Municipal Solid Waste Management In India

Finding Sustainable Pathways For The City Of Bangalore

by

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ABSTRACT

During the months from June to November 2012, the city of Bangalore was faced with a serious solid waste management (SWM) crisis. In the wake of the upheaval, the state court declared source segregation to be mandatory. Yet, while the legislation was clear, the pathway towards a course of action for the transition was not clear and hence, Bangalore was stuck in a state of limbo.

The objectives for this thesis spiraled organically from this crisis. The first objective was to examine the gaps in Bangalore's transition to a more sustainable SWM system. Six particular gaps were identified, which in essence, were opportunities to re-shape the system. The gaps identified included: conflicting political agendas, the exclusion of some key actors, and lack of adequate attention to cultural aspects, provision of appropriate incentives, protection of livelihoods and promotion of innovation. Opportunities were found in better incentivization of sustainable SWM goals, protecting livelihoods that depend on waste, enhancing innovation and endorsing local, context based SWM solutions.

Building on this understanding of gaps, the second objective was to explore an innovative, local, bottom-up waste-management model called the Vellore Zero Waste Model, and assess its applicability to Bangalore. The adaptability of the model depended on several factors such as, willingness of actors to redefine their roles and change functions, ability of the municipality to assure quality and oversight, willingness of citizen to source segregate, and most importantly, the political will and collective action needed to ensure and sustain the transition. The role of communication as a vital component to facilitate productive stakeholder engagement and to promote role change was evident.

Therefore, the third objective of the study was to explore how interpersonal competencies and communication strategies could be used as a tool to facilitate stakeholder engagement and encourage collective action. In addressing these objectives, India was compared with Austria because Austria is often cited as having some of the best SWM practices in the world and has high recycling rates to show for its reputation.

In the loving memory of

Padmavathi and C.R Guru Rao

You live forever through your deeds, your kindness and your stories in the hearts of your Grandchildren

Dedicated to my parents,

Kalavathi & Rengarajan

Thank you for the way you raised me.

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ACRONYMS

SWM	-	Solid Waste Management
MSWM	-	Municipal Solid Waste Management
WM	-	Waste Management
ZWM	-	Zero Waste Management
SLRM	-	Solid & Liquid Resource Management (same as ZWM)
CPCB	-	Central Pollution Control Board
KPCB	-	Karnataka Pollution Control Board
BBMP	-	Bruhat Bangalore Mahanagara Palike (Municipality)
ZWM	-	Zero Waste Management
PPPs	-	Public Private Partnerships
WET	-	Waste to Energy
RDF	-	Refuse Derived Fuel
MBT	-	Mechanical Biological Treatment
CBO	-	Community Based Organization
SHG	-	Self Help Group
NGO	-	Non-governmental Organization
PIL	-	Public Interest Litigation

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Chapter 1

INTRODUCTION

The goals of solid waste management (SWM) are (1) to protect human health directly and indirectly by minimizing waste in the environment and (2) to conserve resources. Sustainable SWM goes further by "not exporting waste –related problems in space or time," to future generations. The first goal of SWM is to reduce the direct contact of the population with waste (Brunner & Fellner, 2007). While SWM is a big problem in developed and developing countries alike, most developed countries have achieved the first goal and are now finding pathways and technologies that enable resource conservation. Developing countries on the other hand have yet to fully protect their population from direct contact with waste. To achieve this, they aim for a 100% collection rate. India is one such developing country where municipal solid waste management (MSWM) continues to remain one of the most neglected areas of urban development. India is often praised for its remarkable progress in human and economic development, for its heritage and culture but the issue of waste eclipses the county's acclaim. Megacities with high population densities and low-income groups are particularly vulnerable to the negative consequences of uncollected waste. The current collection rate in Indian cities is 60 to 85%. The rest is left unattended on the streets (Baud, Post, & Furedy, 2004; Talyan, Dahiya, & Sreekrishnan, 2008; Saxena, Srivastava, & Samaddar, 2010).

India has the 2nd highest population with about 1.3 billion people residing in an area of 3.2 million km^2. India's urban residents comprise 28% of country's population (C.Visvanathan & Trankler, 2004; World Bank, 2011). The economy has enjoyed a near uninterrupted growth, but has slumped a little during the recent past. The current economic growth rate is 4.3% per annum. Rapid urbanization, industrialization and

globalization have undoubtedly brought higher economic prosperity, better living standards and improved livelihoods to low and middle-income countries. Yet, the link between higher economic growth and increasing amounts of solid waste is becoming a threat to the maintenance of better living standards (Curzio, Prosperetti, & Zoboli, 1994). In India most of the urban population is concentrated in Class I cities (where the population is more than a 100,000). The annual per capita waste generation varies from 0.3 to 0.6 kg per day and increases with the size of the city at a rate of 1.33% (C.Visvanathan & Trankler, 2004; J. S. Kumar, Subbaiah, & Rao, 2011; Talyan et al., 2008). Worldwide urban population is expected to double within the next 35 years. 90% of this growth is projected to take place in developing countries (World Resource Institute 1997). The World Bank estimates that waste generation will increase from 760,000 tons per day to 1.8 million tones per day in East Asia alone within the next 25 years (Zhu & Bank, 2008). Furthermore the cost of collection, transport and disposal of SW is expected to double as well. Hence, municipal solid waste (MSW) and SWM are very important issues to consider, especially within the urban Asian context.

One urban Asian city is Bangalore, which is the fifth largest city (in terms of area) in India and the third most populous city with about 4.3 million residents who produce a total of 3,613 tones of waste per day (A Scheinberg, Wilson, & Rodic, 2010a). The subcommittee of India's Supreme Court describes WM in India as a "pathetic situation" (Saxena et al., 2010). India's municipal bodies have not been able to adjust to the rapid demographic and economic changes, are overwhelmed financially and technically, and rarely have the appropriate strategies and infrastructure for an organized SWM system. This leads to low collection coverage and largely unregulated disposal (Zurbrügg, 2003). Bangalore has coped with this reality for the past decade, but between July and November 2012, the city took a turn for the worse.

On October 26th 2012, the front page of a local newspaper was titled "Is Garden City Turning into Trash City?" (Rai, 2012,p.1) while the *New York Times* (2012) wrote:

> Bangalore, the capital of India's modern economy and home to many of its high-tech workers, is drowning in its own waste. Many neighborhoods have not had a trash pickup in nearly three weeks and vast mounds of garbage are scattered through what is known in India as the Garden City" (Harris, 2012, p.1).

The New York Times also noted that the, "garbage crisis grew directly out of Bangalore's stunning success" (p.1). It is safe to say that this city is grappling with SWM issues and is currently undergoing a major transition in its SWM functions. In this study, I will look at the SWM issues facing Bangalore by employing the frameworks of transformational systems and gaps, interpersonal competencies and hierarchies, and bottom-up context based approaches to aid the city towards building a more sustainable SWM system.

Transforming any SWM system from an unsustainable pathway to a more sustainable one necessitates collaboration, communication, awareness, innovative and context-based solutions among other things. Transformation, as used here, refers to fundamentally altering the ecological, economical, social and/or political aspects of a system, especially if the existing system is untenable (Loorbach, 2010; Walker & Holling, 2004). It is evident that the MSWM systems in India need to adapt and transform to be resilient, but transforming from one state to another, is undeniably an arduous task. It involves the cooperation of key stakeholders and actors to push from one basin of attraction to another. Transitions in the Dutch waste management sector shared certain similarities with transitions in developing nations, in so far that it encompassed interacting changes in technology, infrastructure, regulation, institutions, market forces, practice and culture (Loorbach, 2010). India has largely looked towards technology alone as a solution, although overlaps and interactions with other factors, affect the outcome and sustainability of SWM systems heavily. Loorbach (2010) also states that "transitions are often the result of external forces such as innovations, crisis and the self-organization

of social actors" and that the stability depends on a "dynamic equilibrium where power relations need to be stable, the WM infrastructure needs to be sufficient and regulation and policy are formulated and controlled" (p.192). This has certainly proven to be true in the case of Bangalore, where the desire to transition to a better SWM system occurred during a time of crisis, which turned into an opportunity for transition that remains in limbo, due to the "dynamic disequilibrium." This study aims to look at the gaps that prevent Bangalore from transitioning from its current state to its future vision.

National and state government legislations (BBMP, 2003; Government of India, 2000a, 2009) have clearly defined a sustainable SWM future state as a system which minimizes landfill by adhering to the following practices; mandatory source segregation, door-to-door collection, abolition of open storage, abolition of littering and open burning of waste, daily sweeping of streets, transport of waste in covered vehicles, waste processing by composting or energy recovery, and disposal of only inert waste and residues by landfilling (Esakku, Swaminthan, Parthiba Karhtikeyan, Kurian, & Palanivelu, 2007). This study examines the current state of municipal solid waste management SWM systems in Bangalore in order to understand the gaps and unanticipated barriers that halted transitions towards a more sustainable state.

Key competencies necessary to enhance the sustainability discourse have been established by, Wiek, Withycombe, & Redman (2011). Importantly, the authors consider interpersonal competence as the most crucial, and define it to include advanced communicating skills. Especially relevant in the field of sustainability, is the ability to talk to a wide range of individuals from diverse backgrounds to expedite beneficial outcomes (White, 2013). Of the many barriers that hinder development of better SWM strategies, one has been underemphasized: effective communication (Baud et al., 2004; Baud & Schenk, 1994; Baud, 2004; Wiek et al., 2011). Hierarchies are often pronounced

in the Indian context and communication travels predominantly one way - from the top of the hierarchy to the bottom. Feedback loops are rare, which is a pity, because those who handle waste at an intimate level know many of the flaws in the system. Actors in the SWM system are from different economic, social and cultural circumstances, with different needs. Particular communication techniques could foster positive outcomes by aligning the needs and wishes of the different actors with one another (Alberts, Heisterkamp, & McPhee, 2005). Cultural theory, communication strategies and the role of boundary structures play a vital role in fostering better outcomes (Nisbet, 2009). I shall examine how these communication strategies can be translated and adapted to the context of Bangalore's SWM system.

Much of the literature on transition management has arisen from studies of developed countries; the vast difference in socio- economic conditions and cultural norms between developing and developed nations should not be underestimated. This difference affects SWM practices. In the past decade, Indian cities have had to deal with the several failures of MSW technologies that have worked well in other countries. Urban population growth, education, poverty, and other urban dynamics are fundamentally different between developed and developing, and have perhaps influenced the performance of particular technologies in the Indian context. Top-down approaches can be influenced by best practices in developed nations but ideally, would need to be tested in the cultural context first. Which aspects of SWM in other countries could be used in India and which aspects must be created within the Indian context? In this study, I also look at innovative approaches to SWM that are context and culture based, and examine their saliency compared to the current technological approach towards SWM.

Problem Statement & Objectives

In this thesis, I will look at the case of Bangalore through the lens of the above-mentioned frameworks. In Bangalore, piles of garbage and waste litter the streets and this has become a common sight in other Indian cities as well. Civic institutions are facing increasing difficulty in providing adequate services (Iyer, 2012). The Indian legislation acknowledges the need to move away from landfill as the absolute solution. The legislation aims to "minimize the waste going to landfill, and dispose only the rejects from the treatment plants and inert material at the landfills in accordance with adequate standards" (Government of India, 2009, p.13). If landfilling is the last option, other methods of SWM need to be explored. On October 6, 2012 the state legislature has declared source segregation to be mandatory. Bangalore offers a novel case study because it is the first city in India to do this. While the citizen's movement and awareness campaigns are bourgeoning, the technical, social and institutional structures are resistant to change. Furthermore, bottom-up waste processing methods are often ignored in favor of imported technology and modernization without consideration of cultural integration or social realities. If Bangalore's transition is to be lasting, gaps in the system need to be identified and some bottom-up initiatives need to supplement the top-down legislative approaches.

The objectives of this thesis are:

1. Analyze the current state of SWM systems in Bangalore and identify gaps in the transition towards sustainable SWM.
2. Determine the appropriateness of applying a bottom-up SWM model, called the Zero Waste Management model, to the metropolitan city of Bangalore.

3. Identify the different frames, perspectives and communication problems between actors and how addressing them can contribute towards collective action for a more sustainable SWM system in Bangalore.

Significance of Study

While most developed countries have stringent landfill standards and legislation, regulation and control is completely inadequate in India (Sharholy et al., 2008). Developed nations use technologies such as landfill liners, compactors and daily soil-cover on their landfilled waste. These practices produce a sanitary landfill (Olar, 2003); they minimizes the health risks associated with leaking toxic leachate and aids methane extraction for energy. In India, 90% of the garbage is dumped without liners and other adequate landfill technology, causing alarming health risks to nearby populations and landfill workers (Chakrabarti & Majumder, 2009). It also contaminates groundwater and causes other environmental damage. Most Indian cities are constantly expanding and landfills disrupt the city expansion plans by devaluing the land price (due to contamination) and hence reduce investment appeal. Furthermore, waste left uncollected in cities further contaminate the surroundings and cause various diseases as well.

Badly managed waste and waste in itself decreases the resilience and increases the vulnerability of socio-ecological systems and is hence unsustainable. Effective and sustainable SWM is therefore becoming an increasingly important theme within the broader agenda of sustainability. While the negative effects and consequences of badly managed waste is known, the contributions of this study is in understanding what features are important to look at when a city want to transition to a better SWM system but is unable to do so.

Chapter 2

CRITICAL LITERATURE REVIEW

The Brundtland Commission was the first to call international attention to the need to cut waste emissions to air, water and soil in 1987. In 1992, Agenda 21 of the Rio Conference on Sustainable Development stipulated that "…by the year 2000, [we must] establish waste treatment and disposal quality criteria, objectives and standards based on the nature and assimilative capacity of the receiving environment" (p.254). Subsequently the United Nations and the World Bank have published various reports and white papers addressing both the social and technical aspects of SWM (Hoornweg, Thomas, & Otten, 1999; Rand, Haukohl, & Marxen, 2000; UNEP, 2005, 2013; United Nations Sustainable Development, 1992; Zhu & Bank, 2008). They highlight the need for local, innovative solutions in developing countries. While technology is important, India has focused more on importing foreign technology at the cost of developing local, context-appropriate solutions.

Definitions

India's Municipal Solid Waste (Management & Handling) Rules of 2000 define MSW as "commercial and residential waste generated in a municipal or notified area in either solid or semi solid form, excluding industrial hazardous but including biomedical waste,"(Government of India, 2000a, p.2). This definition is unusual because biomedical waste is generally not considered MSW in developed nations, thus medical waste is outside the scope of this thesis. The Indian definition of MSW includes non-hazardous industrial, commercial and domestic refuse including organic trash, street sweepings, institutional garbage and hospital waste. Sludge, human waste and hazardous waste are outside the scope of SWM as they are considered liquid waste (Olar, 2003).

The term "waste" implies a loss of value (Sakikumar & Krishna, 2009). The Vellore Zero Waste Management (ZWM), a bottom-up WM model (which will be discussed in subsequent chapters) adds the dimension of time to the above definition. Waste that is less than 12 hours old is simply "unwanted, discarded material" because organic material is generally odorless, fresh and raw during that period. Organic waste that is more than 12 hours old begins to putrefy and create bad odors. Within 24 hours the mixed waste may attract houseflies and be very repulsive to touch and handle, especially in warmer, tropical climates. If left unattended, unsegregated waste turns into decaying, revolting matter within 48 hours, contaminating other material and making it unhygienic and unpleasant for anyone to handle. Hence, any material that is under 12 hours old is deemed discarded material that has the potential to be a resource. This is not the formal definition of waste, but a definition that is important in the context of the ZWM model.

Organizational Definitions

The *public sector* comprises of government run entities; such as the national government, state governments, and the municipality. These entities are required to provide MSWM services even if they incur a net loss in doing so. The national government dictates the policies about MSWM, and it is the state governments' responsibility to implement those rules via its municipality. They are responsible for the collection, processing and adequate disposal of waste. The *private sector* is split into two parts, formal and informal sector. The *formal private sector* is government-recognized businesses enterprises that perform the MSWM services such as street sweeping, collecting, transporting and landfilling in place of the state municipality for a net profit. They are hired by the government to run MSW services for them more efficiently. The *informal private sector* comprises of those business enterprises, not formally recognized

by the government, which focus solely on recycling activities. These enterprises exist because many materials in the waste stream have market value, especially when accumulated in bulk (E. Gunsilius & Scheinberg, 2011; Ellen Gunsilius, 2010; Kasturi, 2012). While the formal private sector is taxed and encouraged by the government, the informal private sector is not formally recognized or taxed but is merely tolerated by the government. Yet the informal sector provides important benefits: it greatly aids municipalities by saving them millions of rupees annually, it reduces the amount of waste entering landfills and the demand for virgin material imports, thus reducing emissions and scarce foreign exchange. The boundaries between formal and informal sectors blur as materials go up the value chain. The informal waste sector will be discussed further in subsequent chapters.

Brief History of Waste Governance

The Ministry of Health and Family Planning was the first Indian organization to formally acknowledge SWM in 1975. In 1986, the Environmental Protection Act (EPA) discussed soil, water, air and habitat protection in broad terms with no direct, tangible, reference to SWM. Around 1993, an assessment by the World Bank of the Indian legal framework for MSWM observed that most state legislations did not cover the necessary technical or organizational details. Laws referred to street sanitation, providing waste collection bins for storage and transportation in general terms but did not clarify how or what targets are to be met (Zhu & Bank, 2008). Moreover, no mandates or fines were stipulated by the national policies, leaving the regional (state) municipalities to largely build and implement their own SWM framework. This could be due to the fact that before 2000, the waste amount was not as significant as it is today. It could also be due to the availability of vast unused land for dumping, which decreased the priority of SWM as an imperative issue.

Following the outbreak of plague in Surat, a major city in western India, the Indian government became highly aware of the threat that unmanaged MSW could pose. Thus, the unfortunate calamity became the biggest impetus for change and action on the issue of SWM. The landmark case of *Almitra Patel Vs. Union of India,* in which an Indian citizen who filed a lawsuit against the Supreme Court for mismanagement of waste, prompted the government to appoint a committee to assess all the aspects of SWM, interview and consult with more than 300 municipal authorities on best practices for SWM. The Ministry of Environment and Forest, the Ministry of Urban Development together with the expertise from the World Bank and NEERI provided a road map for immediate, short and long-term goals for SWM. Thus in 2000, the Government of India issued the Municipal Solid Waste (Management and Handling) Rules, under the EPA act of 1986 (Annepu, 2012; Baud, 2004; GOI, 2007; Pattnaik & Reddy, 2010; Rajput, Prasad, & Chopra, 2009; K. Shankar, 2011; Zhu & Bank, 2008). The MSW rules of 2000 apply to all cities with a population of 100,000 and above, and mandate proper collection, segregation, transportation, processing and disposal of solid waste.

Rules

The legislations also mention the need to upgrade facilities and to "arrest contamination of soil, air and ground water" (Government of India, 2007, p.8). The rules strictly prohibit the continued use of unsanitary, open, unscientific landfills. The responsibility for implementing the MSW rules of 2000, rest with the state municipalities. The rules were supposed to have been fully implemented by the year 2002, but not a single state has achieved full adherence to the rules to date (Saxena et al., 2010; Zhu & Bank, 2008).

Problems in Solid Waste Management

There are various reasons why the rules have not been implemented. Figure 1 presents a holistic perspective, which can be expressed in a framework with two parts: the primary process problems (physical challenges during collection, transport and disposal) and the secondary core causes that drive the problems (Ali, Olley, & Cotton, 1999; Baud et al., 2004; Esakku et al., 2007; Furedy, 1992; Hazra & Goel, 2009; Kurian Joseph, 2004; S. Kumar et al., 2009; Medina, 2002; Rodic, 2010; Saxena et al., 2010; A Scheinberg, Wilson, & Rodic, 2010b; Talyan et al., 2008; Zhu & Bank, 2008). The main challenge for solid waste management in developing countries especially India is:

1. Open dumping & unsanitary, harmful disposal methods
2. Low collection rates and inadequate servicing
3. Inadequate storage facility for waste
4. Transport problems
5. Underutilization and development of recycling options
6. Poor track record of successful processing methods
7. Presence of hazardous material in MSW

Core causes. While literature concurs regarding the pressing issues that plague SWM in India, the authors have divergent opinions about the root of these problems that I will call core problems. Some claim that technology transfers and adaptation need to perfected in India (Annepu, 2012; Rand et al., 2000; A Scheinberg et al., 2010b; Schübeler & Christen, 1996; Schubeler, 1997). Others claim that the dependency on technology as a panacea is the problem (Ali et al., 1999; Chakrabarti & Majumder, 2009; Medina, 2002; Pokhrel & Viraraghavan, 2005; Snel, 2011). Some authors claim that problems are due to political, legislative and bureaucratic ineffectiveness (Cointreau-Levine, 1994; Esakku et al., 2007; Zurbrügg, 2003), while others claim they are due to

the unproductive nature and profit seeking motives of the private contracting agencies (Coad, 2005; Nunan, 2000; Rathi, 2006). Other factors cited as the core of the SWM problem in India are financial constraints of the municipalities, lack of civic awareness and public involvement of the public in SWM issues, and lack of urban infrastructure and rapid urbanization (Hamer, 2003; Shekdar, Krishnaswamy, Tikekar, & Bhide, 1991; Venkateswaran, 2011). Authors also criticize the exclusion of the often-ignored informal recycling sector (Medina, 2002; Sarkar, 2003; D. C. Wilson, Araba, Chinwah, & Cheeseman, 2009; D. Wilson, Velis, & Cheeseman, 2006). In the next section core causes of process problem are discussed in detail.

