Waste Management Emerging Sectors

First Edition

सत्यमेव जयते

MHRD | Government of India
Ministry of Human Resource Development

Waste Management Emerging Sectors

First Edition: 2019

ISBN : 978-81-940618-2-3

Price: ₹ 750/-

Department of Higher Education

Ministry of Human Resource Development, Government of India

5-10-174, Shakkar Bhavan, Ground Floor, Fateh Maidan Road, Hyderabad - 500 004

Telangana State. Tel : 040-23422112, 23212120, Fax : 040-23212114

E-mail : editor@mgncre.in, Website : www.mgncre.in

Published by: Mahatma Gandhi National Council of Rural Education (MGNCRE), Hyderabad

Printed by: Saras Enterprises, Hyderabad

Cover Design and Layout: Mr. G Sivaram

Contents

About the Book

Acknowledgement

Block 1 ICT and MIS

Chapters

1. Introduction to ICT and ITES 02
2. Foundations of Information Systems 28
3. Information Systems for Operations and Discussions 53
4 Managing Information Technology 77
5 Security and Ethical Challenges 102

Block 2 Hotel Waste Management

Chapters

1. Overview of Hotel Waste 129
2 Waste Management 145
3. Food Waste Reduction 156
4. Good Practices 170
5. Waste Audit in Hotels 184

Block 3 Bio-Medical Waste Management

Chapters

1. Biomedical Waste and Sources 201
2. Impacts on Health 227
3. Legal Aspects 250
4. Steps Involvement in Biomedical Waste Management 279
5 Management and Administration 307

Block 4 E-Waste

Chapters

1. Generation of E-Waste and its Comparison with other Countries 345
2. Hazardous Substances in E-Waste 367
3. E-Waste Management and the Regulatory Framework 388
4. Dismantling and Recycling of E-Waste 406
5. Sustainable Consumption and Production 422

Author's Profile

About the Book

This book provides a comprehensive view of the waste management system in India including the systemic challenges and innovative solutions. The waste sectors addressed include biomedical, hotel and e-waste. The cardinal objective of the book is to address the prevailing lacuna in the waste management industry through promotion of techno-social entrepreneurship in the waste management sector, consequently accomplishing the vision of Swachh Bharat Abhiyan. The book is based on learning through pragmatic, applied and explorative modes rather than theoretical, rote and didactic learning.

Hotel industry consumes lot of resources and contributes heavily to waste generation. Hotels have consistently contributed to tremendous growth in Indian GDP and also fueled the increase in number of hotels around the country. There are improper waste management practices in this industry and lack of suitable facilities and infrastructure, managerial and technical inadequacies add to the poor waste management system. The main goal of hotels should be to create sustainable business along with generating profit from waste. Proper management of waste can lead to higher profitability for hotels and save environmental pollution. A holistic framework for waste management needs optimization of each waste material in hotel industry. Most of the wastes in hotels are recyclable or compostable. Hotels can not only make environmental friendly contributions, but also make profits out of a proper recycling practice in the long term. Waste Management is a serious issue that needs public awareness and practical and governmental attention immediately.

Biomedical waste management has assumed great significance in recent times. The rapid upsurge of HIV infection rates is an added factor. Due to the growing menace of this infectious and hazardous waste, Government of India has made proper handling and disposal of this category of waste a statutory requirement with the publication of gazette notification no 460 dated 27 July 1998. The provisions are equally applicable to all hospitals and it is mandatory for them to be well aware of the basic principles of handling, treatment and disposal of biomedical waste. Biomedical waste is defined as any waste, which is generated during the diagnosis, treatment or immunization of human beings or animals, or in research activities, or in the production or testing of biologicals. The quantity of biomedical waste generated per bed per day varies depending upon the type of health problems, the type of care provided and the hospital waste management practices. It ranges from about 2kg in developing countries to about 5kg in developed countries. Infectious waste is almost 15% of the waste in developed countries while it is about 50% in India, requiring special handling. Hazardous biomedical waste has an inherent potential for dissemination of infection. Almost 60% of all hospital staff sustain injuries from sharps during various procedures undertaken in health care facilities. As microbiological and bio waste is highly infectious, it needs to be treated on site by autoclaving/microwaving/chemical treatment. Biomedical waste should be treated and disposed off in accordance with schedule 1 of the rules and the prescribed standards given in schedule V of Government of India gazette notification.

The growth of information technology and communication systems has provided us with different kinds of electronic and electrical appliances such as mobile phones, laptops, computers, refrigerators, television etc. that have added to our comfort, convenience, entertainment and faster communication with the world. However, the technological advancement in the IT sector and the demand for electronic and electrical equipment (EEE) have also led to the generation of e-waste. The hazardous substances in e-waste such as mercury, chromium, lead, beryllium etc. result in harming the environment adversely when the e-waste is dismantled or recycled by unscientific methods in the informal economy. Regulatory frameworks in India and across the world are discussed. An analytical view of the recycling and the dismantling practices being used in the formal and the informal sector is presented. The principles of circular economy and LOHAS (Lifestyles of Health and Sustainability) focus on adopting sustainable practices in production and consumption based on the principles of 3Rs i.e. reduce, reuse and recycle.

This book is expected to become a primer for students, scholars and teachers across the country to learn, teach, and practice the art of interpretive discussions and learning in Waste Management and Social Entrepreneurship.

Acknowledgement

This book represents the collective efforts of many remarkable individuals. We would like to thank the contributors to this volume for their collective wisdom, experience and insight. Envisioned by Shri VLVSS Subba Rao, Senior Economic Advisor, MHRD, the book took shape under his keen guidance.

We would like to thank our Subject authors: Dr Balamurali Krishna, Socio-technologist, Karpagam Academy of Higher Education, Tamilnadu; Dr Anupma Harshal Wadavlikar, Scientist, Kishin Chand Chellaram College, Maharashtra; Dr Anamika Gulati, Expert Scientific Writer, Novartis Healthcare Pvt Ltd, New Delhi; and Dr Sonal Chaturvedi, Capacity Building Expert, Mumbai.

We would like to thank Major Shiva Kiran, Consultant, MGNCRE; Vani G, MGNCRE and MGNCRE team members including Editor, Ms. V Anasuya and Designer, Mr. G Sivaram for extending their support in completing this book.

Block 1

ICT and MIS

Swachhta Action Plan

सत्यमेव जयते

Mahatma Gandhi National Council of Rural Education

Department of Higher Education

Ministry of Human Resource Development, Government of India

Hyderabad - 500004

Where there is Rural Wellbeing
there is Universal Prosperity

Contents

Chapter-1 Introduction to ICT and ITES

1.1 ICT and ITES
1.2 Digital India
1.3 Digital Transformation
1.4 Computer Fundamentals
1.5 Software as a Service (SaaS)
1.6 Mobile Computing and its Components

Chapter-2 Foundations of Information Systems

2.1 Information Systems
2.2 Electronics and Mobile Commerce
2.3 Software Development Lifecycle (SDLC)
2.4 Geographical Information System (GIS)
2.5 Waste Management Software
2.6 NAVIC – IRNSS
2.7 Industry 4.0

Chapter- 3 Information System for Operations and Discussions

3.1 Digital Marketing
3.2 Database Management System (DBMS)
3.3 Contemporary trends in DBMS

Chapter- 4 Managing Information Technology

4.1 Enterprise Resource Planning (ERP)
4.2 Business Process Re-engineering
4.3 Supply Chain Management (SCM)
4.4 Globalization and its impact on SCM
4.5 Electronic Data Interchange (EDI)

Chapter - 5 Security and Ethical Challenges

5.1 Cyber Security
5.2 Emerging Technologies
5.3 Best Practices in Waste Management Sector

Chapter 1 - ICT and ITES

The Information and Communication Technology (ICT) has become one of the basic requirements of the modern society. In today's digital era, we use mobile devices to perform the tasks of our daily life. It is difficult to think of any event without the use of digital devices. In fact, Information Technology (IT) is one of the world's fastest growing economic activities, which envisages easier flow of information at various levels in the desired pattern.

Computers and information systems has now become an essential part of every business today. Like accounting and legal, every business needs to invest in technology to compete. The IT has several benefits for a business, such as it helps in reaching more potential customers, developing a business relationship with potential customers, streamlining operations, reducing costs, improving efficiency, maximizing profit, minimizing waste, providing better service to customers, supporting better relationships with key partners, and allowing customers to better guide the business.Information Technology enabled Services (ITES) sector has not only changed the way the world looks at our country but has also made significant contributions to e Indian economy. This chapter will elucidate aboutsome basic concepts and ideas related to Information Technology (IT) and IT enabled Services (ITES).

1. Introduction to ICT and ITES
2. Scope of e-Governance in rural development
3. ICT and its impact in rural development
    a. Digital India
    b. Digital Transformation
4. Computer Fundamentals – Hardware and Software
5. Software as a Service (SaaS)
6. Mobile Computing and its components

1.1 ICT and ITES

Today, we may obviate a personal relationship, but we most likely won't be able to turn off a virtual world that persists on a networked server, always waiting for someone to visit via Smartphone, laptop or even virtual reality device. Next generation of ICT and ITESpresents both un-paralleled opportunities for participatory self-organization, citizen empowerment, grassroots activism and corresponding risks too if we don't update ourselves with latest technology trends.

Before going further into the ICT and ITES, let's have a look at the above diagram and have retrospection on the journey we have come across. Frankly speaking, today we are at a dynamic world reckoned and engulfed with technology; metamorphosed to techno-social creatures. But it is to be remembered that ICT depends on Time, say like ICT is directly proportional to time factor. To put it differently, as time changes/passes the corresponding technology (ICT) also does the same.

From sociological perceptive ICT can be viewed as "the convenient instrument harnessed by man to accomplish his communication tasks at a given point of time". For instance, during historical days, man used pigeons as technology (at that point of time) as a medium of communication. Buttoday, we are quite comfortable with the computing technology for communication. Yet, tomorrow we don't have a clue on which technology could be harnessed for communication. In essence, this phenomenon is indeed called as ICT and its allied ITES.

Thence, Information Technology Enabled Services (ITES) enables the business to improve the quality of service.It is also called web-enabled services or remote services that cover the entire operations which exploit Information Technology for improving the efficiency of an organization. Therefore, the ITES is defined as outsourcing of processes that can be enabled with information technology and covers diverse areas.These services provide a wide range of career options that include opportunities in all offices like call centers, payrolls, logistics management, revenue claims processing, medical billing, coding, medical transcription, legal databases, back office operations, content development, GIS (geographical information system), web services and Human Resource (HR) services, etc. Further, the E-enabled services radically reduce costs and improve Notes service standards. In short, Internet service provider aims to provide B2B e-commerce solutions. ITES offers different services integrated in a single delivery mechanism to end users. The services may include: the Medical Transcription, Customer Relationship Management, Data Entry and Data Processing, Software development, Data Warehousing, IT Help Desk Services, Enterprise Resource Planning and Telecommunication Services.

ICT plays a key role in e-governance, and so it becomes essential that ICT reaches rural masses. This will lead to good governance which in turn will lead to better administration, better interaction, less corruption and more transparency in the government. The Government of India recognizes that some good e-Initiatives like 'Digital India' provide an excellent opportunity for improving governance. It is a trigger for introducing various administrative reforms. This could not only go a long way in improving the quality of life of various sections of society, but could actually provide them more equitable access to economic opportunities ever before. In this context, the Government of India views e-Initiative as a strategic tool for transforming Governance and improving the quality of services provided by the government to its people.

The experience in e-Governance/ ICT initiatives has demonstrated significant success in improving accessibility, cutting down costs, reducing corruption, extending help and increased access to un-served groups. The e-Governance in essence, is the application of Information and Communications Technology to government functioning in order to create Simple, Moral, Accountable, Responsive and Transparent (SMART) governance. E-Governance not only provides information about various activities of a Government but also involves citizens to participate in government's decision making process.The types of services possible through e-Governance can be broadly classified into three categories

- providing information
- improving processing efficiency
- facilitating transactions

E-governance stands for electronic governancethat makes use of ICT to provide interaction between Government and Citizens (G-C), Government and Businesses (G-B), and Government to Government (G-G). In all these modes government applied different set of policies and rules for completing the task related to the field.Future of e-Governance can be comprehended as a kind of focal point for convergence of a number of contemporary trends in computing, ICT and ITES. These trends include the technology-driven instrumentation of digital infrastructure by ubiquitous computing and/or ‘intelligent’ devices, with prefix “SMART” now taking precedence over the prefix ‘e-‘ i.e.) Smart Grids, Smart Cities, Smart Motorways etc., rather than the erstwhile e-Commerce, e-Health, e-Learning etc. Consequently,the next generation of e-Governance will be underpinned by the most advanced and potentially most ‘intelligent’ technology so far invented; however the “socio” part – involving the human behavior, nondeterministic decision-making and interactions, complex social structures viz., the culture, morality, ethics, and above all the values — shall be essentially unchanged, except to extent that they are irrevocably changed by the technology itself.

Scope of ICT in Rural Development

ICT play an important role in addressing these challenges and uplifting the livelihoods of the rural poor. It offers an opportunity to introduce new activities, new services and applications into rural areas or to enhance existing services. Rural ICT applications aspire to present the services to citizens at their village access stepladder. E-governance uses ICT in present for better and reasonable connectivity and processing solutions. Emergence of ICT has provided means for faster and better communication, efficient storage, retrieval and processing of data and exchange and utilization of information to its users, be they individuals, groups, organizations or governments. With all these opportunities ICT also have some challenges like literacy, digital literacy, poverty, limited citizens’ awareness, infrastructure, discrimination, digital divide, funding issues, hesitation due to myriad cultural beliefs, language dominance etc.

Activity 1 – Did you know?‘Akodara’ – First Digital Villagein India!

Akodara, a small village in Sabarkantha district of Gujarat has earned the distinction of becoming the country’s first digital village. The village with a small community of 1200 people has gone completely cashless. The village was adopted and developed by ICICI foundation as a digitized village.

All transactions in the village be it a transaction of only Rs.10 or Rs. 10,000, all are carried out through digital modes like SMS, net-banking or debit cards. As a result, the union government's demonetization move did not impact the people of Akodara as it did on the rest of the country.

Impact of ICT in Rural Development

ICT was the key to development of the geographically scattered rural people in developed nation and it is getting its popularity in the developing nations. The primary cost for establishment and set up of ICT infrastructure may be a barrier for developing nation but its enormous usefulness for the rural people cannot be denied. Use of information and communication technology can contribute a lot in socioeconomic development of rural area. Some impacts of ICT in education, agriculture, healthcare are elaborated below, however there are several other sectors like tourism, banking and finance etc. in which ICT also has a great stake to play.

ICTin Education

Education is the backbone for any nation. In many developing countries like India, bringing a large percentage of students to education system is a great challenge. The reasons may be the geographical location, socio-economic condition etc. For example, in the northeast states of India many villages are scattered in impassable hill regions. Poor transport facility discourages the rural students to come to school regularly. Scarcity of efficient teacher in the rural schools and a large student teacher ratio to the student side is also a reason for dropout of a large percentage of students in the midway of their education. Thus a great mismatch of education quality is observed when comparison is made with rural and urban students.

File photograph from Centre for Communication and Development Studies (CCDS)

Adoption of ICT in education can minimize the gap. Role of a teacher is shifted from leader to facilitator in ICT based education system. Adoption of ICT in teaching system enables and supports the move from traditional `teacher-centric' teaching styles to more `learner-centric' methods. A diverse group of students can learn simultaneously even in the absence of teacher.

Some of e-education initiatives by Government of India are as follows:

- **Swayam:** It’s an indigenously designed massive open online course (MOOC), It will host all the courses, taught in classrooms from 9th class till post-graduation and can be accessed by anyone, anywhere at any time. It aims to bridge digital divide for students in e-education.

- **SwayamPrabha:** It provides high quality educational contents, developed by the experts, through 32 DTH (direct to home) Television Channels with an aim to bring uniformity in standards of education. It will cover diverse disciplines of all levels of education in various languages. It will be available to all and will be having new content of 4 hours to be telecasted 6 times a day.

- **National Academic Depository:** It is a digital depository of academic awards for authenticating all certificates issued by institutions. NAD will directly integrate with Boards/Universities which issue certificates which will be verified, authenticated, accessed and retrieved in a digital depository for purpose of employment, education, and loans.

- **National Digital Library:** It is a large online library containing 6.5 million books. It provides free access to many books in English and the Indian languages.

ICTin Health

The medical facility is being the far unreachable section in connection to the rural people. ICT has a great role to play in health section in rural areas. Adoption of telemedicine in some rural areas of India has given an encouraging result for its accessibility, affordability and availability. With this ICT based facility a small e-health kiosk with a trained person can provide medical facility to a large number of people.

File photograph from Ministry of Health and Family Welfare (MoHFW)

When a patient is brought to the health kiosk, he enters the health details and problems of the patient to a central server. The server communicates with some doctor in district or urban hospital. The person at the kiosk communicates with the doctor to the other side and performs check-up and gives medicines according to the instructions of the doctor. By video conferencing doctor sited at some urban health center can face to face talk with the patient. Facility of pathological center is inadequate in rural areas. To take up digital India initiatives ahead, MoHFW has started various e-Governance initiatives in Health care sectors. The division as named as 'e-Health 'with an vision to attain high quality of health services for all Indians through the cost-effective and secure use of information and communication technologies in health and health-related fields. The objectives of e-Health are:

- To formulate "National e-Health Policy and Strategy" for coordinated e-Health adoption
- To oversee orderly evolution of e-Health initiatives (state and nationwide) and to guide adoption of e-Health at various levels and in different geographical and health system areas
- To promote setting up of state health records repositories and health information exchanges (HIEs) to facilitate interoperability
- To formulate and manage all health informatics standards for India
- To lay down data management, privacy and security policies, guidelines and health records of patients in accordance with statutory provisions
- To enforce the laws and regulations relating to the privacy, confidentiality, and security of the patient's health information and records
- To coordinate efforts across departments and ministries, and liaise with other related policy/regulatory groups to ensure consistency and coherence
- To help enable ecosystem that involves stakeholders to improve care delivery outcomes
- To map continuous evolution of e-Health landscape and take on new functions as needed

Thereby, the objective is to ensure development and promotion of e-Health ecosystem in India for enabling, the organization, management and provision of effective people-centered health services to all in an efficient, cost-effective and transparent manner.

ICTin Agriculture

India is primarily an agriculture economy and almost the entire rural region depends on agriculture and its allied sectors. Even with a noticeable growth in industrialization, agriculture still accounts a major part in GDP of India. But till in many rural areas the farmers are cultivating same crops years after years, while in the meantime the weather, soil condition of the land are changed, the pest have acquired immunity against the known pesticides -resulting a declined production graph. ICT can transform the common agriculture process to a smart one. With the help of ICT based service a farmer can directly seek advice in his own language from some agricultural expert. He can apply online for soil test and get suggestion from experts regarding the type of crop which will give best production to that type of land. In developed countries ground sensors set up in agricultural field are used for crop protection. The sensors provide information to the farmer regarding the necessity of irrigation, deficit of mineral (To select appropriate amount of fertilizer), increase of pest etc. Adoption of this technology provides better production in developing nations.

File photograph from ITC Limited

Use of satellites and remote sensors provides accurate weather forecast even a month ago. This gives farmer a long time for crop selection for a season. He can seek for improved seed, best market price for his production, government's credit program etc. from internet. Bulk purchasing policy of some multinational companies directly from the farmer has eliminated the role of middleman as well as providing beneficiary to the cultivators. Different state governments in India have adopted the facility of bringing fresh vegetables directly to urban kitchen from farmers' field. ICT has given wings to these initiatives. Some of the key Government of India initiatives to promote use of ICT in agriculture include National e-Governance Plan in Agriculture (NeGP-A), various Touch Screen Kios, KrishiVigyanKendras, Kisan Call Centres, Agri-Clinics, Common Service Centers, mKisan, Kisan TV and various other applications.

ICT in Disaster Management

The Natural Calamities or Disaster is unpredictable and can occur at any place irrespective whether it's a developed, developing or underdeveloped country. Severe natural disaster leads to massive destruction of properties and even loss of human lives- effect of which remains as a scar for a long time. It is experienced that a large scale natural calamity impacts more severely to the developing or least developed countries than the developed one. The recent devastating monsoon flood of Kerala (2018) is one such instance that tremble the world. It is observed that rural areas are mostly affected than urban areas in natural disaster mainly due to poor transportation and communication facility. In relation to natural disaster for some cases like cyclone, flood, tsunami, volcanic eruption etc. an early warning system can be setup using remote sensing technology. An earlier forecast helps people for preparedness and to take safe shelter. This may save a lot of lives and properties from destruction. Proper use of ICT tools help to build knowledge warehouses and data warehousing techniques. Those can facilitate planning and policy decisions for preparedness in right time, quick response and recovery at all levels. Communication system is largely affected by natural disaster which makes the situation worse. GIS based system is governed by satellite and can easily identify the location of any person having the system(such as Smartphone) and stuck in the disaster.GIS with GPS have been found useful in 2013 sudden flood in Uttarakhand, 2014 flood in Kashmir and even in 2015 Nepal earthquake.

