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A Comparative Analysis of Alappuzha and Thiruvananthapuram

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Implementation of Decentralized Waste Management in Kerala:
A Comparative Analysis of Alappuzha and Thiruvananthapuram

Prathibha Ganesan[1]

Abstract

This paper attempts a comparative analysis of decentralized waste management system in Alappuzha and Thiruvananthapuram municipal areas.The study employed a combination of case study and primary survey methods. It was found that the process of implementation of the two waste management systems are different with its strength and weaknesses. While Alappuzha effectively utilised its community structures for waste management, Thiruvananthapuram fell short of it. The household waste management was more effective in Thiruvananthapuram than in Alappuzha. A transition in solid waste management was made possible by a combination of technological innovation, political will and social mobilization. Conversely, since the programme is in its nascent stage, regular monitoring of the programme with an institutional structure is recommended for identifying potential pitfalls and correction on time.

Keywords: Decentralized Solid Waste Management System; Municipal Corporation; Kerala

JEL Classification: **Q53**; **R00**

Introduction

In the year 2012 Kerala witnessed struggles against centralised waste management system[2] in at least 13 landfill sites. Landfills in half of these sites were closed now, and the local governments were forced to go for the decentralized waste management system[3]. Alappuzha and Thiruvananthapuram are two such places where landfill site are closed and alternative method of waste management was experimented. Alappuzha successfully implemented decentralized solid waste management system, and it is widely known as 'Alappuzha Model.' In 2016, Centre for Science and Environment, New Delhi considered Alappuzha as a clean city (Mohan 2016, Sambhyal 2016). Transition to decentralized solid waste management was not a mere bureaucratic process. It was a concerted effort to change people's waste management habits and to treat the waste at source. Alappuzha model of waste management has since then considered as a replicable model of decentralized solid waste management in the state. Thiruvananthapuram Municipal Corporation decided to follow Alappuzha model. A critical examination of the Alappuzha model of decentralized waste management has not been done in past and understanding its replicability in other settings is important from a policy implementation perspective. By doing a comparative analysis of decentralized waste management in Alappuzha and Thriuvananthapuram, this study intents to examine the process of mobilization and implementation of decentralized waste management and its sustainability aspects. The paper is divided into three sections. Section one looks at the existing literature on solid waste management and methodology of the study; section two explains decentralized waste management in Alappuzha and Thiruvananthapuram. Section three analyses the data to derive at the findings; followed by a conclusion.

Section I

1.1. Transitions in Solid Waste Management

Solid waste management is an integral part of urban socio-technical system. Increase in population and consumption lead to increased production of solid wastes in cities. A regular waste removal system is therefore important to ensure clean environment and better public health of people. Solid waste removal is an obligatory function of the local governments in India.The responsibility of solid waste management in the urban centres rests with the Municipal Health Offier. Industrialised countries faced the severity of increased waste production first, and therefore major technololgical innovations for solid waste management took place in Europe and the United States. Most such technologies focused on centralised waste management. India followed centralised waste management with focus on composting because of the wealth of biodegradable component in its waste stream. In centralised system waste produced in the city is carried away to be treated and disposed elsewhere. Mostly, wastes end up in landfill, but in this process amassing of waste takes place at the disposal sites which depletes the assimilative capacity of the earth and pollutes the environment. Due to the increase in amount of non-degradable wastes in the waste stream, after a point, trenching method becomes redundant paving way for open dumping of waste. Accumulation of waste thus destroys the environmental, economic and social well being of the residents living near the landfill sites. Studies have shown that socially deprived people live near the landfill sites and they are affected by environmental destruction of the neighbourhood. In many places, such discrimination has led to struggles against waste management (Pellow 2006, Lober 1995, Moore 2008). In a state like Kerala with space crunch and where rapid urbanisation occur, landfill sites spell a disaster. People protested

against the centralised solid waste management system and demanded closure of the landfill sites(Ganesan 2017). The government was thus forced to find alternatives for centralised waste management. Experts suggested decentralized waste management in the state.

In decentralized waste management system, waste is segregated and processed at the source. Composting and biomethanation are common methods used for treatment of biodegradable waste. Non biodegradable wastes are collected and made available for recycling processes. These aspects subtantially reduce the amount of waste reaching the landfill sites minimising associated issues. A transition from centralised solid waste management system to a decentralized solid waste system requires change in behaviour of the people. People are used to a throw culture and to change their behaviour towards processing at the source, they require motivation to recycle waste, which can be done by creating awareness and building infrastructure capabilities. Similary, innovations in technologies and its effective organization help in the smooth technological transition towards decentralized solid waste management system.

Interactions between a broad range of actors spearhead transition over considerable time-span by making changes in the technological, material, organizational, institutional, political, economic, and sociocultural dimensions (Fischer-Kowalski 2011). A transition can be technologically driven or socio-politically driven. In a technologically driven transition, usually alternative technologies are made available in a niche (university or lab), and when the circumstances are ideal, the new technologies replace the existing technologies (Geels 2011). Technological substitution occurs at a time when the innovations gain momentum, and it leads to rapid disruptions in the existing system leading to transition. However, technology substitution is not the only pathway that determines the transition, but social mobilizations and political decisions can lead to a transition. Sociopolitical transition can be the result of either resistance

movements or mobilizing for change in the society. Pressure groups, the professionals, entrepreneurs, and politicians play a lead role in such a transition. Mostly the policy decision makers enact the process of transition in response to the pressures from outsiders. However, a transformation does not occur at the first instance of resistance from the outside group. Rather it takes prolonged conflicts, contestations and power struggles from outside to influence the system actors (Geels 2011).

Mobilisation concerning solid waste management are of types in Kerala. Mobilisation of the marginalized communities that bear ill effects of accumulated solid waste (inhabitants near the landfill sites) against landfill sites (Ganesan 2017) and the mobilization of people to ensure a behavior change towards waste management (waste producers)(Choudhary 2017). While the first one triggers a policy change, the second kind of mobilization sets the stage for transformation process. When mobilization is against an existing system the reaction of the government is to introduce new technologies and organise the system in such a way to minimize the impact (Davies 2008). But such changes are experimented within the existing system to improve the effectiveness of the system. However, lack of permanent solution for people's issues result in prolonged struggles for decades and the stability of resistance have the potential to spearhead a transition (Ganesan 2017). Prolonged protests can lead to the system collapse or reorientation of the system. The mobilization for behavior change however targets the city dwellers towards effective waste management at the source. Such mobilization of waste producers in effect prevents the negative impact of waste on environment and vulnerable population. The idea of behavior change mostly rests in the recent political theories like neoliberalism and post-Marxism which hold the view that "states and markets cannot and should not be solely responsible for ensuring social equality and welfare growth. Local actors, knowledge, and interventions are key features in …conceptualizations of development" (Mohan and Stokke 2000). Legget

(2014) argues that in an increasingly complex, differentiated and individualized society which presents challenges, only a widespread behavior change on part of both individuals and institutions can address the issue. A social capital which accepts behavior change fosters reciprocity, facilitates information flows, and tends to be self generating by socialising successive generations into the localized norms which create success (Michie et.al 2011). Capability of the individual, opportunity, and motivation ensure behavior change in people.