Figure 1. Process problems (in blue) and core causes (in red)
Source: Based on author's research

Urban Planning & Health Problem. Rapid urbanization and population growth have often caused hurdles for urban planning in developing nations (Venkateswaran, 2011). Hence MSWM can be viewed through the lens of urban planning and health. Roads and other infrastructure are often not wide enough to accommodate big waste trucks for collection and even if they do enter these neighborhoods, collection

vehicles tend to break down often due to harsh road conditions. Medina (2011) provides an example from Mexico City where at any given time, half of the collection vehicles lie idle in the garage, awaiting repair. Faulty parts are often hard to replace because they have to be imported (Medina, 2002; Olar, 2003). Compactor trucks are another issue. Olar (2003) claims that "collection and transfer trucks which are able to achieve compression rates of up to 4:1 in industrialized nations may achieve only 1.5:1 in developing countries, and landfill compression technology which averages volume reduction of up to 6:1 in industrial nations may only achieve 2:1 compaction with these increased waste densities" (Cointreau 1982, as seen on Olar 2003, p.6). Compactor trucks are considerable investments and must be paid for in foreign currency because they have to be imported. Maintenance of uncommon equipment is another problem. In spite of the downsides of imported compactor trucks, Medina (2002) claims that over 60% of the loans made by the World Bank between 1985 and 1996 were used to buy compactor trucks. The use of trucks also displaces informal refuse collectors and eliminates livelihoods. Medina (2002) concludes that compactor trucks are "technically inappropriate, economically unsustainable and socially undesirable [in developing countries]" (p.15).

Unauthorized slum and squatter settlements pose a difficult dichotomy; since they are illegal, they should technically not be serviced by government funds. On the other hand, they already suffer from inadequate service of water supply, sanitation/toilet facilities and wastewater disposal systems and hence are in vital need of maintenance. The absence of waste management services in such conditions, lead to piling waste contaminated with human and animal excreta, which paves the way for extremely serious consequences.

The conventional urban planning approach is problematic in India, as Shekdar (1999) points out because spatial prediction models are based on linear, fixed point equation models, but developing countries are expanding at a rate faster than the models predict. The lack of proper urban infrastructure reduces collection rates and makes waste transportation problematic. The municipalities want to implement western style door-to-door collection system in Indian cities like in western countries. While this has been implemented in parts of cities like Mumbai, Delhi and Bangalore, some authors claim this to be a highly unrealistic vision given the state of urban infrastructure. Furthermore door collection is going to exacerbate the situation, as it is most likely to benefit the rich areas and neglect the poor. Saxena (2010) claims that 70% of Indian cities lack capacity for waste transport. A review of SWM in Indian cities reveled that 70% to 80% of the municipality's budget is spent on paying the private sector for collecting and transporting waste. Thus, fewer funds are available for waste processing (Sharholy et al., 2008).

Financial, Political and Legislative Problems. Literature highlights that municipalities are highly under-budgeted (Government of India, 2009; S. Kumar et al., 2009; A Scheinberg et al., 2010b; Zurbrügg, 2003). Financial constraints force the public sector to outsource the SWM services. This has brought forth a push towards privatization as a panacea. The municipalities currently get their income through property tax revenues but many municipalities may not be aware of the degree to which revenues are collected or the true cost of MSW operations (Olar, 2003). Olar and Scheinberg state that meeting the financial demands of the SWM will continue to be a problem in cities in developing nations as fewer people will be willing to pay in the face of declining service. The push towards privatization has certainly alleviated the pressure

and cost to some extent, however the local government are still held responsible and accountable for any shortcomings.

In India landfills are essentially dumping grounds. They lack the basic infrastructure that defines a landfill, such as membrane lines, impermeable liners, daily covers and methane extraction infrastructure. Dumping is currently the cheapest and most predominant method of disposal. On average a city requires 4 to 7 landfill sites every 10 years. The sites chosen for are often low lying, marshy lands that are not suited for development (Shekdar et al., 1991). Environment impact assessments of geological and hydrological features are rarely done. It is estimated that around 1400 km^2 of landfill area will be required by 2047 in India (Singhal & Pandey 2001). Vulnerable populations often reside close to dumping sites, making them prone to major huge health issues. Asthma, cancer and other immune toxic diseases are said to be very prevalent amongst these communities (Rao, 2013). Around the dumpsite, people and animals scavenge, as most of the time the area is not fenced off. Usually, metropolitan cities such as Delhi, Chennai, Mumbai and Bangalore have bulldozers to compact the waste but there is no weighing and no specific plan that is followed while filling the dumpsite. Toxic leachate is left open in large cement ponds. Low-lying landfill areas are very prone to flooding during monsoon season making them vulnerable to contaminating to water bodies and aquifers and poisoning air and soil streams. The disposal sites are selected on the basis of their proximity to the city and new disposal sites are found only when the old ones are filled to capacity (Annepu, 2012). Legislation mandating proper environmental standards for landfilling and incineration as well as the financial capabilities to monitor the implementation is needed.

Privatization has been proposed as a solution but that too comes with its own set of problems (Dasgupta, 2012). They now control the majority of the system and the

municipality does not control their quality of service. In Bangalore, 91% of the SWM activities are outsourced to private contractors. Cointreau (1994) states that in Colombia, Mexico, and Nigeria the private contractors are responsible for much of the clandestine dumping of waste because they take advantage of the fact that governments must work towards the overall cleanliness of the city (Cointreau-Levine, 1994). This is very much the case in India and keeps the status quo strongly in place. Furthermore, many dumping grounds are often owned privately and more revenue is made when more waste is dumped.

Technology Mismanagement & Culturally Insensitive Adaptation. The waste hierarchy dictates that landfill should be the last possible option for waste disposal, but in India it is the first and only 5 to 10% of the waste is processed. The primary waste processing methods are:

- Waste to energy (WTE) by combustion (e.g. gasification, pyrolysis etc.),
- Refuse derived fuel (RDF)
- Mechanical biological treatment (MBT)
- Biomethanation and aerobic composting

WTE is recognized as a renewable energy technology by the Government of India just as the governments of Australia, Denmark, Japan and US (Annepu, 2012). Annepu argues in favor of implementing WTE plants for two reasons. Firstly, since waste is increasing at a rate beyond capacity, WTE treatments would be a better environmentally friendly alternative to unscrupulous dumping. Secondly, he suggests that source segregation is unlikely to be a reality in India and hence, WTE is more capable of combusting mixed waste. Although Annepu advocates the technology transfer solution, his own report mentions no less than 12 failed WTE plants, in seven big cities. The plants were built between 1985 and 2005 and each plant costs about US$9.1 million to build.

Cointreau (1994), Medina (2002) and other authors are very clear that incineration and WTE is not technically and economically viable for developing countries due to the waste characteristics (Chakrabarti & Majumder, 2009; Cointreau-Levine, 1994; Esakku et al., 2007; Medina, 2002; Rodic, 2010). Waste composition depends on cultural habits, standard of living, degree of commercial activity and seasonal climate, which makes waste composition in India is very different from waste composition in developed nations (Esakku et al., 2007). A study on the composition of waste in 59 Indian cities revealed that the organic content was between 40% and 70% (S. Kumar et al., 2009; Saxena et al., 2010; Sharholy et al., 2008). Furthermore, while Indian waste embodies low calorific values (800 to 1100kcal/kg), developed nations in Europe, in comparison, have a minimum waste calorific value of 4000 kcal/kg (Rand et al., 2000), which means Indian waste is not worth burning. It is arguable that warmer, equatorial countries like Singapore, also predominantly incinerate their waste. Singapore incinerates its waste for one reason; they have a serious paucity for land and they also augment their waste with more dry material in addition to other dehydration technology. Their WM strategies are quite capital intensive.

Some authors (Annepu, 2012) propose to dehydrate mixed waste in windrows and then incinerate the final product as a solution to the high moisture content problem, but it doesn't solve the low calorific value problem. RDF also requires dehydration technology in addition to mechanical technology. But that neither technology is designed for waste with low calorific values found in India so, investment in either would likely be a losing proposition. RDF plants in Chandigarh and Jaipur are running below capacity due to lack of appropriate waste segregation. Annepu argues that open burning of waste in streets and landfill fires emit a lot of polluting air emissions but he fails to see that WTE plants in India will emit the same or more in emissions. Air quality testing and

management is not prevalent in India and there is little legislation with regard to air pollution quality control. Furthermore, if the plants are privately owned, filters and scrubber technology are likely to be viewed as extra cost for a plant (just like landfills do not have liners or other environmental protection mechanisms).

Ideally, the composition of waste should dictate the type of disposal option chosen. Medina (2002) also did extensive research in developing nations in South America and he highlights two major reasons why technology transfer from developed nations to developing nations may not be the best possible SWM solution. Firstly, industrial nations enjoy a high abundance of capital but have a relatively low supply of labor compared to developing countries. Furthermore labor that is available is expensive. Hence they prefer capital-intensive waste processing mechanisms that focus on technology rather than on manual labor. He says, "developing nations, on the other hand, have low capital options but have a high availability of labor, hence capital-intensive processing methods are not advised" (Medina, 2002, p.6).

Informal Sector Ostracization Problem. Trash in developing nations has a huge impact on livelihoods. A study done by a German SWM working group on the effects of the informal waste sector in 6 cities (Cairo-Egypt, Lima-Peru, Lusaka-Zambia, Pune-India and Quezon-Philippines) showed that around 74,000 livelihoods worked in the informal waste sector, while only 34,000 were formally employed as waste management employees (Gunsilius & Scheinberg, 2011). Waste, when segregated has value hence, a large number of informal small- and medium- size enterprises and businesses operate in the informal sector to collect, segregate, process, recycle and resell valuable goods.

The value chain is intricate and often runs through several waste pickers, waste dealers, junk shop owners and small-scale waste processes before entering the formal

stream (Scheinberg, 2008). Thus, the line between informal and formally traded material is blurred along the value chain. Primarily, the informal sectors work in recovering, recycling valuable material and are highly skilled in recognizing recyclables and "high- value" refuse. They valorize (add value) to the waste by extraction, processing and collecting large amounts of those materials, which have high intrinsic value. Literature seems to be split in two schools of thought on the efficiency of informal sector. On one side some authors claim that all metals, unsoiled paper, most plastics, glass and cardboard are readily marketable and hence are quite efficiently recycled by the informal sector (Visvanathan & Trankler, 2004). In their opinion very little that is recyclable is left in the mainstream waste by the time it reaches the dump. Other authors claim that much of the recyclable material is contaminated beyond salvage, before waste pickers have access to it, and that source segregation would increase informal recycling rates (Gunsilius & Scheinberg, 2011; Scheibe, 2006; Scheinberg, 2012).

The negative aspect of the scavenging (collection of waste by waste pickers) is the scattering of waste outside the bins. This poses more problems for the formal waste collector, as it increases the time taken by waste collectors take to collect the waste. Olar (2003) claims that, "while it takes only 5-10 seconds to empty a 45-gallon container of waste into a collection truck, it takes 1-2 minutes to shovel the equivalent amount of waste" (p.6).

While a majority of researchers conclude that the participation of the informal sector in waste management should be encouraged, most municipal governments in the developing world see them as a detrimental and a nuisance. They are merely tolerated. Even the general public sees them as a nuisance and a threat. But in reality the informal sector saves a lot of costs for the local municipalities, saves many tones of material from entering landfills and hence increasing the life span of landfill sites, and reduce

manufacturing costs by reducing the need to import virgin material (Baud, 2004; Scheibe, 2006).

While the service that informal workers provide is valuable the conditions they work in is deplorable. Occupational health hazards are high for the people working in this sector. Respiratory ailments, fever, skin diseases, asthma, ulcers, scabies, and other infections often plague the workers. The waste pickers, small and medium scale waste dealers and small and large-scale recycling activities are the most dangerous and these populations are the most vulnerable. Long term formal integration of these sectors is advised (Madhav, 2010; Sarkar, 2003). Complete formalized privatization is a threat to these small scales recycling activities and have huge consequences on livelihoods in developing nations (Bhuiyan, 2010; Nunan, 2000; Sarkar, 2003; Shah & Gandhi, 1998).

Stakeholder Participation & Awareness Problem. The public as actors have a very crucial role to play in managing solid waste. Ownership of the problem and civic awareness is lacking and is a very big barrier to the transition to a more sustainable SWM system. One study in Chennai found that the cost per ton of SWM services with community participation was Rs.1518 (US$35); Rs.1797 (US$41) with public private partnership (PPP); and Rs.1908 (US$44) when only the municipality handled the waste (Rathi, 2006). This shows that public participation can significantly reduce MSW cost to the government and be extremely beneficial to the urban environment. But individuals tend to be concerned only with waste in their immediate environment and suffer from the "out of sigh out of mind" syndrome (Ahmed & Ali, 2006; Zurbrügg, 2003). There is a need to work towards changing the perception and attitudes of people towards waste and also a need to sensitize the public for the need of cleanliness and to the problem of limited resources of the municipality (Rathi, 2006).

There is a call for an integrated SWM approach that does not simply seek to duplicate the pathways of the developed nations. It involves identifying key stakeholders and making recommendation based on local information and context-based solutions. Scholars especially highlight the need for local, innovative solutions in developing countries (Joseph, 2006; Pearce & Turner, 1993; UNEP, 2005).

Discussion

SWM in developing countries and developed countries have very different waste management patterns and waste composition due to different consumption patterns. Nonetheless, so far, the processing and disposal techniques have been the same. Although developed countries produce around two times the waste per capita than India does their waste handling capacity is extensively developed (Curzio et al., 1994). This can be attributed to three key factors: a) SWM image, public awareness and stakeholder participation b) relevant, well structured and implemented legislation to which industries and municipalities are held accountable and c) cutting-edge technologies (Curzio et al., 1994; Prüfer, 1997; Wilson, McDougall, & Willmore, 2001). It is evident that so far India has looked towards developed nations for SWM technology rather than critically evaluating the SWM scenario within its own cultural context. The most predominant technologies imported from the West are incineration and sanitary landfilling.

In the following chapters I use the country of Austria to compare and contrast relevant SWM structure and best practices with those of India, because Austria has a reputation for having one of the best SWM system in the world (National Waste Association, 2012). I look at the "soft factors" that Austria has implemented to achieve its high recycling rates, and consider whether these can be translated to the city of Bangalore. Chapter 3 outlines the methodological process for data collection, which was

done in Bangalore. Chapter 4 highlights the current state of the city drawing on the data collected and on literature. Chapter 5 discusses and highlights the gaps in Bangalore's SWM transition. Chapter 6 describes an innovative, local, bottom-up solution to the Indian garbage crisis and assesses the applicability of this model to a metropolitan city like Bangalore. Chapter 7 examines the role of interpersonal competencies in enhancing stakeholder relationships and collaboration within the Bangalorean SWM system. Chapter 8 summarizes the conclusions of the study.

Chapter 3

DATA & METHODOLOGY

I have chosen a mixed quantitative and qualitative methodology to conduct this research about the history, evolution and recent past of MSWM in India and Bangalore. Current literature specifically about waste in Bangalore does not exist. Primary data for this research was obtained through a variety of sources including naturalistic observations, recordings, photographs and interviews, with prior IRB approval. It to be a valuable source of information. In addition, newspaper clippings were a very beneficial source of up-to-date information. Together, they provided valuable insights on MSWM issue in Bangalore. The results from the data and observations were compared and contrasted for further analysis. The findings are highlighted in the following chapters. All human subjects' responses were voluntary and anonymous and consent was obtained in all cases. A brief summary of each dataset highlighting the objectives, the benefits and the limitations are given below.

Bangalore Dataset

Transect Study. In order to get a holistic understanding of the current state of Bangalore's trash collection system, I decided to join a transect study called the trash trail organized by Daily Dump (2012), an independent composting enterprise. The trash trail is an all day journey to follow a bag of waste from inception to final disposal, to understand the systems perspective of waste generation and disposal. The trip included visiting makeshift transfer points and talking to rag pickers, visiting informal collection centers and talking to their owners and workers, visiting a landfill and an informal recycling village in the corner of Bangalore. The informal recycling village covered an area of nearly half a square km and recycled over 800 different types of materials. Lastly we also visited mid level dealers and small and medium enterprises who used recycled

material (paper, plastic, aluminum) to forge new products. As part of the process of documenting and recording this transect study, data was collected through observational naturalistic enquiry, note taking, videotaping short films and taking photos. Short dialogs with the different actors regarding the specifics of their work environment and these interactions were also conducted with their consent. Demographic and socio-economic data was obtained. Interviews with the organizational team led to supplemental information on how local political systems and structural hierarchies affected the current state of SWM in the city. The trip provided a real time approach to understanding the WM process and understanding what was wrong with the current state.

Political Interviews. Over a period of four days I was able to conduct five in-depth naturalistic interviews with five people, four of whom who were associated with NGOs and were activists with strong voices in the field of SWM in Bangalore. One of them was a member of the KPCB, the environmental agency in Bangalore. The objective was to highlight current state and capacity gaps in Bangalore from a political and management perspective. The contacts for the interviews snowballed from one of the initial contacts to others in the same field. Questions regarding the structure of the MSWM system, the hierarchy of the actors, and the state and role of the informal sector were asked. Questions were also asked about the state of source segregation in Bangalore. Each interview lasted between 45 minutes to an hour and all was voice recorded with full consent. The interviews were structured, so questions were prepared ahead of time. A limiting factor was that only a limited number of actors were interviewed and these actors represented only two agencies. More interviews with members of the KPCB and other agencies would have been beneficial, but political connections and ties were needed to get time with any of them. The objective was to find

out reasons for the capacity gaps in Bangalore and interesting and relevant knowledge was obtained. The information was triangulated with literature on the topic.

Vellore Dataset

Zero Waste Management Enquiry. The Vellore Zero Waste Management (ZWM) model is relevant for its novel bottom-up waste strategy. I conducted an observational naturalistic enquiry on a 5-day initiation workshop that every ZWM worker was required to complete, where the potential workers learn to view waste from a different perspective. The data was collected through note taking, videotaping short films and taking photos with their consent. The objective was to find out what ZWM was, how it worked and the details of the components of the model. Mr. Srinivasan, the innovative leader of this program, conducted the workshop and it consisted of the following daily activities:

1. The first day Mr. Srinivasan started by asking the people their concept of waste and went to explain why waste IS NOT waste. He talked about waste in relation to time, and other thought provoking questions,"12 hours before the vegetables are in your dish and 12 hours later the remains are called waste! How is that possible?" He went through some slide shows showing different types of waste.

2. On the second day the speaker started to connect the dots about waste with culture. He talked about specific Hindu traditions, mythology and cultural idiosyncrasies and how they tied in with the notion that "waste" is not waste. It was a value based talked and he drew the speakers in with his oration. He passed the microphone around to hear people's opinions and answer their

questions. It was very clear that the cultural integration evoked positive responses from the audience.

3. On the third day the practical component was introduced. When we walked in the morning, a huge heap of waste had been delivered ready for us to sort through. People's attitude had visibly changed because they were not averse to handling waste and the workers spent the day building compost piles, segregating waste and making a compost pit.

4. On the fourth day the participants were asked about how the activities that happened the day before affect them. Mr. Srinivasan gave a talk on the negative impacts of plastic for human heath and environment. He talked in layman terms and used religious idiosyncrasies and references with humor to tie the rich Indian culture with sustainable SWM, e.g. he talked about how he arranged his eco friendly Indian wedding and coupled this in with the wedding rituals. Before the end of the session another run through of how the ZWM model works was given, tying it in with waste types produced on a daily basis.