File photograph from National Disaster Management Authority (NDMA)

The EWDS is a first-of-its-kind automatic public address system in the country that aims to establish fool-proof communication system to address existing gaps in disseminating disaster warning up to community level. The project is being implemented under National Cyclone Risk Mitigation Project with World Bank's help. It will provide Odhisa's entire population residing on 480 km length coastline a pre-warning siren in event of occurrence of natural disasters like tsunami or cyclone. Further, it will help to warn vast population of state residing along its coast from State headquarters through loud sirens from towers installed at 122 locations in six coastal districts in event of occurrence of natural disasters like a tsunami or cyclone.The EWDS comprises certain devices inbuilt into it like as Satellite-Based Mobile Data Voice Terminals (SBMDVT), Digital Mobile Radio (DMR), Mass Messaging System (MMS) and Universal Communication Interface (UCI) which help in inter-operability among different communication technologies. Whenever, there is slightest hint of disasters like tsunami or cyclone or any other natural calamity, it will broadcast warning to entire state just by press of button from control room in state capital Bhubeneswar. With press of button, loud sirens will go off at same time and warning sound will hear in localities to radius of 1.5 km. With this pre-warning, EWDS will help people to move to safer places before government agencies start evacuation.

Infrastructure for ICT

In order to render quality service using ICT a strong infrastructure backend is prerequisite. Infrastructure backend includes workstation, high speed network, Projection/Display technology, interactive devices, video conferencing equipment, printer etc. For mobile workstation devices like laptop, tablets, notebooks are essential. In hill area or island where setting up wire network is costly, there wireless network infrastructure is the best choice. The workstations must have a focused coverage and publicly access. It aims to provide free service or service at low cost. Those must be set up in some convenient locations, accessible in walking distance. Selection of proper application software and graphical user interface (GUI) are important for smooth operation using ICT. Now a days Cloud computing are becoming popular to provide support to a large number of users without buying individual software copy.

The services provided by cloud computing can be perceived as `whenever and whatever needed'. It reduces the implementation and maintenance cost. Software as a service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) are various cloud computing models as per the user requirement. Knowledgeable technicians in the field of IT community must be staffed to render the technical support for any organization.

Activity 2 – Brainstorming

	Scan the QR Code to Watch the Video

Watch this video to have in-depth understanding on Cloud Computing technology

1.2 Digital India

Government Process Re-engineering (GPR) using the ICT has helped to simplify the bureaucratic processes efficient and successful delivery of services to the common man. The Digital India is one such flagship programmethat transforms India into digital empowered society and knowledge economy. It intends to provide the much needed thrust to the nine pillars of growth areas, namely

1. Broadband Highways
2. Universal Access to Mobile Connectivity
3. Public Internet Access Programme
4. e-Governance: Reforming Government through Technology
5. e-Kranti - Electronic Delivery of Services
6. Information for All
7. Electronics Manufacturing
8. IT for Jobs
9. Early Harvest Programmes

Art by **Avishi Srivastava**, Child Artist

There are three key elements of the Digital India program and vision, namely,

- Digital infrastructure as a utility to every citizen,
- Governance and services on demand
- Digital empowerment of citizens.

Various measures has been taken by government towards this objective like

- Simplification of collection of data by adapting to simple and user friendly forms
- Switching over to complete online automated application, use of online repositories e.g. for certificates, educational degrees, identity documents, etc.,
- Integration of services and platforms e.g. Aadhaar platform of Unique Identity Authority of India (UIDAI), payment gateway services such as e-wallets etc.
- Sharing of data through open Application Programming Interfaces (APIs)

All these measures havelead to integrated and interoperable service delivery to citizens and businesses. Further, continuous efforts are being made to establish databases and information in electronic form. ICT tools are being used to automate, respond and analyze data to identify and resolve persistent problems for process improvements.

Digital India initiatives – At a Glance!

Digi-Locker: Digital Locker facility helps citizens to digitally store their important documents like passport, mark sheets and degree certificates etc. Digital Locker will provide secure access to Government issued documents. It uses authenticity services provided by Aadhaar. It is aimed at eliminating the use of physical documents and enables sharing of verified electronic documents across government agencies.

MyGov.in: It is a platform to share inputs and ideas on matters of policy and governance. It is a platform for citizen engagement in governance, through a 'Discuss', 'Do'&'Disseminate' approach.

SwachhBharatMission (SBM) Mobile Application: Clean India mobile app is being used by people and Government organizations for achieving the goals of Swachh Bharat Mission.

eSign Framework: It allows citizens to digitally sign a document online using Aadhaar authentication Online Registration System (ORS).

eHospitalApplication:eHospital application provides important services such as online registration, payment of fees, appointment, online diagnostic reports, enquiring availability of blood online etc.

National Scholarships Portal: It is a one stop solution for end to end scholarship process right from submission of student application, verification, sanction and disbursal to end beneficiary for all the scholarships provided by the Government of India.

Jan DhanYojana: It is a massive programme on financial inclusion. It targets to have at least one bank account in each household. Further each account holder should have the insurance policy.

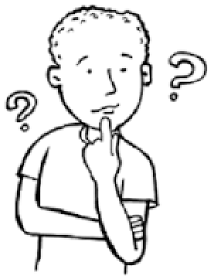
JeevanPraman: This programme facilitates Pensioners from Government to furnish life certificates every year electronically. More than 1.5 million registered pensioners in the country are availing of this digital facility to continue to claim their pension regularly. The Aadhaar Based Biometric Authentication System for Pensioners (JeevanPramaan /Life Certificate) is being used effectively. Pensioners can submit their Digital Life Certificate (DLC) from their home by using PC/Mobile with biometric devices.

Activity 3 –Contributiontowards Clean India Mission

Scan the QR Code to download and install the Clean India Mobile App

Information for All: Open Data platform facilitates proactive release of datasets in an open format by the ministries/departments for use, reuse and redistribution. Online hosting of information and documents facilitate open and easy access to information for citizens. Government pro-actively engages through social media and web based platforms to inform and interact with citizens.

Early Harvest Programme: It basically consists of those projects which are to be implemented within short timeline such as IT Platform for Messages, Government Greetings to be e-Greetings, Biometric attendance, WiFi in All Universities, Secure Email within Government, Standardizing Government Email Design, Public Wifi hotspots, School Books to be eBooks, SMS based weather information, disaster alerts, National Portal for Lost & Found children etc.



Digitization? Digitalization? Digital Transformation?

Digital technologies - the ways we use them in our personal lives, work and society – have changed the face of both society and government and will continue to!

Digitization: It is the conversion of analog information into digital form" (i.e. numeric, binary format). Digitizing, is technically explained as the representation of signals, images, sounds and objects by generating a series of numbers, and expressed as a discrete value.

Digitalization: Unlike digitization, this is the actual "process of the technologically-induced change within the above industries". This process has enabled much of the phenomena today known as the Internet of Things, Industrial Internet, Industry 4.0, Big data, Machine Learning, Blockchain, Crypto currencies etc.

Digital Transformation: It can be described as "the total and overall societal effect of digitalization."Digitization has enabled the process of digitalization, which resulted in stronger opportunities to transform and change existing business models, socio-economic structures, legal and policy measures, organizational patterns, cultural barriers, etc.

The Digitization (the conversion), digitalization (the process) and the digital transformation (the effect), therefore, accelerates and illuminates the already existing and ongoing horizontal and global processes of change in society.This has always been so but the pace at which it is happening is accelerating and is faster than the pace of transformation in organizations.

1.3 Digital Transformation

India is on the path of reforming the public administration organizations with the aim to deliver more efficient and cost effective public oriented services and better information and knowledge, to people at the last mile. Digital transformation is the effective way to improve the system of governance that is in place and provide better services to citizens at large. Digital transformation is considered as a high priority agenda in India by taking Information and Communication Technology (ICT) to the common public. Advancements in digital transformation will harness the power of ICT to make the governance processes quicker, efficient, inexpensive, accountable and transparent.

Digital Transformation refers to the bunch of five technology components;

1. **Social** - Allows people to communicate electronically on social platforms in real time
2. **Mobility -** Connecting with people irrespective of place
3. **Analytics -** Using data to analyze program and policy areas
4. **Cloud** - Changing people to leverage and pay for technology
5. **Cyber Security -** Providing secure communication and data storage

In this digital era, governments target all these five components together to address specific needs as they are useful to connect with the citizens, manage work force, reduce cost and automate processes. On the other-hand, Digital Maturity is measured by a framework consisting of- People, Processes and Preparedness. People include citizens with digital know-how, able leadership, skilled workforce, and enabled talent. Processes involve innovation and collaboration, service and involvement of citizens, use of open source technologies and faster procurement. Preparedness requires strategy articulation, investment reaction and response to digital trends and capability benchmarking.Certain factors that influence digital transformation in an organization namely;

- Strategy,
- Leadership
- Workforce Skills
- User Focus
- Digital Culture

Governments across the globe are at very different stages in the digital maturity. A small percentage is 'maturing' however the majority are still in the 'early' or 'developing' stages. Even in India some states are in the 'early' and some are in 'developing' stages. Digital India initiative is a step forward to put India in the 'maturing' stage. For calibrating the transformation status, The NITI Aayog has come up with an index viz. Digital Transformation Index (DTI) - a tool used for gauging how well one helps an organization grow and thrive in a digital world.

Some of the barriers to digital transformation of organizations are:

- Lack of strategy
- Lack of digital mindset
- Lack of entrepreneurial spirit or un-willingness to take risks
- too many competing priorities
- Lack of organizational agility

Lack of overall strategy is the leading barrier limiting early stage organizations from taking full advantage of digital trends. On maturing, lack of strategy falls away and then barriers become too many competing priorities, insufficient funding and handling cyber security. Therefore we have to set ensure that our strategy shall inculcate to increase efficiency, improve citizen experience and engagement and transparency, create valuable information or insights for innovation and improved decision making and transform organization processes. Hence, the Digital transformation is a way to solve the social as well as economic problems existing in the developing countries like India.

Activity 4 – Innovative

Scan the QR Code to Watch the Video

India has the world's second largest internet population with over 400 million users, but only 30% are women. In rural India, only 1 out of 10 internet users is a woman.To help close this gap, in July 2015 Google partnered with Tata to launch the "Internet Saathi", a digital literacy program. Women in rural India can complete the Saathi training, learning how to access and use the internet, and they in turn impart training to their community and neighboring villages. This video would give you insights on the vision of Internet Saathi. Now discuss with your partner and ideate a strategy to promote waste management policy similar to this.

1.4 Computer Fundamentals

If we taking this course a decade back, then it would be logical enough to study the below definition of Computer (Commonly Operated Machine Particularly Used in Technology Education Researches)

"Computer is an advanced electronic device that takes raw data as an input from the user and processes it under the control of a set of instructions (called program), produces a result (output), and saves it for future use."

But we are in 2019+, where world is an information-rich world and it has become a necessity for everyone to know about computers that it is an electronic data processing device, which accepts and stores data input, processes the data input, and generates the output in a required format.

The basic parts of a computer or (even a laptop) remain the same, namely:

- **Input Unit** − Devices like keyboard and mouse that are used to input data and instructions to the computer are called input unit.
- **Output Unit** − Devices like printer and visual display unit that are used to provide information to the user in desired format are called output unit.
- **Control Unit** − Like the name suggests, this unit controls all the functions of the computer. All devices or parts of computer interact through the control unit.
- **Arithmetic Logic Unit** − It is the brain of the computer where all arithmetic operations and logical operations take place.
- **Memory** − All input data, instructions and data interim to the processes are stored in the memory. Memory is of two types – primary memory and secondary memory. Primary memory resides within the CPU whereas secondary memory is external to it.

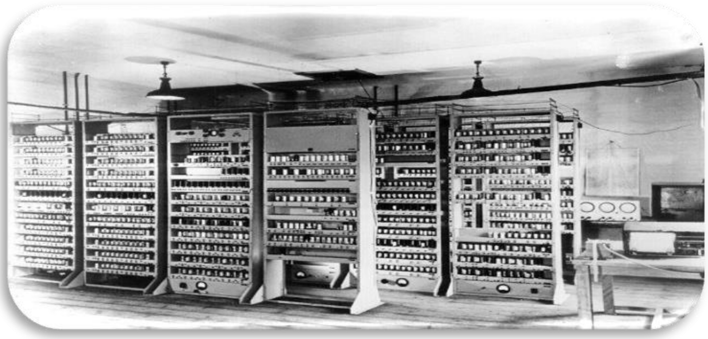
The Control unit, arithmetic logic unit and memory are together called the central processing unit or CPU. Computer devices like keyboard, mouse, printer, etc. that we can see and touch is categorized as the hardware components of a computer.

Whereas the set of instructions or programs that make the computer function using these hardware parts are called software. We cannot see or touch software. Both hardware and software are necessary for working of a computer.

SO WHAT is the difference between hardware and software?

Hardware	Software
It is the physical component of a computer system.	It is the programming language that makes hardware functional.
It has the permanent shape and structure, which cannot be modified.	It can be modified and reused, as it has no permanent shape and structure.
The external agents such as dust, mouse, insects, humidity, heat, etc. can affect the hardware (as it is tangible).	The external agents such as dust, mouse, insects, humidity, heat, etc. cannot affect (as it is not tangible).
It works with binary code (i.e., 1's to 0's)	It functions with the help of high level language like C#, PHP, JAVA etc.
It takes in only machine language, i.e., lower level language.	It takes in higher level language, easily readable by a human being.
It is not affected by the computer bug or virus.	It is affected by the computer bug or virus.
It cannot be transferred from one place to other electronically.	It can transfer from one place to other electronically.
Duplicate copy of hardware cannot be created.	A user can create copies of software as many as he wishes.

Activity 5 –Thought Provoking



Scan the QR Code to Watch the Video

Generation in computer terminology is a change in technology a computer is/was being used. Initially, the generation term was used to distinguish between varying hardware technologies. Nowadays, the generation includes both hardware and software, which together make up an entire computer system.There are five computer generations known till date. This video briefs on the generations along with their time period.

Relationship between Hardware and Software

- Hardware and software are mutually dependent on each other. Both of them must work together to make a computer produce a useful output.
- Software cannot be utilized without supporting hardware.
- Hardware without a set of programs to operate upon cannot be utilized and is useless.
- To get a job done on computer, relevant software should be loaded into the hardware.
- Hardware is a one-time expense.
- Software development is very expensive and is a continuing expense.
- Different software applications can be loaded on hardware to run different jobs.
- Software acts as an interface between the user and the hardware.
- If the hardware is the 'heart' of a computer system, then the software is its 'soul'.

Software Application

Software is a set of programs, which is designed to perform a well-defined function. A program is a sequence of instructions written to solve a particular problem.There are three types of software

- **System Software:** It is a collection of programs designed to operate, control, and extend the processing capabilities of the computer itself. This software is generally prepared by the computer manufacturers. These software products comprise of programs written in low-level languages, which interact with the hardware at a very basic level. It serves as the interface between the hardware and the end users. Some examples of system software are Operating System, Compilers, Interpreter, Assemblers, etc.
- **Application Software**: It performs a single task and nothing else is called application software. Application software are very specialized in their function and approach to solving a problem. So spreadsheet software can only do operations with numbers and nothing else. For instance, Hospital Management Software will manage hospital activities and nothing else. Some of commonly used application software are MS Office, Database Management like SQL, MySQL etc.
- **Utility Software:**The application software which assiststhe system software in doing their work is called utility software. Therefore, utility software is actually a cross between system software and application software. Examples of this software include Antivirus Pack,File Management tools etc.

1.5 Software- as- a- Service (SaaS)

Software has traditionally been a packaged good that consumers and businesses purchase and install on local computers. Over the past several years, however, we are seeing a gradual shift in how software is delivered to customers. Rather than building applications that run locally on a computer, software developers are building applications that run remotely on multiple servers, which can then be accessed from any computer with an Internet connection. This shift in strategy has many implications for both new and existing software companies, as well as for the open source community. With major players such as Microsoft, Apple, Google, and Amazon all moving towards the "cloud", we are without a doubt moving into a different era of computing.

So what is meant by SaaS? The Software- as- a –Service (SaaS) is an application delivery model that enables users to utilize a software solution over the Internet. It essentially refers to software that is hosted on servers and is provided as a service. Some initial uses for SaaS included customer relationship management offerings, content management systems, video conferencing, and e-mail communication systems. SaaS applications are provided over the web, which means they can be accessed from any computer without any special software installed. In fact, many applications are designed to run through a standard web browser. When updates to a SaaS application need to be installed, they are simply installed on the server, which immediately ensures that all users are running the latest version. Unlike traditional software applications that require an upfront purchase, SaaS applications typically offer subscription-based pricing and are usually licensed on a per-user basis. In other words, SaaS revenue models are typically subscription based, where users pay a fixed recurring fee over a period of time (often monthly or annually).

Characteristics of SaaS

- SaaS makes the software available over the Internet
- The software applications are maintained by the vendor
- License to software may be subscription or usage based and it is billed on recurring basis
- SaaS applications are cost-effective since they do not require any maintenance at user end
- They are available on demand
- They can be scaled up or down on demand
- They are automatically upgraded and updated
- SaaS offers shared data model. Therefore, multiple users can share single instance of infrastructure. It is not required to hard code the functionality for individual users
- All users run the same version of the software

Significances of SaaS

Using SaaS has proved to be beneficial in terms of scalability, efficiency and performance. Some of the benefits are listed below:

- Modest software tools
- Efficient use of software licenses
- Centralized management and data
- Platform responsibilities managed by provider
- Multitenant solutions

Applications of SaaS:

- Billing and invoicing system
- Customer Relationship Management (CRM)
- Help desk applications
- Human Resource (HR) solutions

Discuss with you partner and label the gadgets

The SaaS is without a doubt gaining momentum, and is clearly changing the way software companies deliver their products. Large enterprises are looking at the technology as a way to reduce operating costs and deployment times, and small businesses are looking at it to reduce their upfront software expenditures. While SaaS has certainly been around for a while, new and innovative technologies allow developers to provide a more desktop-like experience over the web. These technologies are already obscuring the line between the Internet and the desktop, which is why we will continue to see a growing trend towards moving applications to the web. As more people utilize Internet-enabled mobile devices, they will expect to have access to the same tools that they would normally have with their desktop computers. Although there are some technical and financial concerns that must be looked at before organizations decide to utilize SaaS, the long-term benefits gained from the technology far outweigh the risks. Organizations can significantly reduce their risk by involving IT in their purchasing decisions, and carefully choosing a SaaS vendor that has a proven track record for delivering the product they are looking for. Within the next few years we could undoubtedly see more vendors offering SaaS solutions, and more enterprises adopting it as the technology matures (i.e. notion of digital maturity).

1.6 Mobile Computing and its Components

Mobile Computing is a technology that allows transmission of data, voice and video via a computer or any wireless enabled device without having to be connected to a fixed physical link.

- **Mobile Communication:**It refers to the infrastructure put in place to ensure that seamless and reliable communication goes on. These would include devices such as protocols, services, bandwidth, and portals necessary to facilitate and support the stated services. The data format is also defined at this stage. This ensures that there is no collision with other existing systems which offer the same service.Since the media is unguided/unbounded, the overlaying infrastructure is basically radio wave-oriented. That is, the signals are carried over the air to intended devices that are capable of receiving and sending signals.
- **Mobile Hardware:** It includes mobile devices or device components that receive or access the service of mobility. They would range from portable laptops, smartphone, tablet, Pc's, Personal digital assistants.These devices will have a receptor medium that is capable of sensing and receiving the signals. These devices are configured to operate in full- duplex, whereby they are capable of sending and receiving signals at the same time. They don't have to wait until one device has finished communicating for the other device to initiate.

- **Mobile Software:**It is the actual program that runs on the mobile hardware. It deals with the characteristics and requirements of mobile applications. It's the essential component that operates the mobile device.Since portability is the main factor, this type of computing ensures that users are not tied or pinned to a single physical location, but are able to operate from anywhere. It incorporates all aspects of wireless communications.

National Digital Communications Policy 2018

The new telecom policy has been formulated in place of the existing National Telecom Policy-2012 and aims to facilitate India's effective participation in the global digital economy. The vision is to fulfill the ICT needs of citizens and enterprises through establishment of a ubiquitous, resilient, secure, accessible and affordable Digital Communications Infrastructure and Services; and in the process, support India's transition to a digitally empowered economy and society.The key objectives of the policy that are reckonedby 2022 are:

- Broadband for all
- Creating four million additional jobs in the Digital Communications sector
- Enhancing the contribution of the Digital Communications sector to 8% of India's GDP
- Propelling India to the Top 50 Nations in the ICT Development Index
- Enhancing India's contribution to Global Value Chains
- Ensuring Digital Sovereignty

In pursuit of accomplishing these objectives by year 2022, the National Digital Communications Policy, 2018 envisages three Missions viz.

- **Connect India:** Creating Robust Digital Communications Infrastructure To promote Broadband for All as a tool for socio-economic development, while ensuring service quality and environmental sustainability.

- **Propel India:** Enabling Next Generation Technologies and Services through Investments, Innovation and IPR generation to harness the power of emerging digital technologies, including 5G, AI, IoT, Cloud and Big Data to enable provision of future ready products and services; and to catalyze the fourth industrial revolution (Industry 4.0) by promoting Investments, Innovation and IPR.

- **Secure India:** Ensuring Sovereignty, Safety and Security of Digital Communications To secure the interests of citizens and safeguard the digital sovereignty of India with a focus on ensuring individual autonomy and choice, data ownership, privacy and security; while recognizing data as a crucial economic resource.

