CICLO
Coleta seletiva solar

Design of a sustainable Product Service System for waste collection in Rio de Janeiro's low income communities

Thesis project of Kathrin Dimai _ 765075

Master degree in Product Service System Design
Scuola del Design
Politecnico di Milano

Tutored by Prof. Carlo Vezzoli

19 -12 - 2012

INDEX

PART 3 • *Strategic analysis*

PART 4 • *CICLO, the incubation phase*

ABSTRACT _ eng

Ciclo is a system of door to door separate household waste collection in low-income communities to be carried out with solar-powered quadricycles. It is designed for the city of Rio de Janeiro, Brazil.
The project envisages the scaling up of the service by executing it during the sporting events that will be hosted by the city in the next years, as well as in the most advanced - in terms of innovation and sustainability - neighbourhoods of the city.

Rio de Janeiro produces 10 000 tons of waste every day (half of it is domestic) and recycles just the 3% of it. The most of the recycling material is collected by informal workers called "catadores" without proper tools. These are at the base of the chain of resellers who speculate on the commercialization of recyclables.
Actually the separate waste collection presents big gaps and is not introduced in the whole city. The municipality is working on a program of implementation and development of the selective waste collection, which plans the construction of six stations for the collection, separation and commercialization of recyclables to be executed by "catadores" cooperatives.

The aims of the project are:
- first, to integrate the use of low-emission vehicles in the municipal program of implementation and development of the selective waste collection, covering areas which are not currently included by the program itself;
- to establish a network of actors, which interact in a sustainable way, overcoming the intermediate resellers chain of the recycling market;
- to integrate marginalized people who already operate in the context, improving their socio-economical conditions by offering them formal work opportunities;
- finally, to act as an agent of sustainable change, improving the living conditions of the population and creating awareness about the importance of a correct use and disposal of resources.

The thesis is part of an open project fostered by the Department of Innovation for Sustainability of Politecnico di Milano which aims at spreding sustainable mobility systems through the activation of various pilot projects which can be developed in different low-income contexts, in collaboration with universities, local companies, NGOs and administrations.

The work consisted at first in identifying an intervention context in the city of Rio and carrying out a strategic analysis, in order to generate solutions oriented to sustainability. A set of promising strategic possibilities - which helped to get to the formalization of the actual concept vision - was then generated. Finally, the system was developed on a more specific level in order to be ready for the implementation.
The results of the project are:
- the identification and involvement of a network of stakeholders (defining their roles, motivations and mutual interactions), which took part in the co-design process and set the bases for the implementation of the project;
- the proposal of a concept vision for a sustainable Product-Service System and an hypothesis of transition path toward the introduction and scaling up of the innovation;
- the design of a self standing pilot project capable to be reproduced and multiplied in similar contexts;
- the design of a small-scale socio-technical experiment, aimed at learning and exploring how to improve the PSS innovation and how to contribute to its societal embedding;
- the design of the scaling up process.

ABSTRACT_ita

Ciclo è un sistema di raccolta differenziata domiciliare dei rifiuti porta a porta in comunità carenti, svolta attraverso l'uso di quadricicli ad energia solare. Si tratta di un servizio progettato per la città di Rio di Janeiro in Brasile.
Il progetto prevede lo "scaling up" del servizio applicandolo anche durante lo svolgimento degli eventi sportivi che la città ospiterà nei prossimi anni e nei quartieri più all'avanguardia in termini di innovazione e sostenibilità.

Rio de Janeiro produce diariamente 10 000 tonnellate di rifiuti (la metà domestici) e ne ricicla solamente il 3%. La maggior parte di questa percentuale viene raccolto da lavoratori informali chiamati "catadores", i quali operano senza gli strumenti adeguati e sono l'anello più debole della catena di rivenditori che speculano sulla commercializzazione di materiali riciclabili. Attualmente la raccolta differenziata non è introdotta in tutta la città e presenta molte lacune.
Il comune sta lavorando su un programma di implementazione ed espansione della raccolta differenziata che prevede la costruzione di 6 centrali per la raccolta, trattamento e commercializzazione di materiali riciclabili effettuati da cooperative di "catadores".

Gli obiettivi del progetto sono:
- integrare l'uso di veicoli a basse emissioni nel programma municipale di implementazione ed espansione della raccolta differenziata, coprendo le aree da esso escluse;
- formare una rete di attori, che interagiscano in maniera sostenibile, superando la catena di intermediari del mercato del riciclaggio;
- integrare persone emarginate che già operano nel contesto, migliorando le loro condizioni economiche attraverso l'offerta di opportunità lavorative formalizzate.;
- fungere da agente per un cambiamento sostenibile, migliorando le condizioni di vita della popolazione e sensibilizzando sull'importanza del corretto uso e smaltimento delle risorse.

Questa tesi si inserisce in una strategia più ampia di promozione e diffusione di progetti di mobilità sostenibile che l'unità di ricerca Design e Innovazione di sistema per la Sostenibilità (DIS)del dipartimento INDACO sta portando avanti. Un "open project" che può essere sviluppato in diversi contesti in collaborazione con università, aziende locali, NGOs e amministrazioni.

Il lavoro é consistito innanzitutto nell' identificare un contesto di intervenzione nella città di Rio de Janeiro e nello svolgere un'analisi strategica per la generazione di soluzioni volte alla sostenibilità. Successivamente è stato generato un catalogo di possibilità strategiche promettenti, il quale ha aiutato a formalizzare la visione di concetto.
Infine il sistema è stato sviluppato nello specifico in modo da essere pronto per l'implementazione.
I risultati del progetto sono:
- l' identificazione e il coinvolgimento di una rete di stakeholders (e la definizione dei loro ruoli, motivazioni e interazioni), che ha partecipato nel processo di co-progettazione e costituisce la base per l'implementazione del progetto;
- la proposta di una visione di concetto per un Sistema di Prodotto- Servizio e un ipotesi di percorso di transizione per la sua introduzione e diffusione;
- la progettazione di un progetto pilota autonomo, che può essere riprodotto e moltiplicato in contesti simili;
- La progettazione di un esperimento socio-tecnico in piccola scala per capire come migliorare il sistema e come facilitare il suo inserimento sociale;
- Il design del processo di "scaling up".

PART 1

Theoretical research

STRATEGIC DESIGN FOR SUSTAINABILITY

1

1.1 Sustainable development.

During the last fifteen years, sustainable development has become one of the great matters of global politics as an implication for both the civil and the industrial up growth.
The term refers to the systemic conditions of social and production development on three dimensions:
- the environmental: the harmfulness/irreversibility of the environmental effects/impacts;
- the socio-ethical: same satisfaction level for future generations and equity in the satisfaction's distribution;
- the economic: equal distribution of resources and economically viable solutions.

The environmental issue, intended as the effect of production-consumption on ecological stability, started to be raised from the 1960s as a consequence of industrialization. In the beginning of 1970s the first scientific texts began to be published and in 1987 an significant study was launched by UN World Commission on Environment and Development. During the 1990s, the United Nation's Environment Program and World Wildlife Fund For Nature defined sustainable development as improving the quality of human life within the limits of capacity to protect the ecosystems. In 1992 United Nations Conference on Environment took place in Rio de Janeiro. After ten years another conference was held in Johannesburg and the requirement of consciousness and active engagement of all the social actors in the production-consumption system has been announced.
On May 2000 Sustainable Consumption Unit of UNEP has been set up and on June 2006 the European Council planned a Sustainable Development Strategy for an enlarged EU. Finally this year the United Nations Conference on Environment RIO+20 took place again in Rio with the aim of reinforce the politic commitment for sustainable development with the identification of a new paradigm of economical growth towards social equity and ecoefficiency.

RIO+20
United Nations Conference on Sustainable Development

1.2 System innovations for sustainability.

Sustainability issues can only be solved if we focus on the root of the problem. This means that a profound radical transformation of our development model is necessary. As underlined by Manzini (1999), under discussion there are not only production processes and artefacts (products and services, infrastructure and all various form of anthropological settlements) but also patterns of consumption and access to goods and services. The issue of consumption, lifestyles and needs

has been recently included in the agenda of the main international governmental institutions, showing their crucial importance in the discussions about sustainability. In fact, over the next few decades we must enable ourselves to move from a society where well-being and economic health are measured in terms of growth, to a society where we are able to live better consuming far less (Manzini and Vezzoli 2008). It emerges that if we want to effectively tackle sustainability, there is a need to develop new potential ways of satisfying needs and desires, and in general the social demand of wellbeing.
Given the nature and the dimension of this change, the transition towards sustainability represents a wide-reaching social learning process in which system innovations are needed.
System innovations are major shifts in dominant socio-technical regimes and the way in which societal functions (such as transportation, communication, housing and feeding) are fulfilled (Geels 2002). System innovations imply changes at different levels: at the level of the products, services and production systems, and equally at the level of social and institutional arrangements, such as mechanisms of coordination (regulation, governance) and patterns of interaction at the supplier and the user side of innovation (Weber et al. 2007).
The transition to one socio-technical system to another implies a process of change of the structure of the system, of the relationship among the actors in the system and the practices they carry out and of the culture.
System innovations are characterised by being:
- multi-actor: they involve a wide range of actors, including firms, industries, users, public authorities, governments, research centres, NGOs, etc.
- multi-factor: they are not caused by a change in a single factor but are the result of the interplay of many factors that influence each other; they are a combination of technical, regulatory, societal and behavioural change (Elzen et al. 2004);
- multi-level: they implies changes at various levels
- highly uncertain: they are difficult to be predicted and managed because of their complexity and their inherently highly degree of uncertainty (van den Bosch et al. 2005);
- long-term processes: they take relatively very long time to occur because they require multidimensional changes (Elzen et al. 2004).
The question is: in which way we can re-shape our social institutions and steer our production and consumption systems towards sustainability?

1.3 The Product-Service System concept definition, characteristics and classification.

A concept that theoretically and practically represents a promising model to steer our production and consumption systems towards sustainability is the functional economy one. It is oriented to satisfy consumers through the delivery of functions instead of products (e.g. mobility instead of cars, having clean clothes instead of washing machines and powder), and this can potentially bring about a reduction in the current levels of resources consumption, without minimizing consumers' level of satisfaction.
Within the framework of functional economy it is considered promising to look at the concept of Product-Service System (PSS) innovation.
A PSS can be described as an integrated system of products and services, delivered by one or more socioeconomic actors, and designed to fulfil a specific customer need. The word system refers to both the system of products and services delivered to the client, and the system of actors that produce and offer the combination of products and services. PSS require the development of new relationships and forms of partnership among the stakeholders of a value production chain. In other words, new interactions with the user and innovative partnerships with other producer/suppliers, public bodies or not for profit organisations are needed.
This kind of business model permits to generate profit selling performances instead of goods, producers become providers of value while customers become users of value. For this reason PSS innovation can be considered a promising economic approach to satisfy users and customers needs with a lower environmental impact.

The key elements of a PSS are (Mont 2002):
- products: the tangible artefacts of the system;
- services: they include services that make products available (sales services, renting, sharing, etc.), and services to manage products in the use and end-of-life phases (maintenance, upgrading, take back, etc.);
- network of actors: it include all the socioeconomic actors needed to produce and deliver the PSS, and it comprises the partnerships and interactions between those actors belonging to that particular value chain.
- infrastructures: they comprise existing collective and private systems (such as roads, communication lines, waste collection systems, etc.). PSS and infrastructures are strictly correlated: infrastructures affect the configuration of the PSS and at the same time the PSS can stimulate the development of new infrastruc-

tures or the modification of existing ones.

In general (but this depends on the specificity of each single case), PSS innovations are characterised by three innovative features:
- A shift from selling products to provide satisfaction, meaning that what is offered is not a product but the fulfilment of a particular customer demand. Customer does not pay for the product but per unit of satisfaction delivered.
- As a consequence there is a change in product and resources ownership, meaning that, differently from the traditional sale models, the partnership providing the PSS keeps the ownership of all the products that are part of the solutions. Consequently the relationship between the producer and the user does not end after the transaction (as in the traditional business models), but continues in time.
- An innovative network of stakeholders, meaning that the adoption of a PSS-based approach may considerably change the supply chain structure. In fact a PSS, rather than a technological innovation can be seen as a new way of delivering a satisfaction. Of course it can include some new technological artefacts, but its innovative aspect is mainly related to the innovative actors configuration.

PSSs can be classified as:
- Product-oriented PSS: services providing added value to the product life cycle. It can be defined as a value offer where a company (or an alliance of companies/stakeholders) provides additional services to guarantee functionality and durability (i.e. product life extension) of the product which is sold to the customer). These services can include for example maintenance, repair, upgrading, substitution, product take-back, etc. (UNEP 2002). This type of PSS reduces the user's responsibility in the use and/or disposal of the product/semi-finished product (owned by her/him), and the innovative interaction between the company and the customer could potentially drives the company's economic and competitive interest in continuously seeking environmentally beneficial new solutions, i.e. the economic interest could become something other than only selling a higher amount of products (Vezzoli 2007).
- Use-oriented PSS: services providing 'enabling platforms' for customers. It can be defined as a value proposition where a company (or an alliance of companies/stakeholders) offers access to products, tools, opportunities or capabilities that enable customers to get the results they want. The client obtains the desired utility but does not own the product that provides it, and pays only for the time the product is actually used. Depending on the contract agreement, the user could have the right to hold the product/s for a given period of time (several

continuous uses) or just for one use, and sometimes shared by a number of users (UNEP 2002). The client thus does not own the products and does not operate them to obtain the final satisfaction (the client pays the company to provide the agreed results). Again in this case the innovative interaction between the company and the client could potentially drive the company's economic and competitive interest to continuously seek environmentally beneficial new solutions, e.g. to design highly efficient, long-lasting, reusable and recyclable products (Vezzoli 2007).
- Result-oriented PSS: services providing 'final results' for customers. It can be defined as a value offer where a company (or an alliance of companies/ stakeholders) provides a customized mix of services (as a substitute for the purchase and use of products), in order to provide a specific final result (in other words, an integrated solution to meet the customer's satisfaction). The mix of services does not require the client to assume (full) responsibility for the acquisition of the product involved. Thus, the producer maintains the ownership of the products and is paid by the client only for providing the agreed results. The customer benefits by being freed from the problems and costs involved in the acquisition, use, and maintenance of equipment and products (UNEP 2002). In other words, the client and producer/provider agree on a result, and there is no predetermined product involved in the offer. The client does not own the products and does not operate them to achieve the final satisfaction; the client pays the company to provide the agreed results. The innovative interaction between the company and the client could potentially incentivise the company's economic and competitive interest to continuously seek environmentally beneficial new solutions, e.g. long-lasting, reusable and recyclable products

PSS innovations can be considered system innovations if they bring substantial changes in the societal/behavioural and regulative dimensions and due to the high degree of diffusion become part of the mainstream way in which a societal satisfaction is fulfilled.
In general it is possible to say that sustainable product-oriented PSSs usually cannot be considered system innovations. On the other hand sustainable use-oriented PSSs and result-oriented PSSs usually require multi-dimensional changes (e.g. changes in existing customer and user practice, companies organizational structures, regulative frameworks, culture, etc.), and therefore are system innovation.

1.4 PSS and its sustainability potentials.

PSS in fact offer a promising concept to move in the direction of sustainability; but this potential can be exploited only by PSSs that are specifically designed, developed and delivered (Ceschin, 2010). The PSS should be conceived in order to create economic and competitive incentives for the actors of the value constellation to lower and optimise material and energy consumption. Secondly, the products included into the PSS should be properly conceived in order to exploit this potential: they should be designed with a low environmental impact in the various life cycle phases.

A sustainable PSS doesn't just focus on the economic and environmental dimensions, but presents several benefits also on the socio-ethical dimension.
The Economic and competitive benefits that can result from an appropriately designed PSS are potential improvements on the competitiveness of the company/ies (or more in general the alliance of stakeholders) involved in producing and delivering the offer. A new PSS can in fact represent a differentiating offer from the traditional product-based ones (Davidow and Uttal 1989; Kyj and Kyj 1994; Frambach et al. 1997), and can be more customisable to client wants and needs. Thus, moving up the value chain could represent an alternative to standardization and mass production (Baines et al. 2007), and a potential answer to the price competition from low-cost economies (Tukker and Tischner 2006a).
In addition a PSS can potentially provide an added value to customers compared to a product-based offer. Customers can in fact obtain the requested satisfaction without necessarily making large investments into products (Mont 2004), and without being responsible for the costs and problems associated with the acquisition, use, maintenance and disposal of these products (UNEP 2002)
PSS can improve strategic positioning and competitiveness also because it can establish longer relationships with customers (Manzini et al. 2001; UNEP 2002; Mont 2004). In fact the link between customers and the producer/provider does not end after the purchase choice (as it happens in the traditional product-based offers), but it lasts during the whole period of the contract.
The environmental benefits of PSS-oriented solutions are related to the fact that there is an economic and competitive incentive, for the stakeholders involved in the PSS offer, to optimise the material and energy consumption.
During the use phase, PSS providers have a potential economic interest to reduce the amount of resources consumed. In fact, if what is sold is a performance, fewer resources are used to deliver that performance and fewer costs will be sustained by providers, with a consequent profit increasing. Moreover, if PSS providers

keep the ownership (or at least retains some responsibility) on the products over their life cycles, there is a further economic incentive to extend their life spans. At the end of a product's life, PSS providers have the potential economic interest to re-use or re-manufacture the product/s and their components, in order to save on disposal costs and on the costs to manufacture new products.
Furthermore a PSS-oriented solution can provide several socio-ethical benefits. Socio-ethical benefits for customers include the following:
- PSSs may focus much more on the needs and value of customers (thanks to their customisation potentials) and thus can improve quality of life (Tukker et al. 2006). Moreover PSSs may involve customers directly in the development and customisation of the offer, increasing its value and the satisfaction for customers (ibid.).
- Use- and result-oriented PSSs does not require payment for the full value of the product, thus it is more accessible for consumers who could not afford to buy this product. This means that they may represent a significant opportunity for contexts with fewer economic possibilities (i.e. low-income and emerging contexts) to respond more easily to unsatisfied social demands with lower overall costs (UNEP 2002).
For the society, socio-ethical benefits comprise the following:
- PSSs are more labour and relationship intensive, thus they can also lead to an increase in local employment and a consequent dissemination of skills (UNEP 2002).
- PSS development, when it is based on existing products, can sometimes be done with limited investments. These PSSs may create new business opportunities for entrepreneurs (Tukker et al. 2006). Again it has to be stressed out that this may represent an important opportunity for contexts with fewer economic possibilities.
PSSs can strengthen the role of local economy because they are more focused on the context of use: services are created at the same time and often at the same place when and where they are consumed (Tukker et al. 2006). For this reason PSSs could trigger a greater involvement of more local, rather than global, stakeholders, thus fostering and facilitating the reinforcement and prosperity of the local economy (UNEP 2002). Thus they may empower and enhance local resources, by safeguarding, regenerating and empowering local economies and the related human and natural resources (Vezzoli 2007; 2010).