How has the behaviour change toward decentralized waste management made possible in Kerala? Are the people satisfied with the new system of waste management? Is the decentralized model of waste management sustainable? The process of implementation of decentralized solid waste management is yet to be critically studied. Therefore, this paper examines the process of implementation of decentralized waste management in Kerala with special reference to Alappuzha and Thiruvananthapuram. The specific objectives of this paper are 1) to examine the transition in waste management from a centralised system to decentralized system in Kerala; 2) to analyse the possibilities and limitations of the decentralized waste management system; and 3) to examine the social viability, replicability and sustainability of decentralized solid waste management in Kerala.

1.2. Methodology

1.2.1. Data and Method

Decentralized waste management is on the agenda of Kerala Government. However, Kerala has limited number of local governments which successfully implemented decentralized waste management. Alappuzha Municipality is one of them, and it has successfully implemented the first phase of decentralized waste management programme called “Clean City Clean Home.” Thiruvananthapuram

Municipal Corporation followed the path of Alappuzha Municipality a programme called "My City, Beautiful City." Though the concept is same it is important to study the local adaptation of technological and organizational innovations in dencetralized waste management. Therefore, a case study of Alappuzha and Thiruvananthapuram is done to understand the dynamics of transition in solid waste management. The case study method shed light into the process of transition towards decentralized waste management. Household survey was done to explore the effectiveness and sustainability of decentralized waste management in both the cities. Thus this study uses a combination of both survey research method and case study method.

In both the places, decentralized waste management is in different phases of implementation. In the first phase of implementation, decentrlaised waste management was rolled out in 12 wards of Alappuzha Municipality. The success of decentralised waste management in Alappuzha is attributed to these 12 wards. Second phase of the programme was under implementation during the study period Primary data was collected from twelve wards in Alappuzha Municipality where the programme was implemented. In Thiruvananthapuram, the programme was implemented across all the wards on a need basis.

Total sample size of the study was 100 households. Data was collected from 75 households in Alappuzha and 25 Households in Thiruvananthapuram. The sample size in two locations varies because a massive participation of households in the new programme as seen in Alappuzha could not be observed in Thiruvananthapuram. Random sampling was not possible in Thiruvananthapuram as the implementation of the programme was purely on a need basis and houses where the programme is implemented is scattered. Therefore, a purposive sampling was done in both the locations. The purpose of the primary survey was to understand people's preference of the technology, their experience with the implementation of the programme and people's knowledge of

the decentralized waste management. In both the locations the list of households that installed any of the decentralized waste management technology was collected from the respective offices. Wards for data collection were then randomly selected from the list. In Alappuzha, since massive participation of the households occurred, households were approached from all sides of a ward. Every fifth household was then chosen to collect the data. It took ten days to complete data collection in Alappuzha. In Thiruvananthapuram, decentralized waste management was implemented with the help of registered non-governmental organizations. The civil society organizations were contacted for identifying wards and households that implemented the programme. Data was then collected from the identified households. Out of the four civil society organizations, Haritha Nagaram was non-cooperative (even after repeated attempts to contact the responsible person) and therefore the status of waste management in their designated areas is missing in this study. The reason for non-cooperation is unclear. Thus the primary survey from both locations includes only households which implemented the programme. Since the sample size was small for a statistical analysis, collected data was cross-tabulated to do the analysis. In addition to the primary survey, semi structured interviews were used to collect data from Municipality or Corporation officials, contingent labourers, and service providers. The interview data provided adequate information on the transition in waste management from the perspectives of decision maker and implementer. Interview data were coded and thematically organised. In addition to this 10 households which did not participate in the decentralized waste management programme in both study sites were visited to understand the reason for their non-cooperation in the programme. Both the primary survey data and interview data were used to derive at the conclusion.

1.2.2. Locale of the Study

Alappuzha is a tourist destination with backwaters, canals and beaches located in Kerala. It was described as the 'Venice of the East' by Lord Curson. Alappuzha Municipality is a coastal urban local body with Vembanad Lake (largest brackish water lagoon) in the east, the Arabian Sea in the west, Punnapra North Panchayat in the south and Mararikkulam and Arayanad Grama Panchayats in the north. Alappuzha municipality covers an area of 46.77 square kilometres, and it holds an urban population of 197029 (Census 2011). Alappuzha has the highest population density (3074) in the state and a floating population of 10000. It has about 42957 families and produces around 242g solid wastes per head daily which adds up to 50 tonnes in total. The Municipality transported nearly 40 tonnes of wet waste and 8 tonnes of nondegradable waste to the landfill site which is located in Sarvodayapuram under the jurisdiction of Mararikulam South Gram Panchayat until its closure. Sarvodayapuram was the night soil depot of the Municipality since colonial period. Apart from night soil, solid wastes and cadaver from the town found its way to the site. When modern toilets came into existence in Kerala, the night soil collection disappeared from the public arena. However, Sarvodayapuram continued to act as a solid waste repository from the town. Poor people from different walks of life moved to Sarvodayapuram as the economic value of the land was cheap due to the presence of landfill. When quantity of waste reaching the Sarvodayapuram landfill increased inducing environmental health impact, people rose in protests, and the local government had to take new initiatives to deal with the issues. No measures under the existing system to prevent issues worked, and the government was forced to close the landfill site and treatment plant. Since solid waste management was an obligatory function of the local government, it had to find new ways to tackle waste. Government thus decided to go for a decentralized model of waste management called the "Clean City Clean Home" programme.

Thiruvananthapuram is the capital of Kerala. The Municipality came into existence in 1920, and after two decades it was converted into a Municipal Corporation on 30th October 1940. Thiruvananthapuram Municipal Corporation (TMC) has a land area of 214.86 sq.km with a total population of 9, 57,730. For administrative purpose, TMC is divided into 100 wards. Thiruvananthapuram produces around 300 Tonnes of solid waste per day. Since the year 2000, the Corporation transported collected waste to a village called Vilappilsala which is located 12 Km away from the city for treatment in a centralised composting plant in Vilappilsala. However, mixed wastes that reached the site reduced the efficiency of the plant, and rejects were openly dumped. Garbage accumulated in the village caused public health issues and leachate from the plant polluted the water sources. People protested, and litigations were filed demanding closure of the plant. In 2012, after Supreme Court judgement to limit the amount of waste transported to the village, the Corporation decided to dump waste with the help of police force and this led to ruckus between the Municipal Corporation and the villagers, finally leading to the closure of the waste treatment plant. The TMC leadership later decided to go for decentralized waste management. Some garbage dumps in Thiruvananthapuram was cleaned, and aerobic bins are established initially as part of decentralized waste management. Corporation distributed Pipe composts, Kitchen bins, and Biogas plants to households as per their demand. The decentralized waste management programme in Thiruvananthapuram is called “my city, beautiful city” programme.

Section II

This section discusses the issues of centralized waste management and experiments with decentralized waste management in Alappuzha and Thiruvananthapuram. The main objective is to understand the factors that triggered and processes that enabled the transition.

