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Solid waste management practices under public and private sector in Lahore, Pakistan

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Abstract

Solid waste management (SWM) practices in Lahore, provincial capital of Punjab, were privatised in 2012. This study draws a comparison of solid waste management practices by public and private sector in Lahore. The comparison is done by taking following factors in consideration; administrative structure, waste collection, street sweeping, waste storage capacity and logistics, disposal, mechanical sweeping and washing, monitoring system. Privatisation of solid waste management in Lahore is celebrated as complete success story. In contrast to this, we found the results of privatisation are mixed. Privatisation has improved some components of the system. Monitoring system has been the key innovation under private sector. It has enabled better allocation, management and channelization of available resources. Yet little to no improvement has been done in street sweeping, disposal of waste and administrative structure of waste management in the city.

Keywords: Albayrak; Lahore; Public and Private Sector; Solid Waste Management; Waste Management Company

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Introduction

In recent years, solid waste has become a part of policy discussions because of problems associated with solid waste management, particularly in health and environment, are turning out to be urgent (Marshall, 2013). Increased consumption patterns, population explosion and rapid development have resulted in generating huge quantities of solid waste (JICA and Pak-EPA, 2005). In developing countries, the situation is more complicated because of the factors including rapid urbanization, economic growth, policy, governance and institutional issues (Marshall, 2013). In developing countries people enjoy improved living standards with higher consumption rates of packaged food that increases per capita waste generation (Visvanathan and Trankler, 2003; Batool et al., 2008). Due to these factors, there is more burden on existing solid waste management practices. To manage such huge quantities of municipal solid waste (MSW) require substantial revenue and administrative ability (Beukerering et al., 1999). According to the World Bank estimates, 52% of the population in Asia would be urbanized by 2025 (Hoornweg, 1999). Asian countries are facing more severe problems regarding waste disposal because of uncontrolled and rapid urbanization (ISWA and UNEP, 2002).

Solid waste management is an interdisciplinary and multi-dimensional subject as it includes a wide range of activities. To develop and design an efficient solid waste management system, the very first step is the estimation of waste generation rate of the area., Though rate can never be estimated with full accuracy as quantities of waste generated keep on changing almost every day and specially in those areas where waste generation rate is ever increasing (Dyson and Chang, 2005). Rate of urbanization, pattern of land use and urban planning, components related to waste-waste density, characterization and legal, administrative and institutional limitations of local municipality, these factors are design consideration of a SWM system (Mahar et al., 2007).

Condition of waste collection, transfer and disposal is not satisfactory in Pakistan. Pakistan's estimated population is 180 million (PRB, 2012), about 65% of people live in rural areas whereas 35% live in urban areas (GOP, 2011). Landmark study on solid waste condition in Pakistan was done by KOICA and World Bank in 2007. The study concluded that SWM problems in Pakistan existed because of inadequate regulatory institution, poor legislation, implementation (KOICA-WORLD BANK, 2007) and little understanding among residents. In the same study, it was concluded that public sector in Pakistan lacks in expertise both administrative and financial (KOICA-WORLD BANK, 2007). In another study by JICA (2005), it was estimated that about 55,000 tons / day of waste

are generated in 10 large cities of Pakistan which includes Karachi, Faisalabad, Multan, Hayderabad etc. Waste collection efficacy in Pakistan is not up-to the mark and there are intra-city inequalities. For example, lower waste collection in low socio-economic profile areas and higher waste collection in upper profile areas (JICA and Pak-EPA, 2005). In Pakistan average collection efficiency achieved by public sector is 50% (Fatima 2010) and Adila places this figures at 60% (Batool and Nawaz, 2009).