1.5 Sustainable PSS innovation in low-income and emerging contexts.

Developing countries will have a big impact in the global sustainable development since need to go through a process of economic growth to reach a similar standard of living of developed countries.
In industrially matured contexts it is necessary to reduce the use of resources needed for the production of products, in emerging contexts it is possible to look how to get over it and go directly towards a sustainable consumption and production system. In the low-income contexts the urgent need is to promote the system of production and consumptions in covering basic needs and providing a con-sequent basis for a sustainable growth (Vezzoli 2011). In other words PSS may act as a business opportunity to facilitate the socio-economical development process of emerging contexts, bypassing the stage characterized by the individual consumption of mass-produced goods and going directly in the direction of a more advanced service-economy "based on satisfaction" and on low resources exploitation. In this case, a Product Service Systems approach could reach and provide a widespread higher level of well being or utility at lower cost, because of the higher system efficiencies. It may represent a more promising and environmentally "lighter" path to contribute to industrial development.
PSSs do not require significant investments in specific technologies (except for ICTs, which, in comparison with earlier economic infrastructures, require a drastically lower investment cost).
PSS offerings are more focused on the context of use because they do not just sell products but establish a strong relation with the final user. For this reason an increase of offerings in emerging contexts would bring to a bigger involvement and empowerment of local actors. This would facilitate the strengthening of the local economy because more work and involvement is needed and the implementation of PSSs would bring an increase of local employment.
Furthermore the development of the PSS is based on the establishment of a relations system and coherent partnerships, with a democratic (bottom-up) reglobalization and with the development of a network of local businesses.

A good example of PSS innovation in low-income and emerging con-texts is the project "Luz Agora" : distributed solar energy and electrical devices as an all- inclusive package in Brazil. Brazilian social entrepreneur Fabio Rosa envisioned that he could lease his solar energy service for close to the same cost as people were spending on inferior, nonrenewable energy sources. He knew that the rural poor are not interested in buying solar panels but just in having access to the conveniences that electricity provides, such as effective and safe lighting at night

and the ability to listen to the radio or heat shower water. Based on this understanding, in 2001, Rosa began exploring a new business model to provide Brazils rural people with what they needed: energy services, not just solar energy. He developed a basic photovoltaic solar home system that could be rented for US$ 10/month plus an initial installation fee, a little more than what people were already spending on non-renewable forms of energy. The so-called "solar home kits" include the hardware which generates the energy, the installation service and the devices like lightening equipment and sockets.
Today the project counts 200 installations in the states of Rio Grande do Sul, Santa Catarina and Paraná.

Fabio Rosa & a rural house where the solar system has been installed.

1.6 A strategic design approach to design sustainable PSSs

The design of sustainable PSSs requires moving towards a strategic design approach: a design capable to visualise possible futures to orient the strategy of a company (or an institution, NGOs etc.) and capable to create a clear and comprehensible representation of the values and identity of this company.
In this respect Manzini and Vezzoli (2003) introduced the concept of strategic design for sustainability: "the design of an innovation strategy, shifting the business focus from designing (and selling) physical products only, to designing (and selling) a system of products and services which are jointly capable of fulfilling specific client demands, while re-orienting current unsustainable trends in production and consumption practices".
Within this framework it is clear that this design attitude requires particular skills (Vezzoli 2007):
- the ability to design an integrated system of products and services fulfilling a particular demand of satisfaction;
- the ability to promote/facilitate new socioeconomic stakeholder interactions

(configurations) and promote/facilitate participated design between different stakeholders;
- the ability to orientate the above processes towards eco-efficient and/or sustainable solutions.
However there is an urgent need to not only conceive and propose sustainable PSS concepts, but also to understand the contextual conditions in which they are introduced and which strategies and development pathways are the most appropriate. In this sense designers could have a role in guiding and supporting a company, an institution or a network of actors, in the process of introducing and gradually embedding sustainable PSS concepts in the society.
Hence, strategic design for sustainability can be described as the design of sustainable PSS concepts, and the design and managing of transition strategies to support and speed up their introduction and scaling up.
It is an approach in which design, development and implementation should be carried out simultaneously and in continuous interaction and it is based on:
- envisioning: the development of long term visions to guide project actors towards the implementation of sustainable radical innovations.
- experimenting: the design of sequences of socio-technical experiments to explore and learn how to improve radical innovations and how to favour their scaling up.
- involving a wide variety of actors: the design of the actors network configurations needed to support the societal embedding process, taking in consideration not only the actors belonging to the PSS value chain (producers, partners, suppliers, users, etc.), but also the ones that have the power and willingness to directly and indirectly influence dominant socio-technical regimes.
- reflexive learning: the innovation journey is seen as a path based on exploring, searching and learning, capable to bring actors to continuously reflect on and learn from the activities undertaken, and in case reconsider underlying assumptions.

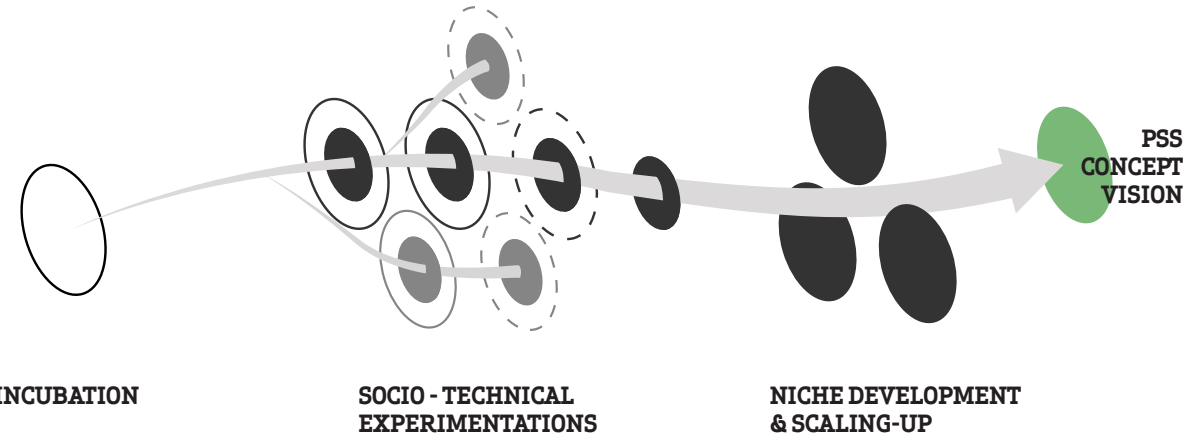
THE INTRODUCING & SCALING-UP OF SUSTAINABLE PSSs

2

2.1 The transition path to introduce and scale up PSS innovations

The starting point of a sustainable PSS innovation is a project vision: a PSS idea or concept developed as an answer to a societal/business challenge. This project vision provides a direction to the societal embedding process.
The process is characterised by dynamic adaptation: what is learned by actors brings to a continuous and mutual adjustment of the transition path, the project vision and the actor network itself.
The process of implementing and scaling-up radical innovations should be seen as a transition path, characterised by:
- an incubation phase, in which the conditions needed to start the societal embedding process are set up.
- a socio-technical experimentation phase, in which experiments are undertaken with the aim of learning and exploring how to improve the PSS innovation and how to contribute to its societal embedding.
- a scaling-up phase, in which the PSS innovation (and the related new practices, behaviours and institutions) begins to influence the socio-technical regime (the initially unusual PSS innovation increasingly becomes part of the dominant way in which a societal satisfaction is fulfilled) (Ceschin 2012).

A crucial role is played by the establishment and development of a proper network of actors: a broad and dynamic network capable to protect, support and foster the innovation.
In particular, crucial actors to be involved in the project are:
- end-users and customers, because they can contribute in testing and developing the PSS innovation.
- outsider firms (firms that do not share the current regime institutions and practices), because they can mobilise knowledge and financial and managerial resources to develop innovations that deviate from that regime;
- research centres and scientists, because they can contribute to introduce new designs, ideas, approaches and concepts;
- societal pressure groups, NGOs, media, etc., because they have the potential to mobilise public opinion and (in)directly influence the regime;
- governmental institutions, ministries, policy makers, politicians, etc., because they can give legitimacy and stability to the experimentation phase, and then can directly influence the dominant culture, practices and institutions to support the scaling-up of alternative PSS innovations.
It has to be underlined that we are dealing with a dynamic network because the different stages of the societal embedding process require different network



The three phases of the design process (Ceschin 2012).

compositions. Therefore the network composition, as well as the required tasks to each actor, continuously evolves in time.
It is also fundamental to build-up a long-term vision, shared among the actors involved in the project. In fact a shared project vision aligns actors' expectations and give a strategic orientation and legitimacy to the innovation
Finally, an adequate learning process is considered key important because it enables continuous adjustments of the PSS innovation and therefore increases chances for a successful diffusion.
The learning should be on many dimensions of the problem and the resulting in changes in actors' reference framework, beliefs, behaviours, practices etc.

2.2 Incubation

The incubation phase consists in the setting up of the conditions needed to start the societal embedding process.
The starting point is a sustainable PSS concept vision developed by a company, a public institution, or a network of heterogeneous actors. Actors potentially interested in the concept, as well as actors needed to give protection and support to the innovation, are firstly identified and involved. The setting-up of the actors network aims to achieve a common consensus on the PSS concept and to build up an action plan with the potential strategies to socially embed the concept.

In detail the steps to undertake are the following (Ceschin 2012):
Formalise the PSS concept vision

The aim is to translate the PSS concept in a set of visual artefacts capable to clearly and effectively communicate:
- the goal of the project;
- the main characteristics of the PSS innovation (how it works, which stakeholders are involved, etc.);
- its potential (environmental, economic and or socio-ethical) benefits

Draft first hypothesis of transition path

After formulating the project long-therm vision, the next step is the development of the first hypothesis of the transition path by identifying:
- the main steps (action plan) between the present situation and a future situation in which the PSS concept becomes part of the normal way in which a societal satisfaction is fulfilled;
- the actors needed along the whole process and the related roles.

Involve actors in strategic discussions

The aim is to involve the previously identified stakeholders in strategic discussions, in order to achieve a common consensus on a project vision and related transition strategy.

Adjust vision, transition path & actors network

The continuous strategic relation with the various involved actors (through workshops, meetings etc.) and the related negotiation processes, lead to adjust and refine the project vision, the transition strategy and the actors network.

2.3 Socio-technical experimentation

In this phase socio-technical experiments are designed and implemented with the aim of learning and exploring how to improve the PSS innovation and contribute to its societal embedding. These experiments are undertaken at a local scale, in an environment protected from market competition, and involve a broad network of actors (e.g. potential users, a public authority, NGOs, etc.). This protected space enables actors to explore and learn about local shifts in culture (new ways of thinking, value, and perspective), practices (new ways of doing, habits and routine) and institutions (sets of rules and procedures that guide the interactions and behaviours of actors). Particular importance is given to the conception and implementation of experiments capable to act as:
- Labs, to test and improve the PSS innovation on multiple dimensions and in relation to different contexts;
- Windows, to raise interest on the innovation project and the related actors, disseminate results and attract and enrol new actors;
- Agents of change, to influence contextual conditions and favour the societal

embedding process.
The output of socio-technical experimentations phase is the development of a more stable PSS, capable to increasingly influence the socio-technical regime.

The steps to go through in this phase are (Ceschin 2012):
Design socio-technical experiments
At this stage small scale socio-technical experiments are designed in order to develop and bring to mature highly risky innovations without the direct pressure of the mainstream market selection environment.
Involve actors in strategic discussions
The implementation of the previously designed socio-technical experiment/s could require to involve new actors. The involvement of new actors (which could have different expectations) could lead to adjustments in the action plan and in the socio-technical experiment/s design
Implement socio-technical experiments
At this stage the socio-technical experiment/s are implemented by the project network.
Monitor and evaluate experiments
Constant observation and analysis of activities undertaken should take place for a consequent adjustments/adaptation.
Adjust vision, transition path & actors network
Through a learning-by-doing approach, the monitoring and evaluation activities can lead to insights on how to adjust/refine:
- the experiment/s (in their different aspects);
- the project vision;
- the action plan;
- and the actors network

2.4 Scaling up

At this stage the aim is to increase momentum of the PSS innovation (and the related new practices, behaviours and institutions), and start to have an influence on the socio-technical regime in terms of expectations, visions, knowledge, rules, etc. It is a process that can lead the PSS to increasingly become part of the mainstream way in which a societal satisfaction is fulfilled.
Key issues to be taken in consideration are: to repeat the PSS innovation in other contexts and create synergies with similar projects and initiatives at a broader level; to disseminate information/project results and stimulate media attention at a national level; to stimulate actors at a strategic level to influence the socio-technical context in order to create the most favourable conditions for the

scaling-up of the PSS innovation.

The main activities to carry out in this phase are (Ceschin 2012):
Design strategies to support scaling-up
At this stage the new practices related to the local experiments can gradually be adopted on a wider scale and increasingly become usual. The proper actions to enhance the development and reinforcement of the pathway of experiments are identifyed.
Involve actors in strategic discussion
The implementation of the scaling-up strategies could require the involvement of new actors.
Implement strategies to support scaling-up
At this stage the previously designed scaling-up strategies are implemented by the project network.
Monitor and evaluate scaling-up progress
Like in the experimentation phase, during the scaling-up process a continuous reflexive monitoring takes place.
Adjust vision, transition path & actors network
Also in this phase adjusting and refining take place as a consequence of the monitoring and evaluation activities.

2.5 New strategic-design attitude and capabilities for the societal embedding of PSSs

As seen in the previous paragraphs designers need to focus on a broader design scope: the ideation of sustainable PSS concepts should be joined with the designing of appropriate transition paths to gradually incubate, introduce and diffuse these concepts. Fundamental in this sense is the strategic design of the sequence of steps that leads to gradually reinforce/improve the PSS innovation and foster its societal embedding.

The designing of transition paths requires designers to adopt a multi-term design perspective in order to focus both on the project long-term goal (the achievement of a future in which a sustainable PSS innovation is part of the normal way in which a societal need is fulfilled) and the short- and medium-term actions to be undertaken in order to orient the societal embedding process towards the long-term goal.

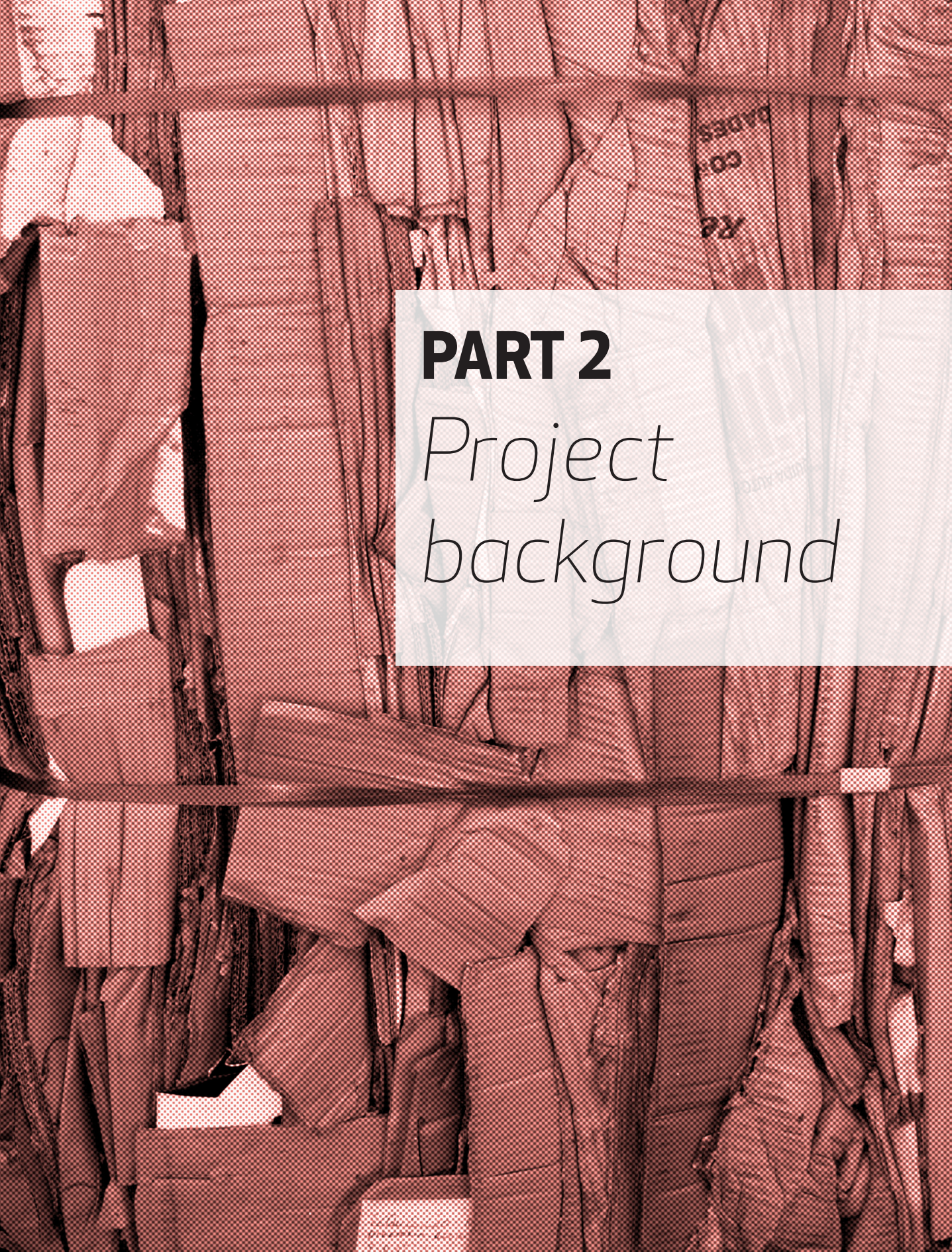
Furthermore strategic designers should focus not only on the PSS innovation

but also on the contextual conditions that may support or hinder the societal embedding process. Strategic designers should therefore adopt a strategic attitude oriented at influencing the socio-technical context, in order to create the most favourable conditions to favour the societal embedding of the PSS (i.e. by involving those actors that, directly or indirectly, could affected regime practices and institutions; by stimulating changes in actors' behaviours and practices).

The design scope should also be extended to the identification and involvement of the actors that can support the societal embedding process in the various steps of the transition path, in other words it is also important focus on the PSS value chain. The actors to be taken in consideration are not only the ones that are more directly linked with the innovation, but also other relevant ones from the science, policy and societal domains (e.g. research centres, governmental institutions, local administrations, NGOs, special interest groups, media, etc.).

The introduction and scaling up of radical innovations should be based on an experimental and learning approach intended to explore the most appropriate characteristics that a PSS innovation should have in order to respond to a societal/business challenge and the most appropriate strategy to create the conditions for contributing to the societal embedding of this innovation.
In fact the project vision and the transition strategies are not static outcomes to be achieved but are continuously adjusted as a result of what is learned by actors during the societal embedding process. Even the network of actors involved in the societal embedding process is dynamic, for instance the process of networking in local socio-technical experiment is different than networking during scaling-up.

Strategic designers must be capable to facilitate the building up of a shared project vision and action plan by facilitating a participatory approach, involving a variety of stakeholders in discussing, negotiating, co-creating and developing alternatives.
In this respect it is crucial for strategic designers to be able to: organise the complexity of the information that must be exchanged and support effective communication activities among stakeholders; manage the diversity of their expectations, and their negotiation and alignment. Fundamental required skills are: being a communicator (capable to effectively illustrate complex information such as project visions and action plans) and a negotiator (capable to facilitate the convergence of actors' expectations).



PART 2

Project background

MULO SYSTEM

3

3.1 An open project intended as an agent for sustainable change.

This thesis work is part of a broader strategy of promotion and diffusion of mobility projects based on the use of sustainable quadricycles, which the Department of Innovation for Sustainability (DIS) of Politecnico di Milano is fostering. It is an open project that can be developed and adapted in collaboration with universities in different low-income contexts, as well as local companies, NGOs and administrations. The common and shared goal is to diffuse sustainable mobility systems, satisfying the needs of mobility in specific contexts, through the activation of various pilot projects or socio-technical experimentation, intended as "lab" and "windows" (i.e. agent for sustainable change).

DIS is adopting the system sustainability approach, which means designing the stakeholder interactions that continuously look for both socio-ethical and eco-efficient new beneficial solution. The strong idea is the cooperation with universities and local manufacturers in order to share the knowledge and collaborate in the developing of the project for a specific context and with the local material and technologies available. The importance of cooperation and co-participatory design allows the design team to understand better the need of the user in the context.