2.1. Case 1: Alappuzha

2.1.1. Perils of a Centralised Solid Waste Management System in Alappuzha

Alappuzha (earler called as Alleppey) Town Improvement Committee constituted in 1894 appointed the *Thotti* community to clean the toilets. The *Thotti* community belonged to the lowest strata of caste hierarchy and was occupationally linked to cleaning the toilets. They inhabited in Sarvodayapuram, a 20 acres land owned by the Municipality, where they carried night soil (human faeces) collected from the Alappuzha town. Night soil, other solid wastes, and cadaver from the town were buried in trenches. Overtime, poor people bought land in the area and as early as 1950 people living near the landfill site had issues with the landfill site. The discontent of people was due to the destruction of coconut trees by an insect named *Komban Chelli* (Oryctes Rhinoceros) which grew in the waste heaps, and pollution of the drinking water sources (Isaac and Gopakumar 2014). Municipality decided to bring in a sewage treatment plant in the area. However, common use of onsite sanitation technologies made the sewage treatment plant obsolete. Other solid wastes and carcases continued to be transported to Sarvodayapuram village. Slowly, composition of people living near the landfill site changed. The Thotti community shifted to the town, and economically weaker sections of the population bought land near the landfill site. As the population in and around the landfill site increased, the issues related to waste dumping became a prominent socio-political issue (Isaac and Gopakumar, 2014). As a result, local government set up a windrow composting plant in 2005 with the support of state government. Municipality signed an agreement with Andhra Pradesh Technology Promotion and Development Centre (APTPDC) to set up a waste treatment plant. The plant could turn 50 tonnes of wet waste produced in Alappuzha into compost on a daily basis. The project cost was Rs.3.77 crores.

Contingent workers of the municipality collected wastes from the streets and carried to the treatment site. For effective function of the waste processing plant however segregated waste is a must and Women's Self-Help Groups named Kudumbashree was involved in door to door waste collection from the town. However, the initiative failed as the people believed that SHGs engross in the collection of mixed waste for financial gains. Mixed waste reaching the plant reduced the operational capacity of the machines. The treatment plant could not treat desired quantity of waste, and it processed only 5-10 tonnes of waste daily. Rejects from the plant were land filled using trenching method. Soon trenching became obsolete due to increased amount of plastic in the municipal waste stream. Waste piled up in the landfill site and people rose in protests with continuous struggles. However, waste dumping in the area continued until 2012 when a hundred day long strike was called by the nearby residents with protests, hunger strikes and blockade of the road that lead to compost plant. Since Sarvodayapuram was under the jurisdiction of a Gram Panchayat, it rejected the renewal of No Objection Certificate (NOC) to continue transporting waste to Sarvodayapuram. In official meetings that followed decision was taken to allow only 5 tonnes of waste to the village on a daily basis. In 2014, the Panchayat withdrew the permission to transport waste to Sarvodayapuram completely which forced the local government to bury collected waste in the open spaces in town for some time. Soon land available in town for burial exhausted resulting in waste accumulation in the streets, canals, and backwaters. Vector-borne diseases like Chikungunya and Dengue became regular. Factors like peoples protest, public health issues, and cancellation of NOC by the Gram Panchayat forced the urban local government to find alternatives for effective waste management.

Suchitwa Mission, state nodal agency for sanitation directed the local self-government to go for decentralized solid waste management instead of a centralised system. Both Mararikulam South

Gramapanchayat and Alappuzha Municipality was ruled by Communist Party of India, Marxist (CPIM). Therefore, the Member of Legislative Assembly who is also from the same political party called for a meeting to discuss the issues of waste management in Alappuzha. A series of meetings were held with municipal authorities, resident associations, councillors, and leaders of political parties. Women's Self Help Groups were entrusted with surveying household waste disposal pattern and their requirements. After a series of deliberations, Alappuzha Municipality approved the idea of a decentralized waste management. Integrated Rural Technology Centre (IRTC), a Kerala Shastra Sahitya Parishad(People's Science Movement) agency, and Kerala Government's Agency for Non-Conventional Energy and Rural Technology (ANERT) was also roped into the discussions. Finally, a decentralized waste management programme called "Clean Home Clean City" was designed after the collective effort. The staff of the Municipal Health and Sanitation Department took the lead of the programme.

2.1.2. Decentralized system in Alappuzha ("Clean Home Clean City")

Alappuzha Municipality has 52 wards and 40000 households. The Urban Local Body decided to implement the programme in different phases. In the first phase, Municipality selected 12 most urban wards with total of 12000 households for implementation of the programme. The programme suggested maximum number of households with adequate land to adopt portable biogas plants (Fig 1) and those households with no space to adopt pipe composting (Fig 2). Portable biogas plants which cost nearly Rs. 13500 and can treat 5-7.5 kg of waste and it is provided by IRTC. Similarly, those households which require fixed biogas plants were supported by ANERT. A fixed plant has an operational capacity of 8-12 kg of solid waste, and it cost Rs.17500. Suchitwa Mission gives 75% subsidy to biogas plants.

Pipe compost is ideal for a small family. It consists of two PVC pipes with 1.25 m length and 8 inches diameter. The pipes are positioned vertically immersed in the soil up to about ¼ m. The pipes have lids, and a layer of gravel is placed at the bottom of the pipe for leachate absorption (Narain and Sambyal 2016). Households put daily waste into one of the pipes until it is full and then close it for biodegradation while using the other pipe for waste disposal. By the time the second pipe fills, waste in the first pipe is turned into compost which could be used by households for gardening purposes. Pipe has some holes on top sides to provide aeration. Cost of installation of pipe compost is Rs. 890 and Suchitwa Mission, gives 75% subsidy to biogas plants and 90 percent subsidy for pipe compost. Apart from the household waste treatment facilities, the municipality also introduced community composting facilities known as Thumburmuzhy model aerobic bins. Thumburmuzhy aerobic composting technique was developed by Dr. Francis Xavier of Kerala Veterinary and Animal

Figure 1. Household Biogas plant

Sciences University with an aim to provide cost effective and eco-friendly waste management system suited for Kerala Agro eco-zone. During an online discussion in a social media group called Fourth Estate Critique, Dr. Xavier, introduced the Thumburmuzhy model and the political leadership who was also part of the discussion decided to experiment with the innovations in decentralized waste management in Alappuzha. The technology was then modified to aerobic compost unit with a layering system to handle organic waste and carcass. The structure is a box with Ferro-cement floor and handles. Layers of cow dung, solid waste are subjected to composting in the presence of oxygen. The temperature increases rapidly to almost 70 degree celsius that kills the pathogens. Microorganism like bacteria, fungi, and actinomycetes are key to the composting process. As composting progresses the carbon in the waste is converted to products like carbon dioxide, water and humus or compost (Xavier, Girija, Kurien & Deepak 2013). Kitchen bin is another technology used for composting developed by IRTC. Waste is stored in a bag kept inside a plastic bucket and it is designed to treat the biodegradable waste aerobically.


Figure 2. Pipe compost

In Phase I of Clean Home Clean City Programme 2800 pipe compost units and 3000 biogas plants were distributed to households. Similarly, the municipality constructed 14 aerobic units with 165 bins for community waste management. In the second phase 300 more aerobic

bins, 10,000 kitchen bins, and biogas plants are to be distributed. Funds are allocated for a plastic waste recycling unit and a material recovery centre. Aerobic bin clusters accept non-bio degradable wastes and sell to Clean Kerala Company Ltd, Thiruvananthapuram or Amala Eco Clean in Tamil Nadu.