🕐 Activity 6 – Food for Thought

If you switch on your mobile internet pack, you could observe an icon 'H+' or '3G' in the right corner of the display. Now try to find out what does that symbol depicts.

Model Questions

1. Elucidate the role of ICT in rural development and social entrepreneurship.
2. Critically analyze how Digital India programmecould foster rural development.
3. Give a detailed account on digital transformation efforts taken by Govt. of India.
4. Differentiate between Hardware and Software. How the two are interwoven?
5. What do you mean by Software Application? Explain its types.
6. Explain in detail about Software as a Service (SaaS).
7. Write short notes on
    a. Internet Saathi
    b. Significance of SaaS
    c. Mobile Computing
8. Give your opinion on how ICT could help in Social Entrepreneurship

Key Words

ICT, ITES, e-Governance, Digital India, Digital Transformation, Mobile Computing

Further Reading/References

📖James A O"Brien, "Introduction to Information Systems", Tata McGraw Hill, 14th Edition, 2008

📖JayitaPramanik, BijanSarkar, ShyamalenduKandar., American Journal of Rural Development. **2017**, 5(4), 117-120. DOI: 10.12691/ajrd-5-4-5. Published Online: September 28, 2017

💻http://www.tutorialspoint.com/– Computer Fundamentals

💻https://www.nceg.gov.in/ – National e-Governance Conference Portal

-ICT and ITES

- E-Governance and its impact on rural development

- Digital India

- Digital Transformation
- Software as a Service (SaaS)

Chapter 2 - Foundation of Information Systems

An information system (IS) refers to a collection of multiple pieces of equipment involved in the dissemination of information. The hardware, software, computer system connections and information, information system users, and the system's housing are all part of an IS. In fact, we could say that one of the roles of information systems is to take data and turn it into information, and then transform that into organizational knowledge. As technology has developed, this role has evolved into the backbone of the organization. In order to get a full appreciation of the role information systems play, we have to retrospect on how they have changed over the years.

After threedecades as the primary computing device used in most businesses, sales of the PC are now beginning to decline as the sales of tablets and smartphones are taking off. Just as the mainframe before it, the PC will continue to play a key role in business, but will no longer be the primary way that people interact and do business.

The limited storage and processing power of these devices is being offset by a move to 'cloud' computing, which allows for storage, sharing, and backup of information on a massive scale. This would require new rounds of thinking and innovation on the part of businesses as technology continues to advance.

2.1 Introduction to Information Systems (IS)

2.2 Electronic and Mobile Commerce

2.3 Software Development Life Cycle (SDLC)

2.4 Geographical Information System (GIS)

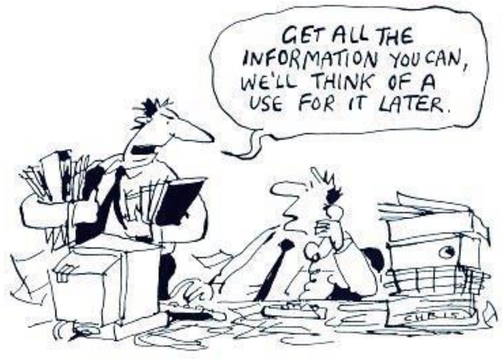
2.5 NAVIC – IRNSS

2.6 Waste Management Software

2.7 Industry 4.0

2.1 Information Systems (IS)

Whenever we come across the word "Information System or Information Technology" it's quite obvious to think that it is related to computer technology, it involves some programming etc. But the real meaning of Information System is quite different. Let's perceive information system by splitting it up. The word 'information' can be conceived as 'communication' and the 'system' can be considered as 'order'. For example, just imagine why all the books in your college library are kept in ordered manner. Because, the books have to communicate its intent knowledge to you and in order to access that knowledge, there should be a system (arrangement of books according to subjects).

Similarly, In context of Computer Science, the IS is used to gain the required action in an organized manner. Therefore, the IS is a set of interrelated elements or components that collect (input), manipulate (process), store, and disseminate (output) data and information and provide a corrective reaction (feedback mechanism) to meet an objective.	

Computer-based Information System (CBIS)

A computer-based information system (CBIS) is a single set of hardware, software, databases, telecommunications, people, and procedures that are configured to collect, manipulate, store, and process data into information. The main components of a CBIS include hardware, software, data, procedures and people. Computer Based Information System (CBIS) depends mainly on the computer for handling business application. System analysis develops different types of information system to meet variety of business needs. There is a class of systems known collectively as computer based information systems namely,

- **Transaction Processing Systems (TPS):** It handles routine information items, more often than not manipulating data in some constructive way as it enters or leaves the firm's databases. An order entry program is an example of a TPS. Reasons for TP are recording, classification, sorting, calculation, summarization, storage and exhibit of results.

- **Management Information Systems (MIS):** It fosters focused vision of information flow as it develops during the course of business activities. This information is constructive in managing the business. We will discuss why MIS is crucial to any organization in the coming section in an elaborate manner.
- **Decision Support Systems (DSS):** It is a methodical model used to progress managerial or professional decision making by bringing significant data to a manager's notice. In many cases, these systems use the identical data as management information systems, but DSS purify the data to make it more functional to managers. It support with exceptional and

nonrecurring decisions, which are moderately unstructured. Mainly what factors to reflect on and what information are needed.

- **Office Automation Systems (OAS):** Office automation systems endow with electronic mail, word processing, electronic filing, scheduling, calendaring, and other kinds of support to office workers. First introduced with personal computers, these "groupware" applications became essential with the extensive use of personal digital assistants. It combines word processing, telecommunications and data processing to computerize office information, draws on stored data as a result of data processing and comprise the handling of correspondence, reports and documents.

Role of MIS in an Organization

The role of the MIS in an organization can be compared to the role of heart in the body. The information is the blood and MIS is the heart. In the body the heart plays the role of supplying pure blood to all the elements of the body including the brain. The heart works faster and supplies more blood when needed. It regulates and controls the incoming impure blood, processes it and sends it to the destination in the quantity needed. It fulfills the needs of blood supply to human body in normal course and also in crisis. The MIS plays exactly the same role in the organization.

- It ensures that an appropriate data is collected from the various sources, processed, and sent further to all the needy destinations. The system is expected to fulfill the information needs of an individual, a group of individuals, the management functionaries: the managers and the top management.

- It satisfies the diverse needs through a variety of systems such as Query Systems, Analysis Systems, Modeling Systems and Decision Support Systems the MIS helps in Strategic Planning, Management Control, Operational Control and Transaction Processing.

- It helps the clerical personnel in the transaction processing and answers their queries on the data pertaining to the transaction, the status of a particular record and references on a variety of documents. The MIS helps the junior management personnel by providing the operational data for planning, scheduling and control, and helps them further in decision making at the operations level to correct an out of control situation.

- It helps the middle management in short them planning, target setting and controlling the business functions. It is supported by the use of the management tools of planning and control. The MIS helps the top management in goal setting, strategic planning and evolving the business plans and their implementation.

- It plays the role of information generation, communication, problem identification and helps in the process of decision making. The MIS, therefore, plays a vital role in the management, administration and operations of an organization.

Significance of MIS

- **Data Capturing:** MIS captures data from various internal & external sources of organization. Data capturing may be manual or through computer terminals.
- **Processing of Data:** The captured data is processed to convert into required information. Processing of data is done by activities like calculating, sorting, classifying, and summarizing.
- **Storage of Information:** MIS stores the processed or unprocessed data for future use. If any information is not immediately required, it is saved as an organization record, for later use.
- **Retrieval of Information:**It retrieves information from its stores as and when required
- **Dissemination of Information:**Data, which is a finished product of MIS, is disseminated to the users in the organization. It is periodic or online through computer terminal.

Activity 1 – Visualization

Have a debate with your partner on e-commerce business & its impact on local market.

2.2 Electronic and Mobile Commerce

At-least we would be familiar with the phrase “the big billion days or biggest ever sale” if not we have purchased amidst that rush to place orders. The E-commerce involves any business transaction executed electronically between companies (B2B), companies and consumers (B2C), consumers and other consumers (C2C), business and the public sector, and consumers and the public sector. It offers opportunities for businesses of all sizes to market and sell at a low cost worldwide, allowing them to enter the global market.

Mobile commerce (m-commerce) is the use of mobile, wireless devices to place orders and conduct business. The M-commerce relies on the wireless communications that managers and corporations use to place orders and conduct business with handheld computers, portable phones, laptop computers connected to a network, and other mobile devices. Today, mobile commerce has exploded in popularity with advances in smartphones.

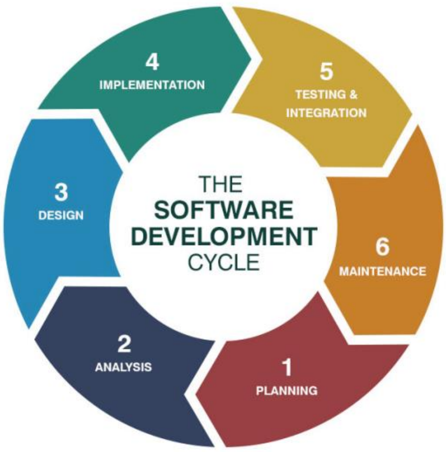
E-commerce offers many advantages for streamlining work activities. As use of e-commerce systems grows, companies are phasing out their traditional systems. The resulting growth of e-commerce is creating many new business opportunities.

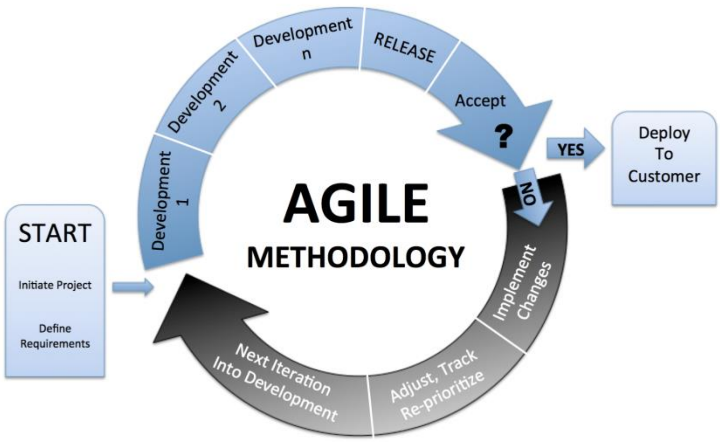
E-commerce can enhance a company’s stock prices and market value. Today, several e-commerce firms have teamed up with more traditional brick-and-mortar businesses to draw from each other’s strengths. For example, e-commerce customers can order products on a Web site and pick them up at a nearby store. In addition to e-commerce, business information systems use telecommunications and the Internet to perform many related tasks. Electronic procurement (e-procurement), for example, involves using information systems and the Internet to acquire parts and supplies.

Electronic business (e-business) goes beyond e-commerce and e-procurement by using information systems and the Internet to perform all business-related tasks and functions, such as accounting, finance, marketing, manufacturing, and human resource activities. E-business also includes working with customers, suppliers, strategic partners, and stakeholders. We can conclude that as compared to traditional business strategy, e-business strategy is flexible and adaptable.

2.3 Software Development Lifecycle (SDLC)

Software Development Life Cycle (SDLC) is a process used by the software companies to design, develop and test high quality software. The SDLC aims to produce high-quality software that meets or exceeds customer expectations, reaches completion within times and cost estimates.A typical Software Development Life Cycle consists of the following stages-





Stage 1: Planning and Requirement Analysis

Requirement analysis is the most important and fundamental stage in SDLC. It is performed by the senior members of the team with inputs from the customer. This information is then used to plan the basic project approach and to conduct product feasibility study in economical, operational and technical areas. Therefore, it is to be remembered that we have to articulate our requirements crisp and clear to the software vendor.

Stage 2: Defining Requirements

Once the requirement analysis is done the next step is to clearly define and document the product requirements and get them approved from the customer or the market analysts. This is done through an SRS (Software Requirement Specification) document which consists of all the product requirements to be designed and developed during the project life cycle. This is the most crucial document; we have to vet this document and ensure that it addresses all our requirements.

Stage 3: Designing the Product Architecture

SRS is the reference for product architects to come out with the best architecture for the product to be developed. Based on the requirements specified in SRS, usually more than one design approach for the product architecture is proposed and documented in a DDS - Design Document Specification. Considering technicality, it is better that we get an expert opinion before signing off the document.

Stage 4: Building or Developing the Product

In this stage of SDLC the actual development starts and the product is built. The programming code is generated as per DDS during this stage. If the design is performed in a detailed and organized manner, code generation can be accomplished without much hassle. Developers must follow the coding guidelines defined by their organization and programming tools like compilers, interpreters, debuggers, etc. are used to generate the code. Different high level programming languages such as C, C++, Pascal, Java and PHP are used for coding. The programming language is chosen with respect to the type of software being developed.

Stage 5: Testing the Product

This stage is usually a subset of all the stages as in the modern SDLC models, the testing activities are mostly involved in all the stages of SDLC. However, this stage refers to the testing only stage of the product where product defects are reported, tracked, fixed and retested, until the product reaches the quality standards defined in the SRS. It is prudent that we do involve and collaborate with the software developers and ensure that all bugs are being fixed.

Stage 6: Deployment in the Market and Maintenance

Once the product is tested and ready to be deployed it is released formally in the appropriate market. Sometimes product deployment happens in stages as per the business strategy of that organization. The product may first be released in a limited segment and tested in the real business environment (UAT- User acceptance testing).Then based on the feedback, the product may be released as it is or with suggested enhancements in the targeting market segment. After the product is released in the market, its maintenance is done for the existing customer base. Hence, we have to remember that collaboration with software developer is an essential component as the SDLC defines a methodology for improving the quality of software and the overall development process.

Is Agile Software Development Methodology?

Agile is a software development methodology to build software incrementally using short iterations of 1 to 4 weeks so that the development process is aligned with the changing business needs. Instead of a single-pass development of 6 to 18 months where all the requirements and risks are predicted upfront, Agile adopts a process of frequent feedback where a workable product is delivered after 1 to 4 week iteration. Therefore, it's better if we demand the software companies to adhere to agile software development methodology while developing our orders.

2.4 Geographical Information System (GIS)

Geographic information systems (GIS) have emerged in the last decade as an essential tool for urban and resource planning and management. Their capacity to store, retrieve, analyze, model and map large areas with huge volumes of spatial data has led to an extraordinary proliferation of applications. The GIS are now used for land use planning, utilities management, ecosystems modeling, landscape assessment and planning, transportation and infrastructure planning, market analysis, visual impact analysis, facilities management, real estate analysis and other applications.

A Geographical Information System (GIS) is a system for capturing, storing, analyzing and managing data and associated attributes, which are spatially referenced to the Earth. The geographical information system is also called as a geographic information system or geospatial information system. It is an information system capable of integrating, storing, editing, analyzing, sharing, and displaying geographically referenced information.

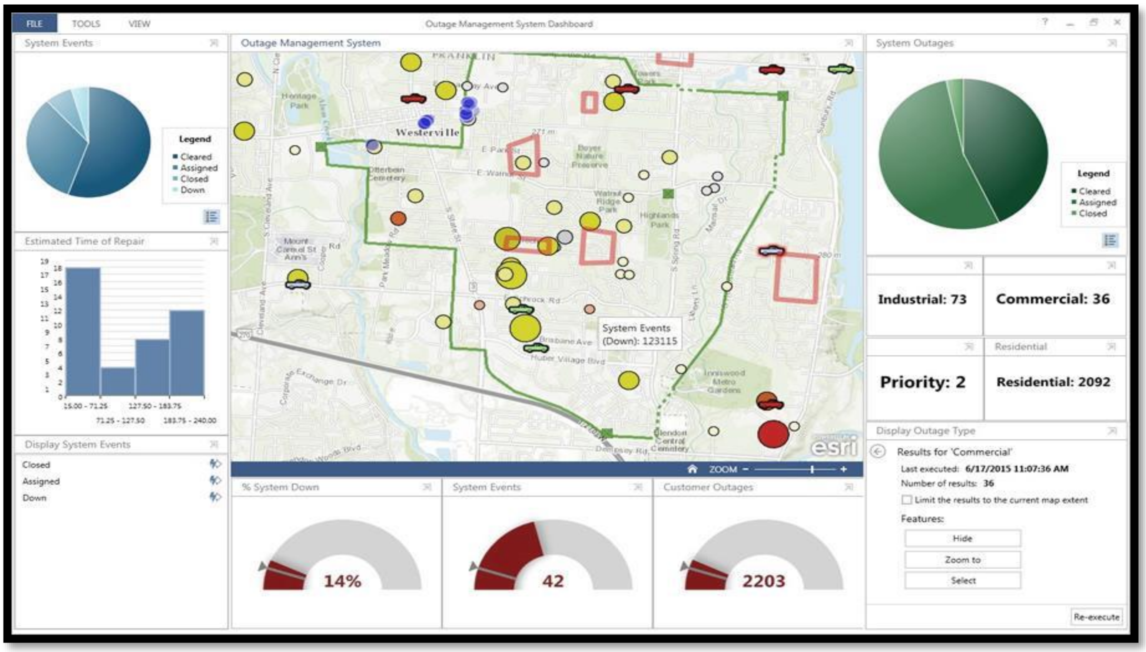
In a more generic sense, GIS is a software tool that allows users to create interactive queries, analyze the spatial information, edit data, maps, and present the results of all these operations. Functions of GIS include the data entry, data display, data management, information retrieval and analysis. The key features of GIS are:

- **Mapping Locations:** GIS can be used to map locations. GIS allows the creation of maps through automated mapping, data capture, and surveying analysis tools.
- **Mapping Quantities:** People map quantities, like where the most and least are, to find places that meet their criteria and take action, or to see the relationships between places. It gives an additional level of information beyond simply mapping the locations of features.
- **Mapping Densities:** While we can see concentrations by simply mapping the locations of features, in areas with many features it may be difficult to see which areas have a higher

concentration than others. A density map lets us measure the number of features using a uniform areal unit, such as acres or square miles, so we can clearly see the distribution.

- **Finding Distances:** It is used to find out what's occurring within a set distance of a feature.
- **Mapping and Monitoring Changes:** GIS can be used to map the change in an area to anticipate future conditions, decide on a course of action, or to evaluate the results of an action or policy.

GIS technology is becoming essential tool to combine various maps and remote sensing information to generate various models, which are used in real time environment. Geographical information system is the science utilizing the geographic concepts, applications and systems. Geographical Information System can be used for scientific investigations, resource management, asset management, environmental impact assessment, urban planning, cartography, criminology, history, sales, marketing, and logistics. For example, agricultural planners might use geographical data to decide on the best locations for a location specific crop planning, by combining data on soils, topography, and rainfall to determine the size and location of biologically suitable areas. The final output could include overlays with land ownership, transport, infrastructure, labor availability, and distance to market centers.GIS Dashboard models are depicted below for better understanding.



Applications of Geographical Information System

Mapmaking

GIS can use and combine all layers that are available for an area, in order to produce an overlay that can be analyzed by using the same GIS. Such overlays and their analysis radically change decision-making process that includes among others:

- Site selection
- Simulation of environmental effects (like creating views of a terrain before and after mining)
- Emergency response planning (for example, combining road network and earth science information to analyze the effects of a potential earthquake)

Land Information

GIS has aided management of land information by enabling easy creation and maintenance of data for land records, land planning and land use. GIS makes input, updates, and retrieval of data such as tax records, land-use plan, and zoning codes much easier than during the paper-map era. Typical uses of GIS in land information management include managing land registry for recording titles to land holdings, preparing land-use plan and zoning maps, cadastral mapping etc. Input of data into a land information GIS includes: political and administrative boundaries, transportation, and soil cover.

Infrastructure and Utilities

GIS technologies are also widely applied to the planning and management of public utilities. Typical uses include management of the following services: electric, gas, water, roads, telecommunication, storm sewers, TV/FM transmitting facilities, hazards analysis, and dispatch and emergency services.

Environmental

The environmental field has long used GIS for a variety of applications that range from simple inventory and query, to map analysis and overlay, to complex spatial decision-making systems. For example: forest, air, water quality modeling & monitoring, environmentally sensitive zone mapping, analysis of interaction between economic, meteorological, and hydrological & geological change.

Archaeology

Archaeology as a spatial discipline has used GIS in a variety of ways. At the simplest level, GIS has found applications as database management for archaeological records, with the added benefit of being able to create instant maps. It has been implemented in cultural resource management contexts, where archaeological site locations are predicted using statistical models based on previously identified site locations.

Natural Hazards

Areas vulnerable to earthquakes, floods, cyclones, storms, drought, fire, volcano, landslides and soil erosion can be used to accurately predict future disasters.

Forestry

Emerged as a strong tool for many areas of forestry, from harvesting schedules to urban forestry

Military GIS

It offers a virtually unique ability to aggregate, automate, integrate and analyze geographical data, which further enhance the intelligence base for defense operations.