5. The final day of the workshop ended with a waste festival. This was a showcase day and prizes were awarded to those who could explain the ZWM model well in their own language. The hall was turned into a physical museum of waste, where photographs, posters and examples of the different waste types were exhibited. Participants brought their family members with them to experience the event. The head of the village/town came to give the closing speech and remarks and talked about the importance of waste and

waste transformation in India. He appealed to the feeling of patriotism in the participants.

The people attending the workshop were low-income groups who were chosen based on their income and family constraints, e.g. widowed, widowed with children, disabled family members in their care, and/or living below the poverty line. Men and women were both welcome to attend, although 80% of the participants were women. The training was brought to the attention of the people by local NGOs, active in improving the livelihoods of slum residents and in low-income neighborhoods. They advertised the training week as a chance to gain employment. Conducting pre and post evaluations of the opinions of the participants in the workshop to get quantifiable results about the effectiveness of the training would have been ideal. This is an avenue for future research.

After the training week I visited the town of Vellore where this model was first implemented almost 10 years ago and visited five locations where the model was implemented. Observations were made on the work difference between the different locations and the theoretical understand of the ZWM model from the workshop was supplemented with the physical reality of understanding how the model works.

Chapter 4 presents the findings of the transect study and the political interviews which is triangulated with literature about Bangalore. The ZWM model is described in detail in Chapter 6 and triangulated with relevant literature on the topic, which was provided directly by Mr. Srinivasan.

Chapter 4

CASE STUDY BANGALORE: CURRENT STATE

The metropolitan city of Bangalore is capital of the state of Karnataka (see Figure 2). It has an area of 226 sq. km and a population of 4.3 million while, the whole city spans an area of 800 sq. km (Visvanathan & Trankler, 2004). It is the principal administrative, industrial and commercial hub of the southern part of India, due to high quality education, scientific and technology institutions coupled with a thriving information technology, biotechnology and manufacturing industry (UNEP, 2005; Ramachandra & Kumar, 2010; Scheinberg et al., 2010b). The city has a multi-billion dollar economy and is placed among the top 10 preferred entrepreneurial locations on the world (Forbes, 2012). This has affected the real estate market where prices are comparable to Tokyo, London and Mumbai (Ramachandra & Bachamanda, 2007).

Figure 2. Map of India and city of Bangalore
Source: http://en.m.wikipedia.org/wiki/File:Map_of_Bangalore_2.png

In stark contrast to other Indian cities, where the weather can be extremes of heat and cold, Bangalore is blessed with mild climatic conditions throughout the year (Scheinberg et al., 2010). It is a very strong part of Bangalore's attractiveness to expatriates, investors and many high net-worth individuals. In a survey conducted in 2008, Bangalore was voted as the most livable city in India beating its sister cities Mumbai, Chennai and New Delhi (Ravinder, 2011). It was once called "garden city" however this epithet no longer applies to as the city diminishes in green areas. In fact, Gupta (2010) claims that "pressure to maintain the city's image as the Silicon Valley of India to attract foreign investments is what put pressure on city municipalities to address the issue of SWM," (Scheinberg et al., 2010a, p.81).

Governance structure

The national government sets the rules and legislations while state government determines the structure, process and execution. After which the state municipality is responsible for proper SWM practices (Government of India, 2009). Figure 3 on the following page highlights the various organizations responsible for SWM. The yellow boxes are the national political bodies, the blue are the state entities and the green is the private sector. The state government has the freedom to decide on the appropriate processing and disposal methods and must make funds available for collection, transport and disposal that comply with national legislation. The Central Pollution Control Board (CPCB) is the national autonomous environmental regulator and has representatives in every state. In Karnataka, it is the Karnataka Pollution Control Board (KPCB) which keeps check on all the activities that can have potentially disastrous environmental consequences. These include monitoring MSWM activities conducted by the Bruhat Bengaluru Mahanagara Palike (BBMP), the municipality of Bangalore.

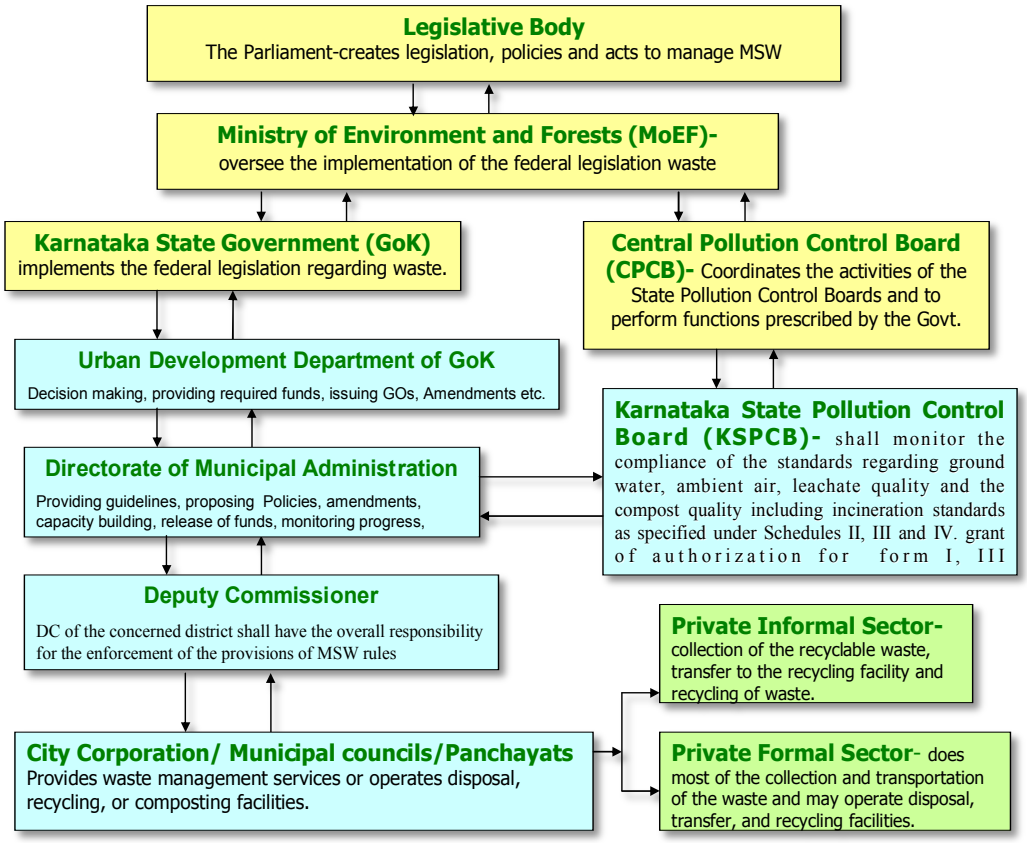

Figure 3. National & state regulatory structure
Source: Unknown

The health department within the BBMP is primarily responsible for the collection, street sweeping, transportation and disposal of MSW and the engineering department is responsible for the adequate technical guidance and infrastructural support. But the municipality suffers from significant financial constraints and hence is obliged to outsource SWM services to the private sector (Ahmed, 2004; Beukering, 1994; Dasgupta, 2012). This was substantiated by the interviews done in Bangalore.

The city of Bangalore is divided into 8 zones which are further divided into a total of 198 administrative wards as shown in Figure 4 (BBMP, 2012). 182 of these wards are privately operated for collection, transportation and disposal; meanings 91% of MSW activities have been outsourced to private companies. For the remaining wards, only the

collection of refuse is managed by the BBMP, while the transportation and disposal is still outsourced to private companies. So the municipalities grip over SWM issue is relatively little.

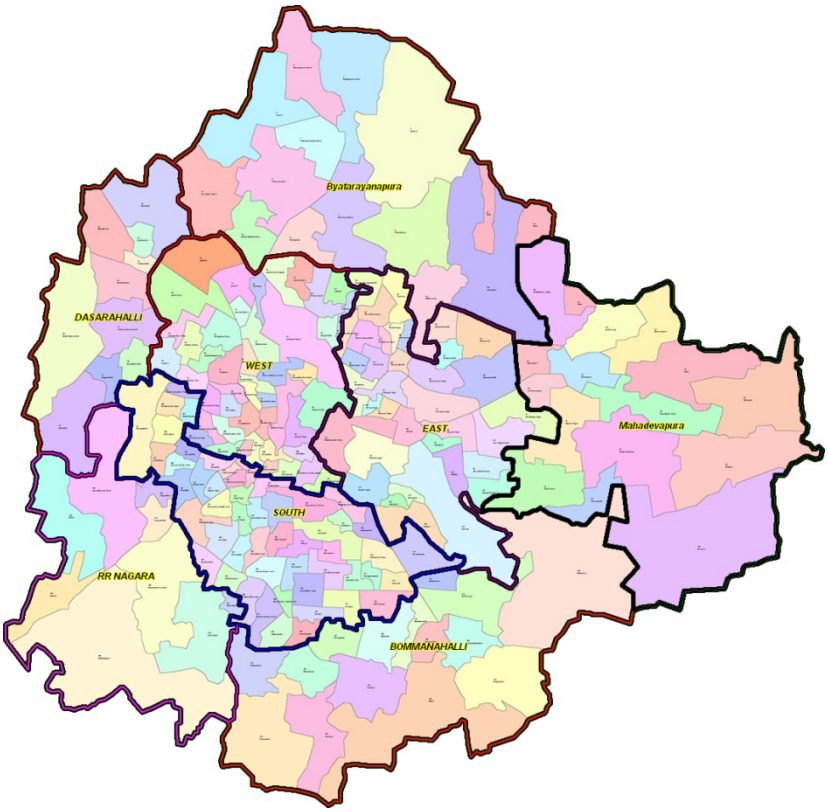

Figure 4. The 8 political zones and 198 municipal wards of Bangalore
Source: BBMP website: http://bbmp.gov.in/maps

Waste Characterization & Processing

Bangalore produces 3,613 tons of waste per day and the per capita waste amount per day is 0.36 kg, which is substantially lower compared to European and American cities. Table 1 below highlights the waste characteristic particular to Bangalore, with organic waste constituting the highest percentage (Ramachandra & Bachamanda, 2007). The dust, ash and fine earth content is high due to the inclusion of street sweepings,

drain silt and construction debris in the MSW stream. This has implications on selecting the appropriate waste processing technology.

Table 1
Bangalore's Waste Characteristics

Type of waste	Percentage of total waste
Organic waste	50% – 60%
Dust, Ash and Fine Earth	5% – 10%
Paper	12%
Plastic	14%
Glass	4%
Metal	1%
Bio medical waste	1%
Card Board	1%
Rubber	1%
Other	1%

Source: BBMP (2013)

The BBMP forges contracts with the private sector for treatment and disposal of 1,000 metric tons of waste per day. The treatment plants are run and maintained by the private contractors, but the plants set up on land owned by the municipality and leased for free. According to a government document "municipality is not expected to pay for the waste treatment but a tipping fee of Rs. 195 per metric ton is agreed upon" (Government of India, 2009, p.43). Bangalore currently has some functioning incinerators that feed on medical waste, but various investments in large-scale WET

plants and RDF plants that were sought to last up to 10 years stopped working within 2 to 3 years (Baud, 2004; Hazra & Goel, 2009; Narayana, 2009). Chapter 2 of this thesis highlights why technology based processing did not have a good track record in Bangalore like in other Indian cities.

Collection, Transport & Disposal

The systems perspective of actors and their relevant niche areas with the SWM system in Bangalore is depicted in Figure 5. While the municipality undertakes a small portion of the collection activities, transport and disposal of waste is solely monopolized by the private sector. They employ over 11,000 sweepers (locally called *pourakarmikas*) while the BBMP employs only 4,300 *pourakarmikas* (Kasturi, 2012). The collection mechanism is either door to door (more in the wealthier parts of the city) or a community street bin system using 11,000 pushcarts and 650 tipper autos for the entirety of the city. Each *pourakarmikas* and tipper auto driver is specified the area or distance they have to cover per day, based on the number of houses on each street (Kasturi, 2012). There seems to be significant differences between the information given in the literature and the information in the interviews. Zhu & Bank (2008) claim, "the start and end of collection route and the timing for the work are well chalked out for each *pourakarmikas*" (p.117). But the interviews and observations revealed that the lines were fuzzy and waste collection was not well organized.

Currently, Bangalore city has no transfer stations for intermediate segregation or storage of waste. The collected refuse is brought to make shift transfer zones and the workmen sift through the garbage with bare hands picking up recyclables like milk packets, glass and paper to sell to informal recyclers for more income (Visvanathan & Trankler, 2004; Kasturi, 2012; Madhav, 2010; Zhu & Bank, 2008 and Trash Trail).

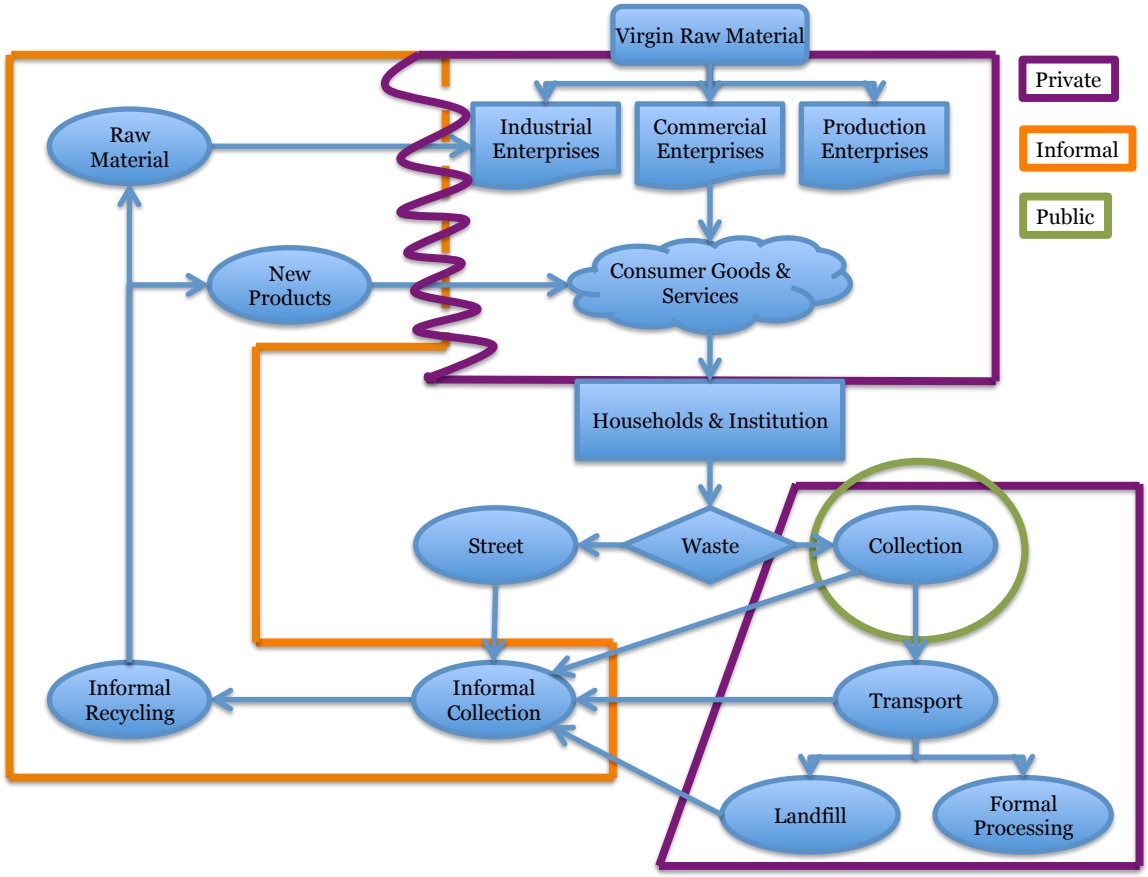

Figure 5. Formal and informal sector actors and waste flows
Source: Based on author's research

Literature suggests that collection rates are around 60% but the ground reality may be much lower because the private contractor collect it only once in two or three days (Chanakya, Ramachandra, & Shwetmala, 2009). Large piles of rubbish are often found littering streets and neighborhoods. Due to the apathy of the private sector, communities sometimes take up the issue into their own hands. Self-help groups (SHG), NGOs, and CBOs are often the first to offer assistance in bottom-up community clean up activities. Sadly, these initiatives seem to have a short life span due to decreasing community involvement over time (Baud & Schenk, 1994; Visvanathan & Trankler, 2004; Hazra & Goel, 2009; Joseph, 2004; Kumar et al., 2009). This information was also ascertained by the Bangalore interviews and transects study. Machinery such as

compactors trucks, tipper trucks, dumper placers and mechanical sweepers are owned solely by the private sector and the average waste truck has a singular capacity of 5 to 9 tons. Figure 6 illustrates how transport accounts for a huge financial and time cost as the trucks are paid based on the number of trips they make to the landfill and hence make three or more trips per day (Madhav, 2010; T. Ramachandra, 2009).

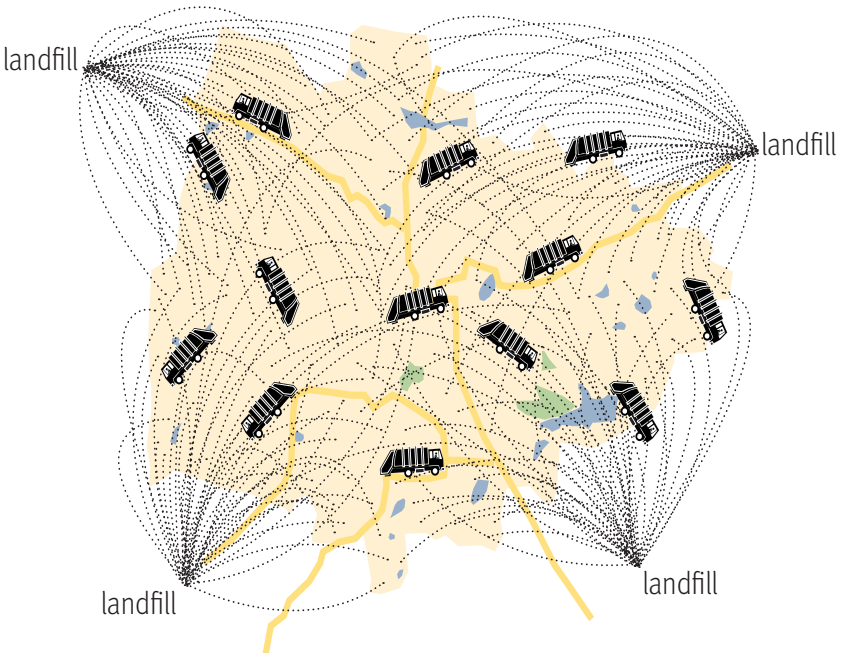

Figure 6. Landfill locations for the city of Bangalore
Source: (Kasturi, 2012)

The state municipality is responsible for a wide range of services including maintenance and development of estates and assets, infrastructure, drainage, storm water engineering and electrical maintenance in addition to MSW issues. Olar (2003, p.4) says problems occur "when revenues of SWM are compounded in a general treasury for all municipal activities," as only 5-25% percent of total budget given (Figure 7) to the municipality is typically spent on MSWM. Over 80% of the municipal budget is spent on paying the private sector for collection and transport only and about 5% of the budget is

spent on waste disposal. This explains the utter lack of environmental protection during disposal. 90-95% of MSW is openly dumped in unregulated, unscientific landfills (BBMP, 2012b; Hazra & Goel, 2009; Sharholy et al., 2008; Shekdar et al., 1991).