The transition in solid waste management in Alappuzha involved both technological and non technological factors. Technological innovations and coordinated work of different actors made the transition possible. Cost effective small scale technologies developed by different agencies made recycling possible in the household premises. IRTC developed Pipe compost and portable biogas plants with modifications to the existing technologies. ANERT worked on the fixed biogas plants. Community aerobic bin is the result of experiments conducted in Veterinary and Agricultural University of Kerala for Kerala agro-economic zones. The university acted as a niche for innovations in compost structure and inoculums. Social media played a role in adopting this technology. However, technological innovation alone does not ensure a transformation in waste management. Coordinated works of different actors played a crucial role in the transition.

Municipality Health and Sanitation officials took the lead in the implementation. Gaining attention and confidence of citizens was a major task for the officials. Different groups conducted various types of mass campaigns in the area. WATSAN (Water and Sanitation) clubs were introduced in the schools to create awareness through children. Children were encouraged to segregate plastic wastes at the household through an exchange programme called 'give plastics and take away books'. Student cadets were formed to prevent public from throwing away waste. Many art forms were used to spread the messages to public like street plays, poetry, painting and flash mobs. Artists joined to do paintings in the Watsan aerobic parks in the city. Christmas Carols with a message for source treatment of waste was conducted during the season. Members

of the people science movement engaged in active campaigning. Municipal officials including Health Inspector and Junior Health Inspectors played a crucial role. A night squad was formed to monitor the street discard of waste. Citizens who threw away waste into the streets were publicly shamed and fined. Surveillance cameras were installed in the streets to monitor defaulters who throw-away waste. Contingent labourers were organised into different groups to segregate waste and manage the community aerobic bin clusters. Self Help Group (Kudumbashree) women who engaged in waste collection earlier were trained by the IRTC to provide technical service to the households. They actively involved in identifying beneficiaries, installing the technology and providing services after installation to households. Local newspapers and social media also played a crucial role in spreading the message of decentralized waste management. The municipal wards which effectively implemented decetralised waste management were given Complete Suchitwa Ward (complete clean ward) status. Thus, technological and non technological factors played a critical role in the implementation of the decentralized waste management system. Technological factors and social interventions facilitated the implementation of decentralized waste management. First phase of clean home clean city programme successfully ended in 2016, and the model was known as 'Alappuzha Model' of decentralized waste management.

2.2. Case 2: Thiruvananthapuram

2.2.1. Perils of Centralised Solid Waste Management in Thiruvananthapuram

Under the centralised system, solid wastes from the households, market places, and commercial centres were discarded in the streets for the Municipal sanitation staff to collect and dispose. Before, beginning of the millennium, the wastes from Thiruvananthapuram was transported

to Vallakadvu. However, in 1985 the state government ordered for closure of Vallakkadavu waste dump as per the request from the Airport Authority of India. Airport authority warned the government that scavenger birds near dump site are a potential threat to aircraft safety. After the closure of the dumpsite, at Vallakkadavu, the TMC decided to go for centralised scientific waste management. They bought land at Chovallur ward of Vilappilsala Grama Panchayat and Commissioned a waste processing plant. Corporation chose windrow composting as the preferred method of waste management, and the agency called Envirotech operated the plant. The plant could treat 300 tonnes of waste per day. The agreement between the local government and the agency was that the government provides adequate waste for the plant and agency processes them. However, the government could not provide adequate waste and also the wastes provided were non-segregated. Only a third of the total amount of waste reaching the plant could be processed using windrow composting, and rejects were openly dumped. Soon Vilappilsala turned into a dump yard. Number of reported Asthma and gastrointestinal cases increased in the Primary Health Centre in the village. Nauseating smell created health issues for people which aggravated when the waste dump catches fire. Vectors like mosquitoes and flies made the life miserable and stray dogs became a nightmare. Water sources were polluted because of the leachate from the waste dump. Door to door waste collection by Kudumbashree was introduced in the city to speed up the process of composting by source segregating the waste. However, the issue aggravated as increased amount of waste reached the landfill site. TMC took over the plant from Envirotech in 2008 and transferred the operations to an NGO. The issues, however, continued affecting the environment and health of the inhabitants.

When the livelihood of people was affected, they mobilized to form a local organization called *Vilappilsala Janakeeya Samara Samithy*

which led the fights for villager's rights. People of the village questioned the involvement of Kudumbashree and carried out protests demanding closure of the plant and landfill site. Due to the increased complaints from the local community, the Vilappil Grama Panchayat, under whose jurisdiction the plant was located, was reluctant to renew the No Objection Certificate leading to a row between the rural and urban local governments. TMC filed a petition in the High Court, and the court ruled in favour of TMC. Panchayat challenged the High Court ruling at the Supreme Court (SC). SC ordered a reduction of the quantity of waste carried to the plant from 300 tonnes to 90 tonnes. With the help of court order and police force, TMC tried to dump waste in Vilappilsala forcefully. However, people protested, and the state government intervened to stop the waste transport temporarily. After the stipulated period ended, when TMC made the first move to transport waste, people resisted. The villagers hit the streets in large numbers and blocked the vehicles from entering the village. Finally, the processing plant and landfill site in Vilappilsala was closed down. After the closure of landfill site, TMC stopped collection of solid wastes from the city. The city turned into a garbage dump within days as people discarded wastes on the streets. Plastic burning in the streets made the city smoke filled. Number of rodents increased, and the public health of the city was in danger which forced the TMC to go for decentralized waste management.

2.2.2. Decentralized WM in Thiruvananthapuram ("My City Beautiful City")

When the landfill site was closed, the Corporation decided to go for decentralized waste management. In the initial stages, the Corporation distributed pipe composts to the households with the help of Kudumbashree in some of the wards. However, it soon became a failure. According to IRTC, the pipe compost works well when it is made of

Ferro cement. However, because the Corporation had to make large number of pipes for distribution, it went for PVC pipes. Health Official mentioned that this shift led to failure of the technology. Aeration did not happen in the pipes which led to anaerobic digestion of wastes that increased nauseous smell. Households were disillusioned with the initiatives. Later, pipes with holes for aeration were distributed. However, problems continued as the worms in the pipe compost crawled out through the holes. In the subsequent local election Communist Party of India, Marxist came into power. The party was in favour of decentralized waste management. With the support of Dr. Thomas Isaac, Member of Legislative Assembly, and other members of Communist Party of India, Marxist (CPIM), a drive for decentralized waste management began in the name of "Ente Nagaram Sundara Nagaram" (My city Beautiful City). The programme aim at creating awareness on effective waste management and implement measures to make the city garbage free. TMC envisages: 1 60% households with the waste treatment facility, 2)80% households have a tie up with service team for waste management, 3)plastic and e-waste collection services, 4)installation of adequate number of community waste treatment facilities and 5)a common waste treatment facility in each ward (TMC 2017). The wards which

Figure3. Watsan park turned dumpsite in Thiruvananthapuram

successfully implemented the programme were given Suchitwa or clean city award. Some of the open dump sites in the city were cleaned by politicians and civil society to start off the programme. However, after a point, the cleaned sites again turned into dumping yard. Similarly, aerobic bin clusters were constructed in some wards in the city. However, the aerobin clusters were not maintained properly and people dumped the waste in front of the aerobin clusters (Fig 3). It seems that inconvenient timing of waste collection in the clusters and the incompetent implementation of new programme has resulted in people's negligence of clean aerobic bin clusters in the city. Very recently some of the aerobic bin clusters have been removed from the city by authorities. Thus community waste management under decentralized system in Thiruvananthapuram faces serious challenges, unlike Alappuzha.

