatives can be a viable approach to overcome certain operational difficulties and further increase the leverage in the tough oligopsony recycling market in Rio de Janeiro. Networks present administrative and structural challenges as seen both in the case study and literature, but if overcome, they hold great benefits (Tirado-Soto and Zamberlan, 2013).

To conclude, mentioned approaches would not only contribute to a lower environmental impact thanks to the immediate removal of waste in the streets but also generate income for the urban poor, i.e. increase social inclusivity.

6.3. Creative

To change the recycling system on a large scale, to really integrate the informal sector and increase social inclusion of Rio de Janeiro's most marginalized groups, a more systematic approach is needed. This means taking yet another step out from the suggested approaches so far, taking on a creative approach. The underlying systematic structures affecting the recycling system were identified to be: Lack of education/attitudes/habits, no compliance of producer laws, oligopsony market, high transportation costs, low income/poverty, geography and criminality. A creative approach in this study means implementing or trying a new method to break or modify the underlying systemic structures.

The Brazilian Government has since 2010 established a law to improve the solid waste management and increase recycling activities in the country (Brazil, 2010). There are many programs and plans in place, both at national and municipal level, to strengthen and integrate catadores and cooperatives into the recycling system. However, when looking at the recycling rates in Rio de Janeiro, and especially in relation to the vast amount of waste pickers in the city, it is clear that these are not working the way they were intended.

Not only does the law establish that manufacturers, distributors and importers are obligated to take every necessary measure to finance and implement a system to collect packaging or packaged products, but they are also obliged to this primarily in partnership with cooperatives and associations of catadores (LegisWeb, 2018). They are also responsible for doing environmental campaigns to prevent waste and for consumers to separate the materials after use. As the law further establishes, the City government, together with COMLURB, can take

over the duties of these actors if they are duly compensated and in turn hire or fund cooperatives or catadore associations (ibid). Many of the participants in this study requested a stronger governmental support and presence in their communities or cooperatives. One possible approach is the development of partnership between the local government and cooperatives, such as the 5P's approach which has been recognized as a suitable approach in several developing countries (Asian Development Bank, 2019). In the light of the manufacturers, distributors or importers that do not take legal responsibility, this appears to be a good option as the local government has knowledge about the neighborhoods and can provide support that could be difficult for private companies. In the study, one of the main reasons for the inability of cooperatives and cooperative networks to expand or intensify their business is that they lack governmental or producer funding. Even though solid waste management and recycling has been described as very costly for municipalities (Brunner & Fellner, 2007; Wilson, Rodic & Scheinberg, 2012; UN-Habitat, 2010a; World Bank, 2019), the monetary savings made thanks to the activities in the informal sector should be sufficient for the funding of their activities (Scheinberg et al., 2010, 2011). The investment in early inclusion of the informal sector in the waste system is also highlighted in literature as a factor for the success of an integrated system (OECD, 2016). With this as basis, this study claims that increased governmental funding is an important systemic change for increasing the social inclusion and economic prosperity of cooperatives in Rio de Janeiro. However, exactly how the cooperatives want to be supported or funded need to be discussed before any initiation of a project. This is also one of the fundamental parts when using a 5P's approach – the informal sector should be included before the initiation of a project (World Bank, 2019). They should be the decision makers, not to have decisions enforced on to them. For example, many of the participating cooperative workers in the study clearly stated that they want to be acknowledged for the work they do and to have the freedom to choose how to help themselves, to choose what part of their operations that needs support. This promotes an approach where cooperatives could receive support based on their specific needs.

COMLURB states it is too expensive to conduct collection of recyclable material in the favelas due to the low content in the waste in relation to high transportation costs (I11). This could instead be seen as another opportunity to use the 5P's model. Local cooperatives or catadore associations could be employed by the government to implement a collection system which is adapted to local prerequisites and where the collected material would go directly to the cooperatives. Through the interviews it became clear that there is knowledge on how to create these systems and a will to do it, as well as the economic benefits this would bring COMLURB.

Moreover, in both literature and in the case study it was identified that partnerships with other organizations, cooperatives, associations or enterprises are important for the success of a cooperative (Wilson, Velis & Rodic, 2013; UN-Habitat 2010a; (I1), (I2), (I3), (I6), (I10)). Networks can create knowledge exchange and are a way to find support and help on how to overcome obstacles. An important aspect of this is environmental education and spread of information. In the present study, NGO's and CBO's help raising awareness around waste and recycling issues through their many platforms in the community which in turn benefits the local cooperatives or catadores.

Yet, as environmental education and attitude were two of the identified problematic systematic structures in the study, the impact of local organizations platforms can be perceived small in relation to the possible impact of governmental environmental campaigns in all of Rio de Janeiro. This is why it is important for the local government to enhance and improve environmental education among the population, in all neighborhoods throughout the city.

The local government in turn has at least two choices to fund these initiatives. Firstly, they can seek grants from the national government for their work with increasing social inclusion in their integrated municipal solid waste management plan (Brazil, 2010). The other option is to demand money from the manufacturers, distributors, importers and marketers actually responsible for the implementation of a recycling system (LegisWeb, 2018). According to participants in the study, much of the activism and lobbying to get these actors to rise up to their responsibilities are led by associations of catadores and cooperative representatives. To gain leverage and move away from the oligopsony market, the informal sector needs to be backed by the government, not only through policy making but also in practice.