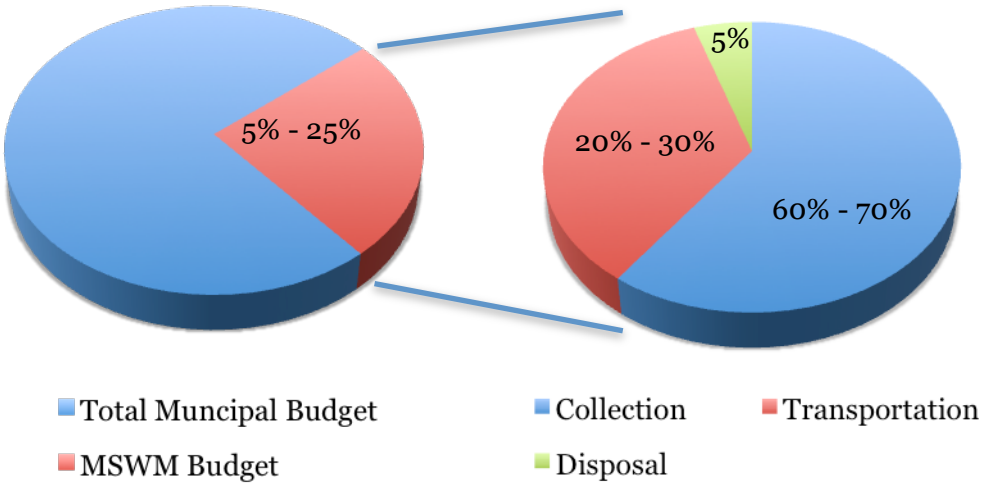

Figure 7. Budgeting of MSW actions in Bangalore
Source: (Visvanathan & Trankler, 2004)

One study reports that "indiscriminate landfilling led to the deterioration of the water quality in the neighborhoods of the sites due to leachate infiltration causing adverse health impacts on the people in the vicinity" (Visvanathan & Trankler, 2004 p.74). Methane gas is not collected and the accumulation poses a constant threat of explosion. About 7 million tons of methane was released into the atmosphere in 1997 from landfill alone (Visvanathan & Trankler, 2004).

Formal Sector Hierarchy & Actors

Generally, the waste collectors (both public and private) come from the bottom of the social and economic hierarchy (Madhav, 2010). While upward mobility exists, the majority of the people working hands on in the SWM sector are highly likely to come from the lower castes in India (Madhav, 2010; K. Shankar, 2011).

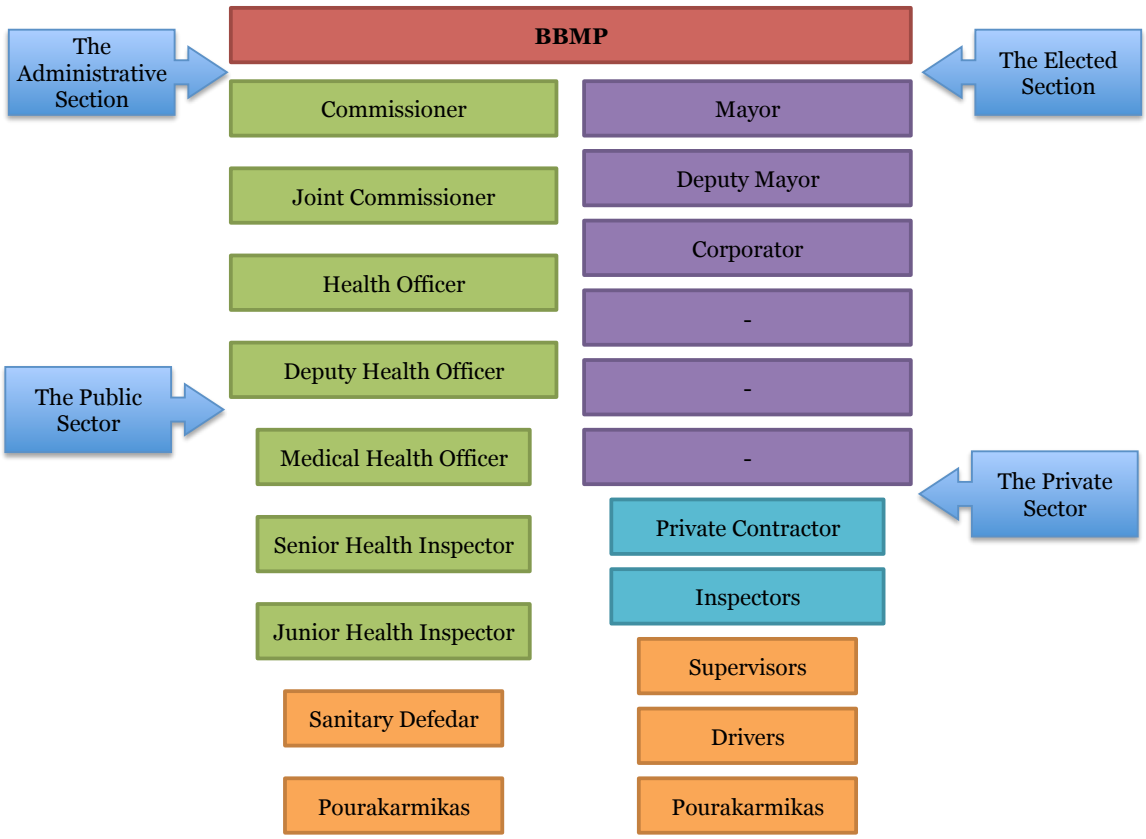

Figure 8. The hierarchical structure of the Bangalore municipality
Source: Based on author's research

Figure 8 indicates the hierarchical structure of the BBMP. The public directly elects the authorities denoted in purple, whereas those denoted in green are permanent administrative posts. The corporator, who is elected on a zone level, represents 5 to 7 wards. It is his/her responsibility it is to pick the right private company for the MSWM task. Those marked in orange have the lowest and/or no education levels among the actors. Many of the sweepers may be illiterate and even more vulnerable to exploitation (Baud et al., 2004; Visvanathan & Trankler, 2004; Furedy, 1992; Government of India, 2000a; Ramachandra & Bachamanda, 2007). Figure 8 was constructed using the sources cited above and R. Madhav's (2012) white paper, which had a case study on Bangalore and details on the structural hierarchy of the MSWM system. Additional information was

obtained from interviews with the actors in Bangalore, the trash trail expedition and information from the BBMP's official website.

There were some gaps in information, denoted by the dashed lines between the corporator and the private contractor. The actors in the Bangalorean MSWM system are diverse and they play a crucial role in the success or failure of waste management systems. There is a distinct power play involved, and this is heavily embedded into the cultural context that has repercussion on how garbage is managed.

Public & Private Sector Participation

Municipal governments worldwide are moving towards increasing private sector involvement in SWM due to expected benefits of involving private sector in collection, transportation and processing of waste (Ahmed & Ali, 2006; Ahmed, 2004; Coad, 2005; Cointreau-Levine, 1994). Such linkages are said to improve efficiency and create new opportunities for employment. This is because the traditional public sector is failing to respond to the increased demand for service (Ahmed & Ali, 2006). According to Ahmed & Ali (2006):

> The public sector is constrained by resource and institutional limitations, whereas the private sector, with its dynamism and flexibility, may fill in the services delivery gaps. In this way both parties get to benefit from the advantages of the other (p.1).

Government document states that Bangalore entered into two kinds of service contracts; one for collection and the other for disposal treatments. This arrangement is said to have cut institutional spending by 50% of what it would have taken to undertake the task departmentally (Government of India, 2009). In sharp contrast, interviews done in Bangalore suggested that while PPPs were beneficial, corruption is rampant resulting in more costs; making the objective futile. One interviewee even said, "At one point Bangalore's SWM expenditure was greater than Bombay's, which is absurd."

Informal Recycling

Rag pickers, itinerant recyclers and collectors from all levels of the informal waste hierarchy collect waste from all part of the waste stream as shown in Figure 5. Waste recycling occurs at different levels. Rag pickers and the municipal workers collect from the community bins while the scavengers pick from the dumps. They all sell their goods to the *Kabbdiwalla*, a middleman who collects valuable waste such as newspaper, plastics and glass in bulk. They may be stationary or do weekly runs, collecting waste from households, which sell at a higher price further along the value chain.

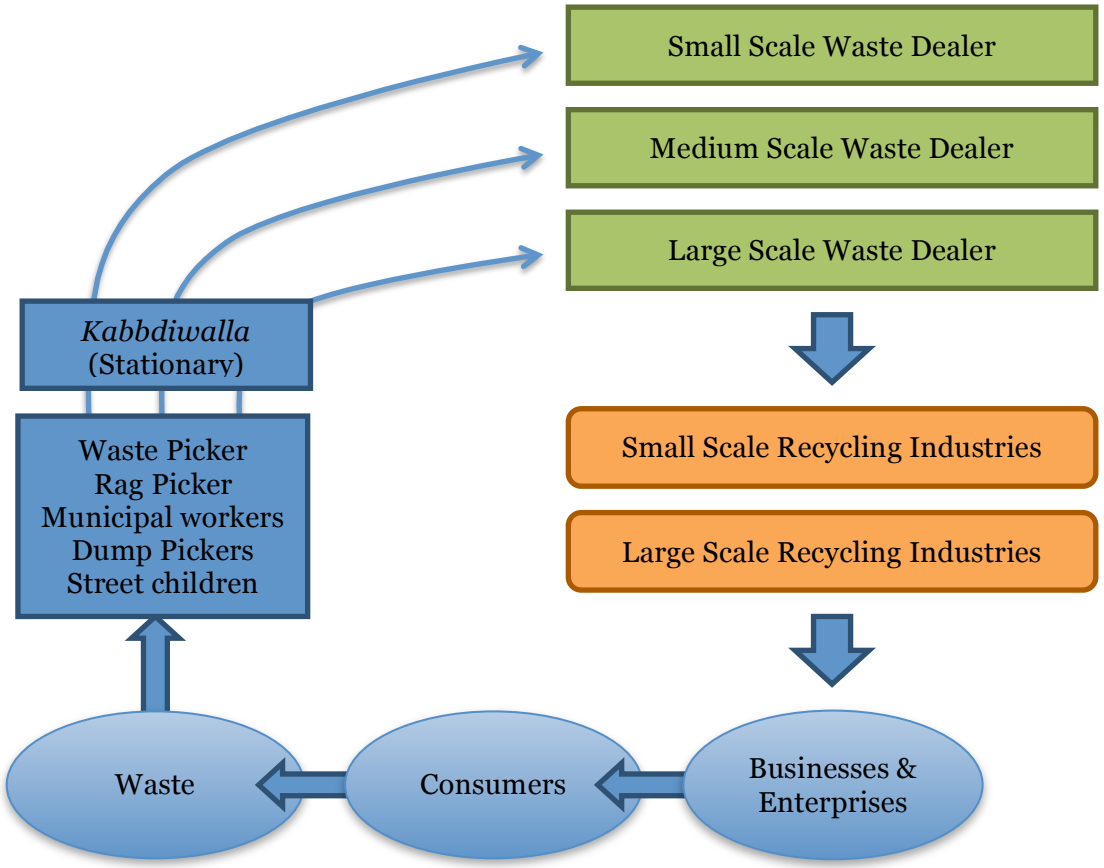

Figure 9. The Informal recycling chain in Bangalore
Source: Based on author's research

The recyclables are sold to dealers who then sell them to recycling units as shown in Figure 9. Resource creativity, abundant labor and poor economic conditions contribute to the prevalence of widespread prevalence of informal practices in SWM (Gunsilius & Scheinberg, 2011; Madhav, 2010). In India, an estimated 92% of the *pourakarmikas* are women and are from economically and socially disadvantaged situations (Madhav, 2010). While collection, transportation and disposal are the duty of the formal sector; the recycling is done completely by the informal sector. Of the 3600 tones of waste the city produces, an estimated 1250 tones are informally collected for recycling in Bangalore 900 from itineraries waste buyer and intermediaries and 350 tones from waste pickers (Visvanathan & Trankler, 2004).

Previous research has found that valuable materials like paper, rubber, textiles, high-grade plastics, leather and metals are almost always recycled and hence the fractions of these in the waste stream are low by the time they reach the landfill (C.Visvanathan & Trankler, 2004). Interviews, observation and the transect study revealed that newspapers are sold by households to middlemen and hence is predominantly recycled or reused as packaging material. But the reality of how much of the recyclables actually get picked up by the waste pickers is questionable. Most of them are not very well organized and come across material serendipitously. Waste picking tends to disrupt the working of the MSW and are seen as a hassle because they pick through the bins and stew the waste around, which is then exposes the waste to animals (dogs, cows).

Current Transitions

During the months from June to November 2012, the city of Bangalore experienced severe WM problems with unprecedented consequences. The death of five villagers, in the Mahavallipura, a massive landfill situated in the outskirts of the city,

made headlines and prompted inquires. Their deaths were a direct result of toxic leachate contamination and asphyxiation due to landfill gas. It was found that the landfill operated by a private contractor was in gross violation to the EPA act of 1986 and the 2000 WM regulations for sanitary landfills. Thus, the KPCB took the unprecedented decision to order the BBMP to shut down Mahavallipura (Saldanha, 2012). The decision came as a 'major relief' for communities in twelve villages around the area who have been suffering the consequences of the city's garbage for close to a decade. About one third of Bangalore's waste was dumped in the Mahavallipura landfill since 2007, which has an area of 48 acres that the villagers use as grazing pastures with grave consequences (ESG, 2012; Iyer, 2012). The authorities temporarily 'extended the deadline to close the Mahavallipura landfill' due to political pressure and lack of other WM disposal options. (Harris, 2012; Iyer, 2012; Rai, 2012; Ramani, 2012). Protests erupted from the villages around the landfill site, immobilizing the rout of the waste trucks transporting city waste to the landfills. Strikes erupted from city waste workers, demanding higher pay and better working conditions. Garbage in several parts of the city remained uncollected for several weeks and due to the monsoon season, dengue fever broke out and citizens of Bangalore were heavily affected (Harris, 2012).

An environmental support group and four Bangalore civilians filed a Public Interest Litigation (PIL) against the BBMP regarding the city's garbage situation in September 2012. The PIL challenged the decision by the KPCB to re-authorize an extension to close two of the city's overflowing landfills. In addition, the PIL also sought directions to enforce progressive ways to manage Bangalore's garbage, based on a model of decentralized administration and segregation at source (Saldanha, 2012). In a highly unprecedented decision the high court "handed down a highly progressive judgment" that all municipal waste in Bangalore was to be segregated at source at household level

and that it should be transported in that manner to composting and recycling units (Shankar, 2012; The Hindu, 2012). The verdict stipulated; “no mixing whatsoever should take place in the trucks (as is presently the case).” The court also directed that “every ward is to have at least three segregation and wet waste processing stations (ESG, 2012,p.2)

While the ambitions and goals of the decision were commendable, the reality of the situation was far more formidable. Different political agendas were at play and while some parties stood to gain from the change, others stood to lose. Further, the SWM ‘system’ did not know how to deal with the segregated waste, as the status quo had been strongly held in place. Moreover, there was no game plan on how to process segregated waste.

Chapter 5

DISCUSSION OF GAPS AND OPPURTUNITIES

Intensive observation and research of the SWM systems of Bangalore revealed six gaps in the transition to a more sustainable SWM state. These were:

1. Gaps in the political process
2. Gaps in incentivization
3. Gaps due to recognition of cultural aspects
4. Gaps in protecting livelihoods
5. Gaps due to exclusion of key actors
6. Gaps due to lack of strategy and innovation

From the perspectives of transformational theory, these gaps also represent opportunities to re-shape and reform the system.

Gaps in the Political Process

Political agendas skew the MSWM decision-making processes. As illustrated in Figure 8, the municipal corporation is split into two parts, the administrative section and the elected section. It is not uncommon for the election contender to bribe the socio-economically disadvantaged classes with goods and services such as television sets, money, the wavering of school tuition fees for the children etc. in return for votes. Once elected, the person is responsible for SWM issues within their ward range, amongst other municipality responsibilities. The interview with the various actors in Bangalore reveled that once elected, most corporators do not keep their election promises.

Corruption is rampant and its cascading effects have a heavy impact on the SWM activates and expressions. Cointreau-Levine (1994), in his extensive study on public private partnerships in waste found that only few developing countries have domestic, private companies with expertise in MSWM. This was substantiated by one of the

Bangalore actors as follows; “the private contracting agency doesn’t have to prove any competencies in proper MSWM. Anybody can just register a company claiming they work in SWM services. They may be good businessmen, but finding a contractor who knows about MSWM and has proven competencies in the field is rare, very rare.” Once in power, the corporator has the authority to choose the private agency to contract SWM activities from. Interviews revealed that many corporators preferred to hire MSWM firms who had family ties to them so that the “money stays within the family,” or contractors choose the person who offers the largest bribes. Hence, again the decision is not based on proven competence but on how much money under the table the elected corporator gets from a contractor. Cointreau-Levine (1994) comments:

> In some developing countries the governments reputation for corruption is founded on a long-standing reality, one which contractors to the government understand better than anyone. The cost of working under contract (in terms of bribes to get the contract payments, delay in payments, risk or non payment) can be substantial (Cointreau-Levine, 1994,p.32).

Due to these reasons, a move towards a sustainable or decentralized SWM system is not in the interest of most politicians.

Opportunity. Ownership of the problems coupled with pride associated with the job, may be a motivating factor. Since the municipality is often burdened with many responsibilities and SWM is seen as an eyesore to be outsourced, it may be worthwhile to appoint a qualified person solely for the responsibility of SWM. The BBMP could also consider giving accolades or awards with a monetary gain to the ward with the best and most innovative SWM solution. Introducing greater transparency and accountability can help negate corruption. This coupled with social campaigns to encourage leadership; trust and integrity can contribute towards a more sustainable solution.

Gaps in the Incentivization

PPPs are often touted as the best solution for the SWM problem in Bangalore, but the incentive structures within PPPs are often in direct opposition to waste reduction. The private sector makes most of their profit from collection and transportation of waste. In an effort to hold contractors accountable and to secure a clean city, the private sector gets paid for every ton of waste they transport *away* from the city. If they collect more they profit more. Hence, it becomes a rat race to collect the most. Thus, treatment, recycling and processing are completely ignored, except by the informal sector. The incentive gap must be considered very seriously if Bangalore is to transform its MSWM systems. As long as actors make money due to more trash, reducing waste will not be an incentive.

The landfills near Bangalore are owned and operated privately, while the municipality sells them the land and operating rights. The private landfill owner is paid about Rs. 300 for every truckload it receives from the city, which suggests millions in revenue annually (Saldanha, 2012). It was apparent that none of the profits were reinvested in the upkeep of the landfill. Instead of closing the already overflowing landfill, the owners resorted to dig 'massive pits, some up to 40 feet and several acres across' to accommodate more incoming waste (Saldanha, 2012,p.2). If a profit is made through more trash being dumped in landfill one must seriously question what incentive the private sector would have to process waste, when it is much cheaper for them to collect and dump it. Incentives must be considered to reduce indiscriminant landfill dumping.

Composting by itself does not earn much profit but the government encourages composting and actively aids the set up of private composting centers. The private sector exploits the benevolence of the government by cutting corners. The example of a

privately owned, large scale, centralized composting plant well illustrates the point. Instead of separating organic and inorganic waste prior to the composting practice, they directly compost mixed waste (containing everything from plastic to vegetable waste). After all the organic matter has decomposed, the larger pieces of inorganic material are removed and the waste is sieved and sold as compost. The final product contains material such as styrofoam and plastic particulates that are toxic to human, soil and environment. Furthermore pieces of glass are also often found in the compost. Farmers now completely distrust urban compost and are discouraged to buy it (Rathi, 2006).

Opportunity. Austria along with Sweden, Germany and other European states have seen a steady decline in their landfill rates (Fischer, Lehner, & Mckinnon, 2012). A fine balance is struck between legislation, taxation, PPPs and technology to encourage environmentally responsible SWM strategies. Austria, for example, has been active in the field of environmentally orientated waste management since the 1980s and have made formidable progress in the forefront of adapting rules and regulations that has paved their current path as EU front runner in SWM systems (DoBerl et al., 2002). Some of the key regulations that put them in the front seat for forging sustainable SWM pathways are listed in Table 2 below.

Table 2
Key Regulations in Forging Sustainable SWM Systems

Waste to Energy Ordinance	The regulation mandates that efficiency of combustion should be 65% or higher for incineration of any waste.
Packaging Ordinance	Obliged producers, importer and final distributers to take back their packaging and to either a) reuse and recycle it into new packaging material or b) pass it down to their suppliers. It mandates the separate collection, reuse and recovery of all metals, plastics, glass and paper.
Recycling Ordinance	This legislation enhances private-public partnerships. In this system municipalities ensure waste collection and segregation of refuse.
Landfill Directive	Mandates all landfills to be sanitary (have adequate liners and landfill technology that is up to date) and to have methane-collecting capabilities. Organic content and reactive material is limited to 5% or less. Landfill tax is also mandated.