Implementation of household waste management in Thiruvananthapuram is different from that of Alappuzha. Household campaigns were conducted to create awareness and ensure engagement of public in the programme. Three types of waste treatment facilities were made available for people 1) pipe composts, 2)Kitchen bin, and 3)Biogas plants. Initial interventions with the Pipe composts failed because of the worms and smell that disillusioned people with the new programme. Therefore, TMC decided to supply Kitchen bins to households, and it is being distributed with the help of civil society agencies in the city. Kitchen bins are normal plastic laundry basket with a sac, choir residues, and inoculum . One sac is placed in the basket and waste is put on the already placed choir residues and inoculum. The process continues, and when the sac is full it is removed, and a new sac is placed. The first sac is then kept for a month for bioconversion. Biogas plants in Thiruvananthapuram were distributed by many private agencies like Biotech, Greentech, ANERT, IRTC, etc. No agency had a powerful influence on the local government in distributing biogas plant at a massive scale in Thiruvananthapuram unlike that of Alappuzha where IRTC and ANERT

steal the show. Decentralized waste management programme in Thiruvananthapuram is implemented through four different agencies. The agencies are allowed to distribute kitchen bins, collect non-degradable wastes from the households and provide necessary service for treatment of biodegradable waste when required. The agencies are V-Care, Harithagramam, Haritha Nagaram, and Pelican Foundation. Operational details of these four agencies are given below.

Vcare- Vcare is a Bangalore based private agency which took up waste management in Thiruvananthapuram when Vilappilsala waste treatment plant was closed down. TMC granted permission to the agency to collect wastes from households and institutions. Currently, Vcare collects biodegradable waste from nearly 10000 households and all major hospitals, medical college and some of the hotels. Households are charged Rs. 300 monthly and institutions are charged Rs.60 per bin per day for their services. Collected wastes are either converted into chicken feed or buried in rubber plantations with the permission of farmers (fig 5). Rubber estates that bury waste is located in three regions: Vizhinjam, Kattakkada and Kanjiramkulam.

Recently officials from Suchitwa Mission visited the rubber plantations where waste is buried and concluded that this method is not a viable option for waste management. They were concerned that the places for burial may exhaust soon and also the method is against principles of decentralized waste management. Recently, the agency developed a V-compost bin which is patented . The V-compost bin is a square box with two plastic drum with holes in it. Both the drums and the square box have separate lids. At the bottom of the box, there are two drawers to collect leachate from the bins. Households use one bin at a time. Saw dust and inoculum are provided to the households for speeding up the degradation process. Once one of the bins is full, it is closed, and the other bin is used. The total installation cost is Rs. 2000 and the service team provides weekly assistance to the households for a monthly pay of Rs.300. Later, agency collects the compost from

households for commercial sale. Currently, V-care bin is used by ten households in the city, and the agency is planning to expand the programme to affluent households of the city. However, TMC is reconsidering the permission given to the agency because they follow a different path of waste management which is not in alignment with the vision of decentralized waste management.

Harithagramam: Harithagramam is a non-governmental organization engaged in promoting organic agriculture. As the issue of solid waste increased in the city, the organization decided to spread their activities to solid waste management as well. The organisation reached an agreement with TMC in 2015 to distribute kitchen bins, choir pits and inoculam to the households for composting and provide services whenever necessary. TMC provided kitchen bins to the organization. The organization also collects non degradable plastics once in a month and electronic wastes once in three months from the households. Collected plastics and electronic waste are then handed over to the TMC for sale to the recyclers. Harithagramam takes a monthly user fee of Rs.200 from the households. The installation cost of kitchen bins for the household is Rs.200. Harithagramam currently has 20 staff and each staff cover 250 households. Currently, the organization provides service to 3531 households across 18 wards. The staff of the organization collects organic compost from the Kitchen bins from households, stores it at a repository located in Vanchiyoor and sells it to the farmers for agricultural purposes. The revenue generated from the sale of manure is then used for organization expenses. A representative of the organization mentioned that some households are unwilling to do source treatment of waste because independent Kudumbashree women still engage in waste collection from the households which are then openly dumped in the city.

Harithanagaram: The contact person of the organization was contacted several times to collect information. However, he refused to support the research or give time for an interview. Requests through

the officials were also turned down. Therefore, data on implementation of decentralized waste management by this organization is unavailable.

Pelican Foundation: Pelican Foundation works closely with the TMC and Suchitwa mission to implement decentralized solid waste management in Thiruvananthapuram. Currently, two wards (Shasthamangalam and Kamaleshwaram) are covered by the organization. Initially, they provided two large baskets with holes in the lid for composting purposes. Currently, TMC provides kitchen bins, and Pelican Foundation distributes it to the households. Like Harithagramam, they also engage in the non-degradable and electronic waste collection. The households provide a user fee of Rs.200 for biodegradable waste and Rs.100 for non-bio degradable wastes. Pelican Foundation staff provide service to a total of 400 households in Kamaleshwaram and Shasthamangalam. They also collect organic manure from the households who do not use it and sell it to the farmers.

Apart from these organizations IRTC also provide biogas plants to the households. Many other private agencies and individuals collect waste from the households. However, there is no system to monitor these agencies that involve in the waste trade in Thiruvananthapuram which can be detrimental to effective implementation of decentralized waste management. My City, Beautiful City programme is in its first phase. Even though households are coming up with requests for newer technologies, most of them still prefer their waste to be collected and removed by Corporation staff. Therefore, the private agencies which engage in waste collection from the households can be a threat to the implementation of decentralized waste management.

Unlike Alappuzha, the response rate towards implementation of decentralized waste management was slow in Thiruvananthapuram. The monsoon in 2017 played havoc with public health in the city with lakhs of people affected by vector borne diseases. The poor state of solid waste management was under scrutiny. This forced the government to reinvigorate the programme. In this context understanding household

perspectives of decentralized waste management is important. Since the households that implemented the programme can influence the motivation of the rest of the households, households that implemented the programme is studied in detail. Citizen perspective on the implementation of the programme points to issues that need to be addressed by decision makers.

Section III

3. Citizen Perspective of Transition in Waste Management

Political institutions and civil society played a major role in the transition in solid waste management in both Alappuzha and Thiruvananthapuram. But, any public programme becomes successful when people accept change and work towards its continuity. In the implementation of any major innovations in the society, the experiences of initial users are crucial. Positive response from a user can accelerate while a negative response can decelerate the diffusion of new idea and technologies. Understanding the initial user's reaction to decentralized waste management in Alappuzha and Thiruvananthapuram may lead some light into the current status of its implementation. Therefore, a primary survey is carried out in the households of initial users to understand their perception and experience of decentralized waste management.

