Integration of Energy Efficient Practices In Operations & Maintenance of Resources In Corporate Offices For Optimum Utilisation– An Exploration

Maneesha Gaur[1], Dr. Sushma Goel[2]

[1]Research Scholar, [2]Associate Professor

Lady Irwin College, University of Delhi, India

Abstract : Facilities management umbrella includes soft services (housekeeping, food &beverages, reception, reprographics, helpdesk, pest control etc.), hard services (DG sets, HVAC, security management, water management, waste management, transportation, building management system etc.) and maintenance services. The study was a review to analyse and understand the management of various facilities in corporate offices. It was conducted in three corporate offices located in Delhi and NCR. In all the three companies, different measures were used for effectively managing the resources like water, power and human personnel. Many energy efficient measures like rain water harvesting, water recycling, solid and liquid waste management and water conservation were found to be functional in all the three companies. Use of solar energy was found to be due to massive power requirement in offices which solar power generation plant is unable to provide. The main finding of the study suggests that there is a great need to have in place strict supervision for optimum utilisation of resources and for delivering quality services.

Keywords :Facilities management, HVAC (Heating Ventilation Air Conditioning, LEDs(Light Emitting diodes), E –waste, Sewage treatment plant and SIPOC tool

I. INTRODUCTION

Facility (or Facilities) management (FM) is an interdisciplinary field devoted to the co-ordination of all business support services. Over the years, FM has been growing as a business field and also as a scientific discipline, slowly finding and anchoring its position among organization's business processes. Nowadays, the dedication of FM organizations to new developments and continuous innovation processes seems to be the way to stay in business, constantly exceeding customers 'expectations and adding value to the core business of the client organization [1]. According to the International Facility Management Association IFMA, "it is a profession that encompasses multiple disciplines to ensure functionality of the built environment by integrating people, place, processes and technology".The FM Umbrella includes Soft Services, Hard Services and Maintenance. FM operations are many and have to be executed and monitored simultaneously. An FM expert has to be aware of all the FM operations for effective function of a company. Soft services include housekeeping, cafeteria, mail room services, vendor management, etc. [2]. Hard services include Power supply, HVAC, Lighting, Waste Management, security system, water management, etc. Maintenance activities are the activities performed to correct faults, to improve performance & other attributes, to adapt to modified product or work environment and to counter the effects of regular wear & tear of any item or equipment. It can be corrective maintenance or unscheduled maintenance, preventive maintenance or scheduled maintenance and predictive maintenance [5].

There are many resources which are being used to provide various facilities. Resources are human, water and electricity are required to provide various services like housekeeping, Lighting, Power supply, Air Conditioning, Heating, Ventilation, Waste Management, etc. Housekeeping may be defined as "provision of a clean, comfortable, safe and aesthetically appealing environment [3]. Most utilities charge commercial buildings for their natural gas based on the amount of energy delivered. Electricity, on the other hand, can be charged based on two measures: consumption and demand the consumption component of the bill is based on the amount of electricity in kWh that the building consumes during a month. The demand component is the peak demand in kilowatts (kW) occurring within the month, or, for some utilities, during the previous 12 months. Energy represents about 19 percent of total expenditures for the typical office building. Office buildings used 2,039 trillion Btu of primary electricity, which brings the total energy consumption for office buildings up to 2,383 trillion Btu, or 23 percent of total primary consumption for all commercial buildings [7]. Energy is used for a number of purposes in office buildings. Among various heads of energy expenditure Lighting accounts for the maximum consumption followed by space heating or cooling and operation of electrical equipment.It has become mandatory for every office building to include treatment of waste water. A water