There is a long policy debate on whether to privatize or not different services of public sector. To example some researchers conclude that the best possible option for waste management is to have a mix system that includes both public and private sector. Public private partnership in SWM can be used to improve less efficient systems into efficient ones by providing resources (Sharholy, 2008) as public sector subsidizes the cost of waste management. So it remains bearable to the people and private sector can introduce efficiency into it thus resulting an optimal system which is more efficient and low cost (Cointreau, 1994; Dillinger 1988). Post 2000, global policy for SWM has shifted more to include private sector. It is argued that private sector brings efficiency to the system and it also creates jobs as scope of services under private sector expands (Wilson and Cheesman, 2006). While some other researchers argue that privatization of solid waste results in higher cost (Lobina and Hall, 2009) that inevitably leaves poor dwellers of city unattended by private sector (Brooks, 2011). It is to be argued that the success of private sector in SWM is only possible if a strong and stringent contract is signed and enforced by the client, i.e., municipality (Zhuang et al., 2008).

In 2001 after decentralization City District Government of Lahore (CDGL) was established under Punjab Local Government Ordinance (PLGO) (GOP, 2001). Waste management in the city became responsibility of CDGL and it was expected that decentralization will enhance solid waste management condition in the city. However, studies done by JICA, KOICA and World Bank found that CDGL never reached to expected efficiency. Keeping in view, increasing quantities of waste and problems identified by international agencies, the government of Punjab embarked on an ambitious project to privatize SWM in Lahore. Later in 2010 a non-profit company Lahore Waste Management Company (LWMC) was established with a vision to "improve and modernize the SWM services in Lahore" (LWMC, 2012). After establishment of LWMC, on June 25, 2011 'Services and Asset Management Agreement' (SAAMA) was signed between LWMC and the CDGL. According to SAAMA agreement the resources and responsibilities of SWM department were handed over to LWMC with the condition to achieve the Key Performance Indicators (KPIs) developed with mutual understanding. Through SAAMA the LWMC has the mandate of public sector and responsibility to improve and modernize the Solid Waste Management (SWM) services in the city. In March, 2012 LWMC signed contract to outsource and privatize the provision of SWM services. The contract was signed with two Turkish companies Albayrak and OzPak. LWMC divided Lahore into two zones viz. Zone A and Zone B. Albayrak was awarded contract to manage waste of Zone A and OzPak for Zone B. Lahore Metro Bus corridor acts as a boundary between two zones, on eastern side is Albayrak and the western part is under the jurisdiction of OzPak.

Materials and Methods

Primary Data

Field Visits/Interviews/Group Discussions: Solid waste collection system of Lahore city was investigated. All data was collected by field visits. Assistant Managers from operations department were identified as target respondents. Detail working of system was discussed with assistant manager and deputy managers of M/S Albayrak through interviews. Comprehensive group consultations were carried. Old and new solid waste collection system was discussed with Zonal officers, sergeants, sanitary workers and sanitary inspectors of LWMC. Officials who have worked under public and private sector were targeted in particular as they have insight on working of both systems.

Secondary Data

Different published and unpublished reports of LWMC and CDGL were also consulted. For waste collection data was collected from respective authority (CDGL, LWMC and Albayrak) for different years. This data was used to calculate total waste collected in the city. Key performance indicators and rates of services were taken from official contract signed. An extensive desk study was also done to identify and consult reports on solid waste condition in the city.

Study Area

Lahore is the capital of Punjab and second largest city of Pakistan, with total area of 1772 km2. It has total population of 8.16 million. The city is divided into nine administrative towns. These towns are marked further into 150 UCs, of which 138 urban and 12 rural. Around 20% of total waste of the city is generated just in one town; Ravi town. It has the highest population density in the city. Table 1 shows information on area, UCs, population and waste generation in all Towns of Lahore.

Results

Population, Waste Generation and Composition of Waste in Lahore

The quantities of waste generated in Lahore has increased many folds in recent years mainly due to rapid urbanization and increasing consumption patterns (Batool and Nawaz, 2009). A large influx of migration and no population census has left us to the estimates. The estimated population as reported by Bureau of Statistics, govt. of Punjab was 8.16 million in year 2011-12 (GOP, 2011).