Miscommunication between the local government and the residents is another reason for improperly disposed waste, identified in literature (UN-Habitat, 2010b). This could for example be improved by implementing an interactive stakeholder platform, just like the one in Moshi, Tanzania, where not only the city but also residents or other actors could communicate and more easily access information regarding their specific favela/complex (Wilson, Velis & Rodic, 2013). A transparent institutional framework is very important for a functional solid waste management (Wilson, Velis & Rodic, 2013) and therefore could laws and plans regarding the solid waste management system be explained to the population in an appropriate way in this platform.

Another important and unignorable aspect which affects the entire waste and recycling system, is the criminality. The results from the case and literature study do not provide any insights or approaches on how to address this on a larger scale. However, the lack of information to the residents why accumulated waste is not being removed can be addressed. Transparency towards the residents is important and the process of spreading information could for example be facilitated if community leaders contacted COMLURB instead of the other way around. COMLURB were reluctant to initiate this contact in certain neighborhoods (I11), but, if contacted, they claimed they would explain the situation and reasons behind their inaction.

7. Discussion

The objective of the thesis was to examine the solid waste management system in the informal settlements of Rio de Janeiro to identify main obstacles and challenges to its development. Furthermore, the study aimed to suggest approaches to improve the management of solid waste in the perspective of environmental protection and social inclusion, at different levels in the waste system. This chapter aims to discuss the results with through the perspective of the Brazilian society.

7.1. *MSWM in the formal city and favelas*

Every day, around 10 000 ton solid waste is generated in Rio de Janeiro. Some of the waste ends up incorrectly disposed of in the nature or streets of the favelas. Except for the small percentage that is recycled, the rest of it ends up in the sanitary landfill in Seropédica. Taking a bigger view on the system, it reaches the objective of providing collection to the entire population rather well in comparison to other developing countries that do not provide this service in informal settlements and/or disposing the waste in open dumps.

Despite this, waste is very present in the lives of the people living in favelas. The biggest difference between the collection in the favelas and the formal city is that collection needs to take place once or even twice per day in the favelas. Almost everywhere you look, you see waste. As the residents are very used to seeing waste spread out in the streets and accumulating in piles it makes them less prone to change their own behavior. To minimize the environmental and public health effects of this waste, COMLURB should intensify the collection services in favelas and remove waste more thoroughly. However, Rio de Janeiro is a very complex city. It has many parallel powers and to change something as big as the waste management system requires changes to be made within other contexts as well. Changes need to be thoroughly planned and executed, to avoid involving criminals or putting anyone in danger. An example of this was the municipal program ‘clean favela’, where the workers allegedly started to work for the drug cartels wearing the COMLURB workwear. Criminality and violence are a part of the life of anyone living in Rio, not only in favelas but also in the formal city. Though this situation is tightly related to the social and economic constraints of the urban poor, who mostly live in the favelas, it turns out that many residents are happy where they live and do not seem to be personally directly affected by the criminal activity happening in the favela. Politicians win elections on their promises on completely demolishing criminality and drug trade in the favelas, which results in police brutality and many innocent favela civilians being injured or killed. This, and many other reasons, creates a deep mistrust and cautiousness for the local authorities and police force. Another reason for the population’s mistrust is the country’s long history of political and judicial corruption. All of this has led to a population with a very individualistic mindset who do not want to help the government if it is not in their own benefit. The authorities do not do anything for them, why should they do this for the authorities? – is how many of them resonate. This is problematic for the waste management in the favelas as it has been shown that MSWM does not work well without the participation and dedication of the population. Therefore, to overcome some of the root issues in the system, the local authorities need to rebuild trust with the favelas residents and be more present in the communities.

However, looking back and analyzing the development of the solid waste and recycling system in Brazil in general and Rio de Janeiro in particular, it is clear that any larger changes can take years, if not decades. As a consequence of this and the long-time existing disconnection between policy and reality in the country, it is only rational to urge the favela residents to organize themselves and take action to improve and prevent the incorrect disposal of waste in their own neighborhoods.

7.2. Challenges and mitigation approaches

The results from the interviews demonstrate that favelas encounter several problems and challenges when it comes to the solid waste management. One of the main issues raised by the participants is that many favela residents lack a higher or even basic education. This leads to less knowledge about how waste and recycling negatively and positively affect the environment. Though this is a problem with roots in the elite educational system of Brazil, the lack of public presence in the favelas further worsen this situation. It is not probable that the educational system in Brazil would change in the coming years. Even if it would, a shift in educational level with those living in favelas would take decades. This means that environmental education has to be carried out in aimed efforts towards the most affected areas. From the information gathered in this study, larger educational campaigns, creating transparency through the outreach of information and the implementation of environmental agents by the local government are some alternatives.

Another consequence of the country's widespread corruption is demonstrated through the lack of legal consequences for the manufacturers, distributors and importers in the recycling system. By not complying with the law they directly withhold money from people which have the right to be compensated for the work they do. As described by COMLURB, not only do they save money by not implementing a recycling system, but they also make further profits on the recycled material, like the tires for example. When the participants were asked why these companies had not been reported and prosecuted, the simple answer was that "this is Brazil, it does not work like that". Meaning that the smaller actors such as catadores, cooperatives and organizations, do not stand a chance if battling such companies due to corruption and criminality. Many of the participants showed a feeling of hopelessness talking about the system in general. The necessary changes seem so far out of reach and the amount of work needed from them to even achieve a small difference, make the situation for many of them desperate. Each and every day is a struggle to sort enough material to be able to put food on the table for their families. The subtle dreams and hopes participants hold for the future, witness of a harsh reality where they are well aware that the political situation in Rio de Janeiro and Brazil will not encourage nor facilitate the improvement of quality of life through the informal recycling sector.