treatment plant is a facility that involves various processes involved in water treatment at such facilities includes sedimentation, filtration, chlorination, disinfection, coagulation and so on. Water purification equipment used are water filters, ozone generator, oil water separators, screening equipment, sludge treatment equipment and many more. Water treatment is done for different purposes and there are water treatment plants serving different applications. Wastewater is defined as water which carries wastes from homes, industries, businesses or any other sources [4]. It is usually a mixture of water and dissolved or suspended solids. Since water is becoming a scarce commodity, hence it is imperative to evolve technologies which treat them efficiently so that they can be reused. Wastewater treatment plants are large energy users with excellent conservation potential. Wastewater treatment and its energy consumption will increase in the future due to population growth, increasingly restrictive environmental regulations, and demand for wastewater reuse.[11]For that purpose there are waste water treatment plants like sewage treatment plants, sludge treatment plant, industrial wastewater treatment plant and agricultural waste water treatment plant[12]. The sewage plant is specifically installed for reprocessing water for several purposes like gardening, irrigation flushing and vehicle washing. Solid waste management includes many steps like collection of the waste, its transport, processing, recycling or disposal and monitoring of the waste material and relevant processes/ activities. The system implemented for solid waste management mostly depends on quantity and complexity of the waste materials. There are three main types of waste management methods widely used across the world – Landfill, Incineration and Recycling. Out of these methods, recycling is the best and most needed method to be followed. Various municipal corporations and waste management companies are involved in these activities. Varieties of environmental legislations are available in India to treat and manage waste materials. Environmental protection acts encourage and reward organizations/companies for managing and recycling their waste to maintain the clean and hygienic environment [9].The main purpose of Heating, Ventilation, and Air-Conditioning (HVAC) system is to regulate interior environment and provide indoor comfort to the occupant HVAC accounts for 60-70% electric consumption by the office building.Heating system can be classified as central or local. Central heating is often used in cold climates to heat private houses and public buildings. Such a system contains a boiler, furnace, or heat pump to heat water, steam, or air in a central location such as a furnace room in a home or a mechanical room in a large building. Air conditioning and refrigeration are provided through the removal of heat. Heat can be removed through radiation, convection or by heat pump a process called the refrigeration cycle. Ventilation is the process of "changing" or replacing air in any space to control temperature or remove any combination of moisture, odors, smoke, heat, dust, airborne bacteria or carbon dioxide, and to replenish oxygen [16]. Ventilation includes both the exchange of air with the outside as well as circulation of air within the building. Ventilation could takes place in an office building in two ways – Natural ventilation and mechanical ventilation. Lighting includes the use of both artificial light sources such as lamps and light fixtures, as well as natural illumination by capturing daylight. Day lighting (using windows, skylights, or light shelves) is often used as the main source of light during daytime in buildings. This can save energy compared with artificial lighting, which represents a major component of energy consumption in buildings [15].

II. METHODOLOGY

The present study entitled “Integration Of Energy Efficient Practices In Operations & Maintenance Of Resources In Corporate Offices For Optimum Utilisation– An Exploration” was carried out to study the maintenance and the operations concerning various facilities like electricity, housekeeping, manpower management, lighting, HVAC, waste management and water management in corporate offices. An effort was made to explore the challenges experienced by the facility personnel in providing the quality services in a building. The study findings focused on energy efficient measures adopted by companies for operations and maintenance of facilities in offices.Rating scales were prepared to find out the employees satisfaction as well as quality of facilities and services. Rating scales were scored from 1-5, 5 being the highest and 1 being the lowest.

III. WATER

Source of water in all three companies was boring water however, in company 3 municipal water was also used partially. Location of company 2 was in the institutional area where in the Municipal Corporation of Gurgaon had made provision for supply of water. Company 3 was a large multi-tenant building in Gurgaon therefore had their own boring system so that they could have sufficient and regular supply of water.

Since the companies were sourcing water from the ground they were well aware of its value. All the three companies were conserving water by recycling it. In this manner they were able to use and reuse the same water again and again. Waste water was collected from all the outlets and was allowed to stand in a tank in company premises where some indigenous method was used to convert the waste in the water into molasses by addition of jaggery and other chemicals.. Then the solids in water were used for making manure while the left over water was treated further for

use particularly for toilet flush or watering the plants. Indirectly by this method the ground water was also being recharged. All the three companies were using recycled water. Company 1 and 3 were using recycled water only for landscaping which in addition was also recharging the ground water. Company 2 was using the recycled water in the HVAC plant for cooling the building. All the three companies had fire fighting systems installed in their building.