Oceanography

Enables study sea level change, marine population, sea surface temperature& coral reef ecosystem

Water Resources

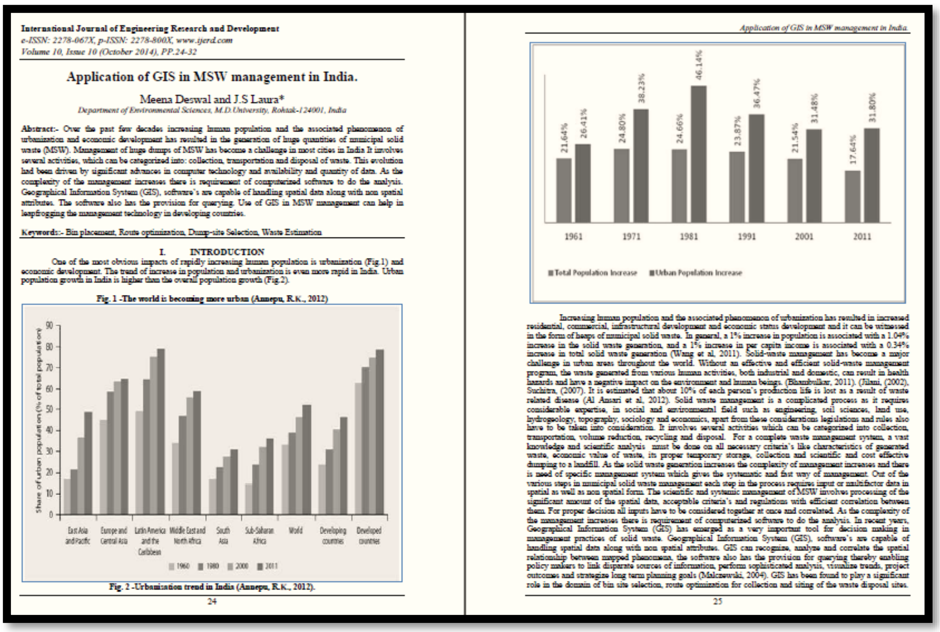
It enables spatial representation of ground water resources, waste quality, watershed management, surface water management, and water pollution.

GIS in Agriculture and Soil

Data includes information on the country's land resources including physiography, soils, climate, hydrology, cropping systems and crop suitability.

Application of GIS in Municipal Solid Waste Management in India – A Case Study

Scan the QR Code to download the report



International Journal of Engineering Research and Development
e-ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com
Volume 10, Issue 10 (October 2014), PP.24-32

Application of GIS in MSW management in India.

Meena Deswal and J.S Laura*
Department of Environmental Sciences, M.D.University, Rohtak-124001, India

Abstract:- Over the past few decades increasing human population and the associated phenomenon of urbanization and economic development has resulted in the generation of huge quantities of municipal solid waste (MSW). Management of huge dumps of MSW has become a challenge in most cities in India It involves several activities, which can be categorized into: collection, transportation and disposal of waste. This evolution had been driven by significant advances in computer technology and availability and quantity of data. As the complexity of the management increases there is requirement of computerized software to do the analysis. Geographical Information System (GIS), software's are capable of handling spatial data along with non spatial attributes. The software also has the provision for querying. Use of GIS in MSW management can help in leapfrogging the management technology in developing countries.

Keywords:- Bin placement, Route optimization, Dump-site Selection, Waste Estimation

I. INTRODUCTION

One of the most obvious impacts of rapidly increasing human population is urbanization (Fig.1) and economic development. The trend of increase in population and urbanization is even more rapid in India. Urban population growth in India is higher than the overall population growth (Fig.2).

Fig. 1 -The world is becoming more urban (Annepu, R.K., 2012)

Fig. 2 -Urbanization trend in India (Annepu, R.K., 2012).

24

Application of GIS in MSW management in India.

Increasing human population and the associated phenomenon of urbanization has resulted in increased residential, commercial, infrastructural development and economic status development and it can be witnessed in the form of heaps of municipal solid waste. In general, a 1% increase in population is associated with a 1.04% increase in the solid waste generation, and a 1% increase in per capita income is associated with a 0.34% increase in total solid waste generation (Wang et al, 2011). Solid-waste management has become a major challenge in urban areas throughout the world. Without an effective and efficient solid-waste management program, the waste generated from various human activities, both industrial and domestic, can result in health hazards and have a negative impact on the environment and human beings. (Bhambulkar, 2011). (Jilani, (2002), Suchitra, (2007). It is estimated that about 10% of each person's production life is lost as a result of waste related disease (Al Ansari et al, 2012). Solid waste management is a complicated process as it requires considerable expertise, in social and environmental field such as engineering, soil sciences, land use, hydrogeology, topography, sociology and economics, apart from these considerations legislations and rules also have to be taken into consideration. It involves several activities which can be categorized into collection, transportation, volume reduction, recycling and disposal. For a complete waste management system, a vast knowledge and scientific analysis must be done on all necessary criteria's like characteristics of generated waste, economic value of waste, its proper temporary storage, collection and scientific and cost effective dumping to a landfill. As the solid waste generation increases the complexity of management increases and there is need of specific management system which gives the systematic and fast way of management. Out of the various steps in municipal solid waste management each step in the process requires input or multifactor data in spatial as well as non spatial form. The scientific and systemic management of MSW involves processing of the significant amount of the spatial data, acceptable criteria's and regulations with efficient correlation between them. For proper decision all inputs have to be considered together at once and correlated. As the complexity of the management increases there is requirement of computerized software to do the analysis. In recent years, Geographical Information System (GIS) has emerged as a very important tool for decision making in management practices of solid waste. Geographical Information System (GIS), software's are capable of handling spatial data along with non spatial attributes. GIS can recognize, analyze and correlate the spatial relationship between mapped phenomena, the software also has the provision for querying thereby enabling policy makers to link disparate sources of information, perform sophisticated analysis, visualize trends, project outcomes and strategize long term planning goals (Malczewski, 2004). GIS has been found to play a significant role in the domain of bin site selection, route optimization for collection and siting of the waste disposal sites.

25

GIS in Waste Management

With GIS technology as a waste collection optimization tool could provide significant financial and environmental benefits for local communities. GISsupports the optimization of waste management as it provides an efficient context for data capture, analysis and presentation. The GIS-based waste management applications can be categorized into two categories.

- GIS is used for the selection of waste disposal landfills, and to a smaller extent, other waste treatment facilities. Most of these applications benefit from map overlay GIS functions and spatial allocation modeling methods. The final output of an application of that type is the suitability map of the area under investigation. This map could be the core of a spatial decision support system for a landfill site/waste treatment facility selection problem.
- More complex category of GIS supported waste management applications is related to waste collection. There are several applications for route optimization, reallocation of waste bins and complete redesign of the collection sectors. The main aim of these applications is to reduce the collection distance and/or time of collection vehicle fleet. The implementation of GIS-based modeling for waste collection optimization in many countries with different socioeconomic conditions and technological background shows that significant savings could be achieved in most setups. The optimization of routing has a direct positive impact on cost savings (reduction of fuel consumption and maintenance costs) as well as significant

environmental impacts due to lower levels of sound pollution within the urban environment and the reduction of greenhouse gases emissions.

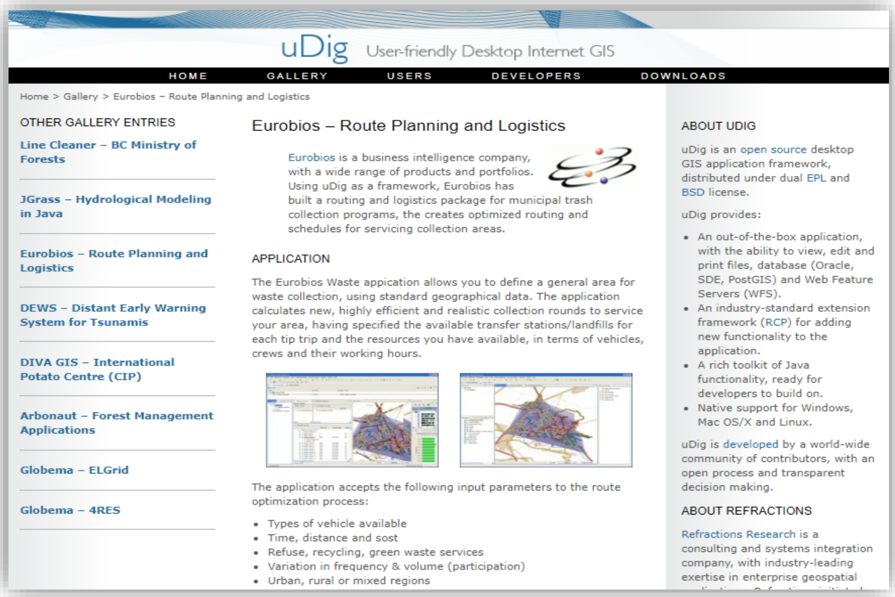
GIS-based waste collection modeling must consider the following aspects, in order to achieve reliable results:

- Accurate and up to date information about the road network of the area
- Detailed capture of the spatial properties of the existing collection system (collection routes, location and attributes of garbage bins, existing time schedule)
- Installation of a modern GIS facility within the municipality/corporationto perform network analysis functions
- Advanced skill training of the staff and officials is a very important factor for the efficient operation of this system
- Validation of outputs from GIS-based modeling in order to ensure the applicability of the proposed routes in real life conditions

Nowadays, although GIS-supported waste collection modeling is a mature scientific field the general diffusion of this technology is hampered by factors such as the absence and the poor quality of digital spatial data, the high cost of spatial data capture and the lack of personnel with the proper technological background to operate such modeling.

Case Study: Eurobios – Route Planning and Logistics

Eurobios waste application allows us to define a general area for waste collection, using standard geographical data. The application calculates new, highly efficient and realistic collection rounds to service your area, having specified the available transfer stations/landfills for each tip trip and the resources you have available, in terms of vehicles, crews and their working hours. The Eurobios is a business intelligence company, with a wide range of products and portfolios. Using uDig as a framework, Eurobios has built a routing and logistics package for municipal trash collection programs, it creates optimized routing and schedules for servicing collection areas.



The application accepts the following input parameters to the route optimization process:

☞ Types of vehicle available ☞ Time, distance and cost ☞ Refuse, recycling, green waste services ☞ Variation in frequency & volume (participation) ☞ Urban, rural or mixed regions	Scan the QR Code to visit the Eurobios website

The application can performance an analysis on how to reduce the number of rounds, or it can optimize existing rounds whilst maximizing the productivity of each vehicle. Eurobios Waste is currently used by seven areas in France and the UK, each serving 50,000 to 100,000 households.

2.5 Waste Management Software (WMS)

With increasing emphasis on compliance with global waste disposal standards and protocols, it is essential that our business uses efficient waste management software. Even companies that use external firms to take care of the disposal need the software for record keeping, reporting and invoicing. This way, it becomes a lot easier for the business to achieve sustainability targets as well as comply with legal standards of waste disposal. Also, companies that deal with waste management and recycling need to use the software for sake of remaining portable in the current competitive and dynamic legislative systems. Use of separate manual spreadsheets and other paper-based systems is outdated and involves too much cost and effort that limits the growth opportunities of such business. The Waste management software is comprehensive and covers all the areas that separate systems deal with, which makes it the perfect solution.

Waste Management Software helps businesses in carrying out efficiently the processes involved from the collection to disposal of waste. Such functions include ensuring that the system of waste disposal is in compliance with Occupational Safety and Health Administration regulations, scheduling dates for the collection, transportation, treatment as well as the placement of waste, management of contracts in terms of invoicing and pricing of the services, and creation of workflows for processes such as sorting and destruction.

Dashboard of Waste Management Software – Waste Logics

Additionally, the software is useful for the sorting of different materials as well as the provision of different functionalities for recycling. Waste management software is also essential for the creation and management of unique waste profiles as well as the display of important notifications and alerts. This makes it easy for the business owners or responsible departments to keep up with the processes as well as take necessary action in case of breaches or any emergencies.

- **Cost control:** WMS helps in the identification and selection of the most cost-effective waste collectors, transporters, treatment administrators and disposers. It then manages the processes of invoicing and pricing as well as estimates costs for anticipated waste disposals.

- **Regulatory compliance:** Software tracks down and includes all the regulations and standards applicable to all wastes disposal processes carried out by the rm. It also checks the facility's permits and generates notifications on impending expiry dates.

- **Simplicity and Generality:** WMS is easy to use. It also makes easier to manage waste profiles by combining them into one system where they can all be monitored and controlled, unlike the manual systems where individual profiles are operated on separate levels.

- **Waste reduction effort monitoring:** The system produces detailed information and reports on both hazardous and non-hazardous waste generated during any specified time. It also helps business to make informed decisions based on details from waste profiles and reports.

- **Scheduling:** It also creates and manages schedules for waste collection and disposal. Some versions display notifications when such dates are close to enable enough preparation.

Top Waste Management Software

- **Intelex** features a web-based system which manages and stores data in a centralized location to help businesses produce insightful reports, meet compliance and risk management needs, and evaluate performance for a set of industry standards. It is compatible with various browsers, has strong mobile capabilities, is configurable to a company's unique needs, and has a robust list of 3rd party integrations. Its interface offers a flexible user experience and can process simple to complex tasks through features such as task management, intuitive dashboards, data security, community support, configurable data storage, and email notifications.

- **TRUX Haul-IT** is the flagship Waste Management Software Application for waste and recycling haulers. Route densities, route statistics, driver productivity, vehicle productivity, disposal statistics, and service pricing anomalies, route profitability, customer profitability, assigned containers, available containers, container inactivity: these are just some of the measurable metrics it provides as a by-product of performing day to day procedures and billing for services.
- **RouteOptix** provides a complete comprehensive package for waste collection and hauling for residential, commercial, roll-o and recycling. The software also handles landfills, transfer stations and has scale integration. The system can be tailored to each company's way of doing business with specific language – i.e., charge type descriptions such as: delivery, dump & return, extra lift, inactivity charge, etc. Disposal costs can also be factored into billing. It is end user friendly, adaptable, and accommodating to changes.
- Built on a platform of Plan-Do-Check-Act, **Dakota's Waste Management Software** helps organizations manage the complex logistics and recordkeeping associated with solid and hazardous waste. This flexible and configurable application allows corporate managers to create and maintain individual profiles for waste type, authorized transporters, and

authorized disposal facilities. Through the use of permission based tools, facility managers can choose from these lists of corporate approved profiles to organize waste shipments and track manifests to closure.

- **Trash Flow** by Ivy Computer is the leading software solution for commercial, residential, roll-off, and landfill operations. Featuring a modular design, Trash Flow offers a host of capabilities for electronic billing, dispatching, routing, container tracking, in-truck mobile apps, scale house management, and more. Users can cost efficiently manage waste hauling business. It supports waste handling businesses and municipalities that operate landfills, transfer stations, and recycling centers as well as those that provide residential or industrial waste collection services.
- **WasteWORKS** is designed to provide a comprehensive approach to waste management information. The products are designed to be easy to use while providing the timely and accurate data one need to manage waste and recycling facilities. The software provides data to manage waste and recycling facilities, including ticketing, monthly billing, accounts reporting, management reporting, graphical analysis and support.
- **Webaspx Waste Manager (WM)** is integrated solution for Waste and Recycling Collection. Doing more with less is the priority for local authorities. For the waste and recycling team that means continuing to deliver the high quality services that members and residents expect, while reducing costs. It helps its customers manage their day-to-day processes more efficiently at the same time as optimizing the overall waste collection service.
- Intuitive and simple to use, **Waste Logics** is cloud-based waste management software. Create bookings, track progress, analyze business performance on the move, and enjoy the flexibility of unlimited access anywhere, anytime, from any device. Waste Logics is simple, easy to use and full of sophisticated features. Effortlessly navigate intuitive screens built around user’s job roles and tasks and prioritize what matters the most with custom dashboards. Leave inaccurate spreadsheets in past and discover the value of business intelligence reporting with Waste Logics.

Activity2 – Food for Thought

Scan the QR Code to visit the website

Are there 1000+ GIS Applications?? Hu, can't believe isn't? Well, that's the fact…

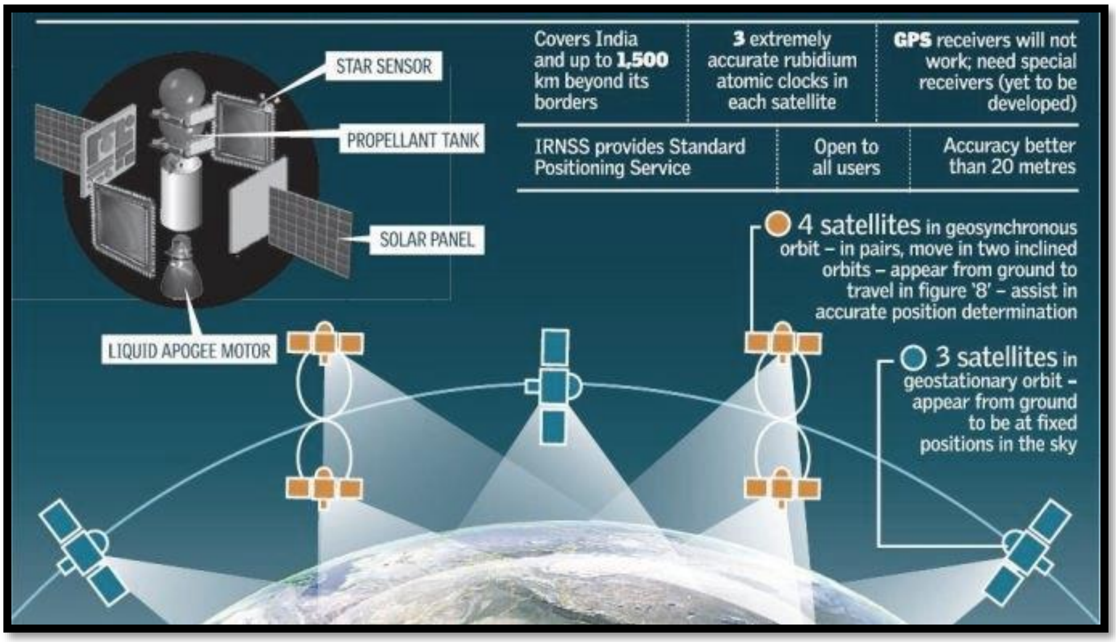
Scan the QR Code to read the article

Disposing of E-Waste in Bengaluru can be as easy as walking into a Cafe..!

With the number of mobile users and phones growing exponentially across the country, it becomes even more imperative for conscientious citizens to ensure e-waste generated is disposed of correctly without causing harm to the environment. And now if you live in Bengaluru, you can stop worrying about your e-waste because two organizations have come together to help members of the general public with disposal. Environmental Synergies in Development (ENSYDE) and Saahas, companies that are part of waste management industry have put up e-waste collection units in various spots in the region…….. (continue reading)

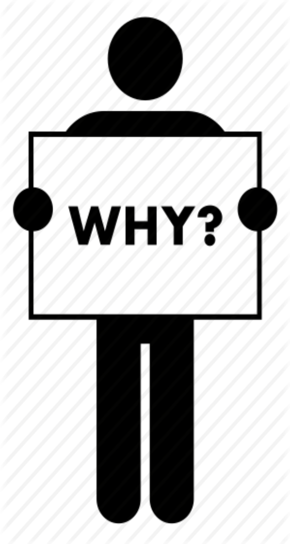
2.6 Indian Regional Navigation Satellite System (IRNSS)

IRNSS is India's regional satellite navigation system that is designed to provide geospatial positioning information within the Indian sub-continent. It enables users to map out their location (altitude, longitude and latitude). The main objective of developing IRNSS was to cut down India's dependency on foreign navigation satellite systems like GPS (Global Positioning System).



IRNSS was renamed as Navigation Indian Constellation (NAVIC) by India's Prime Minister NarendraModi. NAVIC is an indigenous satellite navigation system designed by the Indian Space Research Organization (ISRO). NAVIC is India's own GPS-like system, much like the American GPS system. Difference between both is that while the NAVIC is a regional satellite navigation system, the American GPS is a global satellite navigation system. NAVIC provides location information service to users in India and the region extending for up to 1,500 km from the Indian boundary. This is the primary service area of NAVIC information service to users in India and the region extending up to 1500 km from Indian boundary. This area is the primary service area of NAVIC. The NAVIC is a constellation of seven satellites in space. Out of these, three are located in the geostationary orbit over the Indian Ocean and the other four in geosynchronous orbits, with the desired inclination and equatorial crossings in two different planes. These 9 satellites in IRNSS are: 1) IRNSS-1A, 2) IRNSS-1B, 3) IRNSS-1C, 4) IRNSS-1D, 5) IRNSS-1E, 6) IRNSS-1F, 7) IRNSS-1G, 8) IRNSS-1H and 9) IRNSS-1I, which would be further expanded into 11 satellites in coming years. NAVIC aims to provide two services:

- **Standard Positioning Service (SPS)** for civilian, research & commercial use
- **Restricted Service (RS)** for authorized users. For example defense. IRNSS is used for ground, aerial and marine navigation, disaster management, mobile phone integration, mapping and visual & voice navigation for drivers, among others.



Do we need an indigenous positioning system?

During the **Kargil war** in 1999, when Pakistani troops took the position in high mountains, one of the first things Indian military was trying to get their hands on was **GPS** data of the region. GPS could've provided vital information, but the United States denied access to India. The experience at Kargil made the nation realize the importance of indigenous navigation system and hence the idea of IRNSS began to take shape. With the help of Indian Regional Navigation Satellite System (IRNSS), India will become self-reliant to keep a close watch on its boundaries and much more.

Some applications of IRNSS are:

- Terrestrial, Aerial and Marine Navigation
- Disaster Management
- Vehicle tracking and fleet management
- Integration with Smartphone
- Precise Timing
- Mapping and Geodetic data capture
- Terrestrial navigation aid for hikers and travelers
- Visual and voice navigation for drivers

IS GPS?