Source: (Klein & Loser, 2009; Lebensministarium, 2011; Scheffl, 2004)

The landfill directive essentially meant that organic waste could not be landfilled, encouraging other processing methods. Only inert material, construction material and pre-processed wastes could be landfilled. Between 1989 and 1999, the percentage of waste to be landfilled fell from 75% to 43% in Austria (Bartelings, Beukering, & Kuik, 2005) and the recycling rate in 2011 was 51% (Lebensministarium, 2011). The Austrian state of Graz achieved a recycling rate of 98% for bottles and glass with an overall recycling rate of 68% (Moczygemba & Smaka-Kincl, 2007). Singapore and Sweden have reduced their landfill rate to 12% and 9% respectively due to disincentivizing landfill (Bai & Sutanto, 2002). Now these landfills have an increased lifespan of 30 to 50 years instead of 6 to 10 years Wilson et al., (2001). Wilson (2001) analyzed the legislative

SWM structures in 11 European countries known for their progressive and innovative approaches to MSW. These countries included Denmark, Finland, Austria, Sweden, Germany and Switzerland. Evidently landfill tax was one of the enabling regulations in that it "made alternative treatment option such as recycling and composting less costly than disposal to landfill" (Wilson et al., 2001, p.14). Disposal technologies cannot be seen singularly and the contextualization of the disposal technologies is vital. The ideology that one size fits all must be questioned challenged. Currently, the requirement from the private sector is to collect and transport trash away from the city. Instead, if the demand exists, within the municipality for a private company that has an innovative ideas to manage waste, perhaps with decentralized methods, it could create competition between the private sector to deliver a different kind of SWM service, one that goes beyond just collection, transportation and landfilling.

Gaps Due to Lack of Recognition of Cultural Aspects

A feature unique to the Indian culture is the social and cultural stigma associated with waste. The caste system originally delineated the task of cleaning, grooming and sanitation to people from lower castes. Historically, they were disadvantaged by the lack of access to resources and this situation continues to a large extent today. It reverberates today, as it is hard to escape from the poverty trap. Furthermore, one of the interviewees mentioned that waste related activities are tainted with the notion of "uncleanliness" and "beneath us to worry about such a thing." Hence irrespective of caste, working in waste on any level may be considered to be an unworthy and inferior profession.

SWM can be approached and viewed from a variety of traditions. It encompasses health, technology, social issues, economic and wealth issues, poverty, livelihood and gender issues, but waste in Bangalore is viewed from two perspectives: heath & engineering. Literature shows that sanitary supervisors are predominantly mechanical

engineers (Visvanathan & Trankler, 2004). In Bangalore all the ward level sanitation inspectors are either trained in the medical or hard science/ engineering professions. Given this situation it is hardly surprising to find the push towards technology as the panacea for all SWM woes.

Labor conditions in India are also is very different from western countries. A waste worker in Austria is paid € 1,500 monthly after tax. An Austrian middle school teacher in comparison earns € 1,800 after tax. As noticeable there is little difference in the income levels. Working for the Vienna municipality is like working any other job; one is entitled to holidays, sick leaves and bonuses after certain years of service (Mist, 2011). Furthermore, workers are trained diligently in their responsibilities. This is certainly not the case in India. The workers at the bottom of the waste hierarchy may be illiterate and some receive as little as Rs. 1,500 a month (€ 21). In comparison, the median middle school teacher salary in south India is around Rs 17,000 a month (€ 211), which is a considerable difference. Moreover the former is a job that carries heavy stigma in society, while in developed countries, it carries comparatively less social stigma. Most SWM decisions are taken by authorities trained as either doctor or engineers (since it is viewed as a health problem which technology can solve). The stigma of working in waste *may* affect professionals in the waste field too, even though they are higher up the hierarchy. One interviewee mentioned how he is often asked why he gave up his job as an IT engineer in a promising company to work on sustainable waste issues. For many it is incomprehensible that if one can become a doctor or engineer that one would work with garbage, indicating that garbage may be beneath the wealthy and professionally educated. While an engineer may be hired to run a waste-to-energy plant, due to the stigma attached of working with waste, the work may be predominantly delegated downwards to the labor workforce with the engineer only coming to the site sporadically

to oversee the operations. However, if the labor workforce is not sufficiently trained in the specific technological aspects, the waste plant may not run at optimum capacities. These examples illustrate how a seemingly simple "technology transfer" has different expressions in different cultural contexts. The effects of culture and perception of working in SWM acutely affect outcomes.

Opportunity. In developed countries, the issues of waste carries comparatively less social stigma. In Austria, the waste sector has created an identity, an image for itself. Advertising is extensive and transforms the image of people who work in waste including the image of trash itself.

Figure 10. Advertising campaign for segregating light bulbs
Source: http://www.wien.gv.at/umwelt/ma48/beratung/muelltrennung/kampagne-energiesparlampen.html

The advertisement in Figure 10 is a play on word equating the segregation of waste with intelligence. It subtly says "intelligent people segregate waste" hinting that stupidity may be associated with people who do not segregate. The advertisement in Figure 11 compares waste management personnel to super heroes to subtly uplift their status.

Figure 11. Advertising campaign in Vienna
Source: http://www.wien.gv.at/rk/msg/2012/04/09001.html

The city also has slogans stating, "The city is yours," and "The city is in your hands" on their advertisements to perhaps increases personal ownership and responsibility in the citizens. The uniform for workers is an orange jumpsuit with logos imprinted on the back that say "keeping the city clean for you." The effect of the uniform and the logo are very evident. They are easily recognizable and more importantly, command authority. People caught littering can be fined by anyone employed by the Vienna WM services, irrelevant of their position in the hierarchy, including the workers in the orange jumpsuit.

There are many publications on the effect of job satisfaction, intrinsic motivation and the effects of authority, control, empowerment and self esteem on the level of job performance (Khaleque & Rahman, 1987; Lawler & Hall, 1970; Savery, 1996). Research on self-esteem and labor has indicated that those who value their work as a contribution to society perform better than those who feel their work is meaningless (Judge & Bono, 2001; Kerr Inkson, 1978). How can we hope to influence the public perceptions about SWM as important, when the workers themselves don't value their service to the city as important? It may be worth considering team and self-esteem building workshops to start reviving MSWM actives. Valuable lessons can be learnt from Vienna about creating

value, importance and authority in WM workers, which could have far-reaching outcomes.

Gaps in Protecting Livelihoods

Labor laws stipulate that waste sweepers and handlers (*pourakarmikas*) should be paid a minimum of Rs. 2,500 a month and also be provided hand gloves and boots. They are also entitled to free and regular health check ups, but the labor laws are not taken seriously by the Indian private sector. Those working under the BBMP are provided this service, but those working under private contracts are not (Gunsilius, 2010). The waste collectors in the trash trail say that payment is sporadic. They may not get paid for one month and then get double income the next month. They told this was unnerving and made life difficult for them. Those who are illiterate are further vulnerable to being cheated, especially female sweepers. On the other hand, the men working on waste transport were paid about Rs. 4,000 a month and received their pay regularly. Nonetheless, most of the private contractors did not provide health checks, uniforms and gloves. No monitoring of compliance of labor law is done by the BBMP. This is a very serious issue.

Hierarchies and power structures are deeply embedded in the Indian cultures, often making communication flow in predominantly one direction - from the top of the hierarchy to the bottom. This poses some problems, as the actors at the bottom of the pyramid are the ones working hands-on with waste and intimate knowledge on waste. Problems at basic collection level often cannot be addressed because it cannot be communicated to the management. This problem is prevalent in both public and private sectors.

Opportunity. One possible solution is to encourage stakeholder participation within an organization to brainstorm solutions to various SWM problems every month,

irrespective of hierarchical position. The actors could also be free to voice their opinions and suggestions and highlight any process problems they experience. This may yield surprising and innovative results.

Gaps Due to Exclusion of Key Actors

Manufacturing and production industries are not taken into account in any waste legislation in India. The MSW handling rules of 2000 also do not acknowledge the informal sector and there is no mention of protecting livelihoods dependent on waste (Madhav, 2010). Out of necessity the informal sector actors collect and sort waste materials. Once bulk amount of the same material is collected, places like Naindahalli then transform them into raw material (melted plastic pellets, paper pulp, aluminum recycling, copper wire extraction), which then get sold to production industries. In essence the informal sector is providing raw material to industries at a cheaper rate then virgin material. Yet manufacturing and production enterprises are not part of the current approach and including them would make it a holistic approach. Figure 12 below shows the different approaches taken by the Austrian WM sector and the WM sector in Bangalore. The waste pathway in the center is the action necessary for good SWM. In Austria the public sector is fully responsible for collection, transport and segregation and the landfill is owned by the municipality is a complex PPP arrangement. The entire processing and recycling sector is coupled with production industries while in Bangalore, there are no public incentives for recycling and only market forces drive the informal recycling sector.

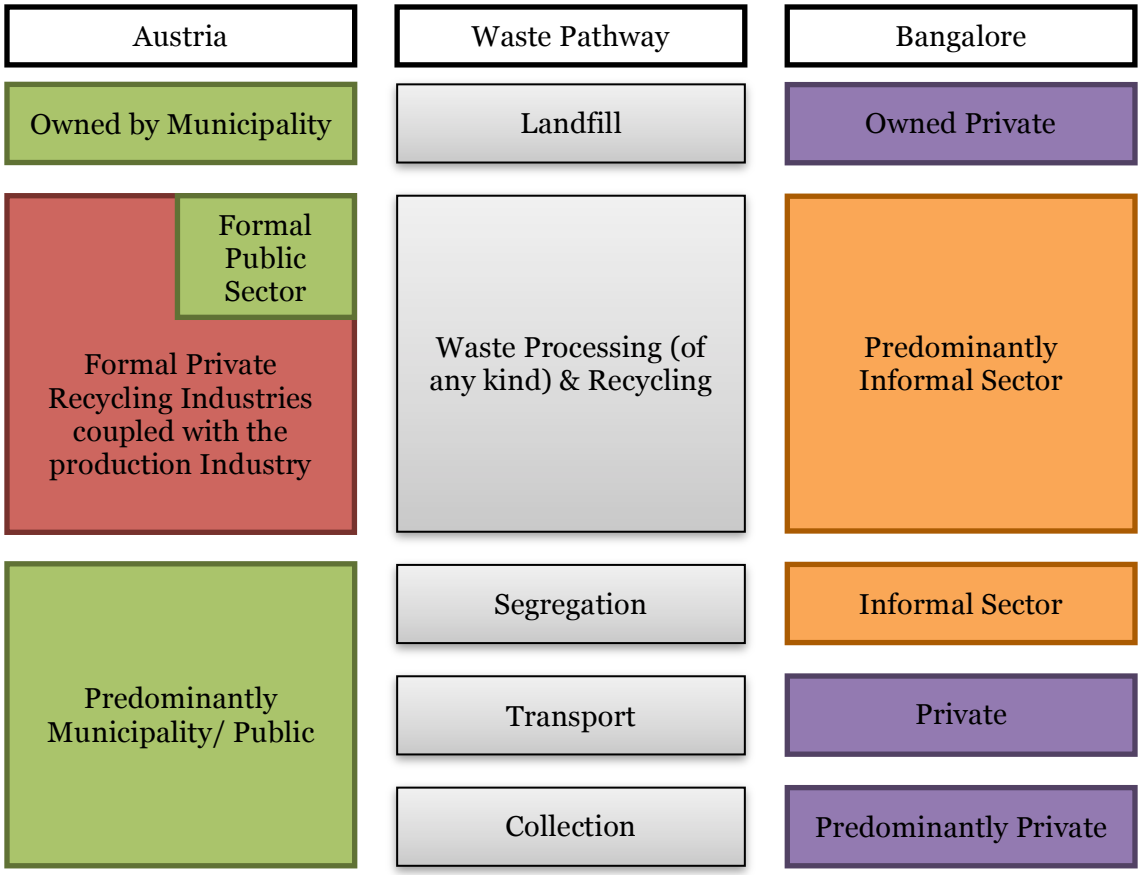

Figure 12. Waste pathways and their respective management approaches
Source: Based on author's research

India has a booming informal waste sector. They are the backbone of the recycling industry. In fact, they are the recycling industry. The informal waste workers collect, segregate and sort waste materials that are of monetary value. The entrepreneurial capacity and creativity is considerable. On the Bangalore transect study I witnessed small and obscure niche materials like magnets, wire cables and micro metal pellet parts being traded in bulk, which may indicate that no material is considered too small or too irrelevant to collect. The links and chains that are in place to collect these miniscule materials are astonishing (See APPENDIX C). The recycling industry provides a huge service to the city and represents large savings for the municipality. The city of Pune for example, has a 22% material recovery rate because of the informal sector, which

amounts to 117,900 tones of material saved from landfill and turned into monetary value. The Pune municipality is saved 2.2 million euros annually due to the informal sector (Gunsilius, Spies, & García-Cortés, 2011). Similarly the Bangalore municipality is saved 164,000 tones of waste disposal costs annually due to the informal sector. It is estimated that for every ton per day of recyclables collected informally, it saves the municipality is saved US $ 500 (Rs 24,500) per year and avoids the emission of 721 kg of carbon dioxide per year (Annepu, 2012). In large Asian cities like Bangkok, Jakarta, Kanpur, Karachi and Manila, scavenging saves each city at least US $ 23 million a year in lower imports of raw materials, and reduced need for collection, transport and disposal equipment, personnel and facilities (Medina, 2002). Ways of aiding their recycling schemes first and then finding pathways for formalization may be beneficial to both parties involved.

Opportunity. Consider the country of Austria and the relevant legislations they put into place that involve the public waste sector, private waste sector and production businesses to form a holistic trio. The recycling ordinance makes the municipalities take responsibility for waste collection and sorting because it seems to be more cost effective for them to ensure proper segregation of waste into the particular streams, which can later be handed down to private firms to be processed/recycled, rather than constantly monitor and inspect profit oriented private sector (who may be tempted to cut corners) during waste collection and segregation (Thon, 2010). The packaging ordinance obligates producers, importers and final distributers to take back their packaging, and to either reuse and recycle into new packaging material or pass it down to their suppliers as shown in Figure 12. The private processing firms are closely tied to production industries. Taking the theoretical example of a yogurt production enterprise. Because the packaging ordinance makes the enterprise responsible for its packaging, the yogurt

factory owns the yogurt cup recycling plant. Due to the municipality being in charge of collection and proper segregation, the packaging materials promptly find their way back to the yogurt producing enterprise. If for example the yogurt enterprise did not want to recycle the yogurt cups back into their product, they would have to pay waste a processing fee and the associated landfill tax to get rid of their waste. From a cost benefit perspective, most firms find it more profitable to reincorporate their packaging back into their materials cycle rather than to pay to discard it. The legislation has also pushed companies to use durable packaging material that has more recycling and downcycling potential. Although the capital cost of adding a material specific recycling plant to a particular production industry maybe high, the benefit is that they will not have to pay for expensive virgin packaging material. If a company outsources the packing of its product, they simply pass the packing material back to their suppliers, and it is the suppliers decision to dump it and pay tax, or reincorporate it back into their stream (Brunner & Fellner, 2007; Klein & Loser, 2009; Thon, 2011). There are of course many unanswered questions that come up about how the Austrian municipality manages to return every type of material with its original producer, and how imported and exported materials are treated. Further research is need for in depth analysis of Austrian MSWM practices.

Austria ensures that production industries play an active role in taking back the material that they produce and hence, sustainably manage waste. Austria has an 80 - 96% recycling rate for paper, milk cartons and glass due to adherence to these laws (Lebensministarium, 2011). Applicability of this success is not a simple move to adopt the technology they use. It is evident that technology is culturally sensitive. A first step involves making Indian production companies responsible for their waste. As of now, production companies are not penalized for any waste they produce. There is a unique

possibility to translate what Austria does in India, and to some extent this gap is already filled: by the informal waste sector. If the informal recycling sector is to be formalized in the far future, production companies will have to play an active part in linking up with informal recyclers who recycle relevant raw material for their enterprise.

Gaps in Strategy & Innovation

The main vision of the Indian Government at this point is to decrease the number of (legal and illegal) landfills to the largest extent possible, to decrease the amount of unaccounted waste in streets and to extract monetary value from waste to stimulate the local economy and create jobs (Government of India, 2009). Following the current crisis the Supreme Court ruled source segregation as mandatory in Bangalore (The Hindu, 2012). The city hosted recycling events and advertising campaigns under the heading "Wake up, Clean up Bengaluru" expo. Information was disseminated on how to segregate waste properly and advertisement campaigns were also run on TV about the waste issue (see APPENDIX C). But while the legislation had brought about a change at the bottom level, it did not address the basic question of how to change the roles of the actors in the system from bottom to the top (Figure 13). The linkages between actors form bottom to the top is still missing. The status quo in terms of positions and roles of different actors is in place because the actors (particularly those in the middle and top of the hierarchy) profited from the unsustainable ways of MSWM. It was evident that they would have little incentive to support the new legislation.

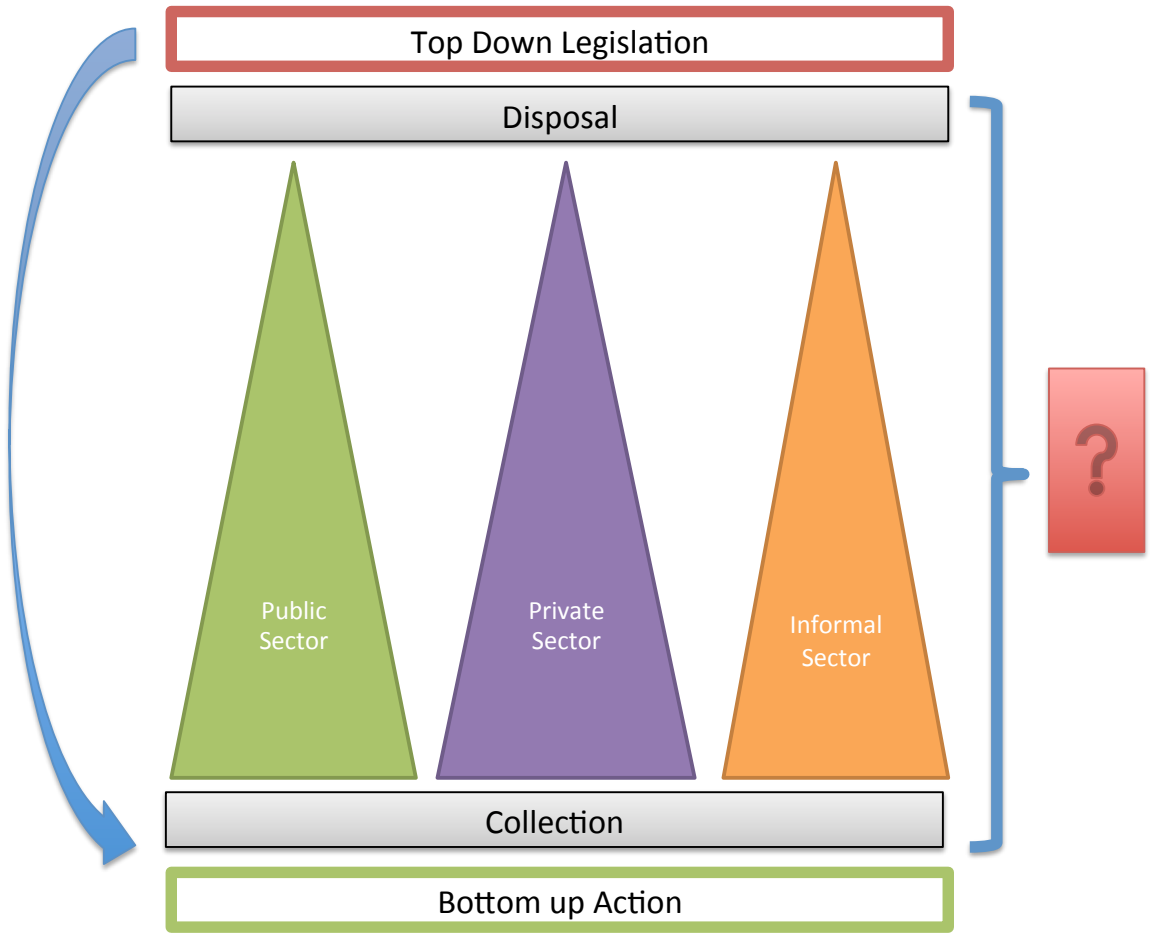

Figure 13. All three institutions are active in the same areas, instead of specializing
Source: Based on author's research

Currently, we see that all three parties are involved in all the process actions (collection, transport, processing and dumping). This makes the system quite inefficient because of the wide range of role diversity as seen in Figure 13. It was previously discussed how Austria focused on one particular action per sector, hence increasing the effectiveness of the action (Figure 12). Furthermore, the formal private sector in Bangalore currently collects and dumps waste. If source segregation were to become reality, then the informal sector would be receiving a larger fraction of waste, decreasing the need for heavy formal private sector participation. Since they are paid based on the

tones they transport away from the city, they would loose financially if more waste were to be recycled.