According to urban aggregate figutres in Kerala, nearly 70 percent of the solid waste produced is a biodegradable wet waste and 30 percent non-biodegradable waste. Plastics constitute a major component of the non degradable waste produced which is detrimental to the environment and society as a whole. In decentralized waste management, therefore, the emphasis is given to source treatment of biodegradable wet waste and recycling of plastics. While studying solid waste management, the structure of houses in Kerala is important because it is believed that independent houses have space to treat their

wet waste compared to apartments that completely depend upon the municipal services for waste removal. Most houses surveyed were independent houses in 5 cents or more of land in both Alappuzha and Thiruvananthapuram. Most households surveyed produce one to two kilograms (48% Households in Alappuzha and 56% households in Thiruvananthapuram) of biodegradable waste (Table 1).

Table 1. Daily waste production in households in the sample area (%)

Waste Produced in households /day	Alappuzha (N=75)	Thiruvananthapuram (N=25)
<1 kg	36%	44%
1 kg-2 kg	48%	56%
>2 kg	16%	0%
Total	100%	100%

Source: Primary Survey

In Alappuzha, most of the suurveyed households opted for biogas plants. Out of the 75 households, 55 of them used biogas plants (46 portable and nine fixed). Households with cattle used fixed biogas plants. Fifteen households opted for pipe compost, and five households carry waste to the nearest community aero bin cluster. In Thiruvananthapuram, however, a maximum number of households opted for Kitchen bin (52%) followed by portable biogas plants (24%)(Table 2). Respondents in Alappuzha mention that an emphasis campaigners emphasized on the adoption of biogas plants for implementing decentralized waste management. Similarly, Kitchen bins are predominantly distributed by the agencies in Thiruvananthapuram. That is the household choice of technology has been influenced by the local governments preference for certain technologies.

Table 2. Waste disposal technologies used in the households in sample area (%)

Technologies used for waste treatment	Alappuzha (N=75)	Thiruvananthapuram (N=25)
pipe compost	20%	8%
Biogas portable	61.3%	24%
Biogas fixed	12%	4%
Aerobin	6.7%	4%
Kitchen bin	0	52%
Others*	0	8%
Total	100%	100%

Source: Primary Survey

*Others include a combination of technologies for waste treatment

However, when asked about their preference, respondents mentioned that they preferred the current technologies because 1) It was used by neighbours (66.6% households in Alappuzha chose biogas plants for this reason); and 2) The technology was useful either in the form of slurry, compost for agriculture, fuel for consumption, or subsidy incentives (52% households used kitchen bin in Thiruvananthapuram because it provide compost for gardening)(Table 3). Unlike Alappuzha where the households had land area for using a biogas plant, in Thiruvananthapuram the houses are crowded. Cost effectiveness and lack of space would have been reasons for promoting kitchen bin in Thiruvananthapuram. Campiagn strength, neighbours opinion and availability of technology seem to be a decisive factor in the diffusion of the technology in both the places.

Table 3. Reasons for household choice of technology in the study sites (%)

Reasons for choosing the technology	Alappuzha(N=75)	Thiruvananthapuram (N=25)
Used by neighbours	66.6%	44%
Utility of the system	29.3%	52%
least cost	1.5%	0%
Ignorance	2.6%	4%
Total	100%	100%

Source: Primary Survey

The technology has been in use for sometime now. How many households continue to use the technology? Primary survey (Table 4) shows that 62.6% households in Alappuzha and 96% in Thiruvananthapuram still use either biogas plants or composting. However, in Alappuzha, a substantial number of households also treat waste using pits (22.6%) or indulge in throwing away (14.6%). Households which use pits or throw away waste are those households in which biogas plant or pipe compost failed. In Alappuzha waste is thrown into the canals or streets. In Thiruvananthapuram, people chose one or more technologies as per their requirement and availability of space. Respondents in Thiruvananthapuram seem to be satisfied with the technologies.

Table 4. Management of biodegradable waste by households (%)

Biodegradable waste treatment	Alappuzha (N=75)	Thiruvananthapuram (N=25)
Dispose in pits in the premises	22.6%	4%
used in biogas plants	53.5%	24%
throw out	14.6%	0%
pipe compost	9.3%	20%
Kitchen bin	0%	36%
Others	0%	16%
Vcare bin	100%	100%

Source: Primary Survey

Plastics constitutes a major portion of the non-degradable wastes produced by households. It has been a major challenge for effective waste processing. Segregation of plastic from the biodegradable waste is crucial in decentralized solid waste management. What do households do with the plastic waste? What options are there for effective plastic waste management in the samaple area? Most households in Alleppey (80%) were found to burn their plastic waste along with dried leaves (Table 5). Burning of plastic is detrimental to health because of the toxic emissions. The people in Alappuzha were aware of the ill effects of burning plastics. However, they believed that they had no option than to burn plastic. It was evident that the people were unaware of the

arrangement that aerobic bin clusters collect recyclable waste to distribute to Amala Eco-clean. In Thiruvananthapuram, however, authorized civil society agencies collected plastic waste, and 44 percent of the households participated in it. Twenty-eight percent of the households in Thiruvananthapuram also resort to the burning of plastic to avoid separate user fee for plastic waste collection.

Table 5. Plastic waste management by households in the sample area (%)

Plastic waste treatment	Alappuzha (N=75)	Thiruvananthapuram (N=25)
Burn	80%	28%
Nirmal Kiosk (aerobic cluster)	6.6%	8%
Sell	8%	8%
Throw out	2.8%	0%
Waste collection by private Agency or independent SHG woman	2.6%	56%
Total	100%	100%

Source: Primary Survey

Table 6. Status of technology in the sample area during field visit (%)

Status of the technology	Alappuzha (N=75)	Thiruvananthapuram (N=25)
Functional	62.6%	100%
Not functional	37.4%	0
Total	100%	100%

Source: Primary Survey

Primary survey shows that most households in Alappuzha faced issues with technologies. The households were using decentralized technologies for almost two years in Alappuzha. Out of the 75 households surveyed, forty-seven (62.6%) of the units were functional, and twenty-eight units (37.3%) were not functional (Table 6). Most respondents who continue to use the technology also mentioned that they face issues with technology. The households which discontinued the technology mentioned that operational issues led them to suspend the units. In Thiruvananthapuram, households have been using the unit for about six

months to one year. All the visited units were functional though households mentioned some issues like worms, rodent attack, etc.

In Alappuzha, respondents mentioned that blockage of the biogas plant and burner issues forced them to discontinue biogas units. Bad smell and worms were reasons for discontinuation of pipe composting units. Blockage of the biogas was mentioned by 27 households(36%), and 18 of them (24%) complained about the burner issues along with the blockage (Table 7). The burner of the biogas plants has bigger holes, and the flame has less heat. Burning of biogas fuel produces ash, which close the holes in the burner. Therefore, frequent cleaning of the burner is important. Households with not enough awareness of the issue have become disillusioned due to the frequent blockage of the stove. Some of them also mentioned about the breakage of burner. One respondent believed that poor quality of burner is the issue. He says "quality of the burner is poor, and we had frequent issues with it. They (IRTC) should come up with high-quality burners"(Respondent 9, Primary Survey, Alappuzha). Households mentioned that lifespan of a burner is approximately one year, and such high maintenance is difficult. In Thiruvananthapuram, only two households complained the issue of blockage but, rodent attack was a concern.