Global Positioning System, commonly known as GPS, is a network of about **31 satellites** orbiting the Earth at an altitude of **20,000 km**. The system was originally developed by the US government for military navigation but now anyone with a GPS device can receive the signals and use it. Each satellite of the GPS constellation circles the Earth twice a day. It depends on only **24 satellites** to provide the accurate location, rest of the satellites are spare ones.

Activity 3 – Patriotic

Scan the QR Code to Watch the Video

Whether GPS or IRNSS - Which will be accurate? Have a debate with your partner.

2.7 Industry 4.0

Before understanding what, why, and how of Industry 4.0, let's have a small recap on how exactly manufacturing has evolved since the 1800s. There are four distinct industrial revolutions that the world either has experienced or continues to experience today.

The First Industrial Revolution

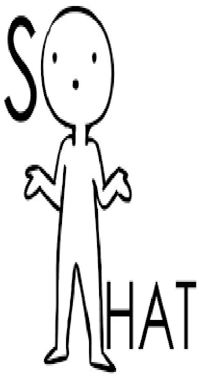
The first industrial revolution happened between the late 1700s and early 1800s. During this period of time, manufacturing evolved from focusing on manual labor performed by people and aided by work animals to a more optimized form of labor performed by people through the use of water and steam-powered engines and other types of machine tools.

The Second Industrial Revolution

In the early part of the 20th century, the world entered a second industrial revolution with the introduction of steel and use of electricity in factories. The introduction of electricity enabled manufacturers to increase efficiency and helped make factory machinery more mobile. It was during this phase that mass production concepts like the assembly line were introduced as a way to boost productivity.

The Third Industrial Revolution

Starting in late 1950s, a 3rd industrial revolution slowly began to emerge, as manufacturers began incorporating more electronic—and eventually computer—technology into their factories. During this period, manufacturers began experiencing a shift that put less emphasis on analog and mechanical technology and more on digital technology and automation software.



The Fourth Industrial Revolution, or Industry 4.0

In the past few decades, a fourth industrial revolution has emerged, known as Industry 4.0. It takes the emphasis on digital technology from recent decades to a whole new level with the help of interconnectivity through the Internet of Things (IoT), access to real-time data, and the introduction of cyber-physical systems. It offers a more comprehensive, interlinked, and holistic approach to manufacturing. It connects physical with digital, and allows for better collaboration and access across departments, partners, vendors, product, and people.

It empowers business owners to better control and understands every aspect of their operation, and allows them to leverage instant data to boost productivity, improve processes and growth.Here are some benefits of adopting an Industry 4.0 model for our business:

- ✓ **It makes us more competitive, especially against big disruptors:** As companies like Flipkart continue to optimize logistics and supply chain management, we need to be investing in technology and solutions that help us improve and optimize our own operation. To stay competitive, we have to have the systems and processes in place to allow us to provide the same level of service (or better) to our customers and clients that they could be getting from a company like Amazon, Flipkart, Snapdeal etc.

- ✓ **It makes us more attractive to the younger workforce:** Companies that invest in Industry 4.0 technologies are better positioned to attract and retain new workers.

- ✓ **It makes our team stronger and more collaborative:** Companies that invest in Industry 4.0 solutions can increase efficiency, boost the collaboration between the departments, enable predictive and prescriptive analytics, and allow people including operators, managers, and executives to more fully leverage real-time data and intelligence to make better decisions while managing their day-to-day responsibilities.

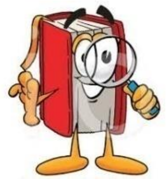
- ✓ **It allows us to address potential issues before they become big problems:** Predictive analytics, real-time data, internet-connected machinery, and automation can all help us more proactive when it comes to addressing and solving potential maintenance and supply chain management issues.

- ✓ **It allows us to trim costs, boost profits, and fuel growth:** an Industry 4.0 technology helpsus to manage and optimize all aspects of our manufacturing processes and supply chain. It gives us access to the real-time data and insights we need to make smarter, faster decisions about our business, which can ultimately boost the efficiency and profitability of our entire operation.

Activity 4 – Thought Provoking

Scan the QR Code to Watch the Video

Industry 4.0 and what this means for the leaders of companies today and tomorrow?



Glossary concepts and terms related to IIoT and Industry 4.0

Enterprise Resource Planning (ERP): Business process management tools that can be used to manage information across an organization.

IoT: IoT stands for Internet of Things, a concept that refers to connections between physical objects like sensors or machines and the Internet.

IIoT: IIoT stands for the Industrial Internet of Things, a concept that refers to the connections between people, data, and machines as they relate to manufacturing.

Big data: Big data refers to large sets of structured or unstructured data that can be compiled, stored, organized, and analyzed to reveal patterns, trends, associations, and opportunities.

Artificial intelligence (AI): Artificial intelligence is a concept that refers to a computer's ability to perform tasks, make decisions that would historically require some level of human intelligence.

M2M: This stands for machine-to-machine, and refers to the communication that happens between two separate machines through wireless or wired networks.

Digitization: Digitization refers to the process of collecting and converting different types of information into a digital format.

Smart Factory: A smart factory is one that invests in and leverages Industry 4.0 technology, solutions, and approaches.

Machine Learning: Machine learning refers to the ability that computers have to learn and improve on their own through A.I —without being explicitly told or programmed to do so.

Cloud Computing: Cloud computing refers to the practice of using interconnected remote servers hosted on the Internet to store, manage, and process information.

Real-time Data processing: Real-time data processing refers to the abilities of computer systems and machines to continuously and automatically process data and provide real-time or near-time outputs and insights.

MODEL QUESTIONS

1. Describe Computer-based Information system. How it will be helpful in waste management and social entrepreneurship?
2. Critically analyze the impact of electronic and mobile commerce on local market.
3. Give a detailed account on Software Development Lifecycle (SDLC).
4. Describe Geographical Information System (GIS) and its applications.
5. Differentiate between Hardware and Software. How the two are interwoven?
6. What do you mean by Software Application? Explain its types.
7. Illustratethe GIS application in Waste Management with any relevant case study.
8. Give a detailed account on NAVIC – IRNSS and its future.
9. Elucidate Industry 4.0 with relevance to Waste Management and Social Entrepreneurship.
10. Write short notes on
    a. Information System (IS)
    b. Agile Methodology
    a. IRNSS Applications

KEY WORDS

SDLC, Agile Methodology, e-Commerce, m-Commerce,GIS, IRNSS, NAVIC, Industry 4.0

Further Reading/References

📖O‟Brien, J.A., and Marakas G.M., Management Information System (MIS), (7th edition), Tata McGraw Hill: India

📖Ralph M. Stair.,and George W Reynolds., Fundamentals of Information Systems,(6th edition), Course Technology, Cengage Learning: USA

💻http://www.tutorialspoint.com/– Software Development Lifecycle (SDLC)

💻https://www.nceg.gov.in/ – National e-Governance Conference Portal

-GIS and its application

- NAVIC – IRNSS

- Industry 4.0

Chapter 3 - Information Systems for Operations and Decisions

Management Information System (MIS) is one of the most important tools in any organization, which aims to provide reliable, complete, accessible, and understandable information in a timely manner to the users of the system.Automation can save time, money, resources, reduce employee’s staff, and enhance organizational workflow. Moreover, it assists in organization productivity, effectiveness, increase customer satisfaction, and efficiency of the work.

MIS for a business organization support the business process, treats inputs as a request from the customer and outputs as services to customer. Supports current operations and use the system to influence further way of working. It renders timely information, maintenance and enhancement which provide flexibility in the operation of an organization. Facilitates the decisions made by employee in their daily operations. It also supports managers in decision making to meet the goals and objectives of the organization. Different mathematical models and IT tools are used for the purpose evolving strategies to meet competitive needs. Each business is running in a competitive market. MIS supports the organization to evolve appropriate strategies for the business to assent in a competitive environment.

1. Digital Marketing
2. Database Management System (DBMS)
3. Contemporary trends in DBMS
    i. Business vs. Artificial Intelligence
    ii. Big Data
4. To Do Activities
5. Model Questions
6. Key Words
7. Further Reading/Reference

3.1 Digital Marketing

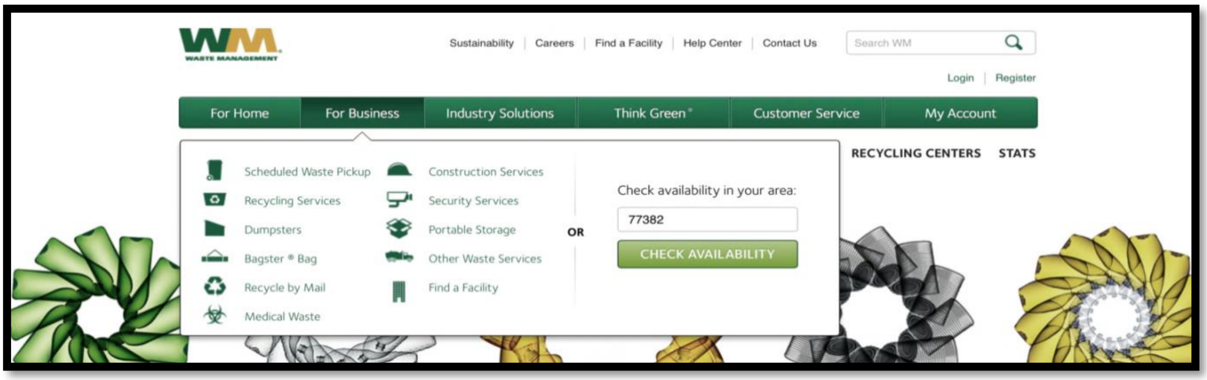
Digital marketing has increased in last a few years in India. People have different views about it. But the fact is this digital marketing has tremendous potential to increase in sales provided entrepreneurs should have knowledge to implement it in right way. Benefits likeincreased brand recognition and better brand loyalty can be gained by effective digital media plan. Digital marketing campaign help in reduction in costs, boost in inbound clients and better ranking in search engines.While formulating plan for digital marketing the following points are worth remembering.

- **Digital strategy as a part of Brand Strategy:**Generally for brands, digital strategies are created in a complete vacuum from the overall brand strategy, or worse, no digital strategy is crafted at all. Since digital is the glue that ties the entirety of a marketing plan and tactics together, anything that happens online needs to ladder up to the higher objectives of the brand. An effective digital strategy is typically composed of a group of sub strategies to effectively plan and account for owned, earned, shared, and paid assets.

- **Innovation of Brands:** Majority of brands have some form of goal around innovation. And that's important because innovations drive the business forward But innovation mean better not new. Our strategy should help us select our tactics, not the other way around. If we are seeking to use a tool or platform because we think it is innovative, and can't identify how or why it works for our audience, we're worshipping shiny object, are destined to fail.

Activity 1 – Innovation

Discuss with yourpartner to develop an e-commerce website for Waste Management Sector.



Waste Management Sector had always relied on account managers, telephone customer service to explain, brief and market diverse number of services &products.So what about a e-commerce website?Scan the QR Code to visit such a sample website.

- **Perceive Consumer Interest:** Too often marketers approach digital from the mindset of their own (or their brand) objectives. Users crave value, utility, and having their needs met. This is especially true online where fractions of a second can make or break a potential engagement. Instead of focusing on our needs, try and determine what our users want and how we can insert our brand or our content into their lives in a way that makes sense.

- **Don't imitate your competitors:** Just because your competitor is doing something doesn't mean you should too.

- **Acknowledge the Importance of Smart Phone and Tablet:** Usage of mobile phone and tablet has increased extensively. About 85% of HCP's are using a tablet in their practice and 1 in 3 people in the US now own a tablet as well. Increasing use of smart phones means your brand had better be ready to provide mobile optimized content, tools, and resources for our users.

- **Understand the Difference between Metrics and Analysis:** There is difference between metrics and analysis. Metrics are just data (i.e. numbers) whereas Analysis tells us what to do next. A common misunderstanding is that they are one and the same. Google analytics may be free, but can't give us any insight into what the numbers mean or where to go from here. Too often marketers collect (orsimply ignore) data and give no thought (or budget) into understanding it. The digital medium allows us to be nimble and react to our users with far greater speed and efficiency.

- **Maintain healthy relationship with stakeholders:**Our employees, suppliers, distributors etc. have to be treatedin such a manner they feel as a partner. Healthy company – client relationships are a true partnership where everyone feels comfortable bringing ideas and co-authoring success. Treat your organization people fairly and with respect and they'll bring results for you.

- **Share your content with those who need it:** Use wants to use contents as per their convenience when and where they want. You should take it positively if they decide to copy, share, link, or tweet it elsewhere. Your contents should be sharable and videos should be post able,because your customers are true amplifier for your brand than anyone else.

🕒 Activity 2 – Food for Thought

Why WhatsApp Marketingis the Next Big Thing in 2019 &Beyond?? Have you ever seen or been part of any WhatsAppgroup that sells dresses (viz., salwar sales) or fancy items? Find it…

Difference between Traditional Marketing and Digital Marketing??

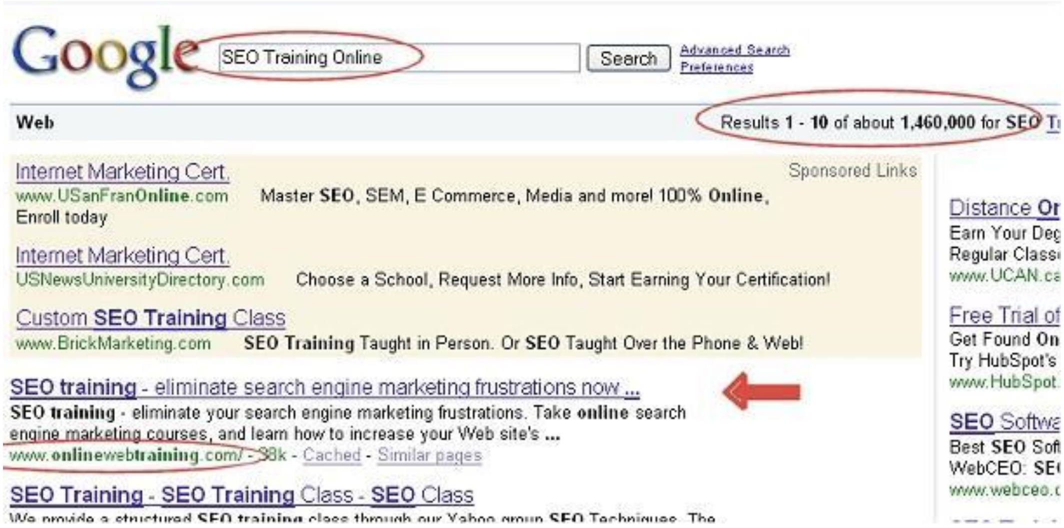
Traditional Marketing

- Communication is unidirectional, which means, an organization communicates about its services with its audiences.
- Medium of communication is generally phone calls, emails, and letters.
- Campaign takes more time as designing, preparing, and launching are involved.
- Limited only to reach local audience.
- It is almost impossible to measure the effectiveness of a traditional marketing campaign.

Digital Marketing

- Communication is bidirectional, as businesses can communicate with the customers and customers can ask queries or make suggestions to businesses as well.
- Medium of communication is more powerful and involves social media websites, chats, apps and Email.
- It can be developed quite rapidly and with the digital tools, channelizing Digital Marketing campaigns is easier.
- It is very effective for reaching global audiences as well as local audience.
- We can measure the effectiveness of marketing campaign through analytics.
- Marketing targets can be achieved through various Digital Marketing Channels.

🕒 Activity 3 – Discursive



Discuss with your partner why certain links appear on top of the search list whereas others don't?

Search Engine Optimization (SEO)

SEO refers to the act of optimizing the structure, design, and content of our website so the search engines (like Google) can index them accurately and position sites in the top results when someone searches those relevant sectors. For instance, if someone searches for disposing kilo tons of e-waste, they will find our company website in top of the search result provided that we have optimized our website accordingly. Optimize refers to the use of 'keywords', which play the most important role in SEO, as its right use is the key to successful SEO. Further, SEO also incorporates different promotional activities that boost search engine ranking of our site.

Conceptually, there are two ways of optimization:

- On-Page SEO – It includes providing good content, good keywords selection, putting keywords on correct places, giving appropriate title to every page, etc.
- Off-Page SEO - It includes link building, increasing link popularity by submitting open directories, search engines, link exchange, etc.

SEO copywriting is the technique of writing viewable text on a web page in such a way that it reads well for the surfer, and also targets specific search terms. Its purpose is to rank highly in the search engines for the targeted search terms. Along with viewable text, SEO copywriting usually optimizes other on-page elements for the targeted search terms. These include the Title, Description, Keywords tags, headings, and alternative text. The idea behind SEO copywriting is that search engines want genuine content pages and not additional pages often called 'dummy pages' that are created for the sole purpose of achieving high rankings.

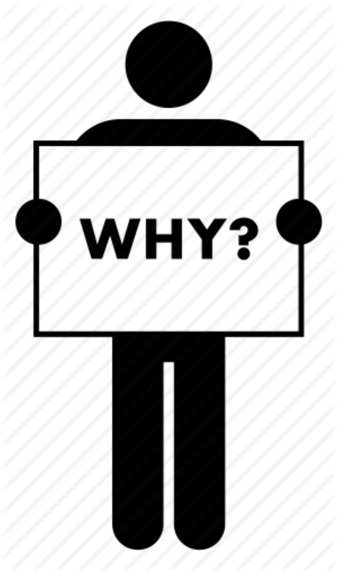
Social Media Marketing

Social Media Marketing makes use of social media sites to raise visibility on the Internet and to promote products and services. Social media sites are useful for building social (and business) networks, and for exchanging ideas and knowledge. Social media networking is part of a trend known as Web 2.0, which refers to changes in the way users and software developers use the Web. It is a more collaborative use of the Web that enhances creativity and knowledge exchange. It is a more interactive and user-driven way to help users participate and collaborate over the Web through open applications and services. It is critical, therefore, that content is accessible to the user; the user should be able to create, share, remix, and repurpose content.

"Web 2.0 (or Web 2) is the popular term for advanced Internet technology and applications including blogs, wikis, RSS and social bookmarking. The expression was originally coined by O'Reilly Media and MediaLive International in 2004, following a conference dealing with next-generation Web concepts and issues".

Social Media Marketing uses podcasts, wikis, blogs, folksonomies, online videos, photo sharing, news sharing, message boards, and posts on social networking sites viz., facebook, twitter etc. to reach a large or targeted audience.Some examples of social media marketing techniques are:

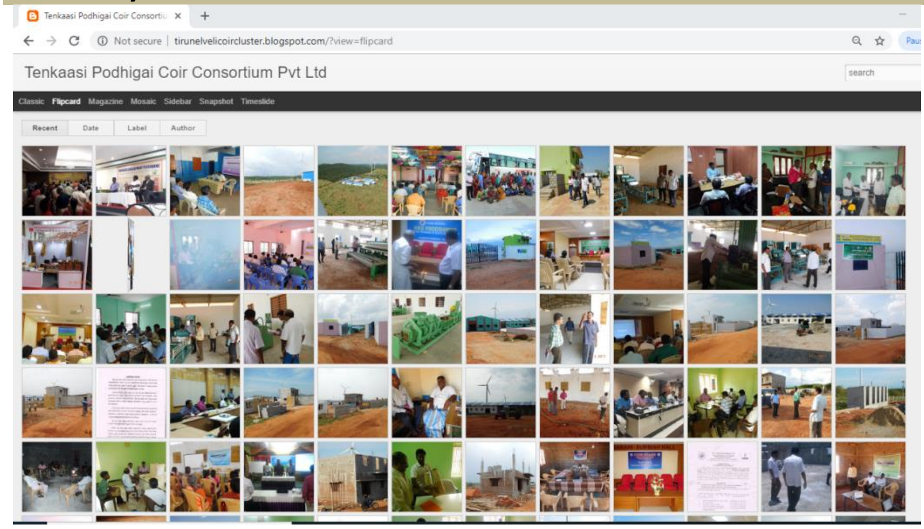
- Joining relevant online communities or groups to help promote our business.
- Adding RSS feeds to our website (RSS stands for Really Simple Syndication that can be used to easily update content).
- Blogging (where we add content to blogs).
- Creating our own business blog.



Small Businesses should use Social Media to Market their businesses

- You can reach a large number of people in a more spontaneous way without paying large advertising fees.
- The use of blogs and social and business networking sites can increase traffic to your website from other social media websites. This in turn may increase your Page Rank, resulting in increased traffic from leading search engines.
- Social media complements other marketing strategies such as a paid advertising campaign.
- You can build credibility by participating in relevant forums and responding to questions.
- Social Media sites have information such as user profile data, which can be used to target a specific set of users for advertising.

Activity 4 – Discursive



Exemplary Model

Blog of TirunelveliCoir Cluster established by MSME, GoI

Scan the QR Code to visit the blog

Along with your partner create a blog and try its features. Ideate a strategy of creating blog for your proposed business model in Waste Management Sector.

To Promote your Business Using Social Media Sites

- Contribute, collaborate, inform, educate but do not sell. Social Media marketing is different from paid advertising. Rather than taking a sales approach (i.e. directly promoting your product), instead consider how you can help and inform your target audience. For example, try to deliver useful and credible information that will help build your reputation and customer relationships.