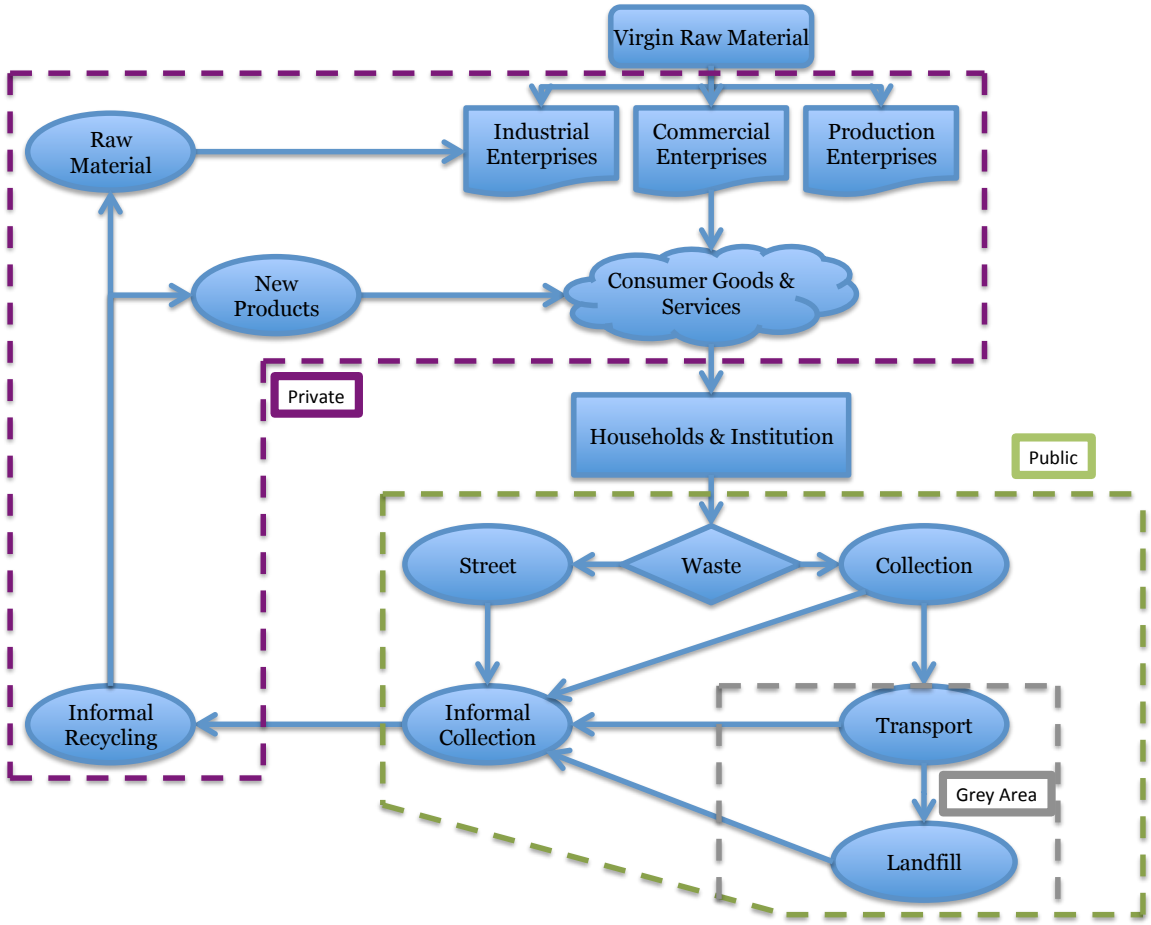

Figure 14. Possible transformation of Bangalore's MSWM system
Source: Based on author's research

Opportunity. The possible transformation for Bangalore's MSWM structure is depicted in Figure 14 in the long-term future. The enterprises that profit from the recycled material the informal sector provides could extend their support to help formalize existing recycling businesses as shown in purple in Figure 14. This, of course must be incentivized by the government. The exact level of involvement must be further researched and other grey areas include transport and landfill. The green line in Figure

14 represents possibilities for involvement of the public sector. Roles changes must be brainstorm by different stakeholders to find the best possible solution.

Finally, while it is certainly beneficial to keep the centralized methods and find ways of expressing the current system, in the long run, a decentralized approach may be better suited for Indian cities. Decentralization is often not seen as a realistic approach since most developed countries do not practice it, but literature argues heavily for decentralization of the Indian MSWM system (Anand, n.d.; Baud & Schenk, 1994; Baud, 2004; Brunner & Fellner, 2007; Medina, 2002; Narayana, 2009; Zurbrügg, Drescher, Patel, & Sharatchandra, 2004) because centralization often means undiversified and thus "ignores the different needs of heterogeneous neighborhoods within each city," (Scheibe, 2006, p.20). Decentralization offers opportunities to consider innovative approaches and outside the box thinking. Transportation of waste is one of the highest costs to the municipalities. Through decentralization, transport would be minimal. Furthermore, literature advocates heavily for composting as a very important processing mechanism (Visvanathan & Trankler, 2004; Chakrabarti & Majumder, 2009; Hazra & Goel, 2009; Hoornweg et al., 1999; Islam & Shafi, 2004; Nunan, 2000; Pokhrel & Viraraghavan, 2005; Schoot Uiterkamp, Azadi, & Ho, 2011; Zurbrügg et al., 2004). The Solid Waste Handling Rules of 2000 make the composting of organic waste fractions mandatory (Government of India, 2000a, 2000b), but composting schemes have largely failed for two reasons. Large scale centralized composting systems that are technology intensive have failed due to process mismanagement, bad quality of output and adulterated waste inputs (Annepu, 2012; Zurbrügg et al., 2004). Secondly, when composting occurs at community level, the lifespan of the scheme does not last long due to gradual loss of interest from the community (Anand, 1999; Anand, n.d.; Colon & Fawcett, 2006). Building a municipal system that with decentralized elements with

active and continued stakeholder involvement may be an innovative solution to Bangalore's MSWM problems. The next chapter explores an innovative local bottom up decentralized waste management model called the Vellore zero waste management model.

Chapter 6

THE VELLORE MODLE: ZERO WASTE

The Zero Waste Management Model (ZWM) is a bottom up decentralized method of waste management. It is often referred to as the Vellore model because was first conceived and implemented in the south Indian town of Vellore. It is also referred to as the Solid & Liquid Resource Management (SLRM) model because it is based on the notion that there is no such thing as waste. Everything is a resource and a raw material if matched to the right user. In this publication I shall refer to it as the ZWM model. All of the information in this chapter was gathered from the ZWM enquiry and published and unpublished material shared by Mr. Srinivasan.

The ZWM is a comprehensive WM model that addresses social, ecological and environmental issues with regard to safe disposal practices. The ZWM was shortlisted as one of the “Best Practices on Improving the Living Environment"(UN-Habitat, 2007). Other notable NGOs in Bangalore and Tamil Nadu have published material aiming at zero waste but they mostly deal with awareness creation and lack depth in waste processing knowledge. The ZWM does target waste segregation awareness in the same ways other NGOs do; by involving the community and creating awareness. However the ZWM also has a solid technical and biological understanding of waste and its intricacies, and thus, it presents a very practical model of processing the segregated waste. It does, however also have its limitations too which will be discussed further.

The ZWM model was conceived as part of a local initiative driven by Exnora International (EI), an acronym for "EXcellent NOvel RAdical" a non-profit, non-political, secular, non-governmental, environmental service organization. The NGO has been promoting community-based projects in cities like Chennai and Hyderabad since 1989. It was the brainchild of Mr. C. Srinivasan, an ardent environmentalist who worked for

Exnora. What began as an endeavor to stop soil erosion, soon led him to find that waste management and composting was the key. Through a journey that lasted 10 years Mr. Srinivasan realized that proper waste management would solve many related and interrelated issues in India, so he created a sub section to EI called Exnora Green Cross, which he now heads. Over 10 years now he has perfected and improved the ZWM model. It was first implemented in the small town of Vellore in Tamil Nadu; South India is now being exported to other states of India such as Pune, Kerala and Gujarat. In May 2011 Mr. Srinivasan talk about his journey with waste at the TEDx Thar in Jaipur under the banner of "Inspiring Ideas for a Clean Future." The model, which was originally conceived for a town, is now being scrutinized for it possible application to cities. The information in this entire chapter pertaining to functions of the ZWM model was collected from Mr. Srinivasan during the summer month of 2012. This section of my thesis looks at the possibility of applying the ZWM model to the city Bangalore in India. I will look at the technical components of the model and then the social implication of the model. Then I will look at the limitations of the model and assess its feasibility and viability in Bangalore.

Components

1. Waste collection
2. Secondary Segregation
3. Cattle shed
4. Tertiary segregation, Processing and Storage unit,
5. Drying unit
6. Vermi-composting
7. Biogas
8. Composting

Each of these components are interconnected and interrelated. They take place under a designated segregation area as shown in Figure 15.

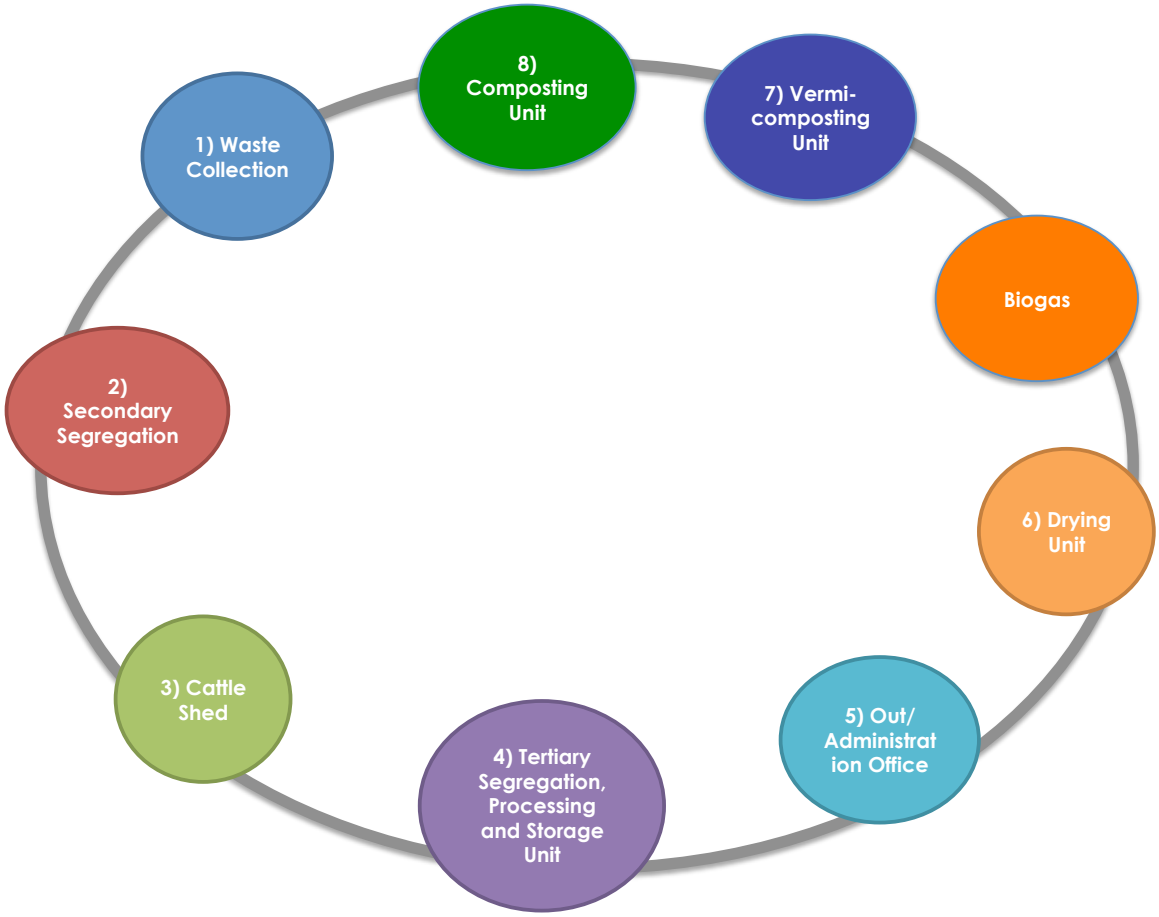

Figure 15. The holistic principal of ZWM
Source: Mr. Srinivasan (2012) http://www.zerowastemanagement.org.in/

I shall first describe the listed components in detail and then explain how the components work together to form a cohesive model.

1. Waste Collection: Waste is collected in two bins – one for dry waste and one for wet waste. The dry bin contains anything from paper, cardboard, plastic, glass, aluminum, metals, rubber, leather and cloth. The wet bin collects organic wastes, kitchen scrap and garden waste.

2. Secondary Segregation: This step involves sorting the collected dry and wet waste further into more waste streams for recycling. The paper, plastics, cardboards, metals are f segregated from each other according to grade, recycling potential and market value. The food waste is segregated into four streams: meats and bones, vegetable scraps and citrus peels. This is a very important process because citrus peels and non-vegetarian food scraps cannot be composted because they upset the pH balance of the system.
3. Cattle Shed: The vegetable scraps which were segregated from the citrus and the non-vegetarian food scraps is given directly to the cows in the cowshed. It may be surprising to mention cows in an urban context, but it is of relevance. The cattle shed is an important, pivotal part of the ZWM model that differentiates it from other models. It is tailored to the Indian culture in particular and the ZWM model manages to capitalize extensively on cultural idiosyncrasies and perspective so unique to the Indian tradition.
4. Tertiary Segregation and Processing Unit: This unit is for the final segregation of the different waste streams and also a storage unit. Here, the different materials are collected in bulk, cleaned and stored for pick up. The sorted waste is now a resource and will be directly sold to the respective buyer of that particular bulk material.
5. Composting & Vermi-composting: Cow manure is a great accelerator of the traditional aerobic composting process. The remaining organic waste (such as non-vegetarian waste that could not be feed to the cows) is aerobically composted. Vermi composting (where worms called red wrigglers digest organic matter) produces high quality compost with a very high nutrient value. The liquid that is excreted by the worms is called worm tee and is an

extremely potent fertilizer. Hence the market value for vermi-composted manure is higher than regular compost, or even cow dung. To increase the value of cow dung, the manure is vermi composted where worms readily devour the manure and within few days, one can get high quality worm castings. This is much more efficient than converting food scraps to worm casting because the food needs to be greatly reduced in size for the worms to ingest and this process can take up to 5 weeks. It must be noted that citrus peels and non vegetarian scraps cannot be vermi- composted as they upset the pH balance and may kill the worms.

6. Biogas Unit: The other pathway for bovine excreta is the biogas plant. Organic compounds decompose under anaerobic conditions to yield biogas, which is a good energy source. According to literature biogas plants have huge potential in India because of the waste characteristics and density (Sharholy et al., 2008).
7. Drying Unit: The ZWM model also utilizes a drying unit to dry the segregated waste streams after they are cleaned. The non-vegetarian kitchen scraps, the citrus peels, various plastics and paper material are dried here. Drying is usually just placing the material out in the sun and collecting it after it is dry. Once dried, the citrus peels are ground into a fine powder that makes for an excellent dishwashing soap when mixed with water. This is packaged and sold. It can be likened to the vast number of "green," biodegradable dishwashing liquids that have citrus as a main ingredient here in the USA.
8. Administration office: A room that takes care of the administrative tasks such as keeping track of records, recording the amount of waste sold, the details of economic transaction with buyers etc. There is also a storeroom for materials

and tools, a dining room or hall for the workers to eat, rest rooms and first aid medical kit. The administration office is where all waste that has turned into a resource leaves the circle. This is so that there can be quality control and accounting of what is sold.

The three aspects that are absolutely required in the ZWM model are:

1. Space corresponding to the population it serves. Without a working area the workers cannot processes, segregate, clean and sort the waste.
2. The guarantee of the community to segregated waste as instructed. Without the correct basic segregation, WM cannot be done, as materials may be contaminated beyond salvage.
3. The grant to the waste workers to pick up waste at 8am and 5pm. Since the bulk of the organic material is feed for the cattle, it must be fresh and they must be fed twice a day.

Without these three fundamental points, ZWM cannot work. It is important to note that the ZWM model is not a linear or circular process. The process depends on the type, quality and grade of waste being processed.

Physical Layout of the ZWM Operations

The ZWM model requires space for waste segregation, composting beds, biogas plants, cattle shed and drying area as Figure 16 illustrates conceptual map of a ZWM center plan for a rural area. An area of about 4500 sq. feet is required to service 300 to 600 families.

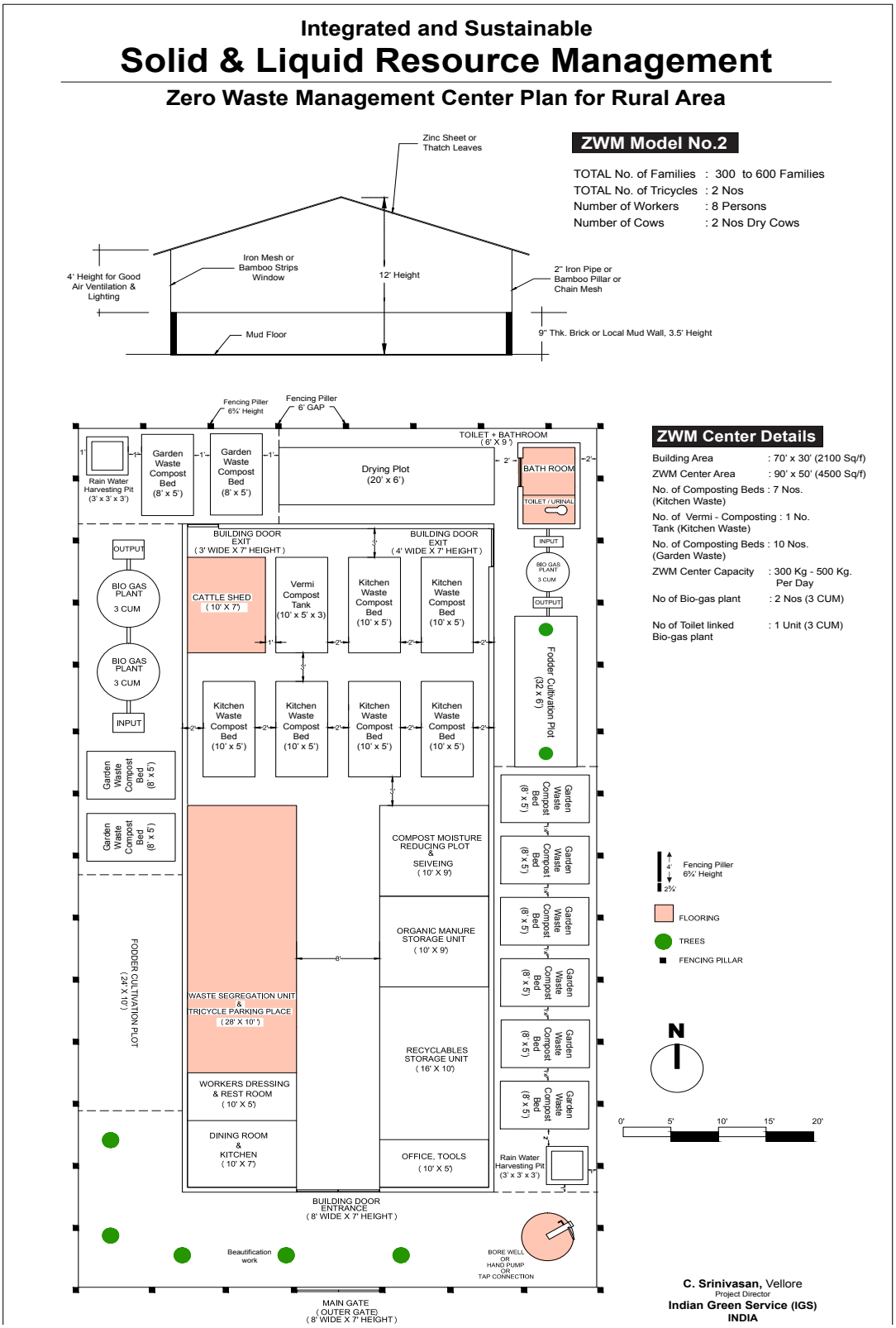

Figure 16. Space requirements for ZWM implementation
Source: Unpublished material from Mr. Srinivasan (2012)