It is also important that the design process and the manufacturing take place locally for not being like many projects for developing countries that have been produced in developed world and then just placed in the needy context expecting them working.

The criteria used by DIS to design system for social equity and cohesion are: improve employment and working conditions; increase equity and justice in relation to the stakeholders; enable a responsible and sustainable con-sumption; favour the integration of the weak and marginal-ized; improve social cohesion; and empower local resources and knowledge

Mulo prototype riding the race from Rome to Maranello.

3.2 Previous experiences in emerging and low-income contexts

In this framework the design and implementation of pilot projects for the transportation of disabled and elderly people was carried out in Cape Town (South Africa) as well as the collaboration with actors in India for the development of a rural ambulace.
Previous projects proposals consisted in a PSS for drinkable water transportation in Burkina Faso and in a PSS for vegetable's transportation in Zambia.
The common focus was the development of sustainable mobility systems with different functions responding to the specific situations working in direct contact with potential users and other interested actors.

Rio de Janeiro - Brasile

Separate waste collection.

Basanti - India

Rural Ambulance.

Burkina Faso

Water transportation.

Zambia

Food transportation.

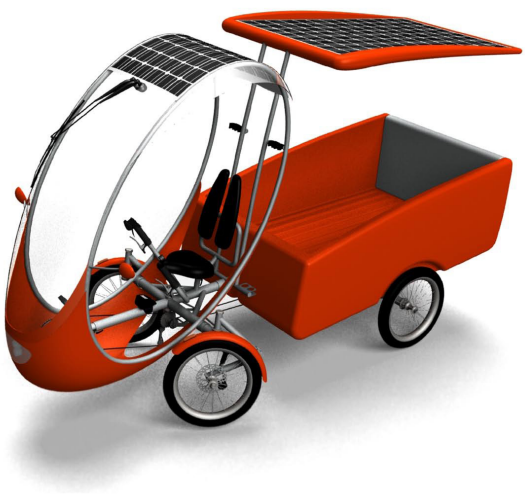
Cape Town - South Africa

Disabled people transportation.

3.3 The vehicle

MULO System (sistema per la Mobilità Urbana da LavorO) is a family of light working vehicles, with zero emissions in use, thought for urban contexts.
The idea was promped by the ambition of favouring sustainable mobility in order to reduce the pollution and traffic problems that effect citizens' quality of life.
The quadricycles are powered by solar, electric and human power and are characterised by a modular logic: a basic platform that can be combined with different modules. The family of vehicles was conceived to fulfil several mobility functions related to working activities in urban areas such as freight transportation, people transportation, green areas maintenance, street selling etc..
These vehicles have been designed to be appropriate and to have access in every kind of urban route: urban roads, pedestrian areas, and limited traffic areas.
Use flexibility, zero emissions in use, soundless, driveability and manoeuvrability, as well as comfort, are the main characteristics of MULO System.
Mulo System has been designed by Fabrizio Ceschin for his master degree thesis defended in April 2006 at Politecnico di Milano. The first version of the vehicle was prototyped in August 2006 by the high school IPSIA "A. Ferrari" Maranello in collaboration with DIS (Design and Innovation for Sustainability) Politecnico di Milano research unit. In September 2006 the vehicle took part in the Levante project, a non-competitive race dedicated to innovative low emissions vehicles, from Rome to Maranello (591 km).
Technically when the vehicle is exposed to solar radiations the two solar panels convert this energy in electric one. Electric energy is stored in lithium ion batteries, which give energy to an electric motor. The electric motor operates on the rear axes, determining the vehicle movement. If solar energy is not sufficient to satisfy the vehicle energy demand, batteries can be recharged through the electric grid.
The electric motor is controlled by a throttle placed on the handlebar. The vehicle can move using only the electric energy or, if required, driver can contribute using his own muscular energy.
During deceleration, when driver pushes the brakes a contact sensor inverts the polarity of the electric motor. In this way the motor becomes a dynamo that transforms the kinetic energy of the vehicle in electric energy (recharging the batteries).

The modular logic of Mulo System.



METHOD AND TOOLS
4

4.1 MSDS - Method of System Design for sustainability

The design of sustainable and eco-efficent PSSs requires an approach and competencies linked to strategic design. A designer must be able to:
- identify possible future directions of a company (or institution, NGO, etc.)
- operate in an integrated system of products, services and communication aimed to satisfy a given demand of needs and/or desires;
- clearly represent the identity and values of a company;
- find and promote innovative configurations between different stakeholders, related to a given value;
- facilitate a participatory design process among entrepreneurs, users, NGO, institutions, etc. orientating this process towards environmentally sustainable solutions.

From the operational point of view it has been followed the MSDS (Method of System Design for Sustainability), which has been developed by the INDACO department of the Politecnico di Milano.
The design path has been articulated in the following phases:

- Strategic analysis, with the objective of obtain the information needed for the generation of ideas oriented towards sustainability.
After a first analysis of mobility in the city of Rio de Janeiro and the highlighting of criticisms and opportunities the strategic analysis served the purpose of understanding deeply the context chosen for the project and to define the starting point of the system design process.
During this phase the existing offering system has been analysed, understanding which are its actors and dynamics. The priorities for sustainable solutions from the environmental, socioethical and economic points of view have been identified. Furthermore it has been carried out a research about the future directions of the reference context in order to define the orientations of actions to undertake and insert the project in a broader program.
To acquire this knowledge in addition to research different techniques of ethnographic analysis on spot have been used.
From the beginning the NGO Ecomarapendì, which is a reference in the context, has been involved and collaborated in clarifying the current situation and providing contacts of institutions and people involved in the sector.

- Exploring opportunities, aimed at producing a "catalogue" of promising strategic possibilities and promising scenarios.
During this phase a series of scenarios related to the possible use of the vehicle

in the reference context and in different areas of the city were generated.
An essential tool to communicate and explain the developed ideas to the stakeholders was the offering diagram, which allowed to visualize in one image which customers needs are fulfilled by the PSS offer.

- System concept design, aimed at developing the system concept/s with higher potentiality .
At this point, with further deepening of the field study and by working side by side with the stakeholders, three promising scenarios were defined.
One of them constitutes the project vision and the other two visions for the scaling up of the project.
System maps were developed to visually represent the stakeholders interactions.

- System design, aimed at developing the PSS concept in a detailed version necessary to its implementation.
The chosen scenario was then developed in detail in order to permit an implementation of a pilot project and its functioning at full operating scale was hypothesized. Here as well the contribution of the stakeholders has been fundamental because of their deeper familiarity with the context.
The stakeholders network and their roles and interactions were defined and a business model and an economic study were elaborated. The principal tools used in this phase were the system map and the interaction storyboard.
The scaling up, which comprehends the replication of the pilot project and the application of the other two scenarios was designed too.

- Communication, aimed for the external communication of the designed PSS, creating interest on it.
This phase was carried out in parallel with all the others and served to communicate the characteristics and the evolution of the project to the stakeholders. During the whole work, presentations and informative material has been produced, using also the mentioned tools.
The corporate identity of the service was designed too and applied to this materials in order to give them a professional aspect.

STRATEGIC ANALYSIS

- ANALYSIS OF THE PROJECT PROMOTERS
- ANALYSIS OF THE REFERENCE CONTEXT
- ANALYSIS OF THE REFERENCE STRUCTURE
- ANALYSIS OF BEST PRACTICES
- DEFINITION OF SUSTAINABILITY DESIGN PRIORITIES

EXPLORING OPPORTUNITIES

- IDEAS GENERATION ORIENTED TO SUSTAINABILITY
- DEVELOPMENT OF THE SUSTAINABILITY DESIGN ORIENTING SCENARIO - VISIONS/CLUSTERS/IDEAS

SYSTEM CONCEPT DESIGN

- VISIONS, CLUSTERS AND IDEAS SELECTION
- SYSTEM CONCEPT DEVELOPMENT
- ENV, SOCIO-ET. & ECONOM. CHECK/VISUALIZATION

SYSTEM DESIGN

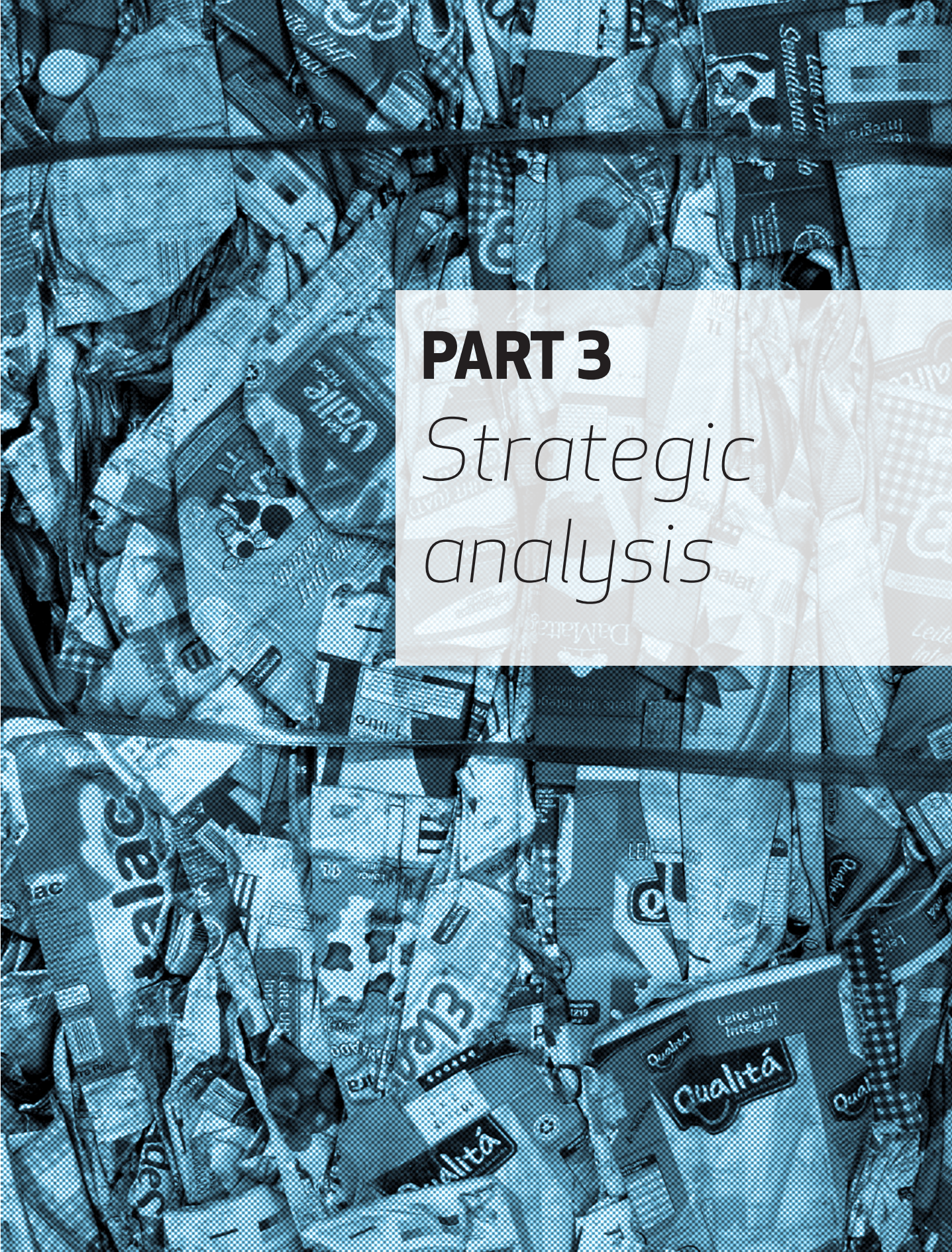
- SYSTEM DEVELOPMENT (EXECUTIVE LEVEL)
- ENV, SOCIO-ET. & ECONOM. CHECK/VISUALIZATION

COMMUNICATION

- REPORT ELABORATION

4.2 Tools

To support the described method a series of tools listed below have been used
- Contextual interviews, that are conducted in the environment, or context, in which the service process occurs. This ethnographic technique allows interviewers to both observe and probe the behaviour they are interested in.
- Shadowing, which allows the researcher to immerse himself in the actions carried out by others in order to observe and document their behaviour and experiences by remaining as unobtrusive as possible. It allows to spot the moments at which problems occur.
- Offering diagrams, that are static representations, made up of images and text that describe the functions of the system.
- System maps, to visualize the structure, the involved socioeconomic actors and the flows of information, money, products and labour.
- Interaction storyboards, a series of pictures that visualise a particular sequence of events carried out by different actors in an hypothetical implementation of the service.
- SDO (sustainability design orienting tool kit) was used to evaluate the sustainability of the project under the environmental, socio-ethical and economic perspectives.



PART 3

Strategic analysis

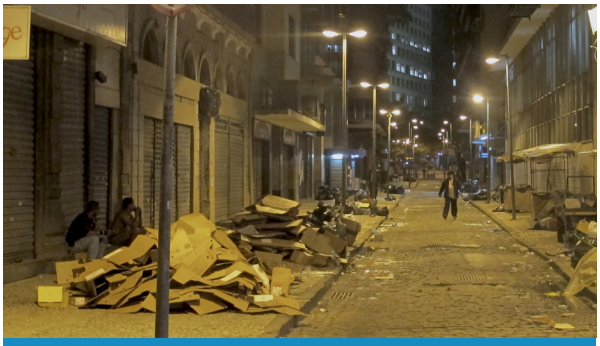
IDENTIFICATION OF THE INTERVENTION CONTEXT

5

5.1 Exploration of possible project contexts

After understanding the projects mission it has been necessary to find out an intervention field in the context of Rio de Janeiro that could be suitable for the introduction of a vehicle like Mulo and an activity to carry out with it. Basically it was needed to find use possibilities for the product and problems to a solution that was already partially conceived.
Since formal and informal city cohabit side by side and in equal parts the socio-environmental context of both has been analysed, focusing on the transportation of people, goods and rubbish.
The transportation and processing of solid waste resulted to be an urgent concern in the city, especially within the topic of sustainable development and from the environmental, social and economic points of view.

Opportunities potential level.

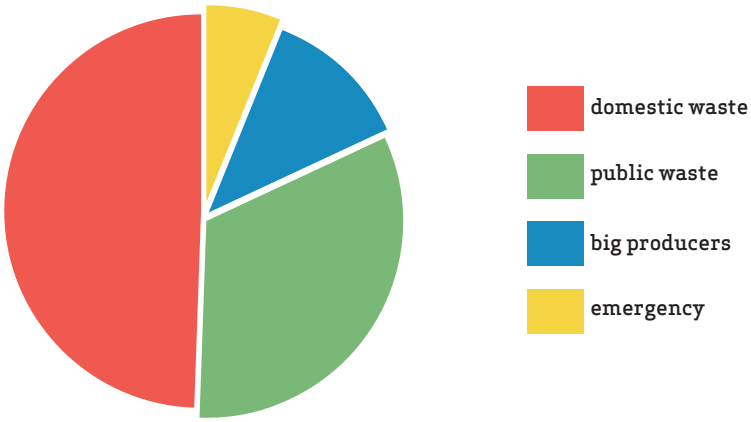
	Formal city	Informal city
People	 • Tourists transportation on the seaside of Leme, Copacabana, Ipanema, Leblon and Flamengo Park	 • Integration to public transportation • Disabled people transportation
Goods	 • Food kiosk	 •Water or goods transportation
Waste	 • Separated waste collection • Waste collection in public and leisure spaces	 • Separated waste collection

ANALYSIS OF THE REFERENCE CONTEXT

6

6.1 Integrated urban solid waste management in Rio de Janeiro

The management of solid waste in Brazil has not received enough attention from the public authorities. Big part of the waste produced in the country is not being collected regularly, remaining outside from the houses or being thrown in public spaces.
In big cities the management of urban waste is facing a privatization of the service in which the municipality contracts third parties companies that execute the work with their own means.
In some smaller cities instead the municipality contracts cooperatives, generating income for population with low instruction level and low technical qualification.
Rio de Janeiro produces daily 10.000 tons of waste (half domestic) and recycles just the 3%. The biggest part of this percentage is collected by informal workers called "catadores". Their participation in the informal waste collection is the highest point of the relation of waste with the social issue: the encounter between the refuse and the marginalized population, which finds in waste its strategy to survive.
In fact municipalities lack in a having a broader political vision that promotes the social participation in the research of solutions for the problems of waste management, which incorporates the "catadores" in their systems.
In Rio de Janeiro COMLURB (the municipal company for urban waste management) has introduced the separate collection in 2011 but the service has not been developed efficiently. From the 160 neighbourhoods just 41 are attended weakly and just partially. Moreover the waste collection service often doesn't cover the poorest areas. These communities are characterized by operational difficulties for the traditional means and by the tendency of get rid of the rubbish immediately after their production and without any kind of caution. For this reason there would be the necessity of a daily collection. Furthermore it would be recommendable the introduction of a communal service, which would generate working places and awareness in the habitants.
The technical solution that is actually been adopted is the use of small vehicles, with good manoeuvrability and able to circulate uphill, like small tractors with carts. The amount of collected material still is restricted on a 30% of the produced waste and obviously the rest of it that remains poured on roads, grounds and water flows generates unhealthy sanitary conditions.
Obviously in the "favelas" the separate waste collection is still far from being adopted but SMAC (the municipal secretary for environment) is planning to install recycling depots for voluntary delivery of recyclable material.



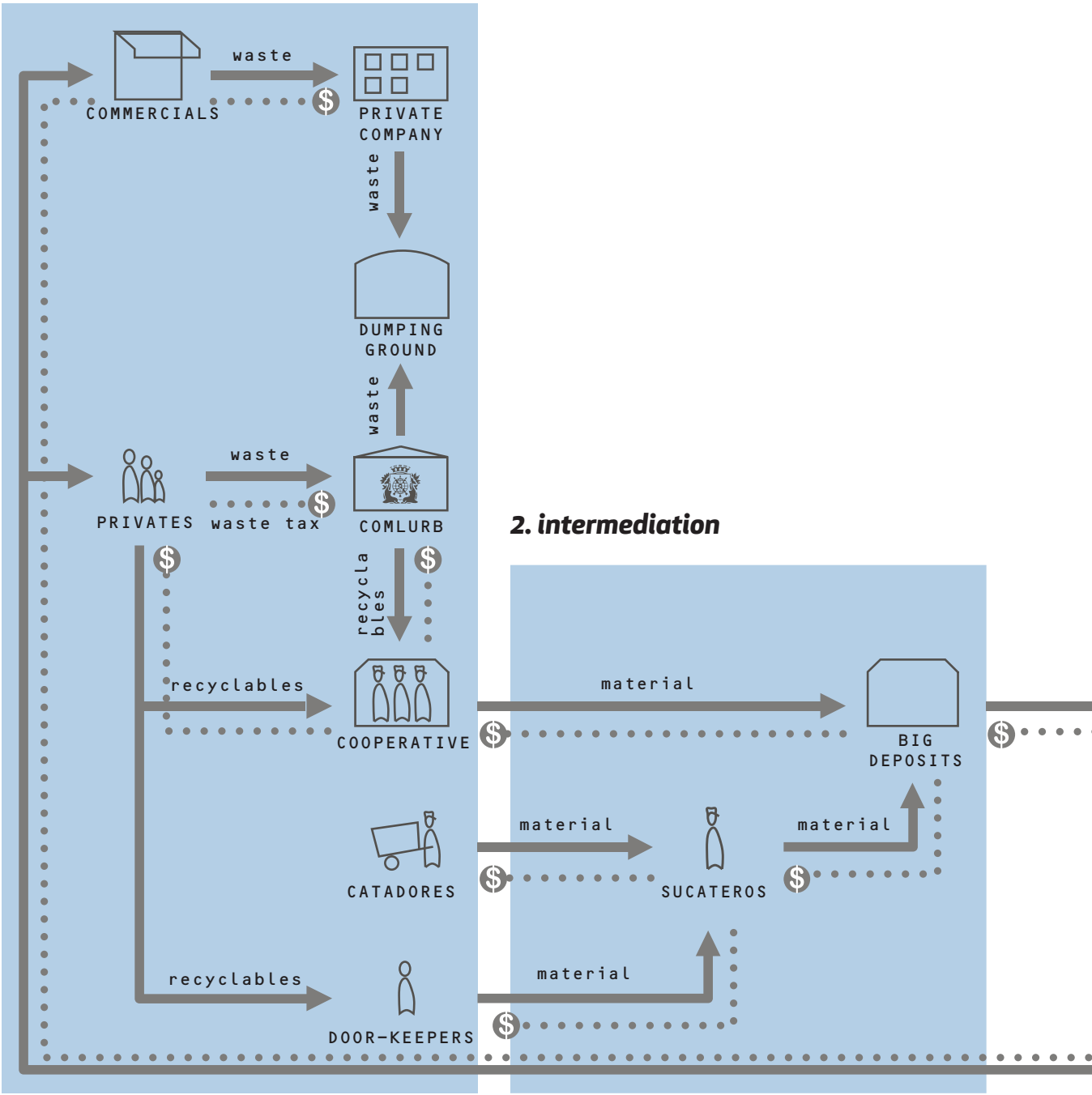
Origin of solid waste in the city of Rio de Janeiro.