Table 1 Water Services In A Building

S.No	Facility	Company 1	Company 2	Company3
1	Source of water	Boring water	Municipal and boring water	Boring water
2	Measures for water recycling	Sewage treatment plant	Sewage treatment plant	Sewage treatment plant
3	Using recycled water	landscaping	Cooling towers for HVAC plants	landscaping
4	Water required to fill fire fighting tank	5, 00,000 ltr.	*3,00,000 ltr	2,00,000 ltr

*****company3 is multitenant company so individually resources were not maintained in the company but company 2 only give annual CAM charges and rest all operations were done by the owner of the building managing the whole building so figures were given keeping in mind the building as a whole.

IV. HVAC

Air conditioning has become the almost indispensible in any office building in Delhi and NCR. The temperature raised above 30^0 C in many part of the year. One has to use artificial method for cooling the building. In winters the temperature dips below 4^0 C therefore, heating of the building is required. All the three companies had installed water based air conditioning plant as the area in question was large and could not be catered by individual AC's. Water based plant were also found to be more efficient in terms of power used by them. In water based plant the indoor environment was cooled by chilled water moving in the pipes. So, effort was made, for maintained temperature of the water in the chiller pipes then, the temperature of the indoor could be controlled. The air conditioning chamber was generally located at the basement or lowest ground in the building with its air handling unit located in ground floor. Air handling unit helps to regulate indoor temperature and any problem during operations can be checked from here.

Table 2 HVAC services in all three buildings

S.No	Facility	Company 1	Company 2	Company3
1	Mechanism for Air conditioning	Water based plant	Water based plant	Water based plant
2	Type of chillers in the building	3 Condensing chillers	3 compression chillers	5 compression chillers
3	Capacity of Air conditioning	375*3tons(TR)	260 * 3 tons(TR)capacity	350*5 tons (TR)capacity
4	Duration for which chillers operated (summers)	10 hours/day	10-12 hours/day	12 hours/day
	Duration for which chillers operated (Winters)	5 hours/day	Not applicable	8 hours/day
5	Method of operating chiller compressor unit	Automatic	Manually	Automatic
6	Checking AC duct filters	Weekly	15 days	Weekly
7	Control for hot water	Yes	No	No
8	Energy resource needed for heating	Electricity /solar energy	Electricity	Electricity
9	Mechanism for ensuring fresh air circulation during summers	Air handling units-suction from fresh air shaft	Through air treatment plant replacement of treated air with fresh air mixed with chilled air supplied to each floor	Intermittent air flow (variable air volume installations)

V. WASTE MANAGEMENT

Waste was a painful but very important because it was generated each minute by the occupants in the building. Efficiency of waste management will determine clean and orderly surrounding. Each building had many types of waste generated vis-à-vis food waste, solid waste, liquid waste and e – waste. The food waste was collected by an outsourced vendor in a container by an outsourced vendor in a container in company 1 and 2 where in the vendor recycle this waste into manure. Company 3 collected the waste in garbage bags and moves it to the garbage disposal site. For solid waste management all three companies had a sewage treatment plant. In sewage treatment plant waste water was collected from all the outlets and was allowed to stand in a tank in company premises where some indigenous method were used to convert the waste in the water into molasses with addition of certain substances and chemicals. The practice of installation if sewage treatment plant was in compliance with ECBC specification where in all the solid waste by institutions/ offices had to be addressed by them so that they do not pollute the surrounding areas.

Table 3 Waste management in all three buildings.

S.no	Facility	Company 1	Company 2	Company 3
1 a.	Treatment of raw water	Treatment with chemicals in collection tank then PVC media cleans sludge then water goes for chlorine cleaning	RO system for entire building	Water treatment plant
b.	Amount of treated water each day	1,00,000 lt	10,000lt	2,00,000lt
2.	Food waste	Collected in container and taken by outsourced vendor	Collected in container and taken by outsourced vendor	Collected in garbage bag and then moved to main garbage disposal area.
3.	Solid waste	Sewage treatment plant	Sewage treatment plant	Sewage treatment plant
4.	Liquid waste	Sewage treatment plant	Sewage treatment plant except oil goes to secondary tank underground	Sewage treatment plant
5	E waste	Collected and given to authorised scrap dealer	Collected and given to authorised scrap dealer	Collected and given to authorised scrap dealer
6	Labelling and colour coding for segregated waste	Blue for liquid waste, yellow for solid waste, red for mixed waste and white for others.	No	No