One thing that instantly became clear in the study, and that I would say characterize these people, is that they have a strong mentality and will to work. They have many ideas on how to advance the system and what they would need to carry out those changes. Unfortunately, they have been born into circumstances with minimal chances to break free from or improve the

situation. The city holds a great opportunity to improve the lives of many people and a more profitable recycling system could possibly even help prevent youths or young adults choosing the path of criminality in lack of other opportunities. The argument that the authorities cannot afford supporting the most vulnerable in the system, especially when it comes to fixing simple things such as the number of containers, was over and over again ridiculed by the participants. They, like many other Brazilians, mean that the question is not about money – the local government has strong financial resources – it is about what they do with the money. Money disappear through corruption and the remains are not invested in favelas or the residents, they are invested in upgrading or improving the formal city. If the people most affected by the poorly managed recycling system were given the opportunity to improve it, big changes could be expected.

Moreover, the results show that the division between the formal and informal system is not always very distinct. For example, COMLURB, which is the foundation of the formal system collaborate with the informal sector. Through the creation and support of material to 4 large recycling centers, COMLURB have formalized the work of these catadores which are now dependent on them to continue their business. As the centers are running well below capacity, it raises the question whether this is a particularly good approach to increase social inclusion for catadores in Rio de Janeiro, or if it is not feasible (yet)? Also, considering that the study participants wish to receive funding to have the freedom to run their business according to their specific needs, should this systematic semi-formalization of the informal system be reconsidered? According to COMLURB (I11), they do not collaborations with cooperatives above the four larger ones mentioned in Figure 19. Due to past experiences with municipal programs and initiatives being taken over by drug cartels, there seems to be a reluctance within the companies to fund projects of this sort or cooperatives being run in the favelas. This frustrates some of the participants as they feel that the criminal actions of a few people affect the rest of the catadores or cooperatives. However, at the same time there seems to be an understanding among the residents that COMLURB do not set the budget themselves, but that their resources are tightly linked to political decisions of the local government. Therefore, COMLURB is normally well respected among the participants as well as residents, and the relationship between them appears to be stronger than that of the local government. This makes COMLURB a possible linkage between the government and the favela organizations in new initiatives or projects.

Through the study it became clear that the real value in improving the recycling system does not necessarily lie in environmental protection or conservation, but in generating vital income for urban poor in Rio de Janeiro's most vulnerable areas. For many of the informal sector workers, selling recyclable material is the only possible income and every dime is valuable.

One reason behind the idea of this study was that, from the eyes of an outsider, it is very difficult to understand how the solid waste system works in Rio de Janeiro. To understand which actors are a part of the system and what responsibilities they have are challenging. The study helps to clarify this. Particularly, it is interesting from the viewpoint of developed countries to get a

better understanding for how solid waste management works in developing countries in general and informal settlements in particular.

Moreover, the results from this study are important as they pinpoint favela residents' views on waste related problems, and how it affects them. This could e.g. be used by the local government to focus their efforts in the direction of the identified topics. Furthermore, the results can be used by favela residents to get an insight to the problems in other communities and better understand the challenges local catadores, cooperatives or organizations face. In this way, the results contribute to spreading knowledge about the solid waste situation in Rio de Janeiro and possibly serve as inspiration to start collaborations or partnerships across favela borders.

The study can be useful for different actors in the solid waste system as it presents mitigation approaches on several levels, ranging from ground level work in the physical environment of the favelas to a more systematic and political level. The study is also an acknowledgement of the catadores, cooperatives, CBO's and other actors that play a vital role in preserving the environment and eradicate poverty, but that do not get the recognition they deserve.

7.3. Method discussion

The interviews and field observations did not all turn out the way they were planned. This has most likely affected the reliability of the study. As mentioned, some visits lasted for several hours, including contact with more people and larger areas of the favela, while others were shorter and more limited in what could be observed and photographed. Longer visits had probably a bigger impact on the results as they created more impressions. Though aware of this during the compilation of the collected material, it could not be motivated to exclude interesting data. During the study, some interviews came to have a more unstructured approach than others. This was mainly because the respondents were very excited to talk about the issue and sometimes ended up talking much off subject. Other times some questions were discussed during the field observations instead of during the interview. One of the interviews had e.g. to be shortened because of a sudden change in the persons plans. Afterwards, extra information was sought by talking to the person via WhatsApp and reading more online, which clearly affects the type and availability of data. The difference in both elaboration and how I received some information made analyzing the data more difficult. A wider knowledge about some of the participants might have angled the results.

Another factor possibly influencing the outcome of the interviews, was the level of my Portuguese. The first interview was in Portuguese without a translator. This was "limiting" as I found it difficult to comprehend everything and also difficult to express myself in a way that could allow for the flexibility that is important in semi-structured interviews. It should however be stated that as I recorded everything, information from the entire interview has been used. For the succeeding 5 interviews, a translator was present. She helped to improve the dialogue with the interviewees and the quality of the answers. However, when I, in the end of the study, went back to listen to some of the first interviews, I understood that my translator sometimes simplified the answers a bit too much, which might have led to the loss some of the nuances of

the answers. The final 5 interviews were done in Portuguese without a translator. At this point, my Portuguese had improved significantly and loss of data due to the language barrier, was small. All things above should be taken into consideration when reading the thesis and it cannot be concluded that the results would be exactly the same if the study was to be replicated with the same method. To conclude, as it was difficult to follow the same method of questioning each participant, the reliability cannot be argued to be high.