- Create high quality content. Whether you are part of a social networking site, have established your own blog, or are contributing to a blog, you need to develop interesting and high quality content. What information will your target audience find helpful?

- Start with Small Steps and Build on Your Success.You can get a feel for how social media sites work by commenting on other blogs, or setting up your own blog. If you have a service based small business you can try “Yahoo! Answers”. This website provides a way for you to share your knowledge with people who are looking for that specific information.

- Leave your name and URL when you comment on other blogs.This will help drive traffic to your website, particularly if you have provided useful or interesting information.

- Consider video and/or photo sharing. If you are handy with a video camera you may want to consider “how to” videos or tours of your business. These videos can be shared on appropriate social media websites (e.g. YouTube). You can also take photos of your products and share these photos with people who are interested (using for example, Flickr). A word of caution though – avoid aggressive or invasive sales tactics on these websites.

- Join online groups or mailing lists that are related to the products and services you offer. Connect with these groups and offer information and assistance.
- Understand how social media websites work. These sites are all about connecting and collaboration. Adopt a collaborative, helpful approach and be an active contributor. These sites generally have rules against aggressive sales tactics.

Online Paid Advertising: Pay per click advertising or PPC is another important digital marketing channel that we need to understand in which each time a user clicks on our Ad,we need to pay according to our bid amount.One of the most popular pay per click programs is Google AdWords.

Email Marketing is one of the most pervasive and effective strategies to reach optimum users with least expenses. It is a type of direct marketing that utilizes email as a method for correspondence.Email marketing is a proficient approach to remain associated with the customers and in the meantime advancing our business and services. With email marketing, marketers can likewise track how much percentage of individuals has demonstrated enthusiasm for our item or administration.

Mobile App Marketing

Growing prevalence of smart-phones makes mobile app one of the most important parts of 'digital marketing PDF'. While building your mobile App, below given are the important things we need to pay heed upon-

- We need to optimize social media presence of our App by improving a steady social media following on different social networks like Facebook, Google+, Twitter, Instagram, Tumblr, etc.
- Weshould drive engagement across our mobile app by focusing our efforts on boosting ongoing engagement and keep updating content to influence users have interest in our app.
- Another important factor is to increasing app store ratings that we ought to try, as this will drive a lot of traffic to our app.
- Ensuring a steady rise in app downloads is one of the important things we need to consider in mobile marketing. But, if our product is valuable, its download rate will automatically increase.

Web Analytics is the review, examinations, and reporting of a web information and data for motivations behind comprehension and enhancing web utilization. This strategy is helpful to quantify what numbers of individuals have gone by a site, and how frequent they have used the site or what course they have selected to reach our site. It is exceptionally helpful for marketers as they can make sense of it, which digital marketing strategy is effective and which is most certainly not.Different Web analytics tools can be used to measure whether our site page is working effectively or not.Some of the most common Web Analytics tools are Google Analytics, IBM Coremetrics web analytics, Adobe site catalyst, IBM's UnicaNetsight, Piwik, Yahoo marketing dashboard, Moz, etc.

Activity 5 – Brainstorming

Scan the QR Code to Watch the Video

Along with your partner watch this video to know how to start Social Media Marketing

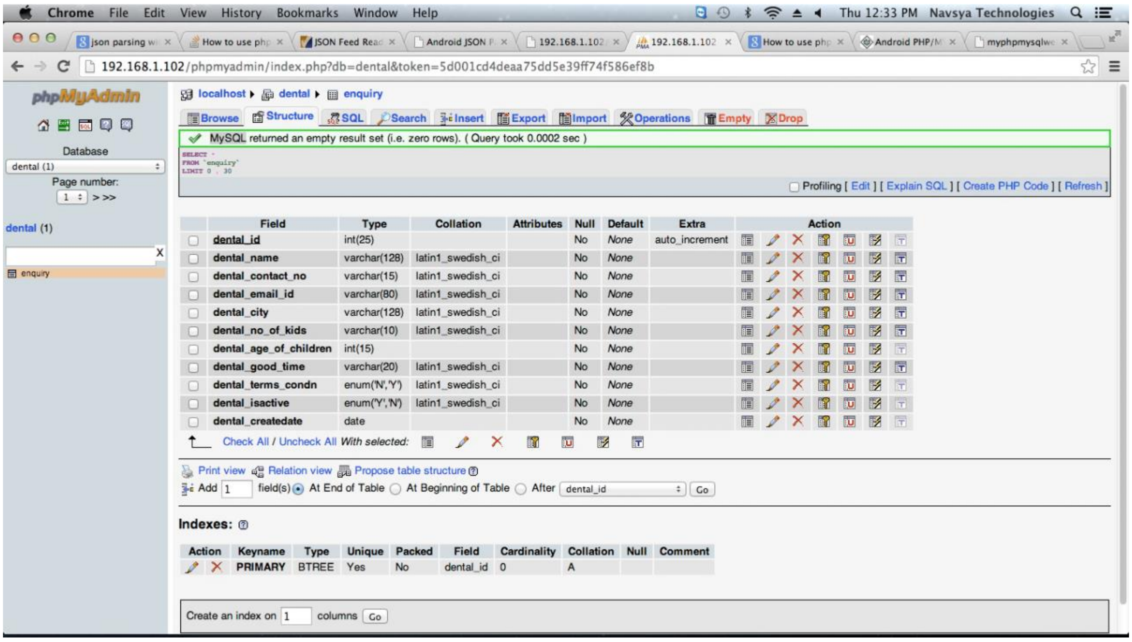
3.2 Database Management System (DBMS)

A database management system (DBMS) is software system for creating and managing information. The DBMS provides users and programmers with a systematic way to create, retrieve, update and manage data. It makes it possible for end users to create, read, update and delete data in a database. The DBMS essentially serves as an interface between the database and end users or application programs, ensuring that data is consistently organized and remains easily accessible.

The DBMS manages three important things:

- the data
- the database engine that allows data to be accessed, locked and modified
- the database schema, which defines the database's logical structure

These three foundational elements help provide concurrency, security, data integrity and uniform administration procedures. Typical database administration tasks supported by the DBMS include change management, performance monitoring/tuning and backup and recovery. Many database management systems are also responsible for automated rollbacks, restarts and recovery as well as the logging and auditing of activity.



MySQL Database Management System Software

The DBMS is perhaps most useful for providing a centralized view of data that can be accessed by multiple users, from multiple locations, in a controlled manner. A DBMS can limit what data the end user sees, as well as how that end user can view data, providing many views of a single database schema. End users and software programs are free from having to understand where the data is physically located or on what type of storage media it resides because the DBMS handles all requests. It can offer both logical and physical data independence. That means it can protect users and applications from needing to know where data is stored or having to be concerned about changes to the physical structure of data (storage and hardware). As long as programs use the application programming interface (API) for the database that is provided by the DBMS, developers won't have to modify programs just because changes have been made to the database.

How efficient is DBMS as compared to traditional records?

Manual Record	Database Management System
Buy a ledger (record book) from shop	Install SQL or MySQL and Create a Database
Allocate a page to record the details	Create a Table (in Software) to feed the details

Write the value in pen or pencil	Type or scan the values that would beconsequently inserted into database
Repeat the process for next set of values	Automated process option are available
In-case of error, erase the values with eraser or whitener	Values can be deleted and also undo delete option are available
In-case of modification, erase the values with eraser or whitener and update it	Update option available and records the list of changes being incorporated (saves it as log file)
Protection? We can keep the book safely inside a locker and keep the key with us	Can be protected with Password
Prone to damage and/or loss of data, subsequently total loss and rework	If backup maintained, can be exported and imported 'n' no. of times
Transfer can be done only through photocopy or scanning of records	Data can be migrated and also integrated with other database
Requires more storage space	______________________________?
___________________________?	______________________________?
	

Database Schema

A database schema is the skeleton structure that represents the logical view of the entire database.It formulates all the constraints that are to be applied on the data. The database schema defines its entities and the relationship among them. It contains a descriptive detail of the database, which can be depicted by means of schema diagrams. It's the database designers who design the schema to help programmers understand the database and make it useful. IT can be divided broadly into two categories:

- Physical Database Schema: This schema pertains to the actual storage of data and its form of storage like files, indices, etc. It defines how data will be stored in a secondary storage.

- Logical Database Schema: This schema defines all the logical constraints that need to be applied on the data stored. It defines tables, views, and integrity constraints.

A database system normally contains a lot of data in addition to users' data. For example, it stores data about data, known as metadata, to locate and retrieve data easily. It is rather difficult to modify or update a set of metadata once it is stored in the database. But as a DBMS expands, it needs to change over time to satisfy the requirements of the users. If the entire data is dependent, it would become a tedious and highly complex job.

Entity and Attributes

An entity can be a real-world object, either animate or inanimate, that can be easily identifiable. For example, in a school database, students, teachers, classes, and courses offered can be considered as entities.

All these entities have some attributes or properties that give them their identity. An entity set is a collection of similar types of entities which may contain entities with attribute sharing similar values. For example, a Students set may contain all the students of a school; likewise a Teachers set may contain all the teachers of a school from all faculties. Entity sets need not be disjoint.

Entities are represented by means of their properties called attributes. All attributes have values. For example, a student entity may have name, class, and age as attributes. There exists a domain or range of values that can be assigned to attributes. For example, a student's name cannot be a numeric value. It has to be alphabetic. A student's age cannot be negative, etc.

Generalization

The process of generalizing entities, where the generalized entities contain the properties of all the generalized entities, is called generalization. In generalization, a number of entities are brought together into one generalized entity based on their similar characteristics. For example, food waste, sludge, plastic wastes, and hospital wastes can all be generalized as Waste.

Specialization

Specialization is the opposite of generalization. In specialization, a group of entities is divided into sub-groups based on their characteristics. Forexample in a waste, certain items can be identified as bio-degradable, non-biodegradable, hazardous, etc. based on what their waste composition.

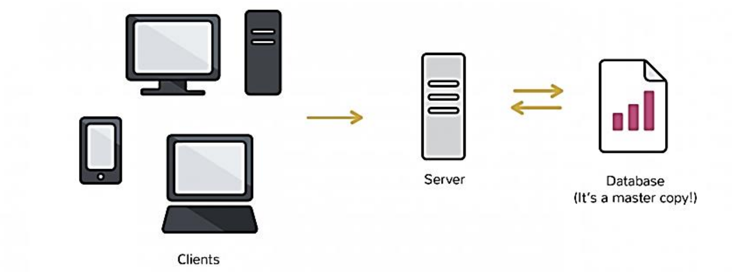
Indexing

We know that data is stored in the form of records. Every record has a key field, which helps it to be recognized uniquely. Indexing is a data structure technique to efficiently retrieve records from the database files based on some attributes on which the indexing has been done. Indexing in database systems is similar to what we see in books.

Components of the Database Management System (DBMS)

There are five major components in the DBMS and their inter-relationship are:

- Hardware
- Software
- Data
- Users
- Procedures



Hardware: It is the actual computer system used for keeping and accessing the database. Conventional DBMS hardware consists of secondary storage devices, usually hard disks, on which the database physically resides, together with the associated Input-Output devices, device controllers and· so forth. Databases run on a' range of machines, from Microcomputers to large mainframes. Other hardware issues for a DBMS includes database machines, which is hardware designed specifically to support a database system.

Software: It is the actual DBMS. Between the physical databases itself (i.e. the data as actually stored) and the users of the system is a layer of software, usually called the Database Management System or DBMS. All requests from users for access to the database are handled by the DBMS. One general function provided by the DBMS is thus the shielding of database users from complex hardware-level detail.The DBMS allows the users to communicate with the database. In a sense, it is the mediator between the database and the users. The DBMS controls the access and helps to maintain the consistency of the data. Utilities are usually included as part of the DBMS. Some of the most common utilities are report writers and application development.

Data: It is the most important component of DBMS environment from the end users point of view. The database contains the operational data and the meta-data, the 'data about data'.The database should contain all the data needed by the organization. One of the major features of databases is that the actual data are separated from the programs that use the data. A database should always be designed, built and populated for a particular audience and for a specific purpose.

Users: There are a number of users who can access or retrieve data on demand using applications and interfaces provided by the DBMS. Each type of user needs different software capabilities. The users of a database system can be classified in the following groups, depending on their degrees of expertise or the mode of their interactions with the DBMS.

Procedures: It refers to the instructions and rules that govern the design and use of the database. The users of the system and the staff that manage the database require documented procedures on how to use or run the system.These may consist of instructions on how to:

- Log on to the DBMS
- Use a particular DBMS facility or application program
- Start and stop the DBMS
- Make backup copies of the database
- Handle hardware or software failures

Activity 6 – Visualization

Scan the QR Code to
Watch the Video

Watch this video to peep inside the Google data center.Discuss with your partner about security, sustainability and the core architecture of Google's infrastructure.

Advantages of DBMS

The database management system has promising potential advantages

- **Improved data sharing**
- **Improved data security**
- **Better data Integration**
- **Improved data access**
- **Improved decision making**
- **Increased end-user productivity**

Disadvantages of DBMS

- **Increased Costs**
- **Management Complexity**
- **Maintenance**
- **Frequent Update**
- **Replacement cycles**

Data Mining

Data mining is process of looking for information and hidden or unknown relations in big mass of data. Development of this analytical method has connection with enormous data ever rising in companies databases. This data is of no use until it is converted into useful information. Therefore, it is necessary to analyze this huge amount of data and extract useful information from it. Extraction of information is not the only process we need to perform; data mining also involves other processes such as Data Cleaning, Data Integration, Data Transformation, Data Mining, Pattern Evaluation and Data Presentation. Once all these processes are over, we would be able to use this information in many applications such as Fraud Detection, Market Analysis, Production Control, Science Exploration, etc. Therefore, Data Mining is defined as extracting information from huge sets of data. In other words, we can say that data mining is the procedure of mining knowledge from data. The information or knowledge extracted so can be used for any of the following applications –

- Market Analysis
- Fraud Detection
- Customer Retention
- Production Control
- Science Exploration

Data Mining Applications

- ✓ Market Analysis and Management
- ✓ Corporate Analysis & Risk Management
- ✓ Fraud Detection

Apart from these, data mining can also be used in the areas of production control, customerretention, science exploration, sports, astrology, and Internet Web Surf-Aid.

Market Analysis and Management

Listed below are the various fields of market where data mining is used −

- **Customer Profiling** − Data mining helps determine what kind of people buy what kind of products.
- **Identifying Customer Requirements** − Data mining helps in identifying the best products for different customers. It uses prediction to find the factors that may attract new customers.
- **Cross Market Analysis** − Data mining performs Association/correlations between product sales.
- **Target Marketing** − Data mining helps to find clusters of model customers who share the same characteristics such as interests, spending habits, income, etc.
- **Determining Customer purchasing pattern** − Data mining helps in determining customer purchasing pattern.
- **Providing Summary Information** − Data mining provides us various multidimensional summary reports.

Corporate Analysis and Risk Management

Data mining is used in the following fields of the Corporate Sector −

- **Finance Planning and Asset Evaluation** − It involves cash flow analysis and prediction, contingent claim analysis to evaluate assets.
- **Resource Planning** − It involves summarizing and comparing the resources and spending.
- **Competition** − It involves monitoring competitors and market directions.

Fraud Detection

Data mining is also used in the fields of credit card services and telecommunication to detect frauds. In fraud telephone calls, it helps to find the destination of the call, duration of the call, time of the day or week, etc. It also analyzes the patterns that deviate from expected norms.

Activity 7 – Brainstorming

Have you heard of AP State's CM Core Dashboard?

Ideate how it is related to DBMS &Data Mining

Model Questions

1. Give a detail account on Digital Marketing and its application in Social Entrepreneurship.
2. Distinguish between traditional and digital marketing. Which marketing would be the appropriate marketing for Waste Management Sector?
3. Explain in detail about Social Media Marketing and its channels.
4. Write short notes on
    a. Search Engine Optimization
    b. Mobile App Marketing
    c. Web 2.0
    d. Web Analytics
    e. Google Adwords
5. Explain in detail about Database Management System (DBMS).
6. Give an account on the components of DBMS?
7. Write short notes on
    a. Database Scheme
    b. Database Entities and Attributes

   c. Database Generalization and Specialization
8. What are the advantages and disadvantages in Database Management Systems (DBMS)?
9. Explain in detail about Data Mining.
10. What are the applications of Data Mining?

3.3 Contemporary trends in DBMS

Business Intelligence (BI)

Business intelligence (BI) refers to the use of various technologies and tools to collect and analyze business data. The main purpose of BI is to provide companies with useful information and analysis to aid decision-making. Using BI allows businesses to make decisions nearly five times faster than they otherwise could.

Objective of Business Intelligence

Business Intelligence aims to streamline the process of collecting, reporting and analyzing data. Using BI allows companies to improve the quality of the data they collect and the consistency with which they collect it. In other words, BI tools can turn reams of noisy data into a coherent picture, but they are not designed to provide clear prescriptions for how that data should be used in decision-making. It aims to streamline the process of collecting, reporting and analyzing data. Using BI allows companies to improve the quality of the data they collect and the consistency with which they collect it.

Artificial Intelligence (AI)

Artificial intelligence (AI) explores the use of computer systems to mimic various attributes of human intelligence, such as problem solving, learning, and judgment. Though in its technological infancy, businesses see huge potential in AI for speech recognition, decision-making, and everything in between.

Objective of Artificial Intelligence

Modeling human intelligence is one of the primary goals of artificial intelligence. By modeling human behaviors and thought-processes, AI programs can learn and make rational decisions.Unlike BI, which makes analyzing data much easier but leaves decision-making in the hands of humans, AI can enable computers to make business decisions themselves.

Activity 8 – Visualization

Scan the QR Code to Watch the Video

Watch this video to have a glance on upcoming technologies viz., Machine learning...

Difference between Artificial and Business Intelligence

Basis	Artificial Intelligence	Business Intelligence
Philosophy	AI is started with the intention of creating similar intelligence in machines that we find in humans	It helps in analyzing business performance through data-driven insight i.e. understand the past and predict the future
Goals	To create expert systems and implement human intelligence in machines	It should provide information that can enable efficient and effective business decisions at all levels of the business.
Areas that contribute	Artificial Intelligence is a combination of science and technology based on computer science, mathematics, Biology, Psychology	It combines business analysis tools which include ad-hoc analytics, enterprise reporting, OLAP(online analytical processing)
Applications	Artificial Intelligence is used in various fields such as Gaming, Natural language processing, Expert systems, Vision systems, Speech recognition, Handwriting recognition, Intelligent Robots.	It is used in Spreadsheets, querying and reporting software, Digital dashboards, Data mining, Data warehouse, Business activity monitoring.
Research	Research areas for Artificial	Research areas for Business

areas	Intelligence are Expert systems, Neural networks Natural language processing, Fuzzy logic, Robotics.	Intelligence include Data mining in social networks, process analytics, Big Data
Issues	Artificial Intelligence faces three issues.They are Threat to Privacy, Threat to Human dignity, Threat to safety.	Business Intelligence issues are classified into two types.They are Organization and People and Technology and data

Big Data

According to Gartner (2012),the Big data is high-volume, high-velocity and/or high-variety information assets that demand cost-effective, innovative forms of information processing that enable enhanced insight, decision making, and process automation. It is to be remembered that the "big" in big data is not just about volume. What it means is that we are not only getting a lot of data but it comes fast, in complex format and from a variety of sources. It is interesting to know that, today's big data may not be tomorrow's big data as technologies evolve. It is, by and large, a relative concept. From anyone's given perspective, if your organization is facing significant challenges (and opportunities) around data's volume, velocity and variety, it is your big data challenge. Typically, these challenges introduce the need for distinct data management and delivery technologies.

Mostly, companies from all industries use data analytics to

- Increase revenue
- Decrease costs
- Increase productivity

Organizations have a long tradition of capturing transactional data. Apart from that, companies nowadays are capturing additional data from its operational environment at an increasingly fast speed. Some examples are

- **Web data:**Customer level web behavior data such as page views, searches, reading reviews, purchasing, can be captured. They can enhance performance in areas such as next best offer, churn modeling, customer segmentation and targeted advertisement.
- **Text data** (email, news, Facebook feeds, documents, etc.) is one of the biggest and most widely applicable types of big data. The focus is typically on extracting key facts from the

text and then use the facts as inputs to other analytic process (for example, automatically classify insurance claims as fraudulent or not.)

- **Time and Location data:** GPS and mobile phone as well as Wi-Fi connection makes time and location information a growing source of data. At individual level, many organizations come to realize the power of knowing when their customers are at which location. Equally important is to look at time and location data at an aggregated level. As more individuals open up their time and location data more publicly, lot of interesting applications start to emerge. Time and location data is one of the most privacy-sensitive types of big data and should be treated with great caution.

- **Smart Grid and Sensor Data:**Sensor data are collected nowadays from cars, oil pipes, windmill turbines, and they are collected in extremely high frequency. Sensor data provides powerful information on the performance of engines and machinery. It enables diagnosis of problems more easily and faster development of mitigation procedures.

- **Social network data**: Within social network sites like Facebook, LinkedIn, Instagram, it is possible to do link analysis to uncover the network of a given user. Social network analysis can give insights into what advertisements might appeal to given users. This is done by considering not only interests the customers have personallystated, but also knowing what it is that their circle of friends or colleagues has an interest in.