Estimating waste generation of an area is highly influenced by different factors. It includes temporal, season, spatial boundary etc. Depending on these parameters findings can be asymmetric so it's wise to use a range. In large cities of Pakistan estimated waste generation rate by Pakistan Environmental Protection Agency (PAK-EPA) ranges between 1.89-4.2 kg/capita/day (JICA and PAK-EPA, 2005). While KOICA-WORLD BANK (2007) esti-

Table 1: Shows towns of Lahore with area and number of UC (Maryam et al., 2014)

Town Name	Total Area (Km^2)	Total Number of UC's	Population (Millions)	waste generated (tones/day)	Percentage waste generated
Gulberg Town	43	15	0.81	526	9.92%
Ravi Town	31	20	1.65	1072	20.2%
Nishter Town	494	16	1.04	676	12%
Data Ganj baksh Town	30	18	1.01	656	12.3%
Wahgha Town	442	12	0.68	442	8.3%
Aziz Bhatti Town	68	13	0.59	383	7.2%
Allama Iqbal Town	513	20	0.8	520	9.8%
Samanabad Town	37	19	1.03	669	12.6%
Shalimar Town	24	17	0.55	357	6.75%
Cantonment area**	97	-	-	-	-
Grand Total	1772	150	8.16	5301	100%

mates that Waste generation in Lahore ranges from 0.5-0.65 kg/ capita/day and according to ISTACT's study it is 0.7 kg/capita/day (ISTAC, 2012) and adila's finding is 0.84 kg/capita/day (Adila and Nawaz, 2009). This range is because of difference in urbanization trends and socio economic development of that particular city (Mahar et al., 2007). Officially LWMC and international contractors use generation rate figure of 0.65 kg/capita/day, same figure has been used for all calculation in this study.

In 2012 ISTAC, Istanbul's municipality, carried out a study for characterization of waste of Lahore. This study collected waste and estimated waste generation rate according to the socio-economic profiles of the area. Study found highest concentration of biodegradables that is 65%, Nylon 11%, textile 10%, hazardous waste 1% and paper waste 2% (ISTAC 2012).

Legal /Administrative Structure of waste management

One of the major reasons for ill functioning solid waste management system in Pakistan is the absence of regulatory framework (KOICA-WORLD BANK 2007). A very small number of laws are available that deal with handling of solid waste management. In Pakistan environmental legislation is made and executed at three levels i. Federal ii. Provincial and iii. Local. Laws and regulations relating environment protection are made at federal level. Provincial governments are responsible for provision of resources and preparation of developmental plans and enforcement of laws. City district governments (CDGs) and District Governments (DG) are in-charge SWM bodies.

At federal level two major acts are Factories Act of 1934 and Pakistan Environmental Protection Act (PEPA) of 1997. Factories act of 1934 was the first legislation to deal with disposal of waste generated by factories. PEPA is the major legislation done regarding environment; it deals with air, water and land pollution and collection, handling and disposal of waste (PEPA, 1997). In year 2001 Punjab Local Government Ordinance declared solid waste management a responsibility of local governments. Since then no major legislative intervention has been done on federal or provincial level either (Table 2).

Waste Collection efficiency

Waste generated in Lahore is about 5500 tons a day (KOICA-World Bank, 2007). It is estimated that in 2012 about 4000 tons/ day waste was being collected in year 2012, which is 75% of the total waste generated (LWMC, 2012). Remaining 25% of waste is uncollected and left on open roads and streets. Waste collection in the city is done at two levels.

1. Primary Collection (Door to Door collection)
2. Secondary Collection (Waste storage facility/Containers)

Primary Collection/Door to Door collection (DTD): Door to door level collection is the starting point in the entire chain of SWM services. Door to Door collection is one of the important activities of the contract with Turkish companies. For Door to Door collection shopping bags are provided to the residents of the area and they are asked to put their waste into these bags. Once bags are filled, users put them outside their houses on announced time and then these bags are collected by the workers in hand carts. Once workers have collected waste they dump it into nearby container/waste storage area. The baseline value for Key Performance indicator (KPI) of door-to-door solid waste collection was 0%. At time of privatization no door-to-door collection service was done in the city. In Zone 1, Door-to-Door bag distribution and collection was started on 20th March, 2012 in all UCs of phase A. After end of transition period door-to-door collection services in phase B,C and D in 138 UCs of Lahore has started.