Furthermore, the interviewees were normally the head of the organization, cooperative or association. It is not certain that individuals at different positions would give the same answers. It cannot be excluded that the answers are more of a personal view of the problem than what is true for the organization, favela or informal sector as a whole. Another aspect affecting the validity of the study is simply my presence, which might affect what the participants do or say. For example, there were times during interviews I had the feeling the interviewee would 'glorify' some of the work done by the organization while others would ask me for ideas on how to improve their business. This shows that the participant's view of me, as an international researcher, might have influenced what they wanted to share. For this, it could be argued that the validity of the study could increase if it was conducted by a Brazilian or Rio native.

Photos taken during field visits only captures the location a very brief period of time. However, the legitimacy of using them to represent the issues in the area could be confirmed by the participants. In this way increasing the validity.

In qualitative research it is important to ask if it is possible to generalize from the results. In this case, is it possible to say that the identified challenges and issues are true for all favelas or actors within the informal sector? Probably not. As the interviewees do not represent or reflect the complete reality or "composition" of the different actors in the waste management system, and that there is a large number of favelas with different characteristics in Rio, the results cannot be completely generalizable. The same goes when considering that the aim was to do 15 interviews whereas only 11 were carried out. However, the results rely on data collected through a multi-case study which represents several different actors and favelas. Above this, the findings in the study are supported by and reflected in previous studies on Brazil, Rio de Janeiro and other informal settlements across the world, which increases the generalizability value.

8. Conclusions

8.1. Study results

In this thesis, challenges with and possible approaches for improving the solid waste management and recycling system in the favelas of Rio de Janeiro, have been investigated. The viewpoint for its improvement was environmental protection and social inclusion.

The biggest difference between the formal and informal parts of the city regarding solid waste management, is the daily collection of waste in the favelas and the complete lack of collection of separated recyclable material. The challenges regarding solid waste in the favelas and informal recycling sector identified in the study are presented in Figure 32.



Figure 32. Solid waste challenges identified in the study.

To mitigate these issues, reactive, adaptive or creative approaches can be used. Through the case studies as well as the literature study possible approaches were identified. These are summarized in Table 3.

Table 3. Possible mitigation approaches identified in the case studies and literature.

ACTION MODE	APPROACHES
Reactive	<ul style="list-style-type: none"> • Clean-ups • Esthetical changes such as painting/planting
Adaptive	<ul style="list-style-type: none"> • COMLURB employ favela residents to keep areas clean • Informal waste collection and street cleaning for community-adapted fee • Door-to-door or other type of small-scale collection system based on in-house separation of recyclables within the favela • Creation of new products from waste through handicraft • Organization of the catadores' work into cooperatives • Formation of partnerships
Creative	<ul style="list-style-type: none"> • Increase and continuous governmental funding for cooperatives • Local government seek grants from national institutions or financial compensation from manufacturers, distributors, importers and marketers • Public and informal sector join forces towards non-complying actors • Creation of cooperative-networks • Increase environmental education in favelas • Creation of stakeholder platform to simplify communication and transparency of institutional frameworks

The study leads to the conclusion that the local government should invest in the solid waste management and recycling system on the terms of the informal sector. The legally bound manufacturers, distributors, importers and marketers must be held responsible for not acting in compliance with the law and also forced to fully invest in the system the way they are obligated to. According to the study results, it is recommended that they do so by duly compensating COMLURB and the local authorities for new investments in the system. However, in the perspective of the historically slow progress of the waste management system and the country's corruption problems, the informal sector is urged to organize itself to put pressure on other actors in the system and for favela residents to collectively improve the local environment and esthetics of the communities to decrease accumulation of waste.

The findings in this study contribute to the on-going discourse on solid waste management as it, from an international perspective primarily, clarifies how the solid waste management system work in the complex city of Rio de Janeiro. It is useful to different actors within the system as it presents highly local to more systematic mitigation approaches to the identified issues. Moreover, it increases the understanding of the needs of the people affected by the reality of the system today, and why it is important to do something about it.

The reliability of the study cannot be guaranteed due to structure variations in data collection and language barriers. Thus, it cannot be excluded that other results could be obtained if the study was repeated by another researcher. The validity of the study might have been compromised due to the presence of the researcher and the interviewees organizational point of view. The study seems to have some generalizability value as it is based on a multiple-case study and the findings are supported by other scholars. However, not including a higher number of favela organizations or representatives drop the generalizability.

8.2. Future research

This work has focused on identifying challenges and mitigation approaches surrounding waste and recycling through the eyes of informal settlements and the informal sector. With this as the starting point, future research should focus on further building on these approaches to see how they can be revised to work in the favelas. Every favela has unique characteristics which means that solutions need to be fitted to the prerequisites and desires of that community.

Furthermore, developing and empowering cooperatives is an important step towards a more socially inclusive system. Therefore, research should be directed to more closely investigate possibilities to facilitate operational difficulties, such as improving logistics and administration of cooperative networks.

One aspect that has not been emphasized in this work is the high percentage of organic waste in the solid waste generated in the favelas. Theoretically, all waste ends up at the sanitary landfill in Seropédica. In spite of capturing methane, the disposal inevitably leads to loss of both nutrients and minerals. Future research needs to address this issue and explore ways to increase local resource recovery in favelas.