RETRIEVAL FORM OF RECYCLABLES RIO	PEOPLE	%
"Catadores" cooperatives & associations	1300	19%
Little and medium "sucateros"	2000	29%
Disorganized	500	7%
Landfill	1200	16%
Stations	200	3%
"Catadores" with carts	1800	26%
TOTALE	7000	100%

Source: Centro de Reciclagem Rio; Ass. Rec. Estado RJ; Assoc. Nac. Aparistas; COMLURB; SMAS

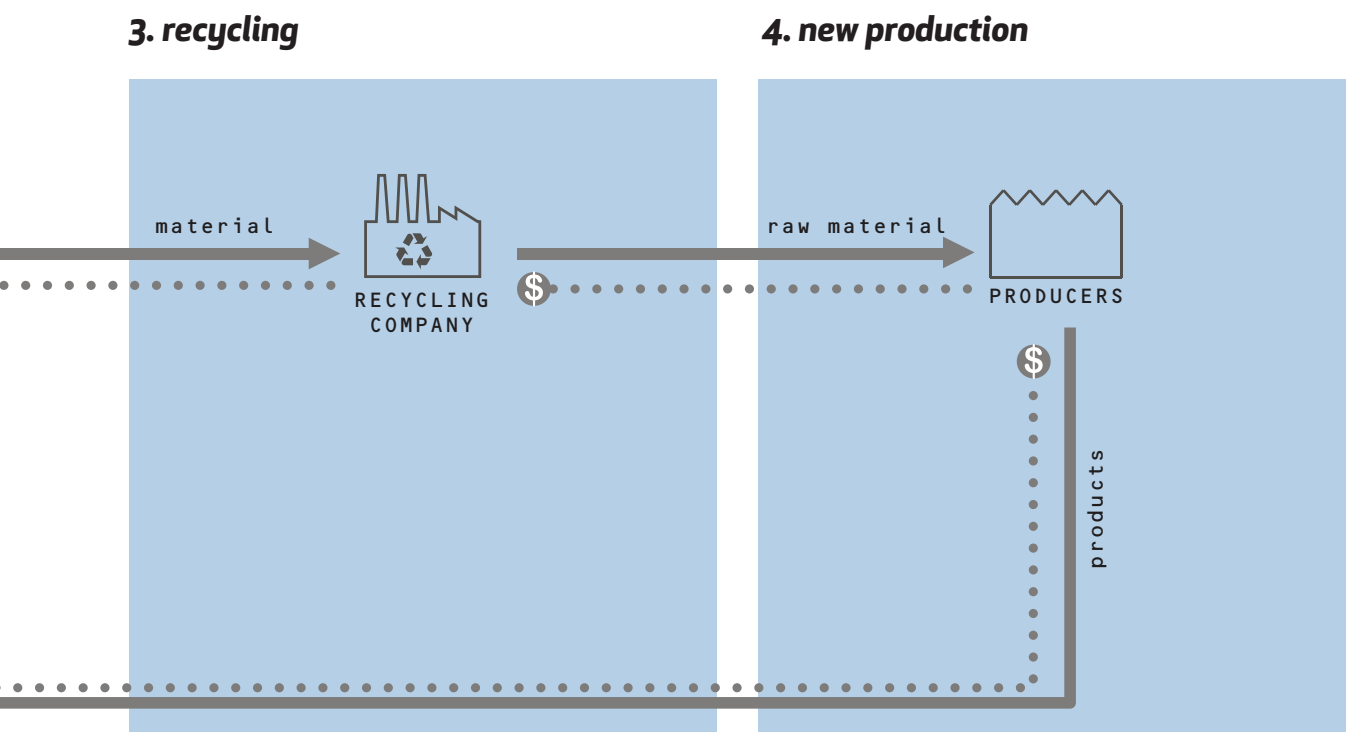
In the city of Rio the waste collection service is carried out by COMLURB (the municipal company for environmental services) for private citizens whereas private companies operate for commercial activities.
The most of the waste is destined to the municipal landfill and just a little part is recycled.
The "catadores" collect the biggest part of the recyclable material, which will afterwards be commercialized by cooperatives or "sucateros" (little jobbers) to big jobbers who resell it to the recycling companies.
After the transformation in raw material the cycle begins again with the production of artefacts destined to be discarded.

1. waste collection



2. intermediation

Map of Rio de Janeiro's waste collection and recycling system.



6.2 Separate waste collection and recycling

Ecological and environmental problems hinder more and more the possibility to find areas for traditional landfills, where to put undifferentiated materials that often are pollutant and could be useful as sources for raw materials. Recycling permits to reduce the consumption of fresh raw materials, reduce energy usage, reduce air pollution (from incineration) and water pollution (from landfills) by reducing the need for "conventional" waste disposal, and lower greenhouse gas emissions as compared to virgin production.
A number of different systems have been implemented to collect recyclables from the general waste stream. Either citizens bring their waste to a collection centre or they put it on the curbside or who executes the collection service picks it up door by door.
The materials can be divided from the beginning or just separated in two groups (humid and dry) which requires less space at home where to stow them. After their collection it is necessary to transport them to a station where they will be further sorted, cleaned, and reprocessed into new materials bound for manufacturing. In addition to the planning of the destination of the material and the collection logistic, an important factor for the success of the introduction of separate waste collection is the collaboration of the population, that can be obtained through environmental education and awareness campaigns.

On August 2nd, 2010 in Brazil was promulgated a federal law that regulates the national policy of solid waste. This empowers the municipalities with responsibility for correct garbage disposal.
Within the duties there is to eliminate open landfills in four years, implant domiciliary separated waste collection and work out a plan for waste reduction and recycling that can comprehend the collaboration of cooperatives of "catadores".
Moreover the law sets the bases for the reverse logistic practice.
Another initiative is Coleta Seletiva Solidaria, a governmental strategy which establishes the separation of recyclable waste discarded by public administration bodies and entities and its donation to cooperatives of "catadores".

6.3 The recycling market

The recycling market in Brazil is growing rapidly.
The prices on the market are very variable because they are directly subjected to the price of the raw materials.
The four determinant factors for the commercialization of recyclable materials are amount, quality, frequence and payment modality.
The recycling companies just buy material in big quantities (minimum 1 ton) of selected and pressed material and prefer who provides the material regularly.
The payment occurs every 3040 days.
The chain of the recycling market is composed by the following actors:

CATADORES
The "catadores" are informal urban workers, which collect recyclable solid waste.
Their activity is characterized by having at disposal a big amount of materia, don't require technical training and being part of a dynamic market.
Their work has big social and environmental relevance, because they participate informally in the execution of a public service, which responsibility should constitutionally be of the local government.
Since they don't have appropriate tools and economic and social organisational skills the "catadores" are subdued to exploitation from intermediate resellers and are in a market of perfect competition because they don't have enough power to establish the prices level.
There are different situations in which they can operate:
Situation 1: 7%
Formally organized in association or cooperative, with own equipment and capacity of enlarge its structure and create the conditions for setting up industrial recycling units.
Situation 2: 21%
Formally organized in association or cooperative, with some equipment but needs financial support in order to purchase more.
Situation 3: 37%
Disorganized group with little equipment.
Situation 4: 35%
Disorganized group.
The national movement of the "catadores" (MNCR) since ten years is working for the development of the category.

CATADORES COOPERATIVES

The organization of the "catadores" in cooperatives and associations is an important strategy to enlarge the separate collection of recyclable materials and has two big advantages: organized groups can come closer to recyclable producers (households, shops, companies) and the fact that they accept lower quantities of materials in comparison to "sucateros" or recycling companies.

Despite in Brazil the separate waste collection and the selling of recyclable materials has structuring difficulties, the growing of the demand of the recycling industry requires investments in the infrastructure of the groups in order to be able to commercialize bigger amounts of material. Pressed materials for example increase the income of the selling 30 to 40%.

The inexistence of a centralized commercialization creates difficulties in overcome the jobbers whereas the formation of self managed cooperative networks strengths the single groups in this direction.

SUCATEROS

"Sucateros" are the link between the formal and informal market because they get in contact on one side with the recycling companies and on the other with the "catadores".

This intermediaries stir up a situation of constant dependance by buying the collected material from an own network of "catadores" for very little money.

Their costs regard the collection, storage, separation, treatment and transportation of the materials so they need to divide their income between their profit, the payment of the "catadores" and the operational costs.

RECYCLING INDUSTRY

The recycling industries have extraordinary power on the market, operating at the same time in monopoly and monopsony.

In Rio there are present industries that recycle metals, paper and cardboard, plastic and glass.

6.4 "Catadores" needs exploration

Interview to "catadores" in situation 4 (disorganized group)

- *Is the cart you are working with yours?*
C1: Yes, it cost 1200 R$ (480€).
C2: No, the "sucatero" for whom I work gives it to me.
C3: I don't have one because I can't afford it, I carry the material by hand

- *Which amount of material do you collect daily?*
C1: 400 kg.
C2, C3: 300 kg.

- *Do you deliver the material and get paid daily?*
C1, C2, C3: Yes.

- *What's the value of the cardboard?*
C1, C2, C3: 0,10 R$/kg (0,04€) but it reached 0,30 R$/kg.

- *Do you work always in the same area?*
C1,C2,C3: Yes, anyone has a special area and boarders are respected.

"Catador" Botafogo with his wife and the charged cart.

-Since when are you doing this work? What changed?
C1: 20 years. Absolutely nothing, for a while I had a formal work but then I returned to work as a "catador" that permits me to work just 4 hours a day.
C2: 3 months.

-Do you have another job by day?
C1: by day I transport building rests or furniture for moves.

- What do you like most of this job and what less?
C1: The best thing is the freedom of self management.
C2: I feel good with this work because working is good in general.

- How much do you earn by night?
C1: It depends of the value of the material on the market and how much I collect

-Which are the economical problems of your job?
C1,C2: The "sucateros" pay very little in comparison to the prices for which they resell the material, so who is doing the hard job is underpaid.

- Would you like to become a formal worker?
C1: More or less, because I would have more obligations and probably would earn less.

- Would you like to join other "catadores" in order to gain a larger salary?
C1: If the cooperative would be well organized and would help me to earn more yes.
C2: It could be good but I think it wouldn't work because it would create confusion.

- How are your working conditions?
C1: dangerous, once I had an accident with a car.
C2: the work is very hard physically.

- Which are the improvements you would wish for your cart?
C1: An engine, my dream is to have a van one day.

- Do you think that an electric vehicle would be useful?
C1: It would be fantastic.

From the interviews it emerges that the big problem is that the "catadores" are underpaid and work in very bad conditions.
However not everybody see the advantages of collaboration and formalization of their work and like the freedom that they have and that let them stay at the end of the chain.

Beside the interviews the "catadores" where observed through the "shadowing" technique in order to capture how they use to work without interfere in their activity and.

A "catador" putting the cardboard on his cart before COMLURB truck is passing

6.5 Rio's municipal development program of the selective waste collection

SEPARATE WASTE COLLECTION NOW

COMLURB has implanted the door to door separate waste collection in the south area and in part of the north area. In the west and north area, due to their urbanization characteristics it has been implanted a collection through voluntary delivery in recycling depots. However, the separate waste collection has many lacks, also due to the fact that when the truck passes to collect the material a big part already has been collected from others in an informal way.

PROJECTS OBJECTIVES

The new project of separate waste collection aims to:
- respect the federal and statal decree "Coleta Seletiva Solidária";
- solve the urban disorder provoked by the "catadores" in the city centre;
- expand in three stages the door to door separate waste collection to all the neighbourhoods with collecting frequence of two times a week.

ACTION PLAN

The project envisages the construction of 6 collection stations equipped for the separation and commercialization of recyclable materials. The work in the stations will be carried out by a network of cooperatives, with the social inclusion of 1500 "catadores", which will benefit of training programs and assistance in the commercialization management. The material will come from the domiciliary separate waste collection of COMLURB and from the collection carried out by the cooperatives at public institutions (coleta seletiva solidaria).
Furthermore there will be done environmental education campaigns and advertising of the program.

EXPECTED RESULTS

- Quantitative and qualitative increase of recycling through the elimination of the intermediate resellers and direct commercialization to the recycling industry;
- improvement of the socioeconomic conditions of the "catadores";
- decrease of the amount of waste sent to the landfill;
- environmental benefits due to the improvement of the solid waste management in the city.

FUNDING

Municipality + BNDES (National bank of economic and social development)

50.000.000 R$ (20.000.000 €)

SCHEDULE

First stage: implantation of the separate waste collection "solidaria" in public institutions, door to door separate waste collection in the centre, Lapa Legal and harbor area. Starting from the second semester extension to the neighbourhoods of the south area and part of the north area
Second stage: part of the west and north areas
Third stage: rest of the city

Location of the stations that will be constructed in the city of Rio.

6.6 Swot Analisys of the reference context

Strenghts

Job opportunity as "catador" for marginalized population.

Informal workers carry out a basic public service.

Environmental and economic benefits of recycling.

Weaknesses

Precarious waste collection in "favelas" because of the difficult access.

Work carried out without the adequate means.

Lack of a centralized commercialization system so that it is difficult to work in small scale and overcome the jobbers.

Opportunities

Create a business model that benefits all the involved actors (without exploitation of the base of the chain).

Improvement of the work conditions of the catadores.

Serve areas where traditional means have access difficulties.

Communitary work offering and execution of the service in low income communities.

Threats

Low commercialization potential of small cooperatives.

Difficulties of the cooperatives in sustaining themselves autonomously.

Not acceptance of the vehicle and the separated waste collection by the community.

High production costs of the vehicle.

ANALISI DELLA STRUTTURA DI REFERENZA

7

7.1 Macro trend analysis

Brasil, together with China, India and South Africa, is the leader of G20 of developing countries. The aim is to boost its position, quickly leaving the current condition and becoming a global actor, with an active role on a international level.
In the last 10 years many steps have been achieved on social inclusion matters, 15 million jobs have been created and 28 million people (on a 190 million population) are not living under the poverty line anymore.
The middle class, in particular, has grown so much that nowadays more than half of the population belongs to that segment.
Nevertheless Brasil still presents deep contrasts between rich and poor people. 15,3% of Brasilians lives under the poverty line and this part of population lives especially in the "favelas" and in the poorest areas of the country (North and North-East).
Some racial differences are also present: Brasilians with European or Asian origins are usually richer than people with African roots.
Recently the government has adopted energy policies based on renewable resources, focusing to find solutions in order to provide the access to electricity to the poorest populations. In particular, the governmental program *Luz para Todos* is aiming to bring electricity to the rural areas of the country, reaching 14 millions people. 80% of the electronic production is obtained from renewable resources and the country is also leader in the production of biofuel.
As a developing country and an future powerful economy on a global scale, Brasil has a crucial role in the environmental situation of the planet. So far many efforts have been taken in this direction and the brasilian government is seriously involved in fighting deforestation in Amazonia and reducing the greenhouse gases emissions.
Brasil is on the first line in adopting an economic model based on recycling and renewable resources. The recycling activity, which gives employment to millions of people, produces every year more than 2 billion dollars, avoiding more than 10 tons of greenhouse gases.
Brasil is also a world leader in the production of bioethanol and it is currently investing resources in wind and solar energy.

ANALYSIS OF BEST PRACTICES

8

8.1 Electric vehicles for recyclables collection in Foz do Iguaçu

Within the Federal program "coleta solidaria" some electric hand-carts have been supplied to the catadores cooperatives of Foz de Iguaçu to collect urban solid waste.
The producer of renewable energy, Itaipu Binacional, was financing the project and developing the technology while the Blest Engenharia was in charge of the production.
With an electric motor of 1,0 hp, the vehicle can carry up to 300 kg of material and is self-sufficienty for 4/5 hours. It also has two batteries of 150 amperes which need to be charged in 6 hours. The dimensions of the vehicle are very similar to a typical hand-cart, 2,10 m length, 2,10 m high and 95 cm widht, with a roof that protects from sun and wind.
The price of the vehicle is 3.000,00 R$ (1180,00 euros).
The use of those vehicles generates pay rise, more safety and social inclusion, considerably increasing catadores' work conditions.
The success of this initiative relies also in the road infrastructure of the city and in the sponsor and support of the local company Itaipu.
The same project has been adapted to Rio de Janeiro's context with the collaboration of the NGO Ecomarapendì (which is involved in raising awareness on the environment and on recycling). Unfortunately this experiment has encountered many difficulties due to the geography of urban context and the lack of financial resources.

Electric vehicle used by a "catador" from Foz do Iguazù.

8.2 Cardboard separate waste collection Cityporto Modena

In Modena's city centre, paper waste is collected door by door from shops and offices. During lunch break, from Monday to Friday, these eco-friendly vehicles (electric or methane ones), already used for transport and delivery of goods, are then employed to accommodate the customers who have difficulties to reach the waste separation and recycling areas.
Those vehicles operate in the last mile, or to be more precise they deliver the material from the city centre to a logistical platform where bigger means of transport can then collect it.

Cityporto Modena truck.

8.3 Limpar project, collection of recyclables in low-income community

The project, promoted by Ceaca Vila NGO, was born in 2008 with the aim to raise awareness within the community of Morro dos Macacos on the necessity to reduce the amount of waste in the streets.
The families involved in the project trade food with collected and separated waste material.
One of the first steps to take to make a successful system is to educate the community on the importance of recycling and how everyone can make a difference for the benefit of the whole community.
Moreover part of the collected waste is used as prime material in works of art.

Seats made out of reused material.

8.4 Light Recicla project, collection of recyclables in low-income community

The electricity supplier Light, in collaboration with the municipality, promotes sustainable development collecting recycling materials from the community and trading them with a discount on the electricity bill.
The customers can collect the recyclable waste in two eco-points, where the material is estimate according to its weight. This price can then be considered credit on the electricity bill.

Light recicla advertising.