Since, all the companies included in research were highly technical and employed the use of computers and other electronic gadgets and equipment which when not functioning were to be disposed-off. All the companies collected e – waste and gave it to the authorized scrap dealer. In company 1 it was found that they were labelling and colour coding for segregating the wastes – Blue for liquid waste, yellow for solid waste, red for mixed waste and white for others. This was a good practice because they were able to give specific wastes to the vendor for recycling.

VI. LIGHTING

All the three companies along with daylight also used electric light. It was observed in all the companies that each room had minimum one wall made up of glass whereas; in some cases almost two walls were in glass which would admit ample amount of day light indoors. The glass used was special as it controlled the ingress of heat and UV rays but allowed only daylight to penetrate. Since these offices were working from 9:00am to 9:00pm therefore, use of electric light was indispensible. In company 2 besides glass wall, there were skylights in the cafeteria area making it appear very bright and pleasant during the day. CFL used in all three companies were 15W and duration was 18 hours a day around workstations and some CFL were connected with UPS so in case of power cut some CFL was lighted for evacuation of employees like

in case of fire power got cut so in that case CFL via UPS will provide illumination. In open corridor some light were functional 24× 7 in these three companies.

Table 4 lighting services in a building

S.NO	Facility	Company 1	Company 2	Company3
1	Source of light Daylight	Yes	Yes	Yes
	Electric light	Yes	Yes	Yes
2	Type of installation A. workstation	Direct lighting		
		Recessed light	Recessed light	Recessed lights
	B. Cafeteria	Down lighter and recessed light	Down lighters and recessed light	Down lighters and recessed light
	C. Reception	Down lighters, focus lights and recessed light	Recessed lights	Down lighters and recessed lights
3	Lighting fixtures around A. Workstation	T5 and CFL	T5 and CFL	T5 and CFL
	B. Cafeteria	CFL	CFL and LED's	CFL
	C. Reception	LED's and CFL	LED's, T5 and CFL	LED's, T5 and CFL
4	Control Mechanisms	Time motion sensors	Do manually	Dimmers

VII. MEASURES TO IMPROVE THE EFFICIENCY OF FACILITIES AND SERVICES PROVIDED IN SELECTED OFFICES USING SIPOC TOOL.

1. Water

All the three companies used water pumps ranging from 5hp to 7.5hp depending upon their usage. For providing drinking water, reverse osmosis plant was provided. So, maintaining these water treatment plants and ensuring quality water supply was the most critical area for facility manager. For that reason, routine maintenance of all hydro pneumatic and other systems linked to water supply and fire fighting in the building was done.

Table 5 Gaps identified in existing water management practices in three companies and their relevant solutions

Supplier	Input	Requirements for input	Output	Customers	Customer requirements	Ideal output
Outsource company and insource company	Manpower	• Plumber • Supervisor • Facility executive • Facility manager	In **company 3,** tap water temperature was not adequate as per employee's need. In **company 1**, many (5) sanitary fixtures were leaking.	All Employees working in company	-Quality drinking water -Regular water supply -Well maintained pumping	**Automatic temperature control** should be provided in tap water to achieve high employee satisfaction For high quality
	Materials	-Plumbing water fixtures like tap, pipes, sinks etc. -Plumbing Tools				

	Machine	-Water treatment plant -Water pumping motor (5-7.5hp) -Fire fighting water reservoir tank -Reverse osmosis plant -Boring water pumping pipes			fixtures	service delivery all the **fixtures should be repaired** in time. **Strict monitoring** as to the performance of working staff is required to have quality output.
	Method of payment Environment	purchase orders, challans and necessary invoices for payments Occupancy safety certificate				

2. HVAC

The type of chillers used were condensing type in company 1 whereas, compression chillers used in company 2 and 3. Water based refrigeration unit was installed in all the three companies so regulated water flow through pipes were to be maintained at uniform speed and frequency.