LWMC is paying 15.8 US$/ton to Albayrak for Door-to-Door collection as per contract. Until now Albayrak has not been able to launch a full scale Door-to-Door collection operation and yet informal sector carries out this activity. Informal sector in Lahore works on different levels. It consists of *Koreywala*, *Pheriwala*, itinerary buyers and junk shops. In most of the city where Albayrak is not collecting waste on Door-to-Door bases the *koreywalas* who provide collection services. These *Koreywalas* charge on average Rs. 200-300 /month and they are working under the auspices of LWMC's officials of the area. Downside of collection is that households have to pay twice for the waste collection. First they pay informal sector (*Koreywala*) for actual collection. The households also bear official charges that are included in water bill collected by Water and Sanitation Agency (WASA). Charges for waste collection are 21.45% of water bills of households, of which WASA retains 15% as services charges and remaining 85% goes to CDGL (LWMC, 2012).

Table 2: Shows legal arrangements regarding SWM in Pakistan (various sources)

Laws	Years	Scope
The Factories Act	1934	• Deals with effluents from factories
Pakistan Environmental Protection Act (PEPA)	1997	• Protection of Environment air, water etc. • Deals with Municipal, Hospital, Industrial, agricultural and Hazardous Waste.
NEQS (National environmental Quality Standards) Regulation	2000	• Testing and analyzing waste samples of factories
Environmental Sample Rules	2001	• Implementation of PEPA 1997
NEQS Rules	2001	• Makes Factories responsible for reporting and monitoring
Hazardous Substance Rule	2003	• Waste management Plan to deal hazardous waste
Hospital Waste Management Rule	2005	• Set duties and responsibilities for planning, segregation, collection, storage of hospital waste
Provincial		
Punjab Local Government Ordinance (LGO)	2001	• Local Governments are responsible for waste management.
Local		
LGOs in City District Government and Town Municipal administration (TMAs)	2001	• Waste collection, Transportation and disposal.
Police order City District Government Lahore	2002	• Establishes Citizen Community Boards participating in local governance.
Lahore SWM By-Laws	2005	• Declares city District Government Lahore (CDGL) for sanitation of areas. • Stops from open dumping of waste.

Secondary Collection/Containers to Containers (CTC): Once waste is collected from households and dumped to the containers. Different types of vehicles visit area and transport it to the dump site. Transportation of waste is mainly done in two shifts. In 1st shift (06:00 am to 02:00 pm) a compactor collects waste from one UC in two trips. In 2nd shift that particular UC is covered by one trip of compactor. Albayrak uses vehicles of different types and capacity to collect waste. The vehicles include arms roll, $8m^3$ and $5m^3$ compactors, tractor trolley and dumpers. Type and capacity of vehicle in use is dependent on the quantity of waste generated. Sometimes space for vehicle movement is also a consideration as roads and streets are narrow in many areas of the city. LWMC is paying 13.4 US$/ton to Albayrak for collection and disposal of waste from container. Table 3 gives comparison of total waste collected by public and private sector and efficiency that is identified as hallmark of success of private sector.