9. References

Al Jazeera English, (2014). *Rebel Architecture - The pedreiro and the master planner*. [video] https://www.youtube.com/watch?v=kv0_ELupyxs&fbclid=IwAR07oM5INdNkj-9A0l0uvno4VkdNA4EE6ULGdfBrqImhMjMLbT7umehC3fg [2019-09-27]

Alves de Oliveira Pinto, (2002). *PROGRAMA FAVELA LIMPA – Um exercício de cidadania*. <http://www.tcm.rj.gov.br/Noticias/4556/VI-185~1.PDF> [2019-07-01]

Asian Development Bank, (2019). *Public-Private Partnership Handbook*. Publication Stock No. 071107. Philippines. <https://www.adb.org/sites/default/files/institutional-document/31484/public-private-partnership.pdf> [2019-09-07]

Babader, A. Ren, J., Jones, K.O. and Wang, J., (2016). *A system dynamics approach for enhancing social behaviours regarding the reuse of packaging*. *Expert Systems With Applications*, 46, pp.417-425.

Bala, B.K., (2012). *Modeling of solid waste management systems*. In *Energy, environment and sustainable development*, pp. 265-289. Springer, Vienna.

Brazil, (2010). Presidency of the Republic – the National Congress. Law No 12.305 August 2nd 2010. *Institui a Política Nacional de Resíduos Sólidos; altera a Lei no 9.605, de 12 de fevereiro de 1998; e dá outras providências*. Available online: [PORTUGUESE] http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2010/lei/112305.htm [2019-04-02]
[ENGLISH] https://www.mma.gov.br/estruturas/253/arquivos/125_publicacao17052011041349_253.pdf [2019-05-20]

Brinkmann, S., (2013). *Qualitative Interviewing*. Published to Oxford Scholarship Online: March 2015. DOI: 10.1093/acprof:osobl/9780199861392.001.0001

Brunner, P.H. and Fellner, J., (2007). *Setting priorities for waste management strategies in developing countries*. *Waste Management & Research*, 25(3), pp.234-240.

Castro, M., (2019). *Rio de Janeiro landfill exposes Brazil's recycling crises*. *The Brazilian Report*, July 9, 2019. <https://brazilian.report/society/2019/07/09/rio-de-janeiro-landfill-exposes-brazil-recycling-crisis/> [2019-09-08]

CatComm, (2019a). *Favela facts*. <https://catcomm.org/favela-facts/> [2019-09-25]

CatComm, (2019b). *A City Planner Responds: What is a Favela?* <https://catcomm.org/planner-on-favela/> [2019-10-17]

CatComm, (2018a). *Sustainable Favela Network*. <https://catcomm.org/get-to-know-the-sustainable-favela-network/> [2019-01-25]

CatComm, (2018b). *Rede Favela Sustentável*. <https://www.google.com/maps/d/u/0/viewer?mid=1vdI-tjNOD4xQZl3TeoS6pd0cL4o&ll=-22.791429326029814%2C-43.46754489245416&z=11> [2019-08-02]

CatComm, (2016a). *Caçamba - Pica Pau Cordovil*. <https://www.flickr.com/photos/catcomm/26549624595/in/album-72157666838594980/> [2019-10-17]

CatComm, (2016b). *What is a favela? [ANIMATION]*. <https://www.youtube.com/watch?v=Evd6ryt3YgA> [2019-11-03]

CocaCola Brasil, (2014). *Coca-Cola Brasil apoia central de triagem de materiais recicláveis no Rio*. <https://www.cocacolabrasil.com.br/imprensa/release/coca-cola-brasil-apoia-central-de-triagem-de-materiais-reciclaveis-no-rio> [2019-07-08]

COMLURB, (2009). *Conheça a Comlurb*. <http://www.rio.rj.gov.br/web/comlurb/conheca-a-comlurb> [2019-10-14]

COMLURB, (2019). *Gerências de Planejamento Local*. <http://www.rio.rj.gov.br/web/smu/exibeconteudo?id=4481419> [2019-09-24]

Ferronato, N. and Torretta, V., (2019). *Waste mismanagement in developing countries: a review of global issues*. *International journal of environmental research and public health*, 16(6), p.1060.

Fitchett, A., (2014). *Adaptive co-management in the context of informal settlements*. In *Urban Forum*, 25(3), pp.355-374. Springer Netherlands.

Freire, A., (2010). *Moradores do Morro dos Prazeres revelam momentos da tragédia*. <http://g1.globo.com/Noticias/Rio/0,,MUL1559475-5606,00-MORADORES+DO+MORRO+DOS+PRAZERES+REVELAM+MOMENTOS+DA+TRAGEDIA.html> [2019-08-08]

Government Secretariat, (2019a). *O Pró-Catador*. <http://www.secretariadegoverno.gov.br/iniciativas/pro-catador> [2019-08-02]

Government Secretariat, (2019b). *Programa Cataforte*. <http://www.secretariadegoverno.gov.br/iniciativas/pro-catador/cataforte> [2019-08-02]

Gutberlet, J., (2015). *More inclusive and cleaner cities with waste management co-production: Insights from participatory epistemologies and methods*. *Habitat International*, 46, pp.234-243.

Gutberlet, J., Kain, J.H., Nyakinya, B., Oloko, M., Zapata, P. and Zapata Campos, M.J., (2017). *Bridging weak links of solid waste management in informal settlements*. The Journal of Environment & Development, 26(1), pp.106-131.

Heale, R. and Twycross, A., (2018). *What is a case study?* Evidence Based Nursing, 21 (1) pp.7-8. DOI: 10.1136/eb-2017-102845.