With most of big data source, the power is not just in what that particular source of data can tell us uniquely by itself but in combination with other data sets that actually counts.

Distinguish Big Data from traditional data

The answer lies in how the data is used. The processes, tools, goals, and strategies that are deployed when working with Big Data are what set Big Data apart from traditional data.

- First, the big data can be an entirely new source of data. For example, most of us have experience with online shopping. The transactions we execute are not fundamentally different transactions from what we would have done traditionally. An organization may capture web transactions, but they are really just more of the same transactions that have been captured for years (e.g. purchasing records). However, actually capturing browsing behavior (how we navigate on the site, for instance) as customers execute a transaction creates fundamentally new data.

☹ Activity9– Brainstorming

Scan the QR Code to
Watch the Video

Watch this video to have in-depth learning on big data.There upon discuss with your partner on how you could apply big datain Waste Management Sector. Try to ideate whether a monitoring mechanism using big data analytics can be formulated to monitor the quantum of waste being disposed today and expected waste generated tomorrow?

- Second, sometimes one can argue that the speed of data feed has increase to such an extent that it qualifies as a new data source. For example, our electricity meter has probably been read manually each month for years. Now we have a smart meter that automatically read it every 10 minutes. One are argue that it is the same data. It can also be argued that the frequency is so high now that it enables a very different, more in-depth level of analytics that such data is really a new data source.

- Third, increasingly more semi-structured and unstructured data are coming in. Traditional data sources are in the structured realm. Structure data are the ones like the receipts from our grocery store, the data on our salary slip, accounting information on the spreadsheet, and pretty much everything that can fit nicely in a relational database. Every piece of information included is known ahead of time, comes in a specified format and occurs in a specified order. This makes it easy to work with. Unstructured data sources are those that we have little or no control over its format. Text data, video data and audio data all fall into this category. Unstructured data is messy to work with because the meaning of the bites and bits are not predefined.Between structured and unstructured data is semi-structured data. Semi-structured data is data that may be irregular or incomplete and have a structure that may change rapidly or unpredictably. It generally has some structure, but does not conform to a fixed schema. Web logs are good example of semi-structured data.

⏲ Activity9 – Visualization

Discuss with your partner about the types of graphical charts depicted in below Big Data Analytics

Model Questions

1. Compare the differences between Business and Artificial Intelligence. Which type of intelligence can be applied to monitor Waste Management?
2. Write short notes on the goals of Business and Intelligence.
3. Give a detailed account on Big Data.
4. How would you differentiate Big Data from Traditional Data?
5. What do you mean by Analytical Dashboard? How it is different from MIS Reports?

Key Words

Digital Marketing, DBMS, Big Data, Business Intelligence, Artificial Intelligence

Further Reading/References

Oz, E. (2008). Management Information Systems. (2nd edn.), India: Cengage Learning

https://www.digitalvidya.com/ – Digital Marketing

http://www.tutorialspoint.com/– Database Management System (DBMS)

💻https://www.nceg.gov.in/ – National e-Governance Conference Portal

– Business Intelligence

– Artificial Intelligence

– Big Data

Chapter 4 - Managing Information Technology

Information management (IM) concerns a cycle of organizational activity: the acquisition of information from one or more sources, the custodianship and the distribution of that information to those who need it, and its ultimate disposition through archiving or deletion.

The Information management embraces all the generic concepts of management, including the planning, organizing, structuring, processing, controlling, evaluation and reporting of information activities, all of which is needed in order to meet the needs of those with organizational roles or functions that depend on information.

1. Enterprise Resource Planning (ERP)
2. Business Process Reengineering
3. Supply Chain Management
4. Globalization and its impact on Supply Chain Management
5. Electronic Data Interchange (EDI)

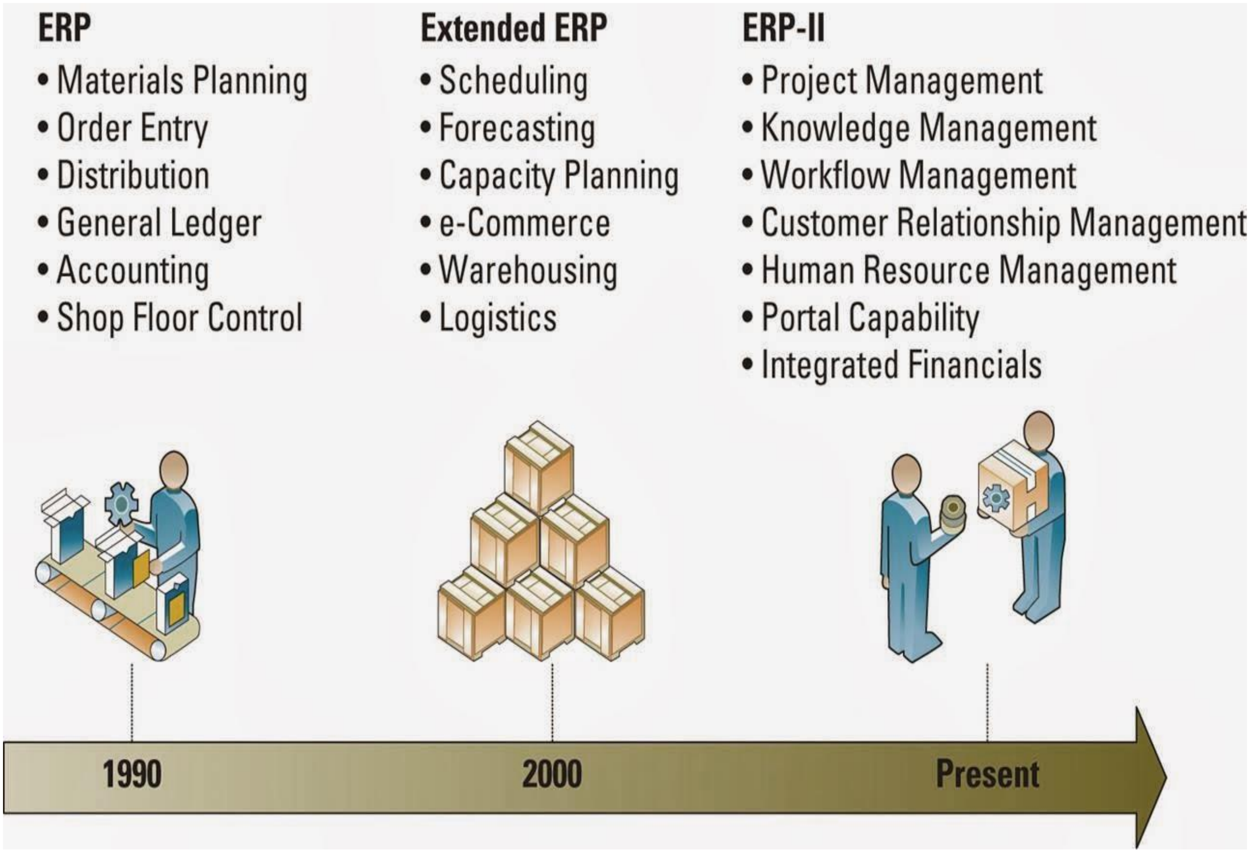
4.1 Enterprise Resource Planning (ERP)

An Enterprise Resource Planning system is a widely-known state-of-the-art information system which automates the business processes of an organization into a fully integrated business management system covering functional areas of an enterprise like Logistics, Production, Finance, Accounting and Human Resources. It organizes and integrates operation processes and information flows to make optimum use of resources such as men, material, money and machine.

Evolution of ERP

In ever-growing business environment, the following demands are placed on the industry

- Aggressive cost control initiatives
- Need to analyze costs/revenues on a product or customer basis
- Flexibility & Adaptability to respond to changing business requirements
- More informed management decision making
- Changes in ways of doing business.



ERP Characteristics

Any system has to possess few key characteristics to qualify for a true ERP solution. Features are:

i. Flexibility: An ERP system should be flexible to respond to the changing needs of an enterprise and must to run across various database back ends through Open Database Connectivity (ODBC).

ii. Modular & Open: ERP system has to have open system architecture. This means that any module can be interfaced or detached whenever required without affecting the other modules. It should support multiple hardware platforms for the companies having heterogeneous collection of systems.

iii. Comprehensive: It should be able to support variety of organizational functions and must be suitable for a wide range of business organizations.

iv. Beyond the Company: It should not be confined to the organizational boundaries, rather support the on-line connectivity to the other business entities of the organization.

v. Best Business Practices: It must have a collection of the best business processes applicable worldwide. An ERP package imposes its own logic on a company's strategy, culture and organization.

Features of ERP

Some of the major features of ERP for the business system are:

- ERP provides multi-platform, multi-facility, multi-mode manufacturing, multi-currency, multi-lingual facilities.
- It supports strategic and business planning activities, operational planning and execution activities, creation of Materials and Resources
- ERP covering all functional areas like manufacturing, selling and distribution, payables, receivables, inventory, accounts, human resources, purchases etc.
- ERP performs core activities and increases customer service, thereby augmenting the corporate image.
- ERP bridges the information gap across organizations.
- ERP provides complete integration of systems not only across departments but also across companies under the same management.
- ERP is the solution for better project management.
- ERP allows automatic introduction of the latest technologies like Electronic Fund Transfer (EFT), Electronic Data Interchange (EDI), Internet, Intranet, Video conferencing, E-Commerce etc.
- ERP eliminates most business problems like material shortages, productivity enhancements, customer service, cash management, inventory problems, quality problems, delivery etc.
- ERP provides intelligent business tools like decision support system, Executive information system, Data mining and easy working systems to enable better decisions.

Components of ERP

Driving Force behind ERP

There are two main driving forces behind Enterprise Resource Planning for a business organization. In a business sense, Enterprise Resource Planning ensures customer satisfaction, as it leads to business development that is development of new areas, new products and new services.

- Also, it allows businesses to face competition for implementing Enterprise Resource Planning, and it ensures efficient processes that push the company into top gear.
- In an IT sense: Most software does not meet business needs wholly and the legacy systems today are hard to maintain. In addition, outdated hardware and software is hard to maintain.

Hence, for the above reasons, Enterprise Resource Planning is necessary for management in today's business world. ERP is single software, which tackles problems such as material shortages, customer service, finances management, quality issues and inventory problems. An ERP system can be the dashboard of the modern era managers.

Activity 1 – Brainstorming

Scan the QR Code to Watch the Video

Watch this video to learn about the components of ERP.Discuss with your partner on how you could relate these components with Medical Waste Management - ERP. Now, ideate the process involved in Medical Waste Management and categorize the key stakeholders with the components of the ERP. For instance: Human Resource = Doctors, CRM = Clinic etc.

Implementing ERP System

Producing Enterprise Resource Planning (ERP) software is complex and also has many significant implications for staff work practice. Implementing the software is a difficult task too and one that 'in-house' IT specialists cannot handle. Hence to implement ERP software, organizations hire third party consulting companies or an ERP vendor.

This is the most cost effective way. The time taken to implement an ERP system depends on the size of the business, the number of departments involved, the degree of customization involved, the magnitude of the change and the cooperation of customers to the project.

Significances of ERP

Following are some of the benefits they achieved by implementing the ERP packages

- ✓ Gives Accounts Payable personnel increased control of invoicing and payment processing and thereby boosting their productivity and eliminating their reliance on computer personnel for these operations.
- ✓ Reduce paper documents by providing on-line formats for entering and retrieving information.
- ✓ Improves timeliness of information by permitting posting daily instead of monthly.
- ✓ Greater accuracy of information with detailed content, better presentation, satisfactory for the auditors, improved cost control, faster response and follow-.up on customers.
- ✓ More efficient cash collection, say, material reduction in delay in payments by customers.
- ✓ Better monitoring and quicker resolution of queries, response to change in business operations and market conditions.
- ✓ Helps to achieve competitive advantage by improving its business process.
- ✓ Improves supply-demand linkage with remote locations and branches in different countries.
- ✓ Provides a unified customer database usable by all applications.
- ✓ Improves International operations by supporting a variety of tax structures, invoicing schemes, multiple currencies, multiple period accounting and languages.
- ✓ Improves information access and management throughout the enterprise.

Points to Remember

- ✓ While employing an ERP system may be expensive, it offers organizations a cost efficient system in the long run.
- ✓ ERP software works by integrating all the different departments in on organization into one computer system allowing for efficient communication between these departments and hence enhances productivity.
- ✓ You should take extra precautions when it comes to choosing the correct ERP system for them. There have been many cases that organizations have lost a lot of money due to selecting the 'wrong' ERP solution and a service provider for them.

Model Questions

1. Explain in detail about application of ERP in Waste Management Sector.

2. What are the driving forces behind ERP software?
3. Write short notes on emerging trends in ERP.
4. Why companies/organizations should undertake ERP?
5. Illustrate an ERP model for Social Entrepreneurs of Rural India.

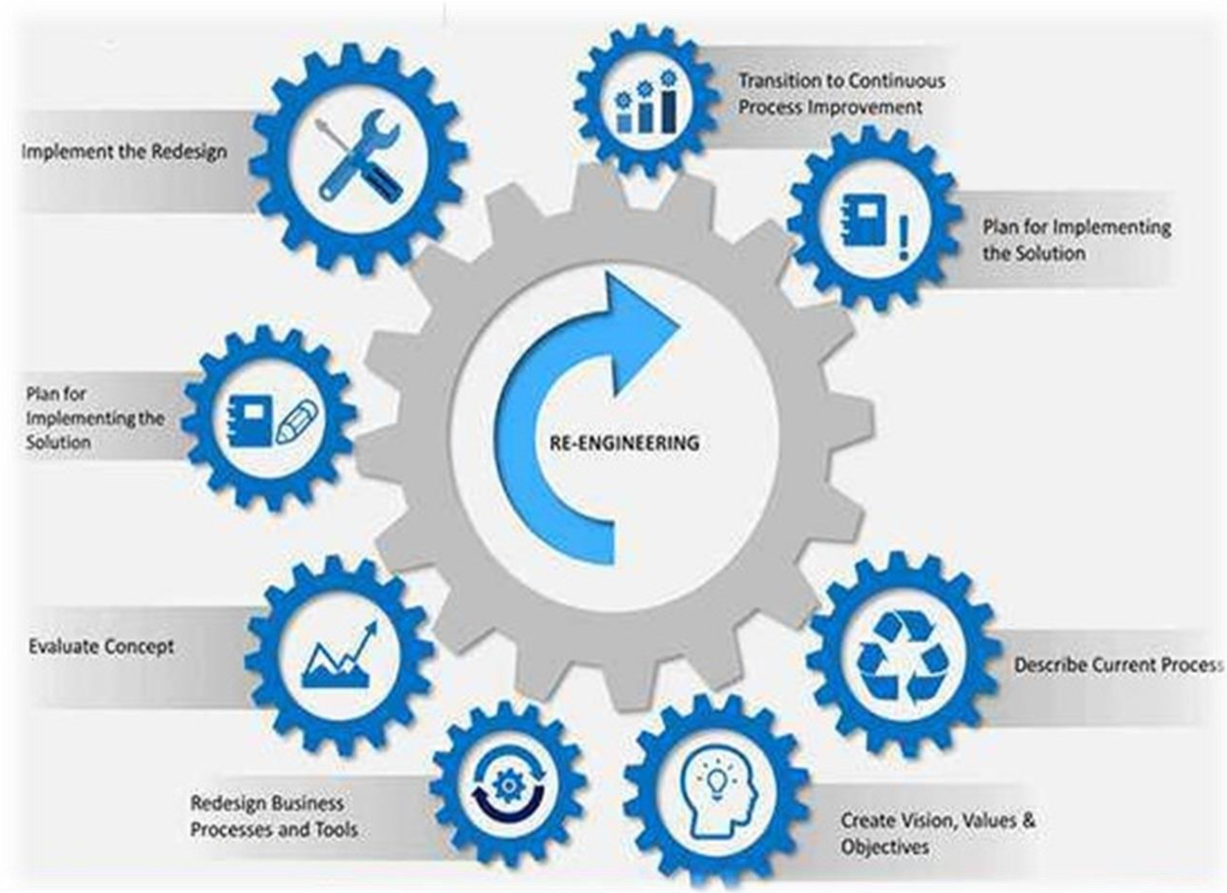
Activity 2–Discursive

Scan the QR Code to Watch the Video

Watch this video to know the emerging trends in ERP Software. For instance, Artificial Intelligence will have more influence on future of ERP software and will undoubtedly have a decisive impact on the future business irrespective of size or industry. Try to listthose technologies being discussed in the video; subsequently try to do a quick research on it. E.g.)Machine Learning, Internet of Things (IoT), Big Data etc.

4.2 Business Process Re-Engineering

ERP is a result of a modern Enterprise's concept of how the Information System is to be configured to the challenging environments of new business opportunities. However merely putting in place an information system is not enough. Every company that intends to implement ERP has to reengineer its processes in one form or the other. This process is known as Business Process Reengineering.



🕮Glossary

Dramatic achievement means to achieve 80% or 90% reduction (in say, delivery time, work in progress or rejection rate) and not just 5%, 10% reduction.

Radical redesign means BPR is reinventing and not enhancing or improving.

Fundamental rethinking means asking the question "why do you do what you do", thereby eliminating business process altogether if it does not add any value to the customer.

In terse, "BPR is the fundamental rethinking and radical redesign of processes to achieve dramatic improvement, in critical, contemporary measures of performance such as cost, quality, service and speed." Companies reduce organizational layers and eliminate unproductive activities in two key areas. First, they redesign functional organizations into cross-functional teams. Second, they use technology to improve data dissemination and decision making.

BPR Implementation

- Success of an implementation mainly depends on how closely the implementation consultants, users and vendors work together to achieve the overall objectives of the organization.

- The implementation consultants have to understand the needs of the users, understand the prevailing business realties and design the business solutions keeping in mind It is the users who will be driving the implementation and therefore their all these factors active involvement at all stages of implementation is vital for overall success of implementation.
- It is worthwhile to remember that ERP is an enabling tool, which makes one do his work better, which naturally needs additional efforts.
- During the course of implementation the standard package may undergo changes which may be a simple one or a major 'functionality' change. Implementing such changes is known as Customization.
- Contents of the package are known as modules which are further divided into Components.
- The roles and responsibilities of the employees have to be clearly identified, understood and the employees will have to accept new processes and procedures configured in the system laid down in the ERP system.
- At the same time these processes and procedures have to be simple and user friendly.
- Awell-managed and implemented ERP package can give a 200 percent return on investment where as a poorly implemented one can yield a return on investment as low as 25 percent.

ERP Implementation Methodology

Pre-dominantly nine steps are involved in the implementation of a typical ERP package. These are:

1. Identifying the Needs

Some of the basic questions, which are to be answered, are

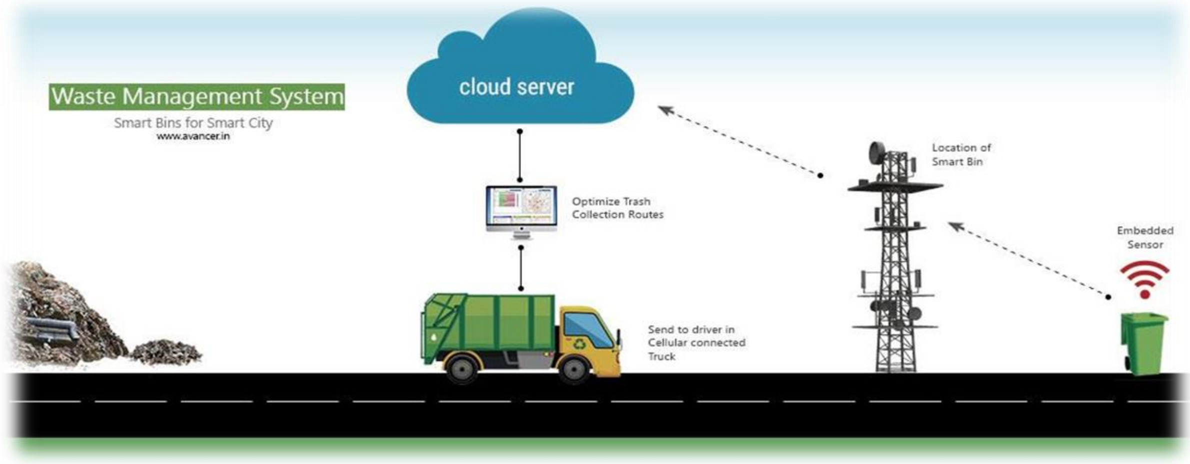
- Why should an ERP package be implemented?
- Will it improve profitability?
- Can the delivery times of products be reduced?
- How does it improve customer satisfaction in terms of quality, cost, delivery time and service?
- Will it help to reduce cost of products?
- How can it help to increase business turnover and at the same time reduce manpower?
- Will it be possible to reengineer the business processes?

2. Evaluating the "AS IS" situation of the business

To understand the present situation of the business, the various functions should first be listed.

- Total time taken by the business processes.
- Number of decision points existing in the present scenario.
- Number of Departments/Locations of businesses process.
- The flow of information and its routing.
- The number of reporting points currently available.

Activity 3 – Visualization



Interact with your partner and conceptualize a garbage collection methodology which shall harness ICT and consecutively foster the [Swachh Bharat Mission](#).

3. 'Would be' situation

Deciding the desired 'Would Be' situation: the concept of 'Benchmarking' is used to see that processes achieved are the best in industry. Benchmarking is done on various factors like cost, quality, service etc. This concept enables to optimize the processes to gain overall benefits.