Street Sweeping

Sweeping is done in first shift i.e. 06:00 am- 02:00 pm. An android based attendance system of sanitary workers, at start and end time of duty, is in practice. Every sanitary worker is assigned an individual and distinct area called *beat*. In manual sweeping streets, concrete or non-concrete road sides are included. Sweeping operation starts early in the morning around 6:00 am and ends by 10:00 am. Once it is complete the workers start collecting solid waste from streets and households of their respective *beat* and tow it to container through wheelie bins or hand carts. IN remaining two eight-hour shifts, 3 workers and one pickup work in their respective area to carry different tasks. These tasks include cleaning surroundings of container, redressing objections on cleanliness, circulation of garbage bags, and clearance of complaints generated by the locals. Street sweeping operation has not changed much

Table 3: Shows Year-wise waste generated and collected in Lahore (Ashraf, 2013)

Year	Waste Generated	Waste collected
	Tons	Tons
2008-09	1777104	977318
2009-10	1777104	1182009
2010-11	1777104	1163481
2011-12	1882524	1231380
2012-13	1882524	1481580
2013-14	2130588	1884600

Table 4: Shows Number and capacity of containers placed by LWMC, 2011-2012 (Personal Communication)

Name of Town	5m^3 containers	10m^3 containers	Total
Allama Iqbal Town	25	57	82
Aziz Bhatti Town	49	07	56
Data Gunj Bakhsh Town	165	00	165
Shalimar Town	12	66	78
Samnabad Town	76	70	146
Gulberg Town	165	27	192
Nishter Town	32	41	73
Ravi Town	88	51	139
Wagha Town	19	25	44
Total	631	344	975

under public and private sector so above explanation is true for both systems.

Waste Storage Capacity/Logistics

Waste that is collected from houses is dumped in containers, from where it is transferred to dump site for final disposal. There is a direct relation in quantity of waste collected and storage capacity at particular point. Tables 4 and 5 give detailed town-wise placement of container by Public and private sector.

LWMC placed about 975 containers in 150 UCs of nine towns (LWMC, 2012). The containers were of two capacities; 10m^3 and 5m^3. With the advent of International contractors, LWMC started withdrawing its storage facilities and in third quarter of 2012 LWMC was managing 784 containers only. The contractors have placed 1834 new containers of different capacities; 0.78m^3 by M/s OzPak and 0.8m^3 by M/s Albayrak. The number of containers being managed by LWMC during the 2011-12 is show in Table 4.

Albayrak places containers at different important and crucial places in a UC. These places are mainly markets, parks, offices and community areas where waste generation is higher. There are some problems attached with placement of containers in the city because of the nuisance and bad odor attached with it. Most of the containers are placed at public places relatively away from the residential areas that reduce accessibility of residents. In congested and populated areas, the containers are placed on roads and streets which also hinder the smooth flow of traffic. At some places capacity of containers is less than incoming waste volume thus resulting waste overflow and while lifting containers this waste is not collected. This waste creates nuisance to the neighboring people that is why people are reluctant to get these containers placed near to their houses, community or religious places. Albayrak uses two types of containers, small containers of 0.8m^3 capacity and large containers *(Doli)* of 5m^3 capacities.

The Table 5 shows that in year 2012-13 M/s Albayrak has installed waste collection capacity of 5113 m^3 in 72 UCs of Lahore. This is more capacity than estimated waste generation, and this capacity doesn't include containers placed inside *Kourgans;* a fixed box having usually 2 containers of 0.8m^3 capacity each are placed this number may reduce or increase according to size of *Kourgan*. As of official record, 216 containers are placed in 182 *Kourgans* (LWMC, 2012), with total capacity of 172.8 m^3. If we include *Kourgan* and container the waste storage capacity becomes 5285 m^{3}that is much higher than previously installed by public sector.

LWMC had a fleet of about 500 vehicles for transportation of waste to dump site. According to company official most of these vehicles were outdated, old and obsolete. A lot of budget was allocated to the repair and maintenance of these vehicles. LWMC's waste collection reduced significantly in 2012 so usage of mechanical machinery reduced. International contractors

Table 5: Shows phase-wise number of containers and waste collection capacity placed by Albayrak (LWMC, 2012)