IBGE, (2019). *Rio de Janeiro*.
<https://www.ibge.gov.br/cidades-e-estados/rj.html> [2019-09-26]

IBGE - Agência de Notícias, (2018). *IBGE releases Population Estimates of municipalities for 2018*. <https://agenciadenoticias.ibge.gov.br/en/agencia-press-room/2185-news-agency/releases-en/22385-ibge-releases-population-estimates-of-municipalities-for-2018> [2019-09-26]

IBGE - Agência de Notícias, (2017). *National Day of Housing: Brazil has 11.4 million persons living in slums*. <https://agenciadenoticias.ibge.gov.br/en/agencia-news/2184-news-agency/news/15701-national-day-of-housing-brazil-has-11-4-million-persons-living-in-slums> [2019-09-26]

Jamshed, S., (2014). *Qualitative research method-interviewing and observation*. Journal of Basic and Clinical Pharmacy 5(4) pp.87-88.

Kim, D.H., (1999). *Introduction to systems thinking (Vol. 16)*. Waltham, MA: Pegasus Communications.

Kum, V., Sharp, A. and Harnpornchai, N., (2005), July. *A system dynamics study of solid waste recovery policies in Phnom Penh City*. The 23rd International Conference of the System Dynamics Society, Boston. Proceedings. Boston: SDS.

LegisWeb, (2018). *Lei Nº 8151 DE 01/11/2018*.
<https://www.legisweb.com.br/legislacao/?id=368998> [2019-05-25]

Marshall, R.E. and Farahbakhsh, K., (2013). *Systems approaches to integrated solid waste management in developing countries*. Waste management, 33(4), pp.988-1003.

Mashayekhi, A.N., (1993). *Transition in the New York State solid waste system: a dynamic analysis*. System Dynamics Review, 9(1), pp.23-47.

Ministry of the Environment, (2019a). *Comitê Interministerial para Inclusão dos Catadores*.
<https://www.mma.gov.br/cidades-sustentaveis/residuos-solidos/catadores-de-materiais-reciclaveis/comite-interministerial-para-inclusao-dos-catadores> [2019-08-05]

Ministry of Environment, (2019b). *Planos Municipais de Gestão Integrada de Resíduos Sólidos*. <https://www.mma.gov.br/cidades-sustentaveis/residuos-solidos/instrumentos-da-politica-de-residuos/planos-municipais-de-gestao-integrada-de-res%C3%ADduos-sólidos> [2018-08-06]

Mohajan, H.K., (2018). *Qualitative research methodology in social sciences and related subjects*. Journal of Economic Development, Environment and People, 7(1), pp.23-48.

Municipal Secretary of Environment, (2016). *Plano Municipal de Gestão Integrada de Resíduos Sólidos – PMGIRS da Cidade do Rio de Janeiro*. http://www.rio.rj.gov.br/dlstatic/10112/3372233/4160602/PMGIRS_Versao_final_publicacao_DO_dezembro2015_19_ABR_2016_sem_cabecalho1.pdf [2019-07-02]

Nationalencyklopedin, (2019). *System*. <http://www.ne.se/uppslagsverk/encyklopedi/lång/system> [2019-07-02]

Njie, B. and Asimiran, S., (2014). *Case study as a choice in qualitative methodology*. Journal of Research & Method in Education, 4(3), pp.35-40.

OECD, (2016). *Extended producer responsibility and the informal sector*, in *Extended Producer Responsibility: Updated Guidance for Efficient Waste Management*, OECD Publishing, Paris, <https://doi.org/10.1787/9789264256385-9-en>.

Osborn, C., (2013). *A History of Favela Upgrades Part III: Morar Carioca in Vision and Practice (2008 – 2013)*. <https://www.rioonwatch.org/?p=8136> [2019-09-26].

Pino, J., (1997). *Sources on the History of Favelas in Rio de Janeiro*. The Latin American Studies Association, [online], 32(3), pp.111-122.

Ravindra, K., Kaur, K. and Mor, S., (2015). *System analysis of municipal solid waste management in Chandigarh and minimization practices for cleaner emissions*. Journal of Cleaner production, 89, pp. 251-256.

Ribeiro, G., Soares, M., (2019). *Brazil's minimum wage, explained*. <https://brazilian.report/money/2019/04/22/minimum-wage-brazil-dollars/> [2019-09-26]

Rio City Council (Rio Prefeitura), (2018). *Coleta Seletiva*. <http://www.rio.rj.gov.br/web/comlurb/exibeconteudo?id=4380174> [2019-06-17]

Romallosa, A. and Kraft, E., (2017). *Feasibility of biomass briquette production from municipal waste streams by integrating the informal sector in the Philippines*. Resources, 6(1), p.12.

Rutkowski, J. and Rutkowski, E., (2017). *Recycling in Brasil: Paper and Plastic Supply Chain*. Resources, 6(3), p.43.

Sanchez Garcia, J., (2018). *Cantagalo and Pavão-Pavãozinho Tackle Waste Management Issues on World Cities Day*. <http://www.rioonwatch.org/?p=48569> [2019-01-24]

da Silva, C. and Bolson, C., (2018). *Public Policy for Solid Waste and the Organization of Waste Pickers: Potentials and Limitations to Promote Social Inclusion in Brazil*. *Recycling*, 3(3), p.40.

Scheinberg, A., Simpson, M., Gupt, Y., Anschütz, J., Haenen, I., Tasheva, E., Hecke, J., Soos, R., Chaturvedi, B., Garcia-Cortes, S. and Gunsilius, E., (2010). *Economic aspects of the informal sector in solid waste management*. WASTE, SKAT, and city partners for GTZ (Deutsche Gesellschaft für Technische Zusammenarbeit) and CWG (Collaborative Working Group on Solid Waste Management in Low-and middle-Income Countries) Eschborn, Germany.