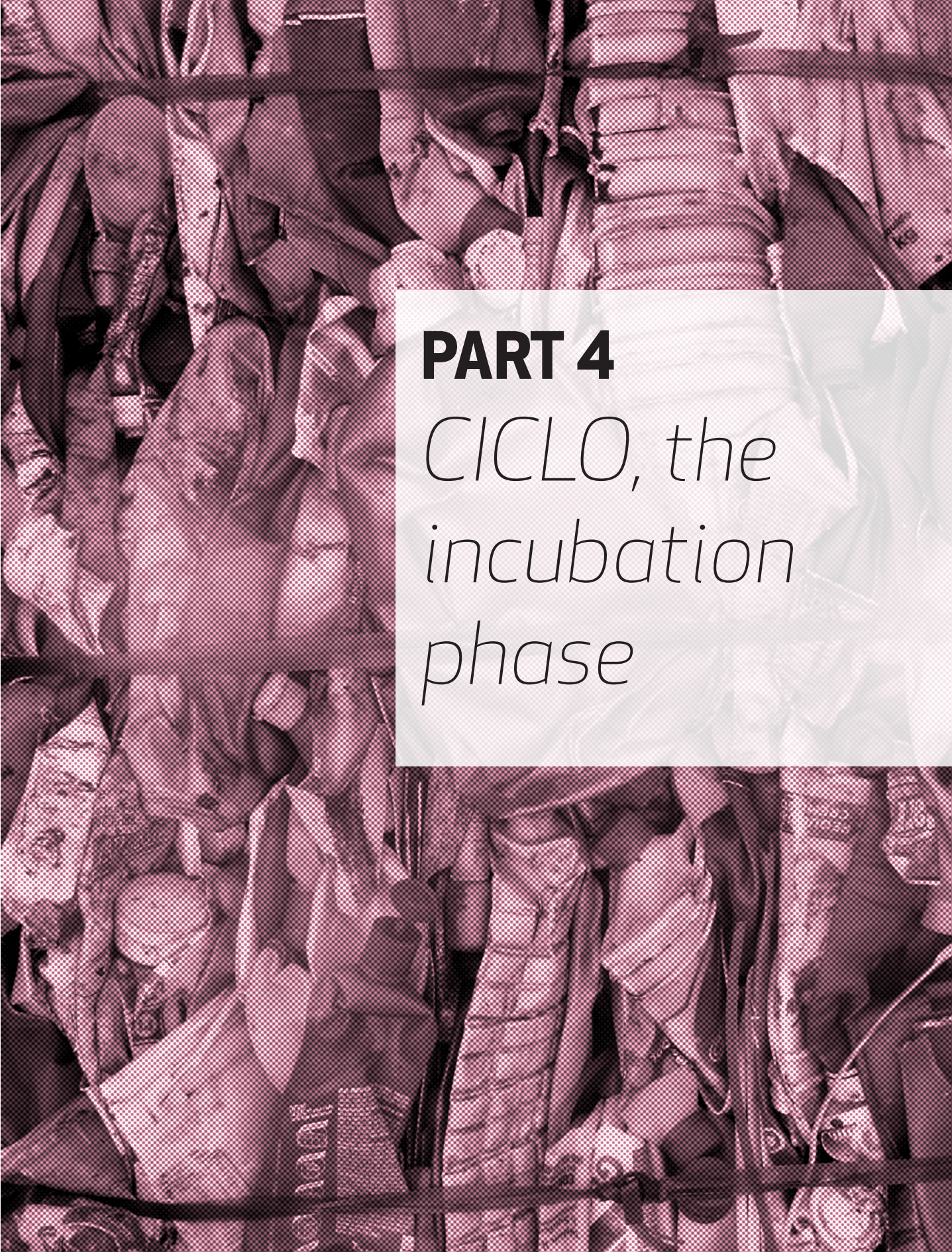
8.5 Bike Rio, an advertising based business model

The business model of the bike-sharing system in Rio de Janeiro is based on the support of a private entreprise (the bank Itaù) which gave initial fundings to start the service and is now in charge of the maintenance of the bicycles.
The bank can then advertise and sponsor its brand on the bicycles and the customers have access to a low cost form of mobility.
The municipality gave the permissions to use some public spaces where the bicycle stations are installed.

DEFINITION OF SUSTAINABILITY DESIGN PRIORITIES

9

From the environmental point of view, the huge benefits of waste recycling are obviously considerable for the chosen context. Among those benefits: the resources and energy conservation, the increase of garbage dump's life and the incentive on raising awareness on environmental issues.
The amount of recycled materials is still very low and it is important to improuve the service where some gaps are in oder to make it efficient, and start a new collection where it doesn't exist, using sustainable systems and eco-efficient vehicles.
From the socio-ethical point of view, the "catador" profession still occupies the edge of social and labour rights.
Despite the low work conditions, a big part of the poorest population has the opportunity to sustain itself and generate a service for the whole society.
What is needed is to improuve the work conditions, giving accessibility to appropriate means of transport and suitable working modalities.
Moreover this could led to an increase of job opportunities and a growth of profits for those communities who have the chance to uplift their situation and consequently change their behaviours.
From the economical point of view, the activity of recycling can offer long lasting job creation for unskilled labour and it does not require big initial investments.
In the developed countries those collecting waste models are usually supported by governments or public entities and the application of these systems to developing countries often finds some obstacles.
In Brasil, the public authorities are usually inneficient on collecting waste so companies decided to use indipendent systems, but in some cases they just refuse to carry out services that should be performed by public entities.
On top of that, the "catadores" don't benefit from the wealth produced by the recycling market and lacking in appropriate working tools, social and economical organisation, they depend on external foundings for most of the time.
Small and local realities found themselves in a disadvantage position and only the ones who got support by public institutions had the opportunity to form cooperatives and associations. An investment in this infrastructure could add value to the materials collected in the recycling activity.
The establishment of a centralised market net would increase their competitiveness, enabling to skip all the middlemen.
The priority is to include the "catadores" in the municipality collection and consequently generate job creation, switching from the informal to the formal employment.



PART 4

CICLO, the incubation phase

BRIEF 10

The project brief resulting from the strategic analysis was to design a PSS which introduces the use of quadricycles powered by sustainable energy in the municipal program of implementation and development of the selective waste collection in Rio de Janerio, trough local resources.
The main goals were to:
- improve the collection service through ecoefficient means and introduce it in the areas which are not included in the municipal program;
- establish a network of actors which interact in a sustainable way, overcoming the intermediate resellers chain of the recycling market;
- integrate marginalized people who already operate in the context, improving their socio-economical conditions by offering them formal work opportunities;
- act as an agent of sustainable change, improving the living conditions of the population and creating awareness about the importance of a correct use and disposal of resources.
From this point on the focus was on reaching the previously mentioned aims by:
- identifying and involve actors in a dynamic network ;
- formalizing a clear PSS concept vision;
- developing an hypothesis of transition path;

A full loaded cart. in the center of Rio.

THE STAKEHOLDERS NETWORK BUILDING

11

11.1 The actors involved in the design process.

It is clear that, to tackle the previously mentioned aims a strong involvement of different stakeholders along the entire process, and a capability in managing, analysing and elaborating information coming from different fields are needed. Therefore the identification of the stakeholders (their roles, motivations and mutual interactions), is a fundamental aspect not only in the solution design but also in setting the proper conditions to support this process, and afterwards for realizing the pilot project, implementing and diffusing it.
The project starts from a university research know-how and role, and so this institutions represent the "start-up" core of the network. Around it a multistakeholder network was built up, including actors like:
- NGOs, because they can operate on the territory as intermediaries for the acquisition of preliminary information and contacts with local communities, suppliers etc; they are interested in take part in the network because they agree in the project's final aim, and therefore there could be a reciprocal support.
- Local Administration and Institutions, because they could encourage and support (with infrastructure for example) the development of experiments and self-standing solutions.
- Users, of course, because they will experiment and use the solution and so they have to be involved starting form the design process.
All these actors take part (with different roles and levels of involvement), in a process of co-production of knowledge and co-design of the transition path.
Here follows a presentation of the involved actors.

POLITECNICO DI MILANO

As already mentioned the Department of Innovation for Sustainability of Politecnico di Milano fosters, guides and designs the project. It acts actively during the incubation phase and the socio-technical experimentation whereas during the implementation of the pilot project it's role is limited to the monitoring of the PSS.

NGO ECOMARAPENDÌ - RECICLOTECA

Recicloteca is an info-center about recycling and environment created by the NGO Ecomarapendì. Its objective is to diffuse informations about environmental issues with the focus on reduction, reuse and recycling of waste. Its materials and the experience of its equipe make the NGO be a reference on the theme in Brazil. Sponsored by AmBev, Recicloteca launched the program Reciclagem Solidaria Cooperativas for social valorization and to raise profitability of associations and

co-ops involved in the collection and commerce of recyclable materials.
The NGO was involved from the beginning of the project and had a crucial role during the strategic analysis by providing informations and contacts.

COMLURB - PREFEITURA DO RIO DE JANEIRO

Comlurb is the biggest organization for public waste management in Latin America. Its main objective is the cleaning of the City of Rio de Janeiro, including household waste collection, streets cleaning, beaches, parks and schools cleaning. In particular a contact was built with the section working on the implementation program of the selective waste collection.
They gave big contribution in the developing of the brief and the concept vision and in providing data for the economical study.

NGO REDES DE DESENVOLVIMENTO DA MARÉ

The Maré Development Network ("Redes") is an organization that promotes sustainable development and joins a network of actors working towards the structural transformation of a group of favela communities called Maré. Through projects and research, Redes fights the socioeconomic inequalities that characterize Rio de Janeiro by contributing to the holistic development of Maré, reducing social, economic, and environmental vulnerabilities. Redes was founded to create an alternative that allies social mobilization with research and proposals to improve the quality of life in the communities.
Their project "Building the Maré that we want" began since 2010 with regular meetings of the representatives of the16 favelas of the Maré with the goal of building a common platform of claims and needs. The list of priorities, transformed into a document called "The Maré that We Want," includes the areas of health, education, arts and culture, sport and leisure, public security, environment, infrastructure, work and income generation, transportation, housing, and communications, underlining the need for spreading access to, and improving, existing public services (including waste collection), as well as creating new structures for residents. These claims are translated into projects and are being presented to municipal, state, and federal government representatives responsible for these areas in order to guarantee that they are transformed into concrete actions.
The idea is to join forces once again to develop new actions and generate a structured project that can transform Maré into a real neighbourhood.
Redes has been involved starting from the designing of the pilot project and the socio-technical experiment and has fundamental importance since it is working directly on the territory of implementation.

11.2 Report of meetings with the stakeholders.

The various stakeholders were involved in the process from the beginning and collaborated in formalising the PSS concept vision and in developing the first hypothesis of transition strategy. The continuous strategic conversation with the various involved actors and the related negotiation processes, leaded to adjust and refine the project vision, the transition strategy and the actors network. Follows a report of the meetings and strategic discussions which lead to the definition of the PSS.

March 23: Ecomarapendì - The mission and the brief of the project was presented to the NGO, creating the bases for a collaboration. Informations about the reference context for the strategic analysis where gathered.

May 18: Ecomarapendì - Discussion of the project vision and the action plan, reaching a shared consensus.

June 12: Ecomarapendì - The first concept was illustrated to the NGO, to support the presentation tools such as the offering diagram and the system map were used. It was proposed to Ecomarapendì to be involved as service provider and they gave a positive feedback.
Furthermore they gave the contact of the team working on the program of implementation and development of the selective waste collection at COMLURB.

June 15: COMLURB - The first version of the system was presented to them, creating the bases for a collaboration. Informations about the municipal program were gathered.

July 1: COMLURB - Strategic discussion of potential alternatives in relation to their program and identification of opportunities in the context.

July 9: Redes - The project is presented briefly and informations about waste collection in the “Maré” are collected.

July 13: COMLURB - The refined concept vision and the pilot project are presented to them (through visualizations like the offering diagram and the systemmap) and then discussed.

July 14: Redes - Participation in a reunion of the representatives of the residents associations of the communities of the “Complexo da Maré” with COMLURB to understand the needs of the population and the action plan of COMLURB.

July 19: COMLURB - How they can collaborate with infrastructure is discussed

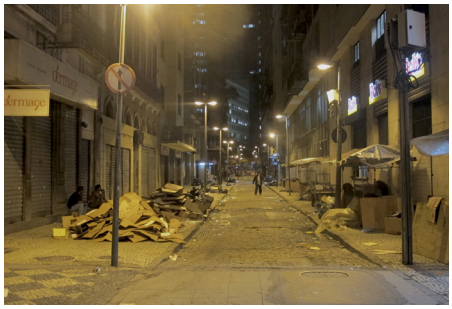
August 14: Redes - The pilot project is illustrated and a first proposal to involve the NGO as service organizer was made.

EXPLORING OPPORTUNITIES 12

12.1 A Catalogue of promising strategic possibilities

Using the knowledge acquired during the strategic analysis various ideas were produced to respond to the demand of separate waste collection. These were supposed to be the bases on which to construct and develop the PSS innovation. At this moment ONG Ecomarapendì and COMLURB were already involved to suggest possible scenarios or generate ideas about contexts within the city which could fit to the general aim of the project.

SEPARATE WASTE COLLECTION ON THE SEA-FRONT AND IN THE FLAMENGO PARK.
Covering the distance of 9 km from Leme to Copacabana, Ipanema, Leblon beaches and the area of 1 200 000 m² of the largest leisure area of Rio de Janeiro. Both places are beloved from the cariocas for sports and recreation, especially on week-ends and have cycling lanes passing through.



COLLECTION OF CARDBOARD IN THE CITYCENTER.
This area is populated merely by day by workers and has a big amount of shops which discard a big amount of cardboard that is regularly collected by "catadores" at night.

SEPARATE WASTE COLLECTION IN "FAVELAS".
In this areas due to the complex road network the use of alternative and smaller vehicles is required. Furthermore this communities have a big need of improvement of peoples life conditions and basic services.

SEPARATE WASTE COLLECTION DURING EVENTS.
The vehicles are produced to execute the waste pick up service in the public spaces, squares and green areas where public events take place.

SEPARATE WASTE COLLECTION IN THE "PORTO MARAVILHA" NEIGHBOURHOOD.
This region is going to face a large-scale urban waterfront revitalization project. The port area is going to be redeveloped increasing the city attractiveness as a whole and offering to the inhabitants a new quality standard of urban services.

The first concept vision hypothesis

The first real scenario which was developed took into consideration and combined the first two strategic possibilities.
It was about optimise the use of the vehicles by giving them to the catadores at night to collect the waste of the commercial area in the city center and by day to COMLURB to execute the service in the park and on the seafront. As exchange COMLURB was supposed to provide the infrastructure for the storage of the material before the selling.
The whole income of the recyclable sellings was thought to be given to the "catadores", whereas the system sustainability was guaranteed by a sponsorships from a brand which would beneficiate from the advertising applied to the vehicles.

CONCEPT VISION

13

13.1 Separate waste collection service in "favelas"

A PSS idea or concept has to be developed to overcome a societal/business challenge. The project vision provides a direction to the transition path and the societal embedding of the PSS.
Through the strategic conversation with the stakeholders the definitive project vision was build up and consists in a service of door to door separate household waste collection in low-income communities to be carried out with solar powered vehicles. The system relates to the municipal development program of the selective waste collection, covering the excluded areas and using its infrastructure and selling channel of recyclable materials.
The NGO Ecomarapendì will act as service provider and will be the owner of the vehicles. The service is going to create job opportunities for the "catadores" who already operate in the communities and will include them in the municipal system of waste management, improving their working conditions. Furthermore their socioeconomic conditions will improve through the overcoming of the jobbers of the recycling market chain. They will practically execute the door by door collection and bring the material to a recycling depot located in the community. COMLURB will then collect the material from there and transport it in one of its 6 transforming stations, where the cooperatives provide in selling it.
In a second moment the system can be expanded by offering the collection of used cooking oil or construction rests.

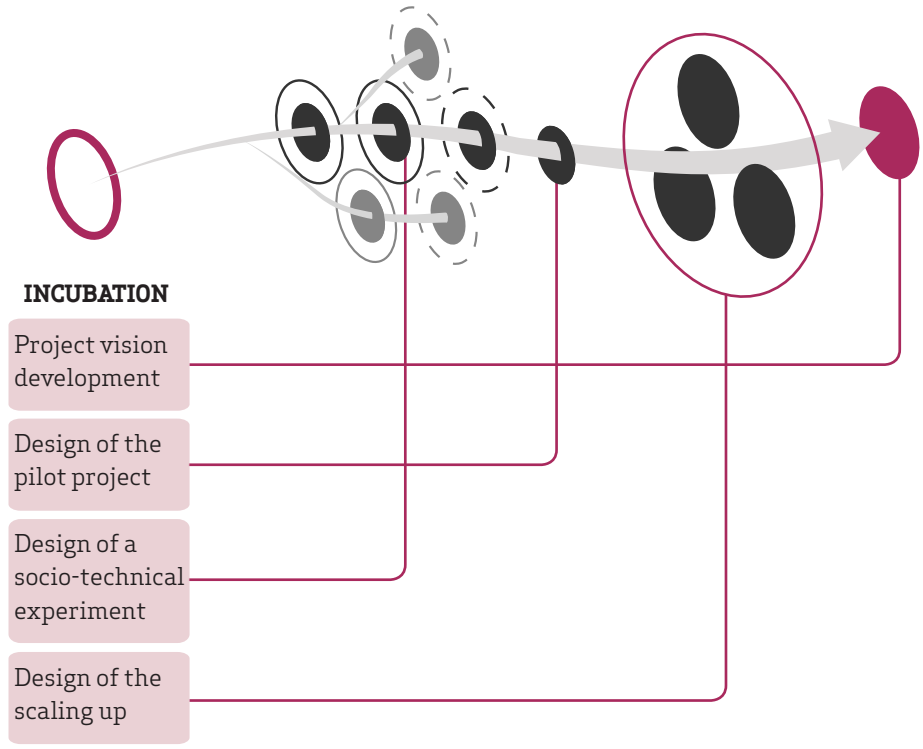
In order to formalise the PSS innovation, the project idea has been translated into an offering diagram which permits to visualise which functions are delivered by the PSS and was used when involving new stakeholders and to have a common understanding of the project vision.

Offering diagram.

THE TRANSITION PATH
14

In the process of designing the transition path it is important to adopt a bifocal design attitude. An attitude that lead strategic designers to focus simultaneously on:
- the long-term project goal: the achievement of a future scope in which a sustainable PSS innovation is part of the normal way in which a societal need is fulfilled (project vision);
- the short-medium-term actions: to be undertaken in order to orient the societal embedding process towards the long- term goal.

The evolutionary transition path emerged from the project, is made up of four main steps, each one with a specific stakeholders configuration:
- Project vision development
- design and creation of the bases for the implementation of a self standing solution (pilot project) capable to be reproduced and multiplied in similar contexts;
- design of a socio-technical experiment to test and learn;
- design of the scaling up of the system.



THE PILOT PROJECT

15

15.1 The "Complexo da Maré": pilot projects implementation community

The first of the three scenarios that are composing the concept vision was chosen for the development of a detailed pilot project because it is the one in which a radical innovation generates the most social benefits and also because it is the one which can be implemented sooner.

The area chosen for the implementation is the "Complexo da Maré", which is the biggest complex of favelas in Rio de Janeiro in terms of population. It has 132 000 inhabitants,distributed in 38 000 domiciles and divided in16 communities which produce an amount of 1080 tons of waste at year.