Phase	Number of UC's	Number of containers		Total Number	Total capacity		Total volume/ capacity (m^3)	Total capacity (weight) (tonne)
					A (m^3)	B (m^3)		
		0.8m^3	5m^3		0.8m^3	5m^3	A+B	
A	9	808	26	936	646.4	130	776.4	958.93
B	14	953	18	1053	762.4	90	852.4	1052.8
C	35	1732	217	1965	1385.6	1085	2470.6	3051.4
D	14	423	135	574	338.4	675	1013.4	1251.6
Grand Total	72	3916	396	4312	3133	1980	5113	6315

have introduced new machinery for waste lifting and other mechanical work, and these vehicles will become LWMC's property after the end of contract period which is 7 years. The number of vehicles deployed by M/s Albayrak and M/s Ozpak is 193 and 216 respectively. Both private companies have established two workshops each for repair and maintenance of vehicle fleet. As it is clear number of vehicles by private companies is much lower than that of LWMC but collection efficiency is much higher. This has been possible because of management controls placed in. For example monitoring system that is explained underneath.

Disposal

In Lahore despite of huge quantity of waste generation and a large population, no scientific landfill is operational. Until recently waste was being dumped at *Mehmood Booti*, which was the only dump site of Lahore. Under public administration three dump sites *Mehmood Booti, Sagian* and *Bagarian* were in use, last two being unofficial sites. With the takeover of international contractors these two sites were closed because no weighing bridge was installed. *Mehmood Booti* being official dump site is equipped with weighing bridge to record total waste collection. It is pertinent to note that the difference in official and unofficial dump site is the ownership of land. In case of unofficial dumpsite the land owner has granted permission to dump waste at his land.

Mehmood Booti dumpsite is operational since 1997 and major problem is that it lies on the flood plain of river Ravi and percolation of leachate is toward the river. Recently LWMC purchased new land near *Lakho Dair*, an area in north-east of city, for construction of sanitary landfill. Due to increased waste *Mehmood Booti* has overflown and now *Lakho Dair is being used* as dumpsite. In parallel construction of landfill site is ongoing and was expected to end by FY 2013-2014. LWMC has allocated Rs. 1.9 billion for construction of landfill site. However the sanitary landfill site has not yet been completed.

Mechanical Sweeping and Washing

The city of Lahore expanded rapidly during last two decades, the new and expanded roads were built along with a number of underpasses, bridges and flyovers. The only option to sweep these roads is to use mechanical sweepers. LWMC has traditionally used tractor driven mechanical sweeper, which are very low at cleaning efficiency. Tractor driven mechanical sweeping is obsolete and outdated. To improve cleanliness of the roads LWMC has designated roads to the contractors and the contractors carry out mechanical sweeping with the vehicles purchased in accordance with vehicle specified in the contract (LWMC, 2012). In period of 2010 -12 total length of mechanical sweeping by LWMC has reduced from1345 km/day to 85 Km/day.

156 intersections and walkways with an area of 107,200 m^2 were marked by the authority for washing in all the nine towns of Lahore. The baseline value for this KPI was 0%. When the Services and assets management act (SAAMA) was signed none out of 156 intersections and walkways were being washed. As per agreements with international contractors the washing activity includes washing the areas like squares and walkways within the Zone-I & II as specified in contract agreements. M/s Albayrak uses 13 sweeper of $6m^3$ capacity and 8 small sweepers of $5m^3$ capacities. Small mechanical sweepers are used to sweep narrow roads that are quite common in the older parts of city. Large sweepers are assigned maximum 45 Km and small 35 Km. Sweeping is done in two shifts, road that are busy in morning time are swept in night shift which starts 10:00 Pm to 06:00Am. Seconds shift starts in 06:00 am in morning and ends at 02:00 Pm. Total length of mechanically swept roads by M/s Albayrak is 68190 m (150 ha), out of which 472498 m (103.9 ha) is swept in night shift and 209492 m (46.09 ha) in morning. International contractor are charging 43 US$ per hectare of mechanical sweeping (1 ha=10000 m^2) (LWMC, 2012).