Table 7. Technological issues faced by households in sample area (%)

Issues with the technology	Alappuzha (N=75)	Thiruvananthapuram (N=25)
Blockage	36%	8%
burner issues	24%	12%
Smell	10.6%	8%
Worms	1.4%	8%
Others	4%	16%
None	24%	48%
Total	100%	100%

Source: Primary Survey

However, an encounter with issues per se was not the reason for discontinuation of household units. Lack of adequate service in a timely manner after the installation was pointed as the major reason.

Alappuzha had service team trained by IRTC to help with installation and servicing. Initially, 25 Kudumbashree women were part of the service team. For various reasons some women left the group and currently there are 19 members. Two to three members provide service in each ward. For each new installation, the women are paid Rs. 700. During the first year following the installation of the biogas plant, services were provided free of charge. After one year each service is chargeable for Rs. 1000 which the households do not appreciate because issues with new technologies are frequent. Once the system is blocked service team needs to be invited, and the waste water inside the system should be removed and refilled with fresh cow dung. Households were also disappointed by the unavailability of service team on a timely manner. Households with pipe composts mentioned that rodents root out vertically placed PVC pipes throwing out half decomposed waste in the open with unbearable stink. Rodents also carry waste to other areas in the house creating inconvenience to the family members. In the second phase, TMC decided to shift to kitchen bins. However, rodents also destroy the kitchen bin, and therefore TMC has planned to distribute kitchen bin made of HDPE (High Density Poly ethylene). Currently, the government is distributing bins made of HDPE.

Table 8. Status of service received by households in the sample area (%)

Service received by households	Alappuzha (N=75)	Thiruvananthapuram(N=25)
Always	36%	16%
Not at all	30.6%	16%
received few times not now	0%	8%
not interested in the service	5.4%	0%
no need of service	28%	60%
Total	100%	100%

Source: Primary Survey

In Alappuzha 36% and in Thiruvananthapuram 16% household mentioned that they received adequate service when required (Table 8). Thirty percent of the households received no service in Alappuzha, which led to their dissatisfaction with the decentralized system of waste

management. 60% of households in Thiruvananthapuram mentioned they did not require service after installation as kitchen bins were of low maintenance and civil society agents frequently visits the households for collection of compost and nondegradable waste. In a place where most households preferred biogas plants, dissatisfaction concerning service may lead to the diminishing enthusiasm for the technology, and this become clear when Health Inspector of Alappuzha say that "now the applications for biogas plants have reduced as compared to the first phase" (31 January 2017). The biogas available for household use ranged from half an hour to more than two hours. Twenty four households received biogas for about half an hour to 45 minutes, 15 houses get it for an hour and seven houses for two hours or more. The availability of fuel is dependent on the quantity and quality of waste produced by the households. We saw earlier that most households generated ½ kg to 2 kg of solid waste per day. Therefore, biogas availability is also limited, and frequent technical issues also affect the biofuel supply. Lack of technical support and frequent technical issues has affected the confidence of the people.

Customer satisfaction has a major role in the diffusion of innovation and its stabilization. If the stabilization of the system does not happen, then chances of the system collapse are high. Households which have not participated in the programme mentioned that the lack of know-how, failed initiative by neighbours and user fee as some of the reasons for their non-cooperation.

Respondent assessment of the system is done through five point Likert scale (Table 9). Excellent in the scale refers to complete satisfaction of the households in using new technology, well refer to approval with a caveat, neutral refers to no opinion, poor and very poor refer to dissatisfaction levels of the respondents. Fifteen households (20%) in Alappuzha and 11 households (44%) in Thiruvananthapuram rated the decentralized system to be excellent. Nearly 35 households (46.6%) in Alappuzha and 11 households (44%) in Thiruvananthapuram agreed that decentralized system is good provided proper service is available when

needed. About 25 households(33.3%) in Alappuzha either remained silent or rated the units poorly (Table 9)

Table 9. Respondent assessment of the technologies in sample area (%)

Respondent Assessment of the technologies	Alappuzha (N=75)	Thiruvananthapuram(N=25)
Excellent	20%	44%
Good	46.6%	44%
Neutral	12%	8%
Poor	13.4%	0
very poor	8%	4%
Total	100%	100%

Source: Primary Survey

Table 10. Respondent willingness to recommend the technologies in sample area (%)

Respondent response	Alappuzha (N=75)	Thiruvananthapuram (N=25)
Yes	65.4 %	96%
No	34.6%	4%
Total	100%	100%

Source: Primary Survey

In Alappuzha, 49 households (65.33%) mentioned that they would recommend the decentralized system provided good services are provided while 34.66% households said they would not recommend decentralized waste management since proper service is not available after installation. One of the respondents who were unwilling to recommend said that

> "The biogas plant had frequent issues, and often parts need replacement. Parts like burner and tubes were not made available by the service provider, and we had to purchase from the market. It was costly to get services, and we decided to stop". (Respondent 17, Primary Survey, Alappuzha)

In Thiruvananthapuram however, 96% households said that they would recommend the new system. In Alappuzha, people were enthusiastic to be part of the project in the beginning but grew skeptical of the efficiency

of the available system. In Thiruvananthapuram people had the willingness to accept technologies; however, they believed that the local government should pay for the services rather than putting a fee for waste management on the households. One respondent mentions

> "The project is good. But why should we pay for everything? For what purpose is Municipality's money used now? Waste management is Municipality's job. They cannot just leave it to the households and move on like that." (Respondent 12 Primary Survey, Thiruvananthapuram)

The Municipal official in Alappuzha mentioned that they could save nearly Rs.50 Lakhs per annum on the transport of waste and the salary of contingent labourers after implementation of the decentralized waste management programme. About user fee, the health official said

> "Households should recognise that waste produced at the household is their responsibility, and we (Municipality) can only act as a facilitator for the programme. Not every service can be made free of cost because service team needs to be paid for their job and that has to be borne by the households. Service team is not part of the Municipality Staff". (Health official, Thiruvananthapuram).

Health official's idea of role of public in basic services fall in line with the Neoliberal argument, that state should not be solely responsible for people's welfare.

In all, Alappuzha and Thiruvananthapuram differ in the implementation of the programme. People's choices of technology are largely determined by local government push for certain technologies. In both, the places operationalisation of the programme faced issues due to lack of awareness and other technical issues. Thiruvananthapuram has experimented with compost technologies starting from pipe compost to variations in materials used for kitchen bin. Also, the implementation of the programme is different in both the sample areas. While Alappuzha

went for direct implementation of the programme, Thiruvananthapuram used the support of private non governmental agencies for implementation of the programme. It can be seen that service provision was a problem in Alappuzha which has led to the disillusionment of the people. One of the advantage for household implementation of decentralized waste management in Thrivuananthapuram is the partnership with non-governmental organisations. The households had few complaints regarding service provision. In Alappuzha, lack of service provision and disillusionment among substantial number of households may have led to the decline in the request for biogas technology.