The region located on the margin of the Guanabara Bay was occupied since 1940 with huts. It is positioned in between of two main arterial roads (Avenida Brasil

Top view of the "Complexo da Marè" & a tiny road of the favela.

and Linha Vermelha), and closed to the international airport.
The 16 communities which form the favelas aggregation are:
- Baixa do Sapateiro
- Bento Ribeiro Dantas
- Conjunto Esperança
- Conjunto Marcílio Dias
- Conjunto Nova Maré
- Conjunto Novo Pinheiro (Salsa e Merengue)
- Conjunto Pinheiros
- Morro do Timbau
- Nova Holanda
- Parque Maré
- Parque Roquete Pinto
- Parque Rubens Vaz
- Parque União
- Praia de Ramos
- Vila do João
- Vila do Pinheiro

At present the waste collection is executed by 36 workers of COMLURB with 7 micro-tractors and 5 trucks but the service needs big improvements and integration.
Generally the waste is thrown on the streets at the crossroads of the smallest with the bigger ones and it remains there until been collected without a fixed timetable.
The "Maré" is favourable for the implementation of a pilot project because there is a request of improvement of the waste collection service and implementation of the separate waste collection that comes directly from the population, this facilitates the involvement of the community. Since it has a high population density the service would beneficiate a big number of people.
Moreover the territories morphology is flat, condition which favours the circulation of the quadricycles.

On the opposite page: waste on a crossroad in the "Maré".

15.2 The stakeholders configuration

After involving different actors in the design process, they were fostered to execute an active function in the PSS and new ones were included in the network. Follows the list of involved stakeholders in the PSS working at its full operative phase and a description of their roles and interests:

NGO ECOMARAPENDÍ - service provider
Its main ROLES are:
- manage the production of the vehicles;
- manage the economical part and the foundlings;
- manage the relation with the service organizers and find new interested stakeholders to enlarge the system
- if needed train the "catadores".

Its main INTEREST is:
- enhance the reduction and recycling of waste

NGO REDES - service organizer
Its main ROLES are:
- organize the waste collection
- educate and create awareness in the community
- hire the "catadores" in the community

Its main INTERESTS are:
- sustainable development of the "Maré";
- create job opportunities and income in the community

COMLURB
Its main ROLES are:
- provide the infrastructure.
- collect the material from the recycling depot with a truck 2 times a week;
- commercialize the material.

Its main INTERESTS in the PSS are:
- reduce the amount of waste going to the landfill;

COOPERATIVES
The cooperatives that will be working in COMLURBs stations will incorporate the "catadores" that will execute the collection.
Their main ROLES are:
- treat the material for commercialization

- commercialize the material.
- include the "catadores" of the Marè
Its main INTEREST in the PSS is:
- overcome the chain of jobbers in the recycling market.

DREAMBIKE
Dream Bike is a company which works in the bicycle market since 1993.
It is specialized in the production of alternative vehicles, especially tricycles. It develops also customized projects and adapts the vehicle to the specific needs of the user. It's production comprehends electric tri-and-qudricycles for freight transport, disabled people transport and others. The Company has the know-how for producing the vehicles both regarding the chassis and the electrical motor system.
Its main ROLES in the PSS are:
- produce the vehicles;
- execute the maintenance on the vehicles;
- train the "catadores" to the use of the vehicle.
Its main INTERESTS are:
- enlarge its production;
- revenues.

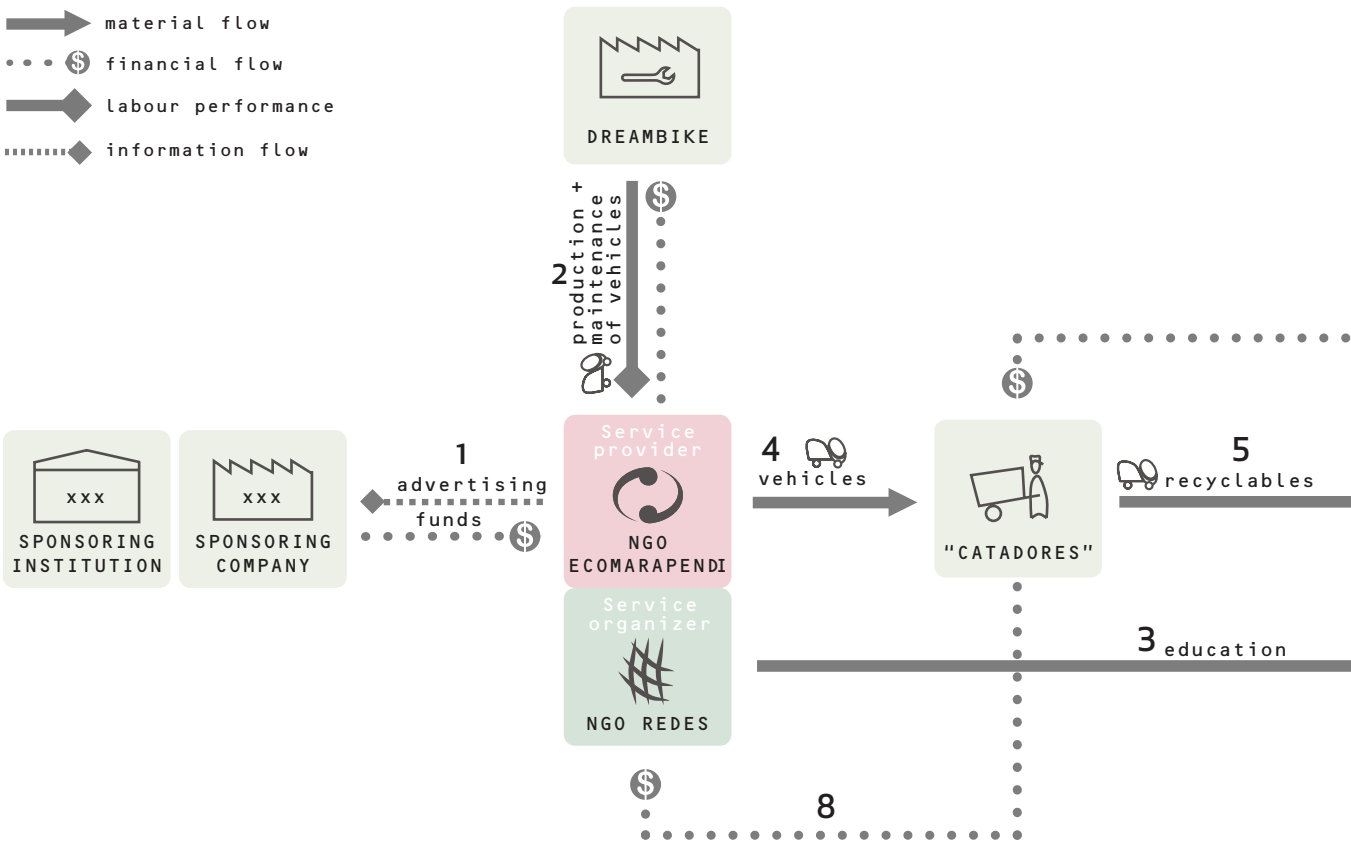
15.3 Service operators and users

CATADORES
The "catadores" who already work in the community will have the chance to get a formal work and becoming part of the cooperative that operates in COMLURBs station.
Their main ROLE is:
- execute the waste collection.
Their main INTEREST is:
- improve their working conditions
- improve their socio-economical conditions.

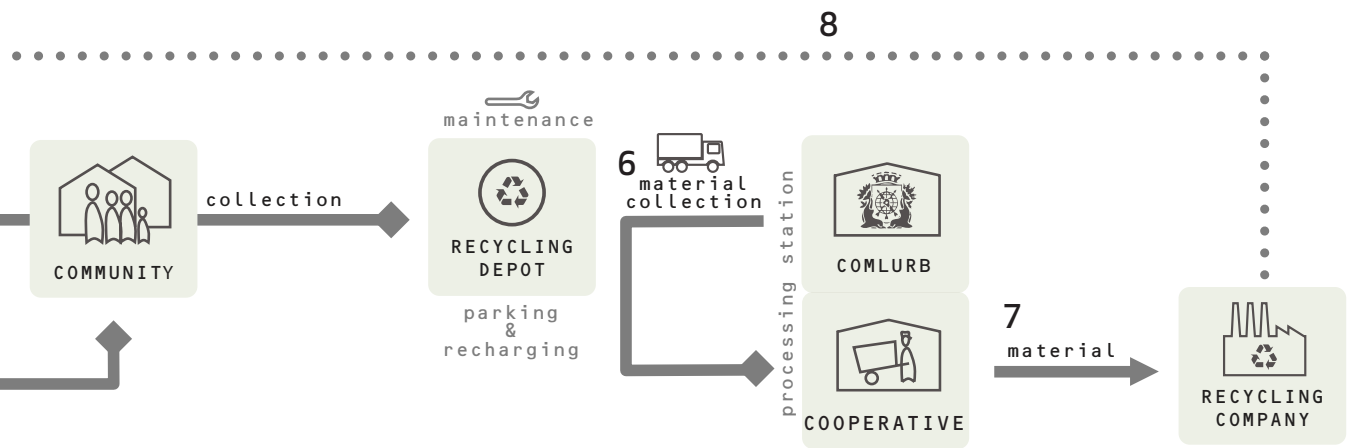
COMMUNITY
The big social group who will be the user of the service and get its benefits is the community who is living in the "Complexo da Maré" Their main ROLE is:
- dispose the waste according to the instructions delivered by the service.
Their main INTEREST is:
- improve their living conditions.

15.4 How the system works as a self standing solution.

The core of the system is constituted by the partnership between the NGO Ecomarapendì (the service provider) and the NGO Redes (the service organizer). The system map below visualizes the interactions between the stakeholders that constitute the PSS value chain. The arrows represent the interactions between the stakeholders, in term of action, material, information, and financial flows. The storyboard (in the following pages) visualises the sequence of actions to be performed by the stakeholders involved to deliver the PSS and the ones to be performed by users to get their satisfaction from the offer.



The main interactions between the stakeholders that compose the system are the following:
1 _ Ecomarapendì collects funds for the vehicles production;
2_ Dreambike produces the vehicles;
3_ Redes creates awareness in the community and educates to the separate waste disposal;
4_ Ecomarapendì/Redes furnish the vehicles to the "catadores" that will associate to the cooperative that works in the COMLURB station;
5_ The "catadores" execute the waste collection and take it to the recycling depot that is situated in the "favela";
6_ 2 times a week Comlurb picks up the material with a truck and takes it to the processing station;
7_ After treating the material the cooperative sells it to the recycling company;
8_ The income gets to the "catadores" cooperative, which will devolve part of it to the system in order to cover and covers the costs.



NGO ECOMARAPENDI

Makes a partnership with COMLURB in order to use its infrastructure.

COMLURB

Makes a partnership with Ecomarapendì in order make its infrastructure available.

NGO ECOMARAPENDI

Makes a partnership with Redes to act as service provider.

NGO REDES

Makes a partnership withEcomarapendì to act as service organizer.

NGO ECOMARAPENDI

Makes a partnership with Dreambikefor the production and maintenaince of the vehicles.

DREAMBIKE

Makes a partnership withEcomarapendì to take charge of the vehicles production and maintenance.

DREAMBIKE

Produces the vehicles.

COMLURB

Creates a recycling depot where to collect the material and park and recharge the vehicles.

NGO REDES

Recruits the "catadores" in the community.

COOPERATIVE

Includes the "catadores" in the cooperative.

CATADORES

Become associated to the cooperative.

DREAM BIKE

Delivers the vehicle to RIOCOOP and trains the "catadores" to its use.

NGO ECOMARAPENDI

Trains the catadores to the collection.

CATADORES

Take part in the trainament.

NGO REDES

Educates the community about the sevice that will be implemented and about the waste disposal.

COMMUNITY

Learns about the service.

NGO REDES

Organizes the waste collection.

COMMUNITY

Puts the separated material out of the house doo-raccording to the schedule.

CATADORES

Executes de door by door waste collection.

CATADORES

Transports the material to the recycling depot.

COMLURB

Sends a truck to pick up the material and tranport it to the COMLURB station.

COOPERATIVE

Treats the collected material.

COOPERATIVE

Sells the material to the recycling company.

DREAMBIKE

Does the maintenance of the vehicle if necessary.

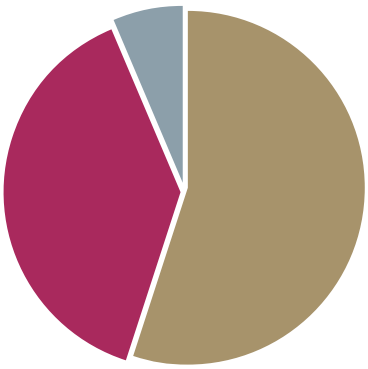
15.5 Economic hypothesis

At the basis of the study, which leaded to an economic hypothesis of the service, there is the household waste composition. This analysis shows important information for the planning of the collection service, like composition, humidity and specific gravity of the waste produced within a certain area. The data is obtained from the relation between the weight of the single component and the total weight of the collected sample.
It is a fundamental tool for studying the income of the separate waste collection of recyclables, the different alternatives for the final disposal, the collection organization and the appropriate dimensions of vehicles and equipment. Furthermore it can reflect the economical level of a certain area. Of course the characterization of the garbage produced in the "favelas" differs quite a lot from the one produced in other neighbourhoods.
As reference for this study it has been used the "favelas" household waste composition analysis carried out by COMLURB in 2011. Since the "Complexo da Marè" was not included in the plan, it has been used the data regarding the "Complexo do Alemão" which is situated right in front and has similar social characteristics.

Starting from the knowledge of the total amount of waste produced in the Marè community which amounts at 1080 t/year, and from the percentages reported in the analysis, the amount of recyclables and of the single materials have been calculated. By then multiplying the weights by the commercial value applied in Rio de Janeiro for pressed and cleaned material the revenues from the sales of the recyclable materials have been calculated.

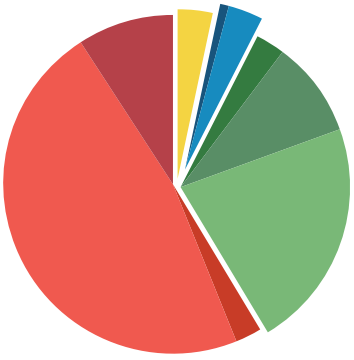
Favelas household waste composition.
Source: Gerência De Pesquisas Aplicadas – Igp/Comlurb, *Caracterização Gravimétrica dos Resíduos Sólidos Domiciliares das Comunidades com UPPs*

Favelas reciclables composition.



55,24% organic waste
38,42% reciclables
6,34% others

1080t/year x $\frac{38,42}{100}$ = 415t/year - amount of reciclables



8,9% hard plastic
47% plastic film
2,7% PET
21,7% paper
9,3% cardboard
2,7% tetra pack
3,3% steel
0,8% aluminium
3,6% glass

415t/year x $\frac{X}{100}$ = amount of single material (see table next page)

MATERIAL	WEIGHT (t/year)	COMMERCIAL VALUE[1] (R$/t)	REVENUE (R$)[2]
hard plastic	36,9	600	22 140
plastic film	190	900	171 000
PET	11	1 700	18 700
paper	89,3	550	49 115
cardboard	38,3	180	6 894
tetra pack	11	300	3 300
steel	13,7	300	4 110
aluminium	2,8	2 700	7 560
glass	14,4	200	2 880
			TOT PROFIT/year 260 679

Profit hypothesis of material sellings in the Marè

Afterwards it has been necessary to find out how many vehicles are needed to cover the whole area with the recyclables collection service.
Looking at the specific weight of the materials to be collected and at the produced amounts it was estimated that a medium specific weight would be about 75kg/m³ and, considered that the capacity of the vehicle is 3m³, the medium amount of material transported by the vehicle filled to capacity would be 220 kg.

MATERIAL	specific weight (kg/m³)
plastic	65,26
paper	89
cardboard	50,43
metal	320,38
aluminium	160,19
glass	195,78

Reciclable materials composition.

Dividing the amount of recyclable materials produced in the Complexo da Marè by the weeks of the year the amount of waste produced by week was calculated, dividing this result by the full capacity of the vehicle it was fund out that 36 loads are necessary to collect all the material.

415t/year : 52 = 8t/week

8000kg : 220kg = 36

Considering two shifts of 6 hours a day, each one covering one route and peak up 2 times a week (one for plastic and one for paper, metal and glass) it is possible to optimise the use of the vehicles in the way that just 3 are needed to cover the whole area.

pick up schedule	1st shift	2nd shift
mon-thu	3 routes	3 routes
tue-fri	3 routes	3 routes
wed-sat	3 routes	3 routes

After the initial investment of the vehicle production, the costs to be covered every year are the vehicle maintenance and salary of the technicians who will be in charge for it, the service manage (from ONG Ecomarapendì) salary and the service organizer (from ONG Redes) salary.

COSTS	
vehicle manufacturing ( )	10 000 R$/ vehicle
vehicle maintenance/year	1 400 R$/vehicle
tecnicians salary/year	2000 R$/vehicle
service manager (Ecomarapendì) salary/year	14 000 R$
service organizer (Redes) salary/year	14 000 R$
REVENUES	
fundings	10 000 R$/ vehicle
material sales/year	265 169 R$

Costs and revenues table.

At this point it has been possible to do the economic study of the service at its full operative phase.

COSTS	year 1	year 2	year 3
vehicle manufacturing (3 vehicles)	30 000 R$		
vehicle maintenance	4 200 R$	4 200 R$	4 200 R$
tecnicians salary ( )	6000 R$	6000 R$	6000 R$
service manager (Ecomarapendì) salary	14 000 R$	14 000 R$	14 000 R$
service organizer (Redes) salary	14 000 R$	14 000 R$	14 000 R$
REVENUES			
fundings	30 000 R$		
material sales	265 169 R$	265 169 R$	265 169 R$
TOT PROFIT	**197 000 R$** 74 838 €	**227 000 R$** 86 234 €	**227 000 R$** 86 234 €

Service economic hypothesis.

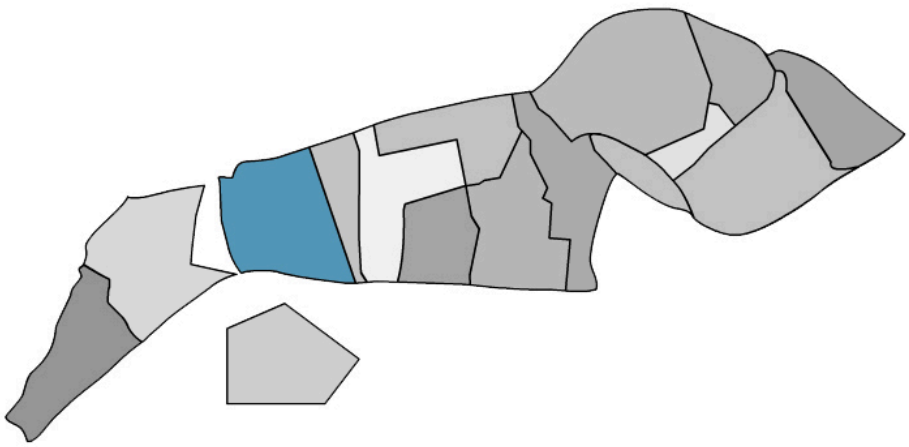
The system results economically sustainable and the total profit will be part of the income of the cooperative that works in the processing station and to which the "catadores" that will execute de collection will associate.
The economic estimation has been made without considering possible financial sponsors/investors that can totally or partly cover the vehicles production costs.

SOCIO TECHNICAL EXPERIMENT

16

16.1 Small scale experiment to act as LAB, WINDOW and AGENT OF CHANGE.

A small scale experimentation is fundamental in order to understand if the solution does work, which are its advantages and critical points. It is part of a continuous iterative learning process involving all the stakeholders in setting the conditions for the pilot project realization by analysing the experimentation results and proposing modifies and integrations. In other words it is a process of positive and negative feedbacks that may lead to the adjustment not only of the pilot project characteristics but also of the concept vision.
Moreover these experiment could represent an optimum "window" because of its potential to show sustainable innovations ideas to the outside. In this sense it could be used not only for prototipation, but also for attracting new potential financiers and in general interested actors.
The experiment is aimed also at stimulating changes in the context and influence present conditions in order to favour and speed up the embedding process (e.g. influence local administrations in adopting policy measures to support the innovation, stimulate potential users in changing their behaviours and routines etc.).
The socio-technical experiment will take place firstly in one of the communities forming the complexo da Maré with the aim of learning and exploring how to improve the PSS innovation and contribute to its societal embedding.
The system will be tested on different dimensions, especially on the technical, usability, and socio-cultural ones.