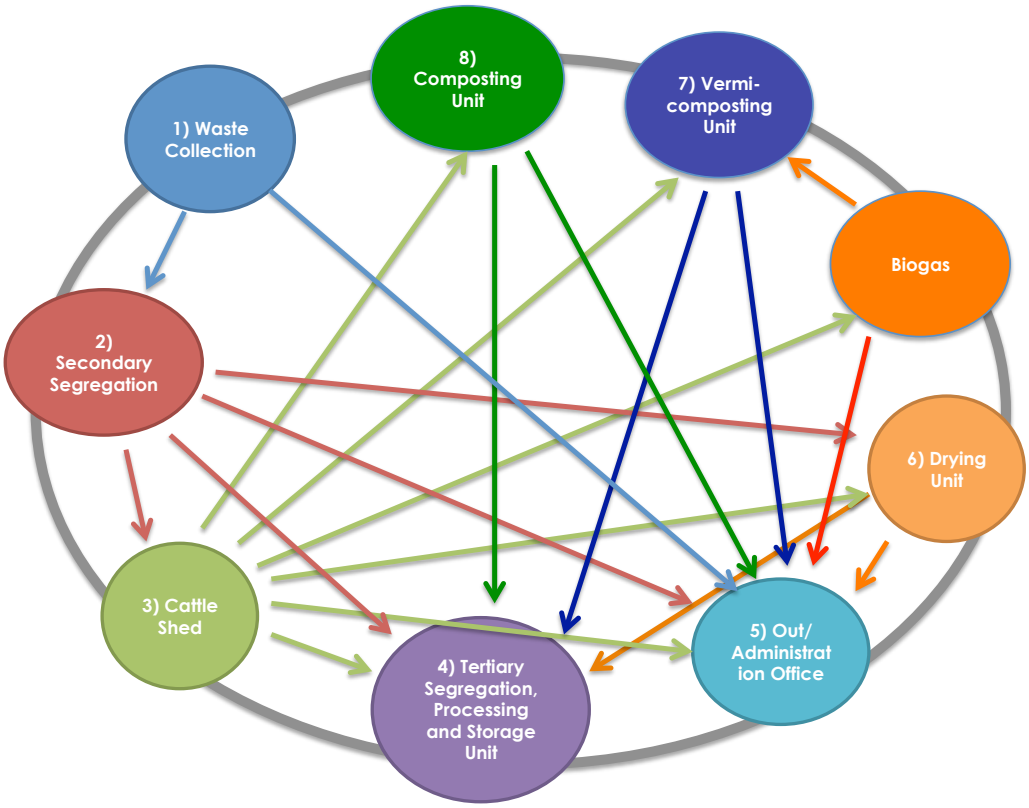

Figure 17. Flow diagram of segregated waste
Source: Mr. Srinivasan (2012) http://www.zerowastemanagement.org.in/

All waste types follow different pathways and are transformed into resources. Plastics, metals, paper are all resource and have market value when they are; cleaned and free of contamination, show consistency of grade, quality and type and are available in bulk. Some materials have more market value more than others. The whole framework is shown in Figure 17 and can holistically decrease the amount of waste that enters landfill and supply raw material to businesses and enterprises.

Social Components Of ZWM

The model is labor intensive and decentralized, which is in accordance to what Medina (2002) suggested; that it would be better for low income countries to focus on high labor low capital waste processing methods. The people hired as labor belong to

low-income groups who are marginalized and who have very few ways of making a proper livelihood. They are currently chosen based on family constraints (e.g. widowed, widowed with children, disabled family members in their care, and/or living below the poverty line). Men and women were both welcome, although 80% of the participants were women. The physically impaired or those with physically impaired family members are given a preference. The model is unique in that it allows for upward mobility. Ties with the local collage have enabled workers who are inclined towards supervisorial positions to take a short exam, provided they have completed a minimum of one year of hands-on ZWM experience. The exam, which can be taken orally or written, tests their knowledge on waste material and their leadership skills. This is very unique as upward mobility is non-existent in centralized public or private firms. Furthermore, the workers are given a uniform, gloves and a mask that must be worn at all times. Regular health checkups and vaccination are provided for free. Furthermore, waste collection starts from 6am to 10am and resumes again at 2pm and last till 6pm for the evening collection and other segregation work. This leaves 4 hours in the middle, to allow workers to attend to their families and personal needs.

Economic Note on ZWM

The concept of ZWM has been implemented in a few towns Indian cities now. The total cost to set up a ZWM system 30,000 US dollars and the regular maintenance comes to 37,000 US dollars/ months to set up a ZWM area to service 2400 families. This would come up to 15 dollars per family per month, but in Indian currency, this is a substantial amount of Rs. 909.

Discussion

In India 80.5% of the Indian population identify themselves as Hindus. In the Hindu culture, along with Buddhism and Jainism, cows are regarded as sacred animals.

To illustrate an example of how culture affects economics and business; if you go to McDonalds in India, you may be surprised to find only vegetarian and poultry choices on the menu. This is because the majority of Muslims do not eat pork and the majority of Hindus do not eat beef and hence, they would lose their clientele if they offered beef and pork. In the same way that McDonalds tailors its products to the social environment, in a similar fashion, the ZWM model tailors its WM strategy to the local context. This is not to claim that every Hindu, Buddhist and Jain does not eat beef in India, but it highlights the cultural proclivity towards the bovine animals. In this light, cow slaughtering[1] is totally banned in Karnataka (and in six other states in India) by the "Prevention of Cow Slaughter and Cattle Preservation Act 1964." The slaughter of bulls and buffalos is permitted only on the "fit- for slaughter certificate" provided that the cattle is "over 12 years old and permanently incapacitated for breeding, draught and milk production." Thus, in honor of their exalted status cattle are often free to wander around, even in big cities and busy roads. It is even considered good luck to feed a cow. These cows often do cause a public nuisance, but are 'put up with' as it would be a punishable offense to kill or injure a cow.

The ZW model capitalizes on this emotional/religious empathy by establishing so called goshallas. These goshallas are "retirement" homes for cattle that are not fit for milk production and are old or disabled in some manner. The goshallas are funded by devote Hindus, Jains and Buddhists who pay a small fee (about Rs 100 to 200 per month) for the maintenance and upkeep of the cowshed. These cows provide a valuable function; digestion of organic waste within 24 hours.

Literature highlights that labor and time involved in composting is often the deal breaker as people want faster processing options (Zurbrügg et al., 2004). The ZWM

[1] http://www.dahd.nic.in/dahd/reports/report-of-the-national-commission-on-cattle/chapter-ii-executive-summary/annex-ii-8.aspx

address this and provides very short turnover time from organic waste to ready compost. Traditionally, composting is a delicate balance between carbon/nitrogen levels, temperature, oxygen, moisture content and pH balance. Depending on these variables and the amount and type of waste at hand, composting to mature compost can take anywhere from 4 months to 6 months. Literature claims that the shortest composting time is 14 days with a technology called continuous thermophilic composting (CTC) (Xiao et al., 2009). Furthermore, traditional large-scale composting takes up lots of space and is rather labor intensive, as it is important to keep check on variables. The cow, on the other hand can take up anywhere from 25 to 50 kg of organic matter a day and turn it into green mulch within 24 hours. The vermi composting of the green mulch will provide ready, useable mature compost within *one week*. The process of reducing the size of vegetable waste (either technology - hence capital intensive or labor intensive), subsequently feeding it to the worms, waiting for 4 to 8 weeks before having a mature compost amount is eliminated. The cow also reduces the volume of the organic matter significantly. As the literature pointed out the amount of organic waste in India is higher than in developed countries, accounting from 40 to 80% of the MSW, hence this is a valuable processing and volume reduction mechanism.

The benefits of the cattle shed is three fold:

- It uses cattle to reduce the volume of the organic waste significantly within 5 days. This is not possible with any technology today.
- It reduces the number of wandering street cows on the road, which cause traffic disruptions and are generally regarded as a nuisance.
- It pleases devote Hindus, Jains and animal rights groups by giving an adequate shelter and location for the cattle in return for funding.

In India, cow manure is used for a variety of purposes. If dried it makes an excellent fuel source. Village houses would line the patios of their house with dung as it was considered to have antifungal and antiseptic properties. It is used as fertilizer for fields. The use of bovine dung and urine in Ayurvedic medicine was always existent, but a recent revival and popularization of Ayurveda, especially for foreign customers in Ayurvedic resorts and clinics, have increased the demand for quality dung and urine. Hence it can be directly sold if the demand exists. The other pathway for bovine excreta is the biogas plant. According to literature biogas plants have huge potential in India because of the waste characteristics and density (Sharholy et al., 2008). The feed for a biogas plant can either be organic waste directly or, as in the case of ZWM, bovine manure. Abubakar and Ismail (2012) did a study on the effectiveness of using cow dung as a source for biogas and concluded that "the data obtained established that cow dung is an effective feedstock for biogas production achieving high cumulative biogas yields with a stable performance" (Abubakar &Ismail, 2012,p1). It was also established that animal waste was more efficient at producing methane than organic kitchen waste (Mandal & Mandal, 1997). Furthermore, *1 ton of organic waste produces 2-4 times more methane in in a biogas plant digester in 3 weeks, than 1 ton of MSW in landfill can produce in 6 to 7 years* (Sharholy et al., 2008). The use of a biogas plant can help reduce the stress on conventional systems (power shortages are very common on India) and provide the community it serves with some amount of "free" energy to offset the set up costs. A useful comparison is the gas cylinder that is used to provide cooking fuel in many households. For a 14 kg LPG cylinder the cost is Rs 901. Biogas can provide gas at competitive prices in comparison to LPG cylinders for example; one of the ZWM centers used a biogas plant, which saved them Rs 10,000 per month after its instilment costs.

The spent slurry, after biogas extraction, is then either composted or vermicomposted and is sold. The entire system makes money from waste.

Nonetheless, there are some wastes that the model cannot process. Sanitary pads, diapers, and plastic aluminum mesh products are some of the unrecyclable products. Hence, landfill is, to a certain extent, unavoidable.

Applicability of ZWM to Bangalore

Chennai and Hyderabad are two cities where Civic Exnora has been active in many community-based projects since 1989, by helping neighborhoods take the issue of SWM into their own hands. Colon and Fawcett (2006) documented the barriers that determined the success or failure of two neighborhood ZWM schemes whose residents decided to set up, run and finance the ZWM model themselves. While the project showed that motivated individuals could successfully set up and manage waste collection systems that lead to overall environmental improvements, they could not manage to continue it for the long term despite the relative wealth of the neighborhood and initial motivation of the community leaders (Colon & Fawcett, 2006).

The ZWM model requires a complete overhauling of Bangalore's waste management systems and the established centralization plans may have to be reimagined. Implementing the ZWM model in Bangalore would imply that every ward – or perhaps every 3 to 4 wards - would have to allocate some land to accommodate a decentralized SWM system. Given the very high cost of the land required for running the recycling center in Bangalore, the expected financial gains from the recycling need to be high enough to make it a viable long term investment. Colon and Fawcett (2006) claim that the model is idealistic in that it was originally "envisaged that citizens would no longer need a local government for the provision of SWM service" but in practice this failed as the "high ideals of community participation rapidly deteriorated" (p.15).

Furthermore, they found that beyond the initial setup of the plant, considerable time and energy is required for its regular maintenance. This requires dedicated community effort, which was difficult to sustain particularly as replacements were needed and future residents were unwilling to undertake these investments in maintenance.

The biggest barriers to the longevity of the model were the lack of consistent source segregation, the inability of the community leaders to delegate work, and the unwillingness of the resident to pay extra charges on top of heavy property taxes, despite it being two relatively wealthy neighborhoods. The authors suggest that to be successful the model needed to develop a better management structure and seek technical and institutional support and consider "working closely with private sector in reclaiming the full value of the waste resources in order to finance and support the collection schemes," (Colon & Fawcett, 2006, p.14). This suggests that public and private partnerships can potentially play an important role in successfully adapting this model. However, this is not going to be easy given the entrenched interests and the strong proclivity in maintaining the status quo. The private sector and municipality need to reimagine and redefine their roles for a new ZWM model to be considered.

In contrast to Vellore, in large metropolitan areas like Bangalore - given the scale and complexity of waste generation, collection and disposal processes – several actors have a strong vested interest in the current unsustainable system, which may be harder to overcome. Thus, there is a stronger role for active dialogue and stakeholder engagement for a role change of the current actors. The ZWM model also poses an interesting dilemma for the government municipalities: on the one hand, they want a better SWM system; but on the other hand, they cannot actively encourage informal recycling industries (which are considered "illegal"), because the model would predominantly benefit informal recycling.

Yet, by adapting the ZWM model there is an interesting opportunity here, to help recognize the informal recycling industry. If the municipality can play an active part in the upkeep of a neighborhood ZWM center, they could argue for the necessity of the recycling enterprise to be willing to semi-formalize in order to buy bulk material from the ZWM center. Looking for an example to Vienna, the capital of Austria, it is interesting to note that even though Vienna has a centralized SWM system, there are certain decentralized elements. For example, collection stations, in Vienna are located within each district (comparable to a "ward" in Bangalore) and any material that is not readily disposable in household trash (e.g. washing machines, dishwashers, televisions, old oil etc.) is brought there. Figure 18 shows the locations of the collection stations in Vienna. The appropriate size of the collections stations depends on the size and population of the district and can range from 100 sq. maters to 500 sq. meters. This is comparable to the area needed for the ZWM system.

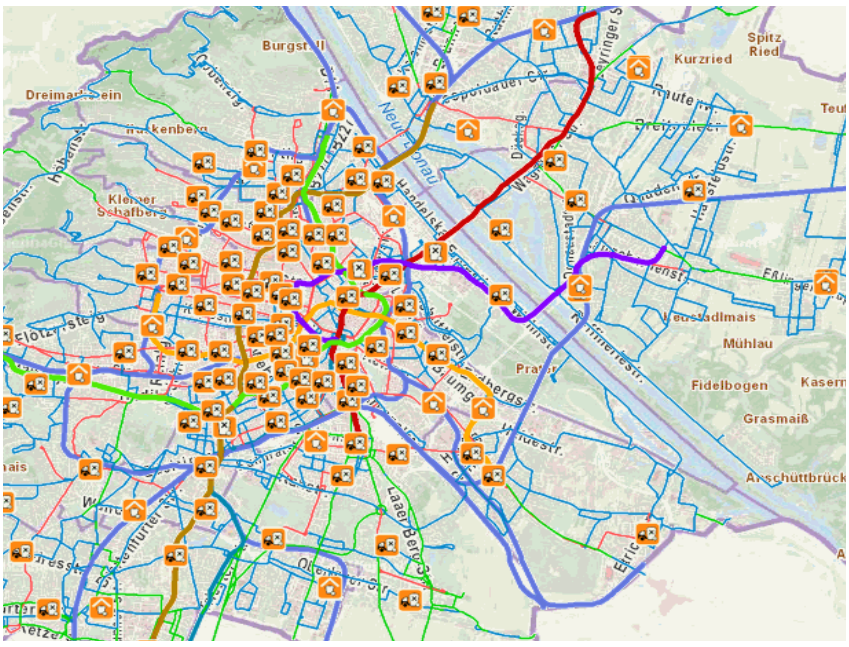

Figure 18. Waste collection centers in city of Vienna
Source: http://www.wien.gv.at/umwelt/ma48/entsorgung/mistplatz/mistplatzabc.html

Thus there is, potential for the model to be implemented per ward, but the transition can be difficult. Some of the factors that facilitate the transition are:

1. The availability of land area proportional to the population it serves.
2. The cost of the land and the rental agreements pertaining to it.
3. The political will and collective action needed to sustain the transition.
4. The willingness and adaptability of actors to change their roles and functions.
5. The complete role change and expression of PPPs in a ZWM system.
6. Building capacity of the municipality to assure quality control and oversight.
7. The availability of workers willing to work in the ZWM system.
8. The availability and acceptability of goshallas (cow sheds) in urban settings.
9. The willingness of citizens to participate in source segregation of waste
10. Favorable market conditions that affect the retail price of material collected and determine the financial viability of the ZWM system.

Alternatively, one could consider a transitional, partially decentralized system, where the ZWM system can be implemented in every 2 or 3 wards for the collection and segregation of dry waste only. While this may be an intermediate solution to ease the garbage crisis, it does not deter organic waste from entering landfill. During the time of writing, Bangalore has attempted to introduce ward dry waste collection centers, but so far it has been unsuccessful. Reasons are unclear as to why, but sources in Bangalore suggest that the private contractors feel threatened by these changes, viewing it as a ploy to decrease their business. Hence, they thwart any effort to change the system.

While the model benefits the informal recycling sector, some of the current actors such as the rag pickers, Kabbadiwallhas, and the small and mid level waste dealers may be displaced (see Figure 9). They risk displacement because the ZWM already collects

bulk amounts of each material. A counter solution is to employ these very people in the ZWM system.

Avenues for future research include a detailed process of stakeholder engagement to find out the needs and values from each group within the SWM discourse. It is evident that some actors need to change their function if a transition to a more sustainable MSWM system is to occur. The next chapter looks at the use of communication strategies and tools to facilitate a shift of Bangalore's MSWM systems and find possible ways to initiate dialogue with and between various actors.

Chapter 7

COMMUNICATION FOR COLLECTIVE ACTION

Wiek, Withycombe, & Redman (2011) establish a set of key competencies required in the sustainability framework for sustainability research and problem solving. These competencies are used in designing academic programs for sustainability to enhance collective action. They include strategic, normative, systems thinking, anticipatory, and interpersonal competencies. Within these five capabilities, interpersonal competence is held above the others due to its importance in facilitating collaboration and teamwork – a core aspect for sustainability. The numerous disciplines of our world create a variety of empirically valid perspectives, which quite often conflict, as they support a multitude of views (unpublished source). As such there is no singular version of truth, or optimal state of the world, but rather a multiplicity of truths (Sarewitz, 2004). The numerous values that affect understandings about the world is evident, hence advance skills in communicating and the ability to speak from different viewpoints are included in the definition of interpersonal competence.

Sustainability problems can be viewed through a variety of different lenses. It is evident that not all people share the same cultural, religious and political opinions. Yet it is vital that these groups come together over specific issues that affect their environment. In a study about control in U.S Salmon Policy, Hall and White (2008) talk about how the use of multiple frames paved the way for a positive debate and actionable outcomes. Similarly, actionable outcome is what is necessary in the Bangalorean SWM field now.

The ability to listen to the opposition, understand some of their cultural frameworks and references, is the first step. The second step is to incorporate the relevant sustainability message into at least *one* of their frames. The capability to speak the language of the audience, anchor-compelling stories in familiar narratives, and thus

use their frames is an essential skill for the sustainability practitioner, and a vital tool for collective action. If used effectively communication could be a very important strategy to use for transition management. A strategic way of doing this is to begin by:

a) Looking at the different actors in the SWM sector in Bangalore,
b) Clarifying what motivates them and what their particular aims and frames are,
c) Selecting justified communication methods that would realign their aims with the SWM aims of the Indian government.

Communication is important within an organization so that different actors do not repeat same actions, best practices within an organization can be shared and utilized and so that wastes and inefficiencies can be addressed. Problems can also be solved cohesively together. How can we get the SWM sector in Bangalore to utilize this knowledge? From the transect study, literature (Baud et al., 2004; Baud & Schenk, 1994) and the Bangalore interviews the following communication issues within the SWM sector in India were identified.

Structural Communication Issues

1. The hierarchies within the government waste division do not communicate much and if they do, it's a one-way communication stream, from top to bottom.
2. The public (government) and private partnerships are not regularly updated about practices in the field. Once the contracts are forged, the private SWM firms are more or less left on their own to achieve the task of keeping their designated area clean.

3. There are no questions asked about how the private organization distributes their money amongst their operations or how exactly they reduce and dispose waste.

Operational Communication Issues

1. How to communicate effectively with the middle and high-income population to understand the importance of waste segregation?
2. How to communicate with (usually low income) workers in the waste management sector on the importance of insisting on segregated waste.
3. How to communicate with low-income waste workers about the importance of their job to build moral and take ownership of their city and job?
4. How to communicate to low-income populations that do not work in the solid waste sector on the importance of waste segregation, hygienic waste habits (such as not throwing it on the street) and importance between waste and heath?