3.1 Analysis of Transition in Solid Waste Management in the Sample Sites

Sustainability transition occurred in both the study sites as a result of the breakthrough in technological innovations and socio-political mobilisation. Transition was triggered by external forces like people's struggles and subsequent political decision. Prolonged protests forced the policy makers to find alternative pathways for waste management. Subsequent mobilization for behavior change and technological innovations provided a positive result.

Technologies developed by Kerala Shastra Sahitya Parishat and Agricultural University facilitated speeding up of decision making on transitions. University acted as a niche for innovations in community waste management technology. IRTC, ANERT and other agencies played a role in the development of biogas plants, pipe compost, and kitchen bin. Regulative, normative and cognitive aspects of the waste management were changed for allowing an easier transition. Information and Communication technologies (the internet and social media) acted as a platform for knowledge exchange. The university-civil society-political party nexus played a major role in this transition. Similarly, a conscious effort to transforming the consciousness of citizens provided the landscape for change.

Literature on innovations shows that diffusion of an innovation is dependent on various factors including the willingness of the people to adopt the innovations and financial and technical viability for replication (Pederson,1970). Failure to achieve desired results in diffusion of innovation may be either due to the problem of implementation or failure of the innovation itself. This study highlights that the implementation issues are prominent. Community participation, private sector involvement, low-cost technologies and strategies to provide an interface among the complementing sectors is also found to be essential for the successful replication of an innovative programme (Koppenjan and Enserink, 2009). The case of Thiruvananthapuram sheds light into these aspects of private sector involvement.

Massive campaigns and official requests forced people to accept new technologies. People chose technologies that were promoted by the local government, e.g. biogas plant in Alappuzha and kitchen bin Trivandrum. However, after the first phase of implementation in Alappuzha, people's enthusiasm for new technologies fizzled out according to the officials. One of the reasons for this decreased interest could be reduced campaign trail. User's perception of the new technologies becomes important in accepting and stabilizing innovations in the society. A negative review of a programme can, therefore, affect the demand for innovative technologies and programmes. The primary survey shows that 37.3% of households are disillusioned with the new technologies. Kemp et al. say that "in the early phase of development, new technologies are ill developed regarding user needs and expensive because of low production." (1998). Most households in Alappuzha preferred Bio gas plants because of its utility as a fuel. However, blockage and burner issues resulted in widespread dissatisfaction of the households. Issues were also due to lack of operational awareness, poor quality of technology, and lack of service provision. Similarly, areas where rodent attack was rampant the pipe compost also failed. The households that did not participate in the programme mentioned two reasons for their non-cooperation: 1) Municipal staff has not approached them, and 2)

Technological issues faced by the neighbours. That is, since the technologies were new and issues cropped up every now and then people of Alappuzha were not convinced of an absolute change in behavior. Reverting to throwing away habit or use of pits is a result of this negative attitude. In Alappuzha, however, community waste management structures like aerobic clusters/WatSan parks have shown a higher level of performance efficiency because of the proper organization of the contingent labour, supervision by the health inspectors and convenient waste collection timing for the population; where as in Thiruvananthapuram, community waste management using aerobic bin clusters are falling apart. While the officials tend to blame the attitude of people for failure of the community structures, the question that remains is how user friendly the operation of aerobic bin clusters are in Thiruvananthapuram? Commitment of contingent labourers and officials in proper maintenance of the aero bin clusters are important.

In Thiruvananthapuram, households received constant support from the implementing civil society organizations. Therefore, issues due to lack of service were not found in Thiruvananthapuram. In case of biogas plants in Thiruvananthapuram, such frequent servicing is not available. However, households that use biogas plants are lesser in Thiruvananthapuram, and authorized distributors of the plant provide the services for households charging a fee. However, 'give away' waste culture has not been eradicated from Thiruvananthapuram. Organisations like V-care, independent individuals, and other smaller agencies continue to collect wastes from the households. While V-care buries the wastes in rubber plantations with the support of farmers, others throw away waste in public spaces which is problematic. The attitude and eagerness of people to give away waste also shows that the awareness campaign for decentralized waste management in Thiruvananthapuram is weak currently. Allowing organizations like V-care to engage in centralised waste collection can be detrimental to the vision of the Municipal Corporation in long run as the agricultural spaces for burial may exhaust and changing attitudes of people may not come to fruition. Therefore, it

is important that emphasis is given to encourage the VCare's innovations in source treatment of waste using V-care bin. In short, in Alappuzha, we could see that the willingness of people to embrace change and diffusion of innovation in the first phase was higher. However, sustainability of the programme is under threat because of the issues in implementation. A weak link in the campaign is also found when people say that they are ignorant about the plastic waste collection mechanism at the aerobin cluster. In the case of Thiruvananthapuram, the diffusion is slowed down because of the lack of campaign trail and decisive, systematic perusal of the programme.

Both the local governments attempted to change the behavior of the people using both coercive and non-coercive methods. Installation of street cameras and fining of defaulters are coercive surveillance mechanism used in Alappuzha and to a certain extent in Thiruvananthapuram. However, in Thiruvananthapuram, even the cleaned up open spaces are becoming waste dumps. Due to weak surveillance enforcement of behavior change towards street discard could not be seen. This coercive method, however, had an impact on the change people's attitudes towards street discard in Alappuzha. Non coercive methods involve creating awareness through creative involvement in society, persuading people to change their behavior, and providing subsidies and technical support to people. The study shed a light into the political aspect of behavior change. By emphasizing on behaviour change in the programme local government is pushing towards a neoliberal development agenda. Health Inspector's words on the responsibility of the waste producer are clear indication in this direction. However, people are yet to acclimatize to such a development perspective.

Conclusion

While replicating a model of governance of solid waste in other context, it is wise to tweak the implementation strategy according to the local needs in which it is applied for increased effectiveness. Mere transfer of technologies to a new context may not be effective.

While Thiruvananthapuram has drawn much from Alappuzha experience, both the towns differ in the implementation of the decentralized waste management. Alappuzha has performed better in community waste management. However, shortfalls in household waste management are visible. Thiruvananthapuram, performed better in the household waste management due to the involvement of NGOs in implementation of the programme. However, it failed to maintain the community aero bin structures. Both the towns have lessons to learn from each other. TMC may follow Alappuzha model of human resource arrangement in maintaining aero bin clusters. Alappuzha may explore the possibilities of PPP in decentalised waste management service provision in future. More importantly, continuous monitoring of implemented programme and timely support to the households is crucial for ensuring sustainability of decentralized solid waste management system. Otherwise, people's disappointment may impact the diffusion of new idea and technologies. Also, various agencies involved in waste management other than the mentioned four agencies in Thiruvananthapuram city needs monitoring. This is because household collection and careless handling of waste by private players may negatively impact the implementation of decentralized waste management system, because people's behavior change may not come into fruition and open dumping will become regular habit. A platform for monitoring the effectiveness of decentralized waste management on a regular basis should be created to ensure the sustainability of the programme.

Notes

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[2] The centralised system refers to a mode of waste management, where the waste is collected and transported to the treatment plant for processing and finally dumped off in the landfill. Urban local bodies play vital roles in centralised waste management as solid waste management is one of their mandatory function. The centralised waste management still continue to be the primary method of solid waste management in Kerala.

[3] In decentralized waste management, the role of local government is limited, and households become the unit of waste generation as well as treatment.

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