Table 6 Gaps in existing HVAC management in existing companies and their relevant solutions

Supplier	**Input**	**Requirements for input**	**Output**	**Customers**	**Customer requirements**	**Ideal Output**
Outsource company and Insource company	Manpower	Electrician Technician Building maintenance engineer Facility manager	In company 1 foul smell due to downpour seepage. In company 1 and 2 lot of employees complained of indoor temperature too cold.	All Employees working in company	Comfortable indoor environment	Preventive check of false ceiling prior to monsoon should be done. Repair any default and leaking in the wall. Automatic temperature controller system should be incorporated in the building.
	Materials	Insulated pipes for cold water Plumbing Tools Hot water pipes				
	Machine	-water reservoir tank -Compression Refrigeration Unit -Chillers -Air cooled condenser -Cooling towers				
	Method	Pre-planned maintenance schedules not followed in company 1and 2. Daily temperature log sheets were followed				

	Money Environment	purchase orders, challans and necessary invoices for payments Occupancy safety certificate				

3.Waste Management

For solid waste management all three companies had a sewage treatment plant. All the companies collected e – waste and gave it to the authorized scrap dealer.

Table 7 Gaps in existing waste management practices in three companies and their relevant solutions

Supplier	**Input**	**Requirements for input**	**Output**	**Customers**	**Customer requirements**	**Ideal output**
Outsource company And insource company	Manpower	• Electrician • Vendor • Scrap dealer • Building maintenance engineer • Facility manager	Sewage treatment plants were maintained for liquid waste in all the three companies. Authorised scrap dealer were contracted for e waste. Vendors were contracted for food waste. Company 1 had incorporated labelling of wastes like different colour coding for liquid, solid and other wastes.	All Employees working in company	Recycled water	Waste management was maintained quite satisfactory in all the three companies expect the fact than like **company 1** company 2 and company 3 should also **incorporate labelling of wastes** in their waste management process for ease of identification and final disposal.
	Materials	• Garbage bags • Bins			Recycled solid wastes	
	Machine	• Reservoir tank • Secondary tank • Sewage treatment plant				
	Method	• Housekeeping checklist • Regular audits.				
	Money Environment	• Purchase orders, challans and necessary invoices for payments • NOC from pollution legal compliance • Occupancy safety certificate				

4. Lighting

All the employees were satisfied with the lighting provided at workstation, circulation area, cafeteria and reception area. Provision of day light was provided in company 2 in cafeteria. All efficiency of use and for optimum utilisation maintenance of lighting fixtures in terms of cleaning should be done on fortnightly basis.

Table 8 Gaps in existing Lighting practices in three companies and their relevant solutions

Supplier	**Input**	**Requirements for input**	**Output**	**Customers**	**Customer requirements**	**Ideal output**
Outsource company And insource company	Manpower	Electrician Building maintenance engineer Housekeeping boy Supervisor Facility manager	- In all the three companies employees were satisfied with the lighting provided in workstation. - Sky lighting was provided in cafeteria of company 2. - Periodic cleaning was provided on monthly basis. - Automatic control system for lighting was installed in company 1 and 2.	All Employees working in company	Optimum lighting	- Frequency of cleaning of lighting should be done on fortnightly basis. - In company 2 energy efficient measures like dimmers, daylight or motion sensors should be installed.

VIII. CONCLUSION

Nowadays, Facilities Management Company and its unique services are hired in order to manage perfectly the facilities of an owner occupied property like business Park of offices or blocks of flats or large hotel complex or commercial mall etc. Best methods for building maintenance are use and importance is given to preventive type of maintenance. The maintenance management is done by a team of well qualified and trained staffs. The facility managers take care of overall supervision of the assigned task of providing facilities and services. Finding of the study suggests that there is a need to have strict supervision for optimum utilisation of resources and for delivering quality service. In the present scenario, software are there and companies have their own software too for having an upkeep and regular checks on performance of manpower and utilisation of resources to minimise the wastages and maximise the efficiency.

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