Scheinberg, A., Spies, S., Simpson, M.H. and Mol, A.P., (2011). *Assessing urban recycling in low-and middle-income countries: Building on modernised mixtures*. *Habitat International*, 35(2), pp.188-198.

Seidman, I., (2006). *Interviewing As Qualitative Research: A Guide for Researchers in Education and the Social Sciences*. New York: Teachers College Press.

Simon, M., (2011). *Assumptions, limitations and delimitations*. Retrieved from Simon, M. K. (2011). *Dissertation and scholarly research: Recipes for success* (2011 Ed.). Seattle, WA, Dissertation Success, LLC.

Skidmore, T., (2010). *Brazil: Five centuries of change*. Chapter 9. 2nd ed. New York: Oxford University Press. Planet of slums. London: Verso. [online]
<https://library.brown.edu/create/fivecenturiesofchange/> [2019-09-26]

Stake, R.E., (2010). *Qualitative Research: Studying How Things Work*. NY: Guilford Publications.

Swedish Research Council, (2002). *Forskningsetiska principer inom humanistisk-samhällsvetenskaplig forskning*. <http://www.codex.vr.se/texts/HSFR.pdf> [2019-09-20]

The Brazilian Report, (2019). *Explaining Brazil #46: The rise of urban militias in Rio de Janeiro*. <https://brazilian.report/podcast/2019/02/06/urban-militias-rio-de-janeiro/> [2019-09-26]

Tirado-Soto, M.M., Zamberlan, F.L., (2013). *Networks of recyclable material waste-picker's cooperatives: An alternative for the solid waste management in the city of Rio de Janeiro*. *Waste management*, 33(4), pp.1004-1012.

Tukahirwa, J.T., Mol, A.P.J. and Oosterveer, P., (2011). *Access of urban poor to NGO/CBO-supplied sanitation and solid waste services in Uganda: The role of social proximity*. Habitat International, 35(4), pp.582-591.

UN, (2016). *Identifying social inclusion and exclusion*.
<https://www.un.org/esa/socdev/rwss/2016/chapter1.pdf> [2019-11-10]

UN Habitat, (2018). *Sustainable cities and communities. Make cities and human settlements inclusive, safe, resilient and sustainable*. <https://unhabitat.org/wp-content/uploads/2018/07/UN-Habitat-Brochure.pdf> [2019-02-03]

UN Habitat, (2010a). *Solid waste management in the world's cities*.
https://thecitywasteproject.files.wordpress.com/2013/03/solid_waste_management_in_the_worlds-cities.pdf [2019-09-05]

UN Habitat, (2010b). *Collection of Municipal Solid Waste in Developing Countries*.
<https://www.ccacoalition.org/en/resources/collection-municipal-solid-waste-developing-countries> [2019-09-05]

UNCHSUD, (2015). *Housing III Issue Papers. 22 – Informal Settlements*.
http://habitat3.org/wp-content/uploads/Habitat-III-Issue-Paper-22_Informal-Settlements-2.0.pdf [2019-11-10]

University of Southern California, (2019). *Organizing Your Social Sciences Research Paper: Writing a Case Study*. <https://libguides.usc.edu/writingguide/casestudy> [2019-09-21]

Valladares, L., (2006). *Social science representations of favelas in Rio de Janeiro: A historical perspective*. <http://lanic.utexas.edu/project/etext/llilas/vrp/valladares.pdf> [2019-09-26].

Van der Merwe, L., (2008). *Scenario-based strategy in practice: a framework*. *Advances in Developing Human Resources*, 10(2), pp.216-239.

Velis, C., (2017). *Waste pickers in the Global South: Informal recycling sector in a circular economy era*. *Waste Manag. Res.* (35), pp.329-331.

Visvanathan, C. (2012). *Public Private Partnership in Waste Management through IPLA: What does Private Sector Want?* IPLA Global Forum on Zero Waste, Seoul, Korea 4-5 September 2012. http://www.uncrd.or.jp/content/documents/01_Visu-AIT.pdf [2019-09-07]

Wellington, J., Szczerbinski, M., (2007). *Research Methods for the Social Sciences*. Bloomsbury Publishing. Ebook ISBN: 9781441114167.

Wilson, D.C., Rodic, L., Scheinberg, A., Velis, C.A. and Alabaster, G., (2012). *Comparative analysis of solid waste management in 20 cities*. Waste Management & Research, 30(3), pp.237-254.

Wilson, D.C., Velis, C.A. and Rodic, L., (2013). *Integrated sustainable waste management in developing countries*. In Proceedings of the Institution of Civil Engineers: Waste and Resource Management, 166(2), pp. 52-68.

World Bank, (2019). *Brief – Solid Waste Management*.
<https://www.worldbank.org/en/topic/urbandevelopment/brief/solid-waste-management>
[2019-09-08]

Yin, R.K., (2011). *Applications of case study research*. Sage. Chapter 1:
http://study.sagepub.com/sites/default/files/a_very_brief_refresher_on_the_case_study_method.pdf [2019-09-22]

Zapata Campos, M.J. and Zapata, P., (2013). *Switching Managua on! Connecting informal settlements to the formal city through household waste collection*. Environment and Urbanization, 25(1), pp.225-242.

Zapata, P., & Zapata Campos, M. J., (2015). *Unexpected translations in urban policy mobility. The case of the acahualinca development programme in Managua, Nicaragua*. Habitat International, 46, pp.271–276.