LWMC had 14 water bouzers, which were mainly used for sprinkling and washing of squares, roads and streets. Albayrak started washing activity in June 2012. One "team day" is equal to washing of 10 km with high pressure pipe; it includes one vehicle and driver with 2 helpers for washing. M/s Albayrak has deployed 2 washing teams a day, for 6 days a week. Total length covered by M/s Albayrak is 125.66 km. Each washing team costs LWMC 294.95 US$.

Monitoring System

Monitoring is the key factor under private administration to ensure standard performance and keep a check on activities for effective management. For effective monitoring of contractors LWMC has placed different monitoring systems.

- Vehicle Tracking and Monitoring System (VTMS)
- Vehicle Trip Counting System (VTCS)
- Android Attendance System

Vehicle Tracking and Monitoring System (VTMS): In order to efficiently manage a large fleet of about 300 vehicles, LWMC envisaged installing Vehicle Tracking & Monitoring System (VTMS) on all of its vehicles. The services of M/s. PAKSAT International (Pvt.) Ltd was hired after competitive process to install tracking devices on LWMC fleet and establishment of a control room at LWMC office. This system has also been installed on vehicles of contractors. This helps LWMC officials to keep a check on drivers and vehicles of private contractors. It also enables LWMC officials to cross check performance claims of the contractors. It plays very important role in mechanical sweeping and washing as the system monitors route followed by vehicle.

Vehicle Trip Monitoring System (VTCS): VTCS provides continuous monitoring of trips of vehicles and total tonnage carried in respective vehicle. It's a web based system accessible through internet. It keeps records of the vehicles and tonnage with imagery of vehicle through camera installed at weighing bridge at dump site. This automated system collects total waste dumped at Mehmood Booti and the end of month LWMC cross check quantity of waste and pays to the private contractors.

Android Attendance System: Attendance of workers in field is the key to ensure smooth working of system. This had been a

wide discussed problem that how to ensure attendance in field. It is also reported that salary of a worker is calculated based on his/her attendance. In manual attendance system many of the officials shows more workers than actual number in field; ghost workers also called "Kaboter". These ghost workers put a lot pressure on company in terms of salaries, to cater this problem LWMC has recently introduce a new attendance system i.e. Android based monitoring. In new system all workers of a certain area line up at start and end of duty timings, a photo is taken of all the workers tagged with names and uploaded on a portal accessible by the officials. This photo also ensures that all the workers are in proper uniform. Since the introduction of this system attendance of field staff has increased and system has also helped in reducing number of ghost workers.

Conclusions

In developing countries like Pakistan and India municipal solid waste refers to collection and disposal of waste (Batool and Nawaz, 2009). This research shows that even after privatization there has been little interest in adding new components (energy or material recovery) in the system. As far as working of the system is concerned privatization has mixed effect; improvement in some areas and some remain unchanged. For example in primary/ DTD waste collection privatisation has not yielded desired effects. Primary waste collection was being done by informal sector in past under public administration and so is under private sector. Maryam et al. (2014) estimates that size of informal sector waste collection is around $1.1 billion. However in terms of secondary waste collection and disposal private sector has achieved lot more than public sector. As from Table 1 it is clear that under public administration 57% of total waste generated was being collected and under private sector in year 2013-14 about 88% of total waste was being collected. Street sweeping remains the same under both systems. Private sector has installed more waste storage capacity than LWMC. In terms of vehicle fleet LWMC had much larger number of vehicles as compared to private sector. Despite having much more resources LWMC's waste collection efficiency was way low. Private sector's scope of services also includes mechanical sweeping and washing that were absent in the past. Key innovation under private sector has largely been in monitoring systems i.e VTMS, VTCS and attendance system. Monitoring systems have enabled private sector achieving higher waste collection efficiency by better allocation and management of resources. This study concludes that full benefits of privatization can be reaped if other components, like energy and material recovery, sanitary landfill and integration of informal sector, are introduced.

Compliance with ethical standards

Conflict of Interest

The authors declare that they have no conflict of interests.

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