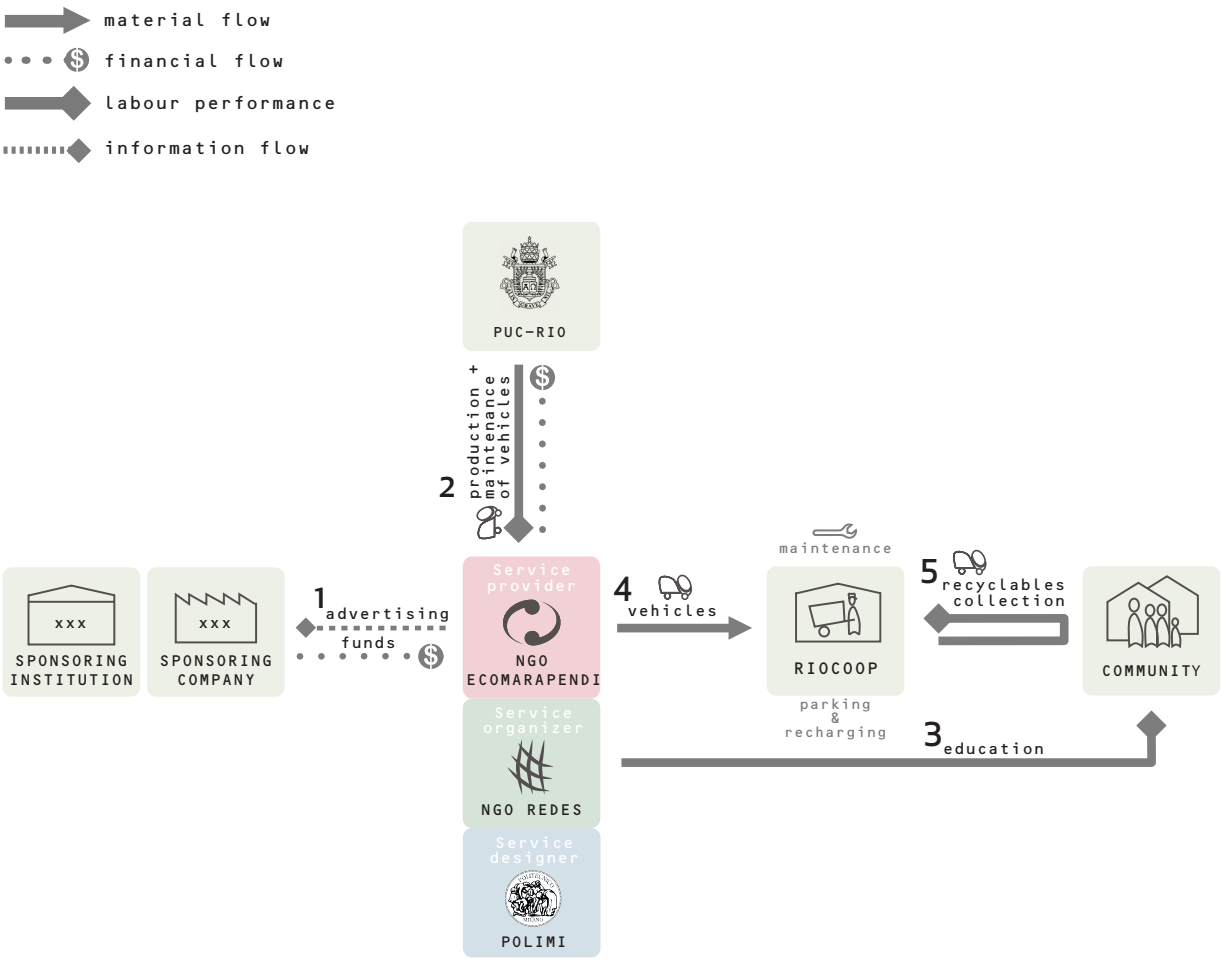
The subdivision of the "Complexo da Marè" in 16 communities.

16.2 Involved stakeholders

The actors network should be managed dynamically because different stages of a societal embedding process require different network compositions (Weber et al. 1999). For instance some actors may have more relevance in the first phases and disappear in the following ones.
Since the idea is to protect the experiment from the traditional environment in financial and institutional therms, the actors configuration differs in part from the one of the pilot project because some stakeholders execute temporally the actions which require more definitive changes. In this way just when the system is mature and up to scratch infrastructure intervention will be applied.
The Politecnico University will still be at the core of the system by activating the experiment together with the NGOS and it will sign a partnership with PUC-Rio university for the production of the vehicle prototype.
RIOCOOP is a cooperative of "catadores" that is located in the "Marè", which collects the material through partnerships with offices in the city centre (within the Coleta Seletiva Solidaria program). In the experiment they will collect the material (by driving the vehicle) and do the commercialization by themselves.

16.3 How the experiments system works

The main interactions between the stakeholders that compose the system are the following:
1 _ Ecomarapendì and PoliMi collect funds for the vehicles production;
2_ Puc-Rio produces the vehicle prototype;
3_ Redes creates awareness in the community and educates to the separate waste disposal;
4_ Ecomarapendì/Redes furnish the vehicles to the "catadores" of RIOCOOP
5_ RIOCOOP executes the door by door waste collection
At the experimentation stage the system has no revenue. RIOCOOPs catadores who execute de service get paid by commercializing the material (by now they are not selling the material directly to the recycling industry because they are not working in network with other cooperatives and do not collect a sufficient amount). The production of the prototype should be founded by the universities partnership and by the sponsorships and at this stage the NGOs should carry out the work for free.
The storyboard (in the following pages) visualises the sequence of actions to be performed by the stakeholders involved in the experiment and the ones to be performed by users.



System map of the experiment.

NGO ECOMARAPENDI

Makes a partnership with RIOCOOP for the execution of the waste collection.

RIOCOOP

Makes a partnership with Ecomarapendì to get responsible for the waste collection.

NGO ECOMARAPENDI

Makes a partnership with Redes to act as service provider.

NGO REDES

Makes a partnership withEcomarapendì to act as service organizer.

POLITECNICO DI MILANO

Makes a partnership with PUC_Rio to develop the system and produce the vehicles.

PUC-RIO

Makes a partnership with PoliMi to develop the system and produce the vehicles.

PUC-RIO

Produces the vehicles prototype.

PUC-RIO

Delivers the vehicle to RIOCOOP and trains the "catadores" to its use.

NGO REDES

Educates the community about the waste disposal.

NGO ECOMARAPENDI

Trains the catadores to the collection.

COMMUNITY

Learns about the service.

RIOCOOP

Take part in the trainament.

NGO REDES

Organizes the waste collection.

COMMUNITY

Puts the separated material out of the house doo-raccording to the schedule.

RIOCOOP

Executes de door by door waste collection.

RIOCOOP

Treats the collected material.

RIOCOOP

Sells the material.

PUC-RIO

Does the maintenance of the vehicle if necessary.

SCALING UP
17

17.1 Solutions replication and integration plan

The learning process is finalized in setting the conditions for the evolution of the experiment in a self-standing solution. In other words what has been learnt during the experimentation should bring the adjustment of the characteristics of the solution, and the definition of the modalities by which it can become economically sustainable and self-standing (without the external financial support). At the pilot project stage in fact it is hypothesized that the local-based network become autonomous, with the local actors assuming a key and primal role, and the university acting in monitoring the solution and collecting feedbacks.
At this point the solution could be replicated in other "favelas". The key features of the solution could be copied, modified, integrated and adapted in relation to the specific context's needs and characteristics. That could potentially bring a proliferation of sustainable separate waste collection system solutions in low-income communities.
In order to create a system that can be economically more balanced other two promising scenarios which include more profitable activities were choosen for spreading the innovation not only in low-income contexts.

SEPARATE WASTE COLLECTION DURING EVENTS

To work as a window, raising interest on the project and to get a bigger income the service can be implemented during events like the 2014 Football World Cup and the 2016 Olympic Games. The vehicles would afterwards be reused to replicate the pilot project in other low-income communities or in some situations of the second case (like the Olympic park) they would continue to work in the areas which will be converted in neighbourhoods.

SEPARATE WASTE COLLECTION IN THE "PORTO MARAVILHA"

The urban operation Porto Maravilha is preparing the port area to the development process driven by the big event which the city will host in the next years. The goal is to improve the life quality of its actual and future inhabitants (population will raise from 22 000 people to 100 000 people) and to reach environmental and socio-economical sustainability.
The use of the Mulo vehicles and the introduction of the service in this context would contribute in transforming the area in an innovation reference point of the city.

The following action plan illustrates the steps of the scaling up.

September 2013 - Implementation of the Pilot Project as selfstanding in the "Complexo da Maré";

June 2014 - Execution of the PSS in the events of the Football World Cup;

July 2014 - Reuse of the vehicles produced for the FWC for the replication of the PSS in other "favelas" (could be also in the other cities that host the events);

August 2016 - Execution of the PSS at the Olympic events;
- Implementation of the PSS in the "Porto Maravilha" neighbourhood;

September 2016 - Reuse of the vehicles produced for the Olympics for the implementation of the PSS in the neighbourhood which will rise on the Olympic Park area or for the replication of the PSS in another "favela".

Scaling up offering diagram.

17.2 Interaction between the service provider and the service organizers.

Ecomarapendì, as service provider, will be the owner of the vehicles and will create partnerships with the actors which will work as service organizers in the specific contexts. For the first scenario it will be an NGO which is operating in the "favela" were the service will be implemented (Redes for the pilot project), in the second one it will be the organization of the events (FIFA World Cup and Rio 2016) and for the third one it will be the enterprise (Concessionaria Porto Novo) who will take care to execute the public services in the "Porto Maravilha" neighbourhood.
In the first case the vehicles will be given at disposal for free whereas in the second two the service organizer will sign a contract of vehicle rental with Ecomarapendì.

Back office system map.

THE *CICLO* BLOG

18

It has been developed an on-line platform where the most relevant activities have been communicated with texts and pictures.
The on-line blog has been an important mean to communicate and keep updated the involved actors about the developing of the pilot project and to give visibility to the project. In fact the blog is composed of different sections: Home page, About and Project background. The Home page appears like a wall of news posted in during the journey; the About page includes the description of the vision of the project and its aims and the project background page is aimed at describing the origin of the project. Moreover through the comments of the blog it is possible to receive from followers, interesting feedback and proposals of Mulo's applications in new contexts.
Who will be in charge of implementing the project will have the possibility to update the blog with further results or even to create new sections in order to enrich its contents with new data.

Ciclo blog homepage.

CORPORATE IDENTITY

19

The name of the system is thought in portugues in order to be understood and identified as well by population with lower instruction. In the name “Ciclo” (easy translatable to english as “cycle”) are contained the concept of cycle of the material as well as the kind of vehicle that is used. The dotted arrows of the logo are a reference of the recycling symbol as well as the shape of the sun.
The claim tells in a more precise way what the service is about (sun powered separate waste collection.
The color orange reminds to the sun but also to COMLURBs corporate identity and sky blue simbolizes cleanliness.
The logo is to be applied to the vehicles, which are thought to be yellow as they are sun powered and attract peoples attention.

C= 74
M=22
Y= 0
K= 15

C= 0
M=80
Y= 69
K= 0

According to the brazilian National Coucil of Environment (CONAMA) the color selection to identify the different categories of materials has been choosen.

PAPER

C= 74
M=22
Y= 0
K= 15

PLASTIC

C= 0
M=80
Y= 69
K= 0

GLASS

C= 50
M=0
Y= 66
K= 9

METAL

C= 3
M=5
Y= 96
K= 0

VEHICLE REDESIGN

20

20.1 Design requirements for the adaptation of the vehicle

Obviously it was necessary to do a redesign of the Mulo vehicle to adapt its concept to the context of the PSS. After the formulation of the concept vision and the on-situ exploration of the contest a list of design tasks to fulfil was elaborated.

MANOEUVRING
- the vehicle must be able to circulate on irregular road conditions;
- it must be easy to manoeuvre in a complicated road net, reverse motion is needed.

LOADING
- It must be easy to load and unload the material;
- It must be safe for the operator without risking to be knocked down;
- It must be easy to get on and off from the vehicle frequently.

MAINTENANCE
- Everyday maintenance should be easy to be carried out by the driver.

PRODUCTION COSTS
- Costs should be kept at minimum.

DIMENSIONS
- considering that the medium specific weight of the material would be about 75kg/m³ the dumpster should be quite capacious.

Road conditions in the "Maré".

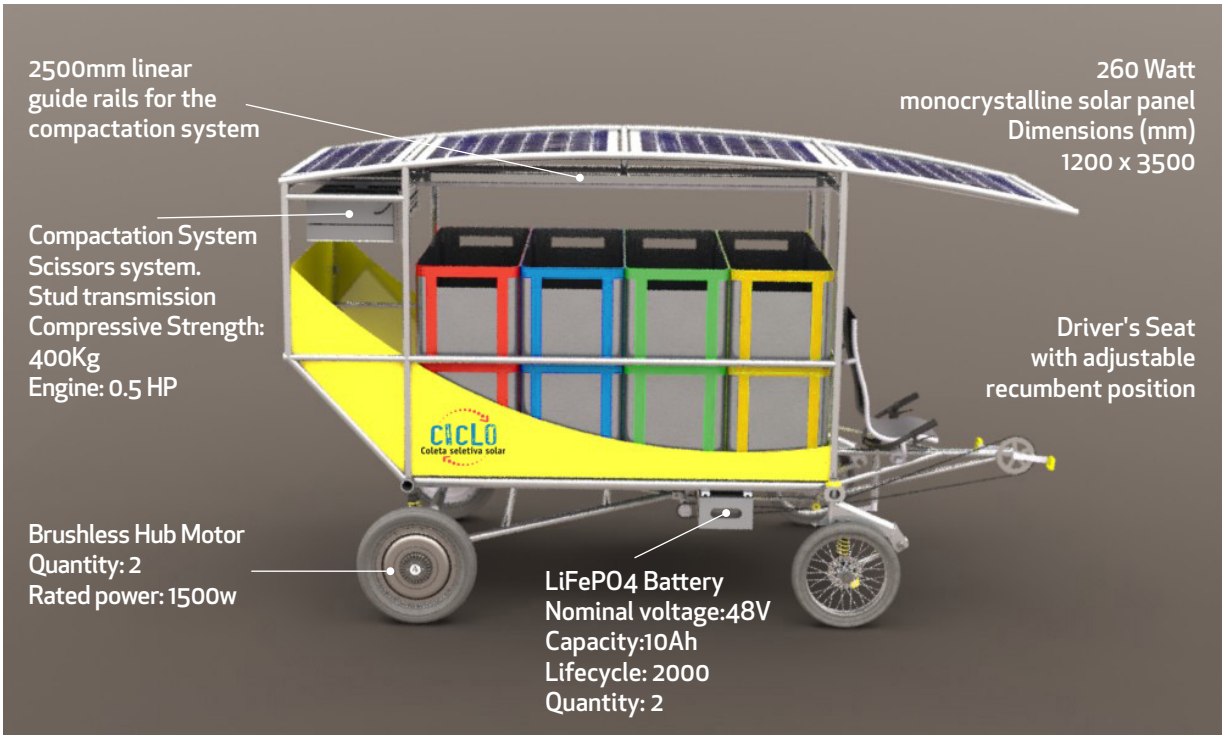
BODY:
- space for advertising of the sponsoring company is needed.

***** A version which could circulate uphill would be useful because most of the favelas in Rio de Janeiro are located on steep hills.

20.2 Redesign proposal

The redesign of the vehicle was carried out by Diego Mendez for his masters degree thesis in Design and Engineering at the Politecnico di Milano. During the PSS design process periodical conversations helped in share the on-field observations in order to find the best technical solution.
The vehicle moves through two hub motors located on the rear wheels, which are connected to the transmission system of pedaling.It has a container for each kind of matreial (paper, plastic, metal and glass). It has a compaction system that optimizes the space of containers to make longer trips using the energy from the solar panels. The compactation system is also used for evacuation of the containers, in a way that the operator will not perform unnecessary efforts. The vehicles chassis is made out of steel AISI 1020.

Mulo Rio, design by Diego Mendez.


2500mm linear
guide rails for the
compactation system
260 Watt
monocrystalline solar panel
Dimensions (mm)
1200 x 3500
Compactation System
Scissors system.
Stud transmission
Compressive Strength:
400Kg
Engine: 0.5 HP
Driver's Seat
with adjustable
recumbent position
CICLO
Coleta seletiva solar
Brushless Hub Motor
Quantity: 2
Rated power: 1500w
LiFePO4 Battery
Nominal voltage:48V
Capacity:10Ah
Lifecycle: 2000
Quantity: 2


CICLO
Front Cog
Diameter 200 mm
50 Teeth
Rear Cog
Size: 1 to 2
from side Cog
Middle Cog
Size: 1 to 4
from front Cog
Side Cog
Size: 2 to 1
from middle Cog

Loading and unloading of the containers.

On the opposite page above: broad components.

On the opposite page below: down view broad components.

PART 5
Conclusions

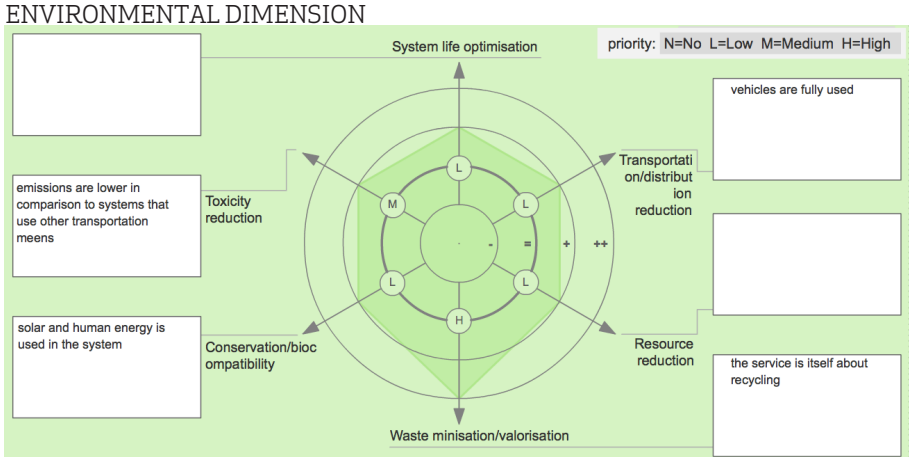
WHY *CICLO* A SUSTAINABLE PSS IS

21

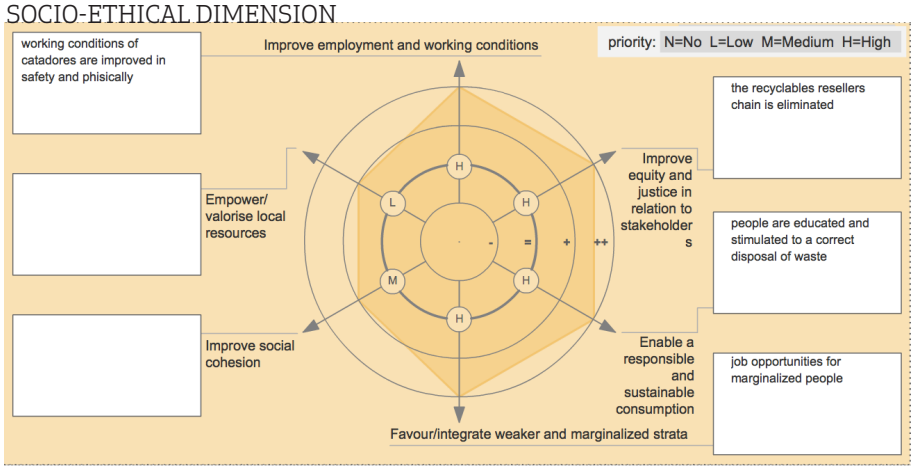
As already argued in the therotical background section, a sustainable PSS can be defined as a PSS where the economic and competitive interest of the providers continuously seeks environmentally beneficial new solutions, while maximising social well-being, equity and cohesion (Ceschin 2012).
As shown by the economic hypothesis, *Cyclo* is a self-sustaining business.
From the environmental point of view it is sustainable because the core product of the system is a low-emission vehicle which has eco-efficient charachteristics but most of all because the benefits of separate waste collection together with recicling encompass the central matters of sustainability:
- reduction of the greenhouse gas emissions,
- energy saving,
- natural resources saving,
- urban sustainability.