Appendix I

Interview questions

Depending on the participants role, organization and answers, the questions were somewhat modified, and some questions were added/removed.

1. Name, role in the organization and how many years working/volunteering with it?
2. How is waste disposed and how does collection work in the favela?
3. What problems do you have when it comes to solid waste in your community? Where does it end up?
4. Why do you think this happens?
5. What social issues are most present in the community? Is there a presence of criminality and violence?
6. How and why did the organization start?
7. What is the main aim of the organization and how is it run?
8. What do the organization do in terms of waste management?
9. Do you have partnerships, collaborations or financial support? How did you get it or why not?
10. What relationship do you have with the local authorities and COMLURB?
11. What are the biggest challenges the organization faces?
12. Are you able to generate income for anyone through the organization? How many volunteers?
13. What are some of the key factors to have a successful/working organization?
14. What contact do you have with the residents in the community and how do you communicate the organization to other stakeholders?
15. Is there anything you would like to add to the questions?

Appendix II

1. Interview 1

The CBO and joint cooperative is a selective collection and environmental awareness project in the favela Morro dos Prazeres that started in 2012. Their activities range from educational campaigns, workshops on recyclable materials, selective collection, working groups, community breakfasts, eco bingo, lectures and themed meetings inside and outside the community, building and strengthening a partnership network.

2. Interview 2

The NGO which started in 2012/2013 and is run by 25 volunteers and around 10 who works and live of recycling activities. The organization do both social and environmental work. They have many different activities and do everything from community runs, soccer practices for children and young adults, graffiti workshops and museum, solid waste collection and separation and recycling activities, composting of organic food and plating, handicraft workshops to teach community residents to use waste to create products they can re-use or sell.

3. Interview 3

The organization and joint cooperative, based in Vila Cruzeiro in Complexo do Alemão, started out as a reaction to all the diseases happening to the residents due to the amount of waste laying around in the community. From this was also the project 'learn and grow' born which aims to give children and young adults educational support and help to learn to read and write. Today the organization also gives food donations and hold events where hungry children can come and eat as well as spiritual guiding to help youth walk down the criminal path. The organization has also evolved into a network for catadore women working with recycling activities in the community. The organization plan includes expanding recycling activities and more recreational activities for children and youth.

4. Interview 4

The cooperative is located in Maria da Graça and started around 16 years ago as a way to create jobs and decrease the poverty in the local area. Today the cooperative is run by around 54 fulltime workers who previously were individual catadores or unemployed. The cooperative receives and collects almost all types of material form the selective collections system as well as electronic equipment. However, the recycling activities does not generate enough income to be able to run the entire business and therefore they also provide other services such as cleaning staff, cleaning and sorting waste at events etc.

5. Interview 5

The NGO was founded in 1969 and is currently run by professional volunteers such as educators, psychologists and other supporting professionals. The aim of the NGO is to carry out social projects to empower, improve and create opportunities for the residents of the community. Some of the free activities or services provided by the organization are social work, psychology, capoeira, taekwondo, K-Pop, English, computer science, crafts and adult literacy.

6. Interview 6

Cooperative and partnering CBO. The CBO is a social movement run by residents in Jardim Gramacho. The CBO strives to educate and sensitize the community residents

about waste related issues and recycling to promote the in-house sorting of material in benefit for the cooperatives working in the area. They collaborate with cooperatives, private enterprises and the local government of the municipality. The cooperative is one of many cooperatives which were created after the closure of Jardim Gramacho landfill in 2012. The cooperative share working space at a sorting center and the recycling business generate income to 21 families.

7. Interview 7

This interviewee normally works as an environmental agent on the behalf of the local government. She works with several communities on environmental education, income generation, sustainable hand-crafting, forest conservation projects and local economy. Moreover, and the reason why she was in the Catcomm data-bas is for the volunteer work she does and the NGO she is trying to start. Beyond the environmental part of the volunteering work she also tries to cultivate hope, optimism and empowerment of women.

8. Interview 8

Funded in 2014, the cooperative is a result of the closure of the landfill in Jardim Gramacho and currently provides for 22 catadores. The cooperative workers also partake in social work in the neighborhood and there are several events held in the main building. There are educational campaigns, social programs for young adults and empowerment for women held in their building.

9. Interview 9

The resident's association of the Asa Branca favela. The favelas is known in the Catcomm team and around Rio de Janeiro for being a very calm and peaceful favela without occupation of drug traffickers. Under the lead of the associations, the members of the community built a sewage system, made city authorities to pave entrances and streets. The community has been the focus of several studies exploring sustainable urban development and has been praised for the friendly, socially cohesive, safe and healthy living environments.

10. Interview 10

The CBO is a collective funded by 6 young adults who, together with 4 volunteers, conduct actions and projects to remove improperly disposed waste and revitalize the surroundings and environment in the favela Nova Holanda in Complexo da Maré. Actions involve environmental education through "table-discussions", documentaries and physical transformation of public spaces by planting and painting. They have no financial funding but have partnerships with e.g. COMLURB and Redes da Maré (Networks of Maré).

11. COMLURB stands for "Companhia Municipal de Limpeza Urbana", in English meaning Municipal Urban Cleaning Company. The company is the biggest organization of public cleaning in all of Latin America with its 22 000 employees. They are responsible for the collection and treatment of all solid waste generated in the city of Rio de Janeiro, including hospital waste but excluding other hazardous waste. The mission is "Keep the city clean, making the carioca more proud, healthy and happy" (COMLURB 2009).