Table 3 below identifies most of the actors in the SWM sector in India as informed by various literature (Baud et al., 2004; Visvanathan & Trankler, 2004; Madhav, 2010; Sudhir, Srinivasan, & Muraleedharan, 1997; D. C. Wilson et al., 2009; D. Wilson et al., 2006; Zhu & Bank, 2008) and as observed during my trip to Bangalore, India.

Table 3
Actors in the Bangalorean MSWM System & Their Roles and Incentives

Actors	Roles	Social & Economic Levels	Skills and Objectives
The Public (Government) Wing	To delegate work and hire the cheapest contracts to rid the city of waste.	High	• To hire the cheapest private contractors that pledge to get as much waste out of the city as possible.
The Private Wing	To direct and transport as much waste per day as possible from city to dump.	Managers and Supervisor positions – High to higher middle income.	• To get their hired labor to collect and transport as much waste out of the city as possible • Otherwise be held liable by government • Make a profit
Private Waste Collectors	Hired by the government wing to collect household waste on small vehicles.	Low Education Low Income Labor No benefits or Pension	• Collect as much waste from the different households as possible. • Have to cover a certain area per day to get paid. • Need to make ends meet – hence do what they are told by management.
Public Waste collectors	Same job description as above but more benefits.	Low Education Low Income Has Government benefits and Pension	• Have less responsibility than above. • Have to keep a certain area clean by collecting and passing the collected waste to private sector trucks. • Low income, but secure job. • Health care (tetanus shots etc.) and pension covered.

Actors	Roles	Social & Economic Levels	Skills and Objectives
Transporters of the Waste Trucks (only private)	Transport waste from city to dump many times per day.	Drivers, mostly middle school educated. Low-income job.	• Get paid by the number of fully loaded drives they do per day. The more the better. • Are the spine of the private sector
Rag pickers	Pick and identify recyclable along the entire waste stream as individuals at the fringe of society. An estimated 25,000 of them in Bangalore alone.	Working alone and inefficiently. Pick through garbage dumps. Very low income.	• Pick at the waste at every level of collection and transport. • Are seen as nuisance by locals and the formally hired labor. • Make a livelihood from what others throw out. • Skilled at recognizing high value recyclables.
Kabbdiwalla	They collected valuable material in bulk – which sells at a higher price.	Higher on the low-income group. Income is distributed from collective income as group. Unsteady income and fluctuates with collection rate. Back bone of recycling and show remarkable skill in identifying recyclables.	• Establish formal pick up cycles with households, and buy paper cardboard and other valued recyclables. • Organized to some extent in (family) groups so can gather larger volumes of high value recyclable. • Seen as cheaters by local population because of price squabbles.

Actors	Roles	Social & Economic Levels	Skills and Objectives
Informal Recycling	Located at the fringes of the city, groups of family businesses. They either forge new products from a certain material, or sell the collected material further to its respective industry.	Higher low to lower -middle income. Heavy labor. Remarkable resilience.	• Seem to embody remarkable creative and business skills. • Very knowledgably in waste streams. • Can be an independent (unregistered) small business themselves and/or be a supplier to one.

The skills and objectives for all these actors are diverse. Yet they make up the entire waste system. Furthermore, it is evident that the private sector has nothing to gain from source segregation laws. In addition the hands on waste collectors have been trained under the assumption that the more they collect and dump the better. It will take a complete reeducation of the labor force to install segregation values in them. Table highlights what White (2013) illustrates in his paper about the assumption behind Water Sim for the Desert City and how this affects behavior (White, 2013). We cannot just assume that all the actors in the India SWM have the same objectives want the same outcome as the over vision of the government. The table below looks at what communication strategies can be employed to realign at least some of the frames as recommended by Benford & Snow (2000) to enhance social movement. The table below looks at what is interesting to us; communication strategies and how it could be translated to the Indian SWM context.

Table 4
Communication Strategies for Collective Action

Actors	Same Interest as National Government Legislation?	Change	Communication Strategy for desired outcome
The Public (Government) Wing	Yes	At loss to change status quo. Have to keep city waste free as well as change system dynamics simultaneously. Negate corruption	• Need to keep in mind the different frames by the hierarchical systems and need to find fitting roles for them in the new system. • Need to encourage and aid boundary organization to take action. • Need to be effective in conflict management.
The Private Wing	No. Stand to lose financially if mandated.	Have to change their role from collector, transporter and dumper.	• Need to find and embrace different roles. Old power structures could be calling into question hence conflict management techniques are important. • Framing process is vital. Frame as "new opportunity" for better business NOT "changing business operations." • Appeal to the citizen inside the businessman as well, by highlighting cleaner city, wellbeing and health.

Actors	Same Interest as National Government Legislation?	Change	Communication Strategy for desired outcome
Private Waste Collectors	No.	Have to be retrained to handle segregated waste.	• Need to make compelling by using stories and narrative techniques to give them the tools to understand importance of at source segregation. • Need to speak their language • Communicate strategies to help them feel empowered: they keep the city running and clean. • Employ at least one or more of their frames.
Transporters of the Waste Trucks (only private)	No. Have to be downsized if people start home composting.	Have to change roles	
Rag pickers	Yes.	Need to be more efficient	Already part of the National Government's ultimate vision and aim. They are just doing the job amidst a lot of difficulties. A communication strategy (amongst other strategies) with them would be to hold focus groups as to HOW the local public/ private entities could assist them in doing the job better in return for willingness to formalize in the long term.
Kabbdiwalla	Yes.	Need to have easier access to recyclables and that means changing their image in society	
Informal Recyclers	Yes.	Have to be aided and strengthened by government	

Many researchers highlight the need for communication between the city administrations and the various stakeholders (Medina, 2002; Scheibe, 2006; Zhu & Bank, 2008; Zurbrügg, 2003). The current system is rigged. To affect change, it needs to come from all levels of management and it will take a lot of time and investment. As brought to light in this chapter, the drivers and objectives of some of the actors are not coherent with the main vision. Some stand to lose from the sustainability vision. It is imperative that the correct communication steps are taken to inform the various actors about the changes and it is important to "speak their language." It is also important to frame the topic in a manner that is positive and does not threaten the players. Sarewitz (2012) claims that a lot of wicked problems are political and that wicked problems need to be addressed in a manner that is non-threatening. It must be clear that the proposed vision is not the final option, but a reiterative process. Stakeholder engagement is vital in the process and focus groups would be extremely beneficial to gather valuable knowledge about how to aid the informal recycling sector better.

Chapter 8

CONCLUSION

Over the past decade, SWM technology that has worked well in developed nations has proven to be largely ineffective in the urban Indian context. Yet the focus remains on "technology transfers" as a panacea for India's SWM problems. India is vastly different, socioeconomically and culturally, from developed western nations. These differences shape the execution, expression, and function of SWM in India.

During the summer months of 2012, the city of Bangalore faced major upheavals. Waste workers went on strike, the landfills were overflowing, the city's garbage was piled up for weeks and dengue fever erupted, as the city tried to grapple with its SWM situation. The disorder resulted in an unprecedented legal decision to mandate source segregation of MSW. While the mandate was clear the course of action to be taken was not. Hence, the goals of my thesis were three fold; first, to analyze the current state of the SWM systems in Bangalore and identify gaps in the transition. Second, to determine the appropriateness of applying a bottom-up SWM model to the metropolitan city of Bangalore and third, to identify the role of communication between actors in promoting collective action towards a more sustainable SWM system in Bangalore. The SWM system in Bangalore was faced with the following problems:

1. Open and unsanitary waste disposal methods
2. Low collection rates
3. Lack of waste storage facilities and inadequate waste transport.
4. Underutilized potential of recycling options,
5. Poor track record of successful processing methods and
6. Presence of hazardous waste in MSWM

These process problems could be traced to the larger systemic inadequacies in the following core problem areas:

1. Urban planning & health
2. Stakeholder participation,
3. Financial, political and legislative authority of the municipality,
4. Inclusion of actors, and
5. Culturally sensitive technology assimilation.

In Chapter 5, I outlined various gaps (conflicting political agendas, the exclusion of some key actors, and lack of adequate attention to cultural aspects, provision of appropriate incentives, protection of livelihoods and promotion of innovation.) in the process of moving towards a more sustainable SWM system. Table 5 on the following page summarizes my conclusions about whether improvements in the five core problems listed above could be facilitated by addressing the six gaps in Bangalore's SWM system and effective communication, as discussed earlier. The various solutions to the gaps explored in chapter 5 are intended to directly aid or alleviate the core problem areas in MSWM. For example, if gaps in the political process are addressed, as suggested, improvements in urban planning are likely to result, and municipal political, financial, and legislative authority will likely improve. Closing the gaps in the private sector participation by formulating strategic incentives for private-sector players to become partners with municipalities in transitioning towards a more sustainable SWM system will have a lasting impact on all the identified problem areas other than urban planning and health. Table 5 illustrates how addressing the gaps may have positive ramifications. However, many of the solutions discussed in Chapter 5 are not simple to implement. They require clear understanding of the needs of each actor in the system and the role of the community. Solution implementation will require a dedicated effort from all players

in the SWM field to work together. Hence, effective communication plays an especially important part in Bangalore's transition to sustainable SWM. In fact it is the only tool, which, if used effectively, may help in addressing all of the problem areas.

Table 5
Potential for Alleviation of Core Problems by Addressing Identified Gaps

Core problems	**Addressing identified gaps in:**					
	Political Process	Incentivization	Recognition of cultural aspects	Inclusion of key actors & protection of livelihoods	Strategic thinking and innovation	Effective communication
Urban planning & health	Yes	-	Yes	-	Yes	Yes
Stakeholder participation	-	Yes	Yes	Yes	Yes	Yes
Political, financial and legislative authority	Yes	Yes	-	-	Yes	Yes
Culturally sensitive technology adaptation	Yes	Yes	Yes	-	Yes	Yes
Recognition of informal sector	Yes	Yes	Yes	Yes	Yes	Yes

Source: Based on author's research

The ZWM model, on the other hand, proposes a structural shift in waste management processes. The limitations of this model are that it requires a substantial amount of space in a city where land prices are high. According to Exnora there are 17 types of wastes that cannot be recycled. Hence, the model does not eliminate the need for

incineration, landfilling and other technologies, but it merely decreases the load on them. As Einstein once said "problems cannot be solved with the same mindset that created them." The model's strength is that it presents a radical new shift from the current centralized process. It is based on a different worldview and trajectory than the one imported from the developed nations, and thus offers a potential new model for success. It may give residents 'ownership' of the waste issue and decrease the 'out of sight – out of mind' attitude. The ZWM model may also pave the way for the strategic long-term inclusion of the informal sector, which stands to benefit greatly from this system. Further research and pilot tests can improve understanding of urban planning issues associated with a decentralized pathway. The municipality and other actors in the field need to embrace new roles and altered responsibilities if a modified version of the Vellore model is to be accepted in Bangalore. In the long term, ZWM encourages recycling and decreases the amount of waste entering landfill.

Table 6
Effects of Zero Waste Management Model in Alleviation of Process Problems

Process Problems:	**Zero Waste Management Model**
Stops or alleviates open dumping & unsanitary disposal	Yes
Aids collection rates:	Yes
Aids adequate storage	Yes
Aids better transport	Yes
Aids recycling options	Yes
Stops or alleviates hazardous material in MSW	No

Source: Based on author's research

Table 6 identifies the Bangalore process problems that could be solved or reduced by implementing the ZWM model. Theoretically, the model could alleviate five of the six process problems. If implemented in a ward wise system the ZWM would drastically reduce landfill waste. Since the waste is collected by source segregation, dry waste is no longer contaminated with organic waste and can be stored without negative consequences. The model certainly provides intermediate waste storage options, as segregated waste can be stored on the ZWM premises. The need for daily transport on big trucks and over long distances is completely negated, but transportation will be needed intermittently to transport bulk recycling material to their buyers. The model is completely dependent on community participation and involvement to segregate waste adroitly. It was necessary to scrutinize the actors in the system and incentivize a path towards a more sustainable SWM future in a way that is not threatening to their existence and livelihood. During my fieldwork I found no dearth of impetus as many people: professionals, citizens, doctors, lawyers and slum residents alike desired a better waste management system. But the biggest barrier to a sustainable SWM system, one that can be inimical to collective action and individual motivation, was, I concluded, corruption. That barrier will have to be overcome for SWM to become sustainable.

Fruitful avenues for further research on making SWM systems sustainable in India would include testing communication strategies in preliminary stakeholder meetings, evaluating how municipal and private sector roles would change in a decentralized system, further understanding the exact nature of PPPs in Austria and other countries with best practices in SWM, and understanding the psychology and view of waste in the Indian context and how it may be capitalized on to enhance sustainable SWM actions.

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APPENDIX A

INDIVIDUAL INTERVIEW GUIDE

All questions were IRB approved.

Questions for the KPCB:

1. How long have you been working for KSPCB?
2. What are your responsibilities here?
3. What is the most problematic waste in Bangalore - domestic or industrial?
4. Domestic waste can be managed well with citizen's initiatives, how about support for citizens for managing waste. How many waste segregation units have the government setup in various localities to aid citizens to manage waste?
5. What are the deterrents for government taking up initiatives for managing waste in India?
6. How many landfills are there around Bangalore?
7. With the city expanding what is the plan for waste management and reduction of waste at source?
8. What are the steps taken towards companies who are utilizing NON-recyclable plastic covers like aluminum mixed with plastic?
9. What are the steps taken by Government to ensure there are better working conditions for people in Naindahalli working on recycling units?
10. How would you connect the waste of city market to composting centers?
11. Why are there no designated transfer points in the city?
12. How do you think the segregation centers will work for the city?
13. What is the government doing to prevent waste?
14. Are there any awareness campaigns?
15. What is the annual budget for SWM in Bangalore?
16. How many contractors are there in Bangalore?
17. What are those contractors responsible for?
18. Do you think we should strive for foreign methods of WM (landfill, incineration) or devise our own?
19. How will we make our own path?
20. Have you heard of daily dump and Zero waste?
21. What are your thoughts on them? How can we encourage people like them?
22. What is the future plans for Bangalore n terms of WM?

Questions for the NGO, CBO actors:

1. What is your profession?
2. What made you go into WM when your day job is quite far from this subject?
3. How many years have you been active in WM?
4. What motivated to you to get into this field?
5. What have your experiences been?
6. What is the current structure of the waste management system in Bangalore?
7. Under who's authority is it?
8. How did it start?
9. What role does government have in sustainable solid WM?
10. What have your experiences been so far?
11. Government- top down versus people initiative– which is more effective?
12. If it is a combination of both, to what percent should the efforts be split in your opinion?
13. Any recommendations you have for future? How can we improve the current system? What can we make better? Where do we start?
14. What have your observations been on social aspects of waste?
15. Why do you think it is that the educated class in India is still not educated about waste, its consequences and proper disposal of it?
16. Are the caste system issues still prevalent in your opinion?
17. Do you think that sorting waste at source, - in people's houses is possible in India in the future?
18. Depending on your answer, what sort of government waste structure would be more apt?
19. What are the steps we can take for more awareness?
20. Why in your experience have people been impervious to this?
21. Tell me about reaction from different income classes and social classes.
22. Would you like to add anything more?

APPENDIX B

CONSENT LETTERS

INFORMATION LETTER
India.

Dear _____:

I am a graduate student under the direction of Professor Rimjhim Aggarwal in the School of Sustainability at Arizona State University. I am conducting a research project to identify barriers to implementing the Vellore Zero Waste Model and also Bangalore's current solid waste management system.

I am inviting you to an interview, discussing local resource use and waste, daily activities, and community trends. The duration of the interview will be 1 hour. You have the right not to answer any question, and to stop participation at any time.

Your participation in this study is voluntary. If you choose not to participate or to withdraw from the study at any time, there will be no penalty. You must be 18 or older to participate in the study.

Although there is no direct benefit to you, there are no foreseeable risks or discomforts to your participation. You are free to skips questions if you do not wish to answer them.

Your responses will be confidential. As this is an interview, complete confidentiality cannot be maintained. The results of this study may be used in reports, presentations, or publications but your name will not be used. Results will only be shared anonymously.

I would like to audiotape and take notes during this interview. You will not be recorded, unless you give permission. If you give permission to be taped, you have the right to ask for the recording to be stopped. The audio recordings will be stored on an external hard drive in a locker in the School of Sustainability to which only the researcher has a key. The audio recordings will be deleted after transcription and translation, which is expected to be by March 15, 2013.

If you have any questions concerning the research study, please contact the research team at:
Dr. Rimjhim Aggarwal – 480-965-6680, rimjhim.aggarwal@asu.edu
Nivedita Rengarajan –nrengara@asu.edu

Thank you,
Nivedita R.

If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at (480) 965-6788.
By signing below you are agreeing to participate to in the study.

_____ _____
Signature Date

By signing below, you are agreeing to be taped.

_____ _____
Signature Date

APPENDIX C

ADDITIONAL INFORMATION AND SAMPLE TRANSECT STUDY MATERIAL

Figure C- 1. Informal Waste Recyclers Reducing The Size Of Plastic Bottles To Sell As Raw Material For Other Industries.

Figure C- 2. Informal Workers Segregating Collected Plastic Items According To Grade

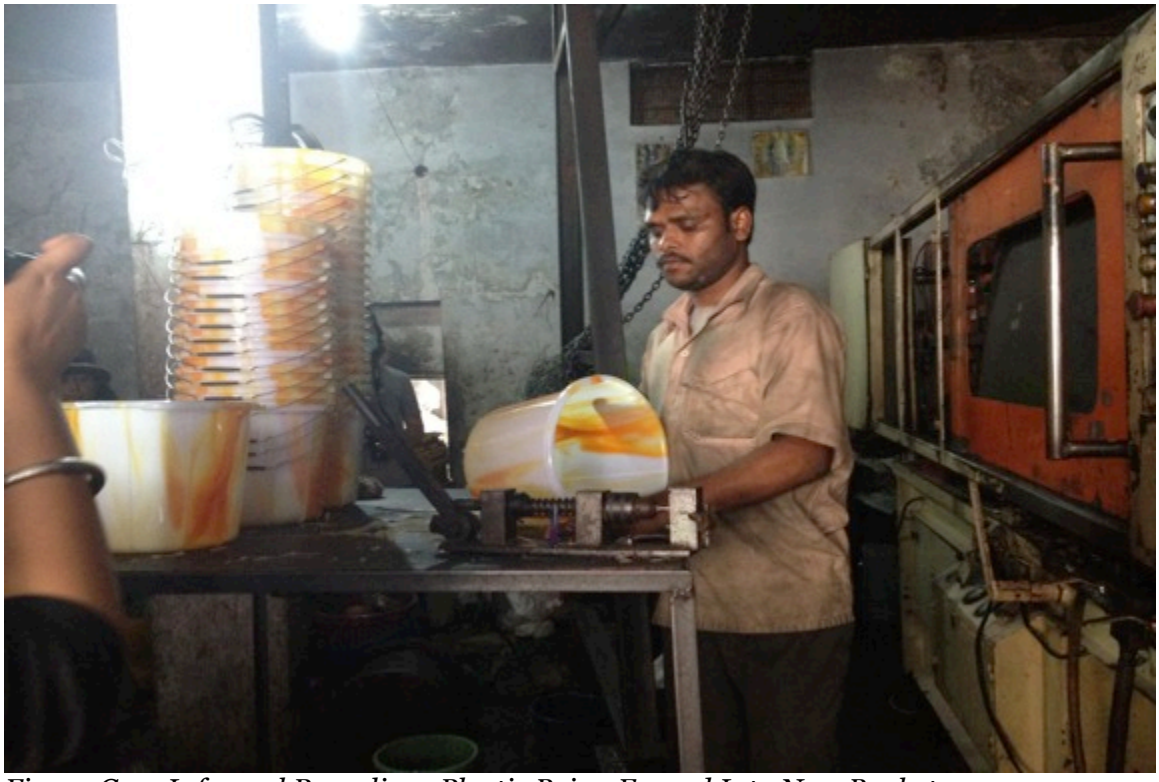

Figure C- 3. Informal Recycling; Plastic Being Forged Into New Buckets

Figure C- 4. Semi-Formalized Workers Recycling Aluminum Into New Products

Figure C- 5. Bulk Collection Of Plastic At A Kabbdiwalla Shop

Figure C- 6. Informal Bulk Collection Of Paper

Figure C- 7. Waste Segregation Awareness Campaigns After Court Order

Figure C- 8. One Of The Many Ad And Awareness Campaigns