Finally it can be considered a socio-ethically sustainable system because through the waste collection it aims at offering a better quality of life to low-income communities and because it creates better job oportunities and revenues for marginalized people.
The sustainability evaluation was carried out using the sustainability design orienting tool kit (SDO) by checking and visualizing (through proper checklist and radar diagrams) the improvements in relation to the existing reference system and its sustainability priorities.
The following reported radar diagrams show the project priorities (classified as no, low, medium, high) on the bold circle and the improvements obtained visualized through the darker area.

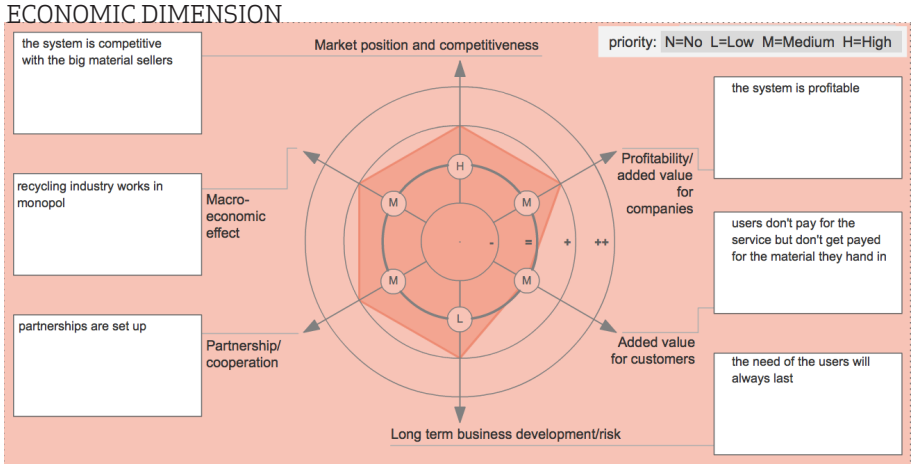
ENVIRONMENTAL DIMENSION



SOCIO-ETHICAL DIMENSION



ECONOMIC DIMENSION



INVOLVED PEOPLE

22

In the design process, and expecially in the setting up of the stakeholders network and during the co-creation activities many people were involved in the project and gave their contribution. Follows a list of the persons which in specific rapresented the stakeholders and personally followed the work.

Eduardo Bernhardt is graduated in biology and is environmental consultant at Recicloteca. He works since eight years at NGO Ecomarapendì on research, divulgation of information about waste, recycling and enwironmental issues and giving lectures and workshops on the topic. By the way he is in the directory of another NGO, called Transporte Ativo which aims at quality of life through the use of human powered transportation means in the transit system.

Roberto Jose da Silva and Jorge Otero Peixoto are working in the team that manages the separate waste collection program of COMLURB.
Robson Olivé de Carvalho is manager of COMLURB services in the area of the pilot project - SG10R

Edson Diniz diretor redes is graduated in history and is director of NGO Redes de Desenvolvimento da Maré.

Alfredo Jefferson de Oliveira is design professor at PUC-Rio and has done research on design for sustainability. He held the "Socio-environmental use and impact project" course, during which the strategic analysis and the exploration of opportunities phases were conducted. Furthermore he agread on a partnership with Politecnico in order to lead the continuation of the project by producing a vehicles prototype and tutoring the students who will carry on with the socio-techical experimentatio.

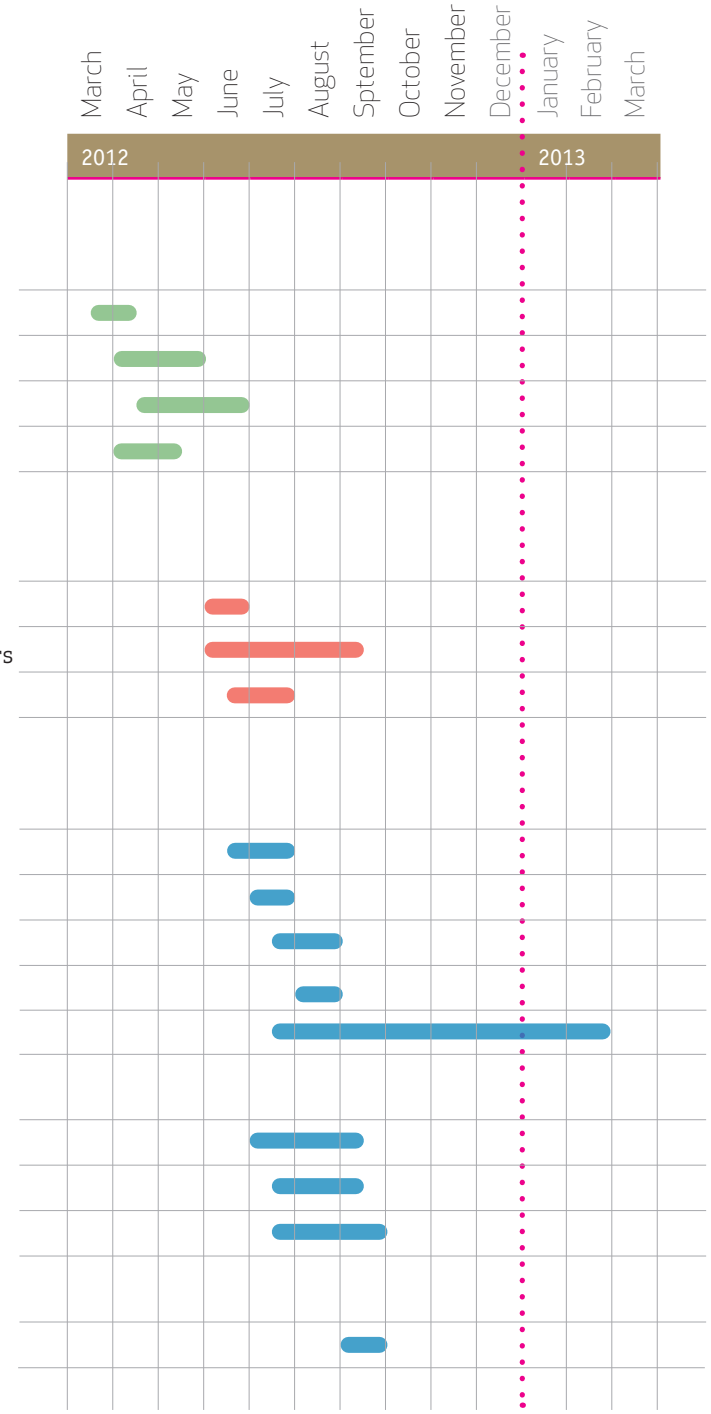
Lucas Portes is product design student at Pontificia Universidade Catolica do Rio de Janeiro and participated in the formulation of the first concept vision (that was later abandoned) during the "Socio-environmental use and impact project" course we attended togheter.

Diego Méndez Urrego is student of the Master Degree in Design Engineering at Politecnico di Milano and for his final thesis he worked on the redesign of the vehicle.

José Luiz de Oliveira Estácio is president of the RIOCOOP cooperative and member of MNCR (Movimento Nacional dos Catadores de materiais Reciclaveis).

WORK BREAKDOWN

23



STRATEGIC ANALYSIS

Understand the context

Identification of the intervention area
Analysis of the reference context
Analysis of the reference structure
Analysis of best practeces

GENERATING

Define the PSS

Exploration of opportunities
Identification & involvement of stakeholders
Definition of promising scenarios

DEVELOPING

System design

Offering diagrams
System map
Interaction storyboards
Corporate identity
Vehicles redesign

Transition path design

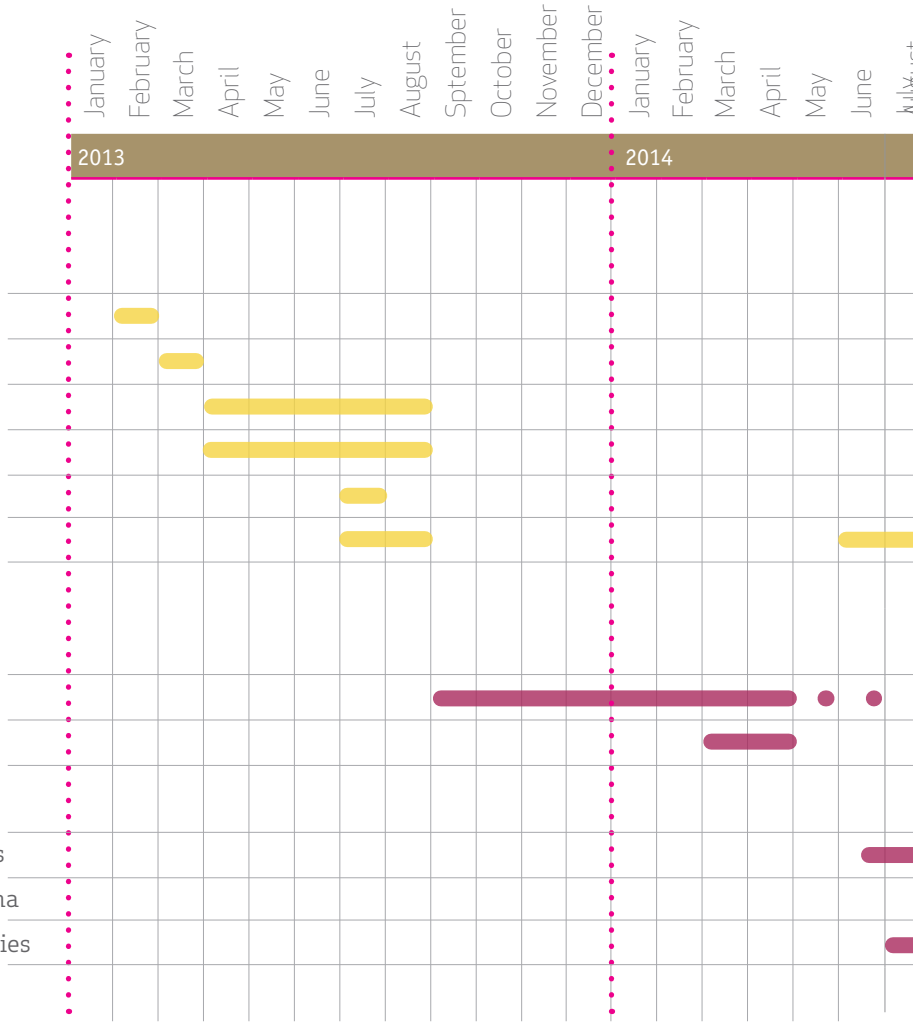
Pilot project design
Scaling up action plan development
Socio-technical experiment design

Econonic evaluation

Economic hypothesis

NEXT STEPS

24



PROTOTYPING

Socio-technical experimentation

Collection of fundings

Vehicles production

Socio-techical experimentation

Advertising of the service

Experiment evaluation

System improvements

IMPLEMENTATION

Pilot project

Service implementation

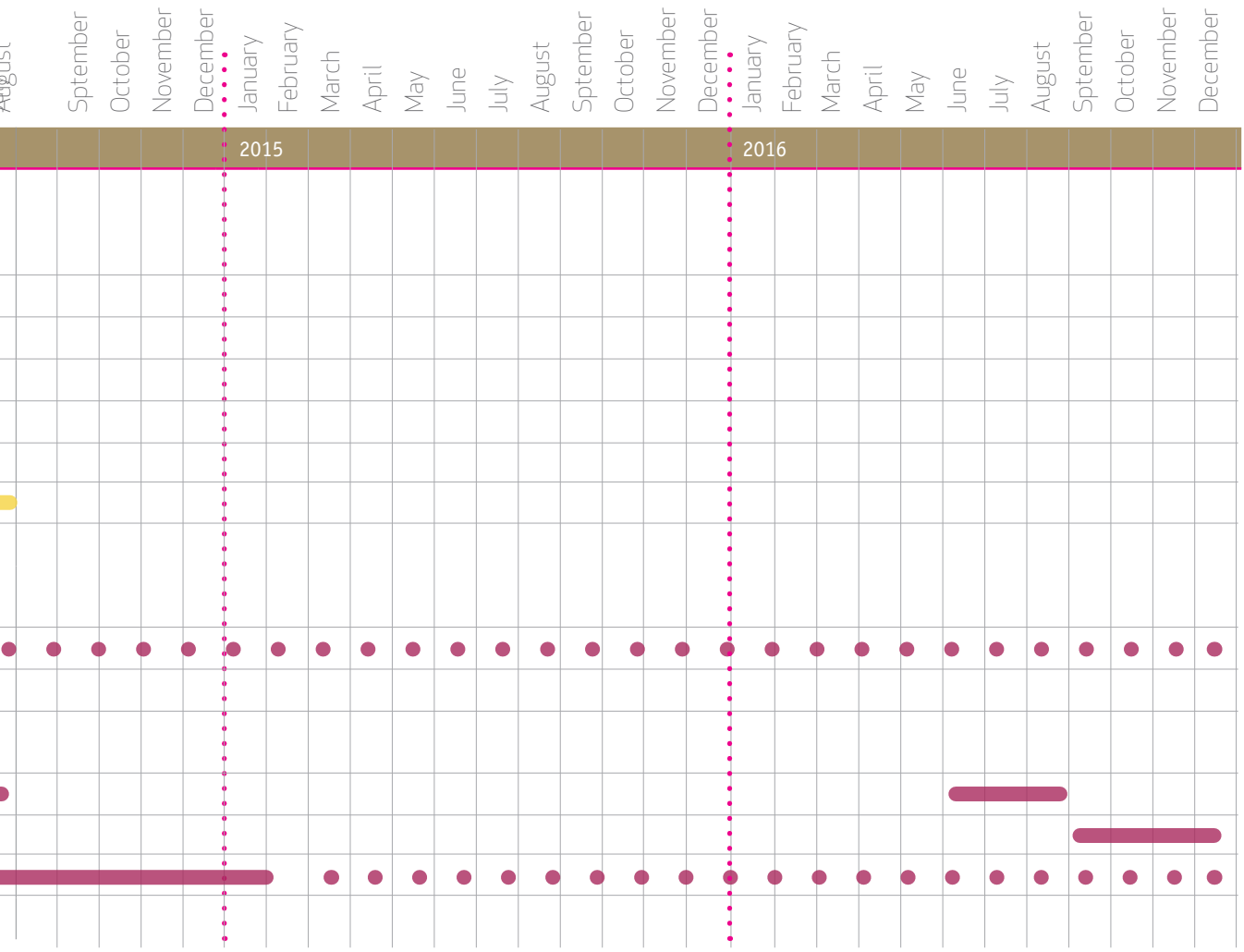
Feedback collection

"Scaling up"

Service implementation during events

Service implementation in P. Maravilha

Replication of the service in communities


August
Sptember
October
November
December
January
February
March
April
May
June
July
August
Sptember
October
November
December
January
February
March
April
May
June
July
August
Sptember
October
November
December
2015
2016

THE PROJECT AS EXPERIENCE

25

This thesis project has been an important experience for me because it gave me the opportunity to conceive and work on a project with the aim of a real implementation in society.
I began the research during the "Socio-environmental use and impact project" course that I attended at PUC- Rio university and continued it in the following months.
The first phase took quite a long time because I was unfamiliar at all with the city of Rio de Janeiro, so a continuos investigation and discovering process was carried out. Working on situ was essential to understand the context and to develop a customized project.
It was stimulating to collaborate with people from NGOs and institutions and are involved in the topic in their work, they always showed big interest in collaborating and in the proposal itself.
The systemic scale of the innovations area was a difficulty I had to face, since there are a lot of dynamics overlapping in the field of waste management and it is a field that in Brazil still is in big evolution. It was challenging to work in a low income context and get in touch with very different realities as the ones I was used to.
The work is intended as the beginning of a path in which I hope the concept will be translated into reality, succeding in improving the actual situation through a positive change. As the name "Evolutionary Transition Path" says, it is a process that faces continuos changes due to the refinement and improvement of the idea and design but also depending on external factors. I believe that the outcomes of this thesis will undergo transformations during the implementation phase but set the basis on which to start.

REFERENCES

F. Ceschin, *Introduction and scaling-up of sustainable Product Service Systems: A new role for strategic design for sustainability*", Phd Design Thesis, Politecnico di Milano 2012.

E. Delfino & S. Remotti, *SunRide: Design and implementation of a sustainable mobility PSS in Cape Town*, Master degree thesis, Politecnico di Milano, Faculty of Design, 2012.

H. Gumus, *Kanga, a sustainable system design for the transportation of learners with disabilities in Cape Town- South Africa*, Master degree thesis, Politecnico di Milano, Faculty of Design 2009.

E. Manzini & C.Vezzoli, *Product-Service Systems and Sustainability: opportunities for sustainable solutions*, UNEP, Milano 2002.

José Henrique Penido Monteiro ...[et al.], coordenação técnica Victor Zular Zveibil, *Manual de Gerenciamento Integrado de resíduos sólidos* ,IBAM, Rio de Janeiro, 2001.

J. Thackara, *Plano B. O design e as alternativas viáveis em um mundo complexo*, Editoras Saraiva e Virgília - 1.a. edição - 2008

C. Vezzoli, *System design for sustainability Theory, methods and tools for a sustainable "satisfaction-system*, II edition, Maggioli Editore, Milano, 2010.

M. Stickdorn, J. Schneider,*This is Service Design Thinking: Basics, Tools, Cases*, BIS Publishers, 2011.

UNEP and TUDelft, *Design for Sustainability: a practical approach for developing economies*, 2006.

UNEP, *The role of Product Service System in a sustainable society.*

Caracterização Gravimétrica dos Resíduos Sólidos Domiciliares das Comunidades com UPPs, COMLURB, Gerência De Pesquisas Aplicadas, 2011.

Programa de Expansão da Coleta Seletiva da Prefeitura da Cidade do Rio de Janeiro, Prefeitura do Rio de Janeiro, 2012.

http://www.cempre.org.br
http://www.coletaseletivasolidaria.com.br
http://www.ideaas.org
http://www.light.com.br
http://www.lixo.com.br
http://www.mncr.org.br
http://oglobo.globo.com/rio
http://www.plataformaitaipu.org/projeto/coleta-seletiva-reciclaveis-com-veiculos-eletricos
http://www.recicloteca.org.br
http://redesdamare.org.br
http://www.rio.rj.gov.br/web/comlurb

ACKNOWLEDGEMENTS

I would like to thank Prof. Carlo Vezzoli for giving me the opportunity to work on this project.

My infinite gratitude to my parents, who always support me and believe in my work.

A special thanks to Silvia, great friend and work colleague and to Masha, Federico, Mathilde and Brian for the nice days (and nights) spent together during the last two years in Milan.

Thanks to Mauricio forhaving been by my side and to all the good people I met in Rio during this experience.