4. Reengineering the business process

Reengineering of business processes is done to I Reduce the business process cycle time.

- ✓ To reduce the number of decision points to a minimum.
- ✓ Streamlining the flow of information and eliminating the unwanted flow of information.

5. Evaluation of various ERP packages

Evaluation of ERP packages are done based on the following criteria:-

Flexibility: It should enable organizations to respond quickly by leveraging changes to their advantage, letting them concentrate on strategically expanding to address new products and markets.

Comprehensive: It should be applicable across all sizes, functions and industries. It should have in-depth features in accounting and controlling, production and materials management, quality management and plant maintenance, sales and distribution, human resources management and plant maintenance, sales and distribution, human resources management, and project management.

Beyond the company: It should support and enable inter-enterprise business processes with customers, suppliers, banks, government and business partners and create complete logistical chains covering the entire route from supply to delivery, across multiple geographies, currencies and country specific business rules.

Best business practices: The software should enable integration of all business operation in an overall system for planning, controlling and monitoring and offer a choice of multiple ready-made business processes including best business practices that reflect the experiences, suggestions and requirements of leading companies across industries. In other words, it should intrinsically have a rich wealth of business and organizational knowledge base.

New technologies: It should incorporate cutting-edge and future-proof technologies such as object orientation into product development and ensure inter-operability with the Internet and other emerging technologies.

?Food for Thought

Are there any other factors to be considered?

i. Global presence of package
ii. Local presence
iii. Market Targeted by the package
iv. Price of the package
v. Obsolescence of package
vi. Ease of implementation of package
vii. Cost of implementation
viii. Post-implementation support availability

And still any-other?

Common... Just try it yourself!

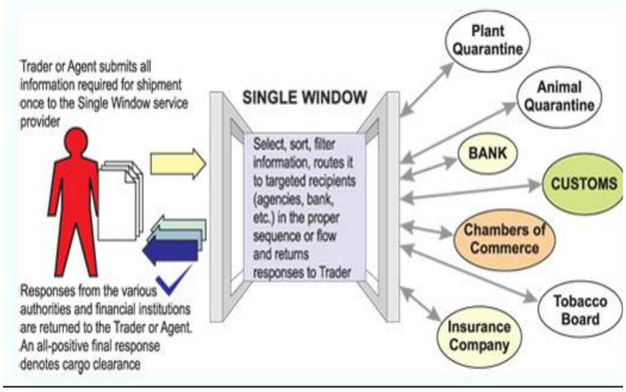
6. Finalization of the ERP package

Finalization of the ERP package can be done by making a comparison of critical factors through a matrix analysis.

7. Installation of Hardware and Networks

This work is carried out in a phased manner depending on the schedule of implementation and need of the hardware components.

Activity 4 – What is Single Window Clearance?



8. Finalizing the Implementation Consultants

The factors of selection for consultants are

i. Skill set
ii. Industry specific experience
iii. Cost of hiring consultants

9. Implementation of ERP package includes

- Formation of team, Plan preparation
- Mapping of business process to package
- Gap analysis, Customization
- Development of user specific reports
- Uploading of data from the existing system
- Test run – (User Acceptance Testing)
- User training, Parallel run
- Concurrence from user
- Migration to the new system
- User documentation

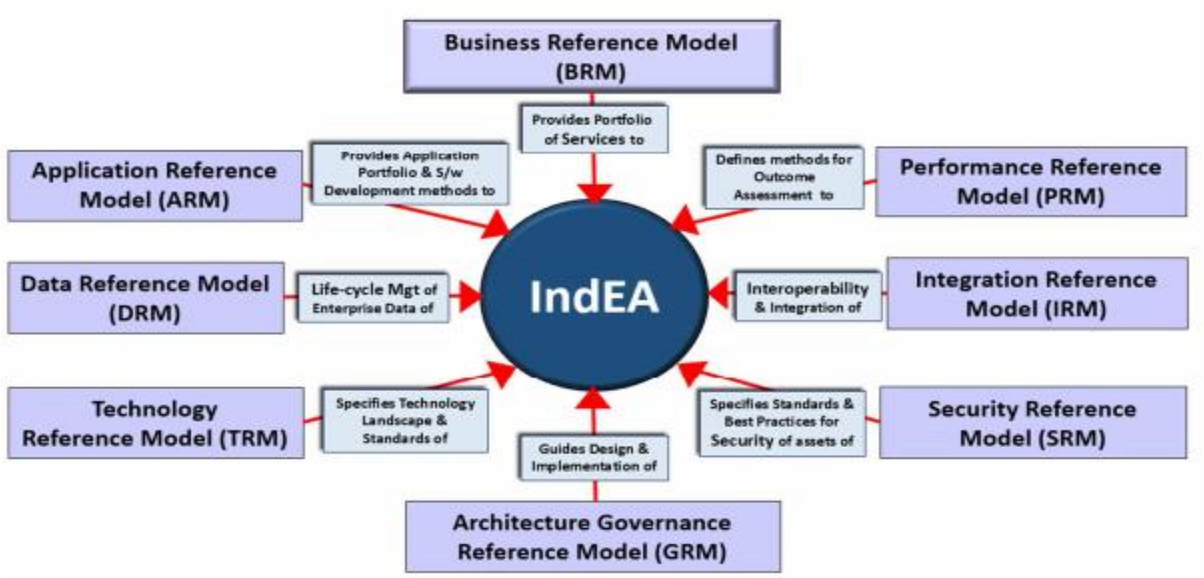
Activity 5 – What is Single Sign On?

- Post-implementation support
- System monitoring and fine tuning

📖Did you know?

What you mean by India Enterprise Architecture Framework (IndEA)?

The India Enterprise Architecture Framework, aptly called IndEA, was formally notified by the Government of India as a national standard. The vision is to establish best-in-class architectural governance, processes and practices with optimal utilization of ICT infrastructure and applications to offer ONE Government experience to the citizens and businesses. Citizen-centricity, Outcome-focus, Standardization, Reusability and Integration are the key mantras followed while designing IndEA.



IndEA aims to define the strategic use of Information and Communication Technology by the Government to enable transformation of Government and Governance towards a connected ONE GOVERNMENT. It offers the effective process for translating Government's vision and strategy into effective change in the Government Enterprise from people, process and technology perspective and their relationship with one another and with the external systems to create an integrated environment that is agile, pro-active and predictive.

Risk and Governance Issues in ERP

You could face several new business risks when you migrate to real-time, integrated ERP systems viz.

- **Single point of failure:** Since all the organization' data and transaction processing is within one application system and transaction processing is within one application system. Structural changes significant personnel and organizational structures changes associates with reengineering or redesigning business processes.

- **Job role changes:** transition of traditional user's roles to empowered-based roles with much greater access to enterprises information in real time.

- **Online, real-time:** An online real-time system environment requires a continuous business environment capable of utilizing the new capabilities of the ERP application and responding quickly to any problem requiring of re-entry of information.

- **Change management:** It is challenging to embrace a tightly integrated environment when different business processes have existed among business units for so long. The level of user acceptance of the system has a significant influence on its success. Users must understand that their actions or inaction have a direct impact upon other users and, therefore, must learn to be more diligent and efficient in the performance of their day-today duties. Considerable training is therefore required for what is typically a large number of users.

- **Distributed computing experience:** Inexperience with implementing and managing distributed computing technology may pose significant challenges.

- **Broad system access:** Increased remote access by users and outsiders and high integration among application functions allow increased access to application and data.

- **Dependency on external assistance:** Organization accustomed to in-house legacy systems may find they have to rely on external help. Unless such external assistance is properly managed, it could introduce an element of security and resource management risk that may expose the organizations to greater risk.

- **Program interfaces and data conversions:** Extensive interfaces and data conversions from legacy systems and other commercial software are often necessary. The exposures of data integrity, security and capacity requirements for ERP are therefore often much higher.

- **Audit expertise:** Specialist expertise is required to effectively audit and control an ERP environment. The relative complexity of ERP systems has created specialization such that each specialist may know only a relatively small fraction of the entire ERP's functionality in a particular core module,

More recently, some of the additional risks and good governance issues introduced by are:

  - **Single Sign On:** It reduces the security administration effort associated with administrating web-based access to multiple systems, but simultaneously introduces additional risk in that an incorrect assignment of access may result in inappropriate access to multiple systems.

- **Data Content Quality:** As enterprise applications are opened to external suppliers and customers, the need for integrity in enterprise data becomes paramount.
- **Privacy and Confidentiality:** Regularity and governance issues surrounding the increased capture and visibility of personal information, i.e. spending habits.

Benefits of ERP

- ✓ Increased control of invoicing and payment processing
- ✓ Reduce paper documents
- ✓ Improves timeliness of information
- ✓ Greater accuracy of information
- ✓ Faster response and follow-up on customers
- ✓ More efficient cash collection
- ✓ Better monitoring and quicker resolution of queries
- ✓ Helps to achieve competitive advantage by improving its business process
- ✓ Provides a unified customer database usable by all applications

Model Questions

1. Explain in detail about ERP implementation methodology.
2. What is meant by Business Process Reengineering?
3. Give an account on the risk and governance issues associated with ERP?
4. What is meant by India Enterprise Architecture Framework?
5. Short notes on
    a. Single Window Clearance
    b. Single Sign On
    c. Benefits of ERP

4.3 Supply Chain Management

Supply Chain can be defined as a group of inter-connected participating companies that add value to a stream of transformed inputs from their source of origin to the end products or services that are demanded by the designated end-consumers. It can be perceived as the management of flow of products and services, which begins from the origin of products and ends at the product's consumption. It also comprises movement and storage of raw materials that are involved in work in progress, inventory and fully furnished goods. The main objective of supply chain management is to monitor and relate production, distribution, and shipment of products and services.

Companies in any supply chain must make decisions individually and collectively regarding their actions in five areas:

1. Production—What products does the market want? How much of which products should be produced and by when? This activity includes the creation of master production schedules that take into account plant capacities, workload balancing, quality control, and equipment maintenance.

2. Inventory— What inventory should be stocked at each stage in a supply chain? How much inventory should be held as raw materials, semi-finished, or finished goods? The primary purpose of inventory is to act as a buffer against uncertainty in the supply chain. However, holding inventory can be expensive, so what are the optimal inventory levels and reorder points?

3. Location—Where should facilities for production and inventory storage be located? Where are the most cost efficient locations for production and for storage of inventory? Should existing facilities be used or new ones built? Once these decisions are made they determine the possible paths available for product to flow through for delivery to the final consumer.

4. Transportation—How should inventory be moved from one supply chain location to another? Air freight and truck delivery are generally fast and reliable but they are expensive. Shipping by sea or rail is much less expensive but usually involves longer transit times and more uncertainty. This uncertainty must be compensated for by stocking higher levels of inventory. When is it better to use which mode of transportation?

5. Information—How much data should be collected and how much information should be shared? Timely and accurate information holds the promise of better coordination and better decision making. With good information, people can make effective decisions about what to produce and how much, about where to locate inventory and how best to transport it.

The sum of these decisions will define the capabilities and effectiveness of a company's supply chain. The things a company can do and the ways that it can compete in its markets are all very much dependent on the effectiveness of its supply chain.

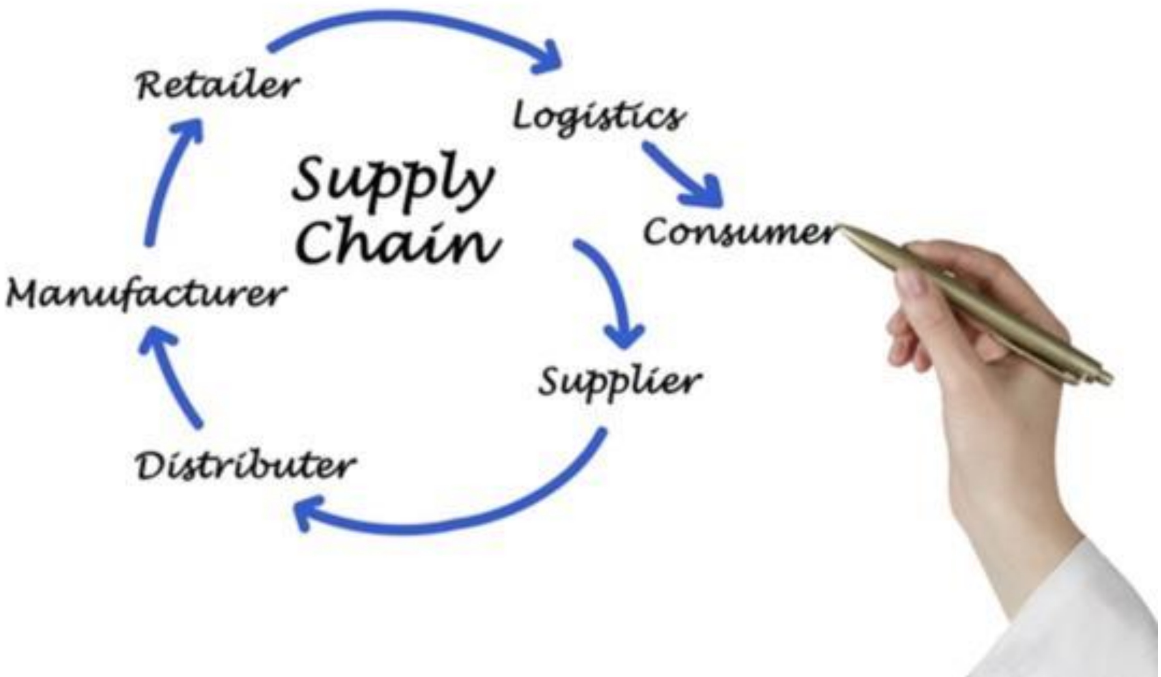
Activity 6 – Brainstorming

Scan the QR Code to Watch the Video

Watch this video about the application of Supply Chain Management in Waste Collection Process. Discuss with your partner and ideate how to improve the waste management process in municipalities through Supply Chain Management.

Stakeholders in Supply Chain Management

In its simplest form, a supply chain is composed of a company and the suppliers and customers of that company. This is the basic group of participants that creates a simple supply chain. Extended supply chains contain three additional types of participants. First there is the supplier's supplier or the ultimate supplier at the beginning of an extended supply chain. Then there is the customer's customer or ultimate customer at the end of an extended supply chain. Finally there is a whole category of companies who are service providers to other companies in the supply chain. These are companies who supply services in logistics, finance, marketing, and information technology. In any given supply chain there is some combination of companies who perform different functions. There are companies that are producers, distributors or wholesalers, retailers, and companies or individuals who are the customers, the final consumers of a product. Supporting these companies there will be other companies that are service providers that provide a range of needed services.



1. **Producers or manufacturers** are organizations that make a product. This includes companies that are producers of raw materials and companies that are producers of finished goods.

2. **Distributors** are companies that take inventory in bulk from producers and deliver a bundle of related product lines to customers. Distributors are also known as wholesalers. They typically sell to other businesses and they sell products in larger quantities than an individual consumer would usually buy
3. **Customers or consumers** are any organization that purchases and uses a product. A customer organization may purchase a product in order to incorporate it into another product that they in turn sell to other customers.

4. **Service Providers** are organizations that provide services to producers, distributors, retailers, and customers. They have developed special expertise and skills that focus on a particular activity needed by a supply chain. Because of this, they are able to perform these services more effectively and at a better price than producers, distributors, retailers, or consumers could do on their own. Some common service providers in any supply chain are providers of transportation services and warehousing services. These are trucking companies and public warehouse companies and they are known as logistics providers. Financial service providers deliver services such as making loans, doing credit analysis, and

collecting on past due invoices. These are banks, credit rating companies, and collection agencies. Some service providers deliver market research and advertising, while others provide product design, engineering services, legal services, and management advice. Still other service providers offer information technology and data collection services. All these service providers are integrated to a greater or lesser degree into the ongoing operations of the producers, distributors, retailers, and consumers in the supply chain.

Supply chains are composed of repeating sets of participants that fall into one or more of these categories. Over time the needs of the supply chain as a whole remain fairly stable. What changes is the mix of participants in the supply chain and the roles that each participant plays. In some supply chains, there are few service providers because the other participants perform these services on their own. In other supply chains very efficient providers of specialized services have evolved and the other participants outsource work to these service providers instead of doing it themselves.

Activity 7 – Thought Provoking

Scan the QR Code to Watch the Video

Watch this video and have an interaction with your partner about Walmart's Strategy.

4.4 Globalization and its Impact on Supply Chain Management

With the advent of globalization, managing supply chain activities has become more complex. Today a company operating in the United States may have its manufacturing facilities in China, Mexico or Taiwan and its customers throughout the world. Many companies in order to manage its global operations may outsource their supply chain activities to third-party organizations around the globe. Outsourcing reduces the supply chain operating cost but when not managed effectively proves otherwise.

Globalization has dramatically changed how manufacturers operate, offering an opportunity to reach new customers in new markets while at the same time exposing firms to greater competition. Meanwhile, raw materials and supplier relationships must now be managed on a global scale. Just as there are benefits and costs of globalization, there are similar pros and cons of a global supply chain. In particular, companies need to manage the related risks.

The Four Driving Forces of the Globalization Process:

a) Global Market Forces

b) Technological Forces

c) Global Cost Forces

d) Political and Macroeconomic Forces

Benefits of a Globalized Supply Chain

1. Expanded sourcing opportunities: A world market offers businesses opportunities to secure a diverse selection of workers, materials, and products. This larger selection of goods and services often means the opportunity to select higher or lower quality options.
2. The opportunity to reach new customers in new markets: Just as globalization offers more materials and laborers, it also offers new customers in new locations with new needs.
3. More room to grow: New technologies and a shrinking globe mean that it is easier for companies to grow generally: to produce more, offer more, and sell more. Expanding borders also means expanding businesses and corporations.
4. More opportunities to save money: Globalization's biggest benefit is that increases options: options for source materials, options for workers, and options for transportation. More options mean more chances to save on spending and increase profits.

A global marketplace has been both a blessing and a curse, to an extent. While new markets have opened up, greater risk now exists, which could potentially impact the survivability of your company. And, as some of these risks could even compound with each other, it is now critical for manufacturers to increase their visibility into not only their own operations, but those of their suppliers. With this much risk in play, any system that can help mitigate excess risk is well worth the investment.With the onset of globalization, managing supply chains has become more complex and business critical than ever before. The recent disaster in Indonesia have highlighted the need for effective risk management along the supply chain for manufacturers to minimize disruptions and resume normal business conditions quickly in the event of an outage.

When a company's operations are under its own control, there are fewer moving parts. As a result, the company has greater access to information. In this type of scenario, it is much easier to identify, quantify, prioritize and mitigate risk for better decision making. In an environment that has become increasingly global in nature, there are more parties involved and less information available at any point in the production process. This makes it much harder to identify, quantify, prioritize and mitigate risk for better decision making.

There are three major factors that impact supply chain risk: Increasing supply chain complexity, decreasing access to information and greater need for higher quality faster, all for a lower cost. The ability to anticipate and address risk effectively has been severely handicapped by complexity. Now that manufacturers are outsourcing more work to suppliers across the globe and are managing second and third tier suppliers, it has become difficult to track, trace and monitor production.

Supply Chain Network Models

Supply chain networks present different types of models that help us understand the various optimization methods used for studying the uncertainty and scenario modeling. There are six distinct supply chain network models, as given below.

1. **Producer storage with direct shipping**

   In this model, goods are moved directly from the manufacturer's location as the starting point to the end customer's location as the destination point bypassing the retailer. The retailer is the person who takes the order and initiates the delivery request. This Supply Chain Management is also called drop-shipping, with product delivered directly from the manufacturer's location to the customer's destination.

2. **Producer storage with direct shipping and in-transit merge (cross docking)**

   It is somewhat congruent to pure drop-shipping or moving, but the difference is that pieces of the order come from different locations and they are merged into one so that the customer gets a single delivery.

3. **Distributor storage with package carrier delivery**

   This comes into action when the inventory is not owned by the manufacturers at the plants; instead it is owned by the merchants/retailers in intermediate warehouses and package carriers are used for shipment of goods from the intermediate location to the final customer.

4. **Distributor storage with last mile delivery**

   This type results when the merchant/retailer delivers the goods ordered by the customer to the customer's home instead of using a package carrier.

5. **Producer or distributor storage with costumer pickup**

   In this type, the inventory is stored at the warehouse owned by the manufacturer or producer but the customers place their orders online or through phone and then come to pick up points allotted for collecting their orders.

6. **Retail storage with customer pick-up**

   This is mostly applied on situations when inventory is locally stored at retail stores; customers walk into retail shop or order something online or on the phone and pick it up at the retail store.

The supply chain network basically deals with three major entities: Producer, Distributor and Merchant. Two different options are available, i.e., customer pickup or door delivery. For example, if the door delivery option is opted for, there is transport between producer and distributor, distributor and merchant and producer and merchant. The distribution system decision is made on the basis of the choice of the customers. This in turn results in the demand for the product or products and cost of the distribution arrangement. Mostly, companies go for merging of different types for distinct products, different customers and different usage situations, coming back to the different optimization models mentioned above.

❓Conceptualize: Distributed vs. Centralized vs. Decentralized Processing

In an organization, computers are connected to each other which make a network. In the network, various tasks are completed by different computers and data is shared among computers. Every computer is controlled by different methods and different ways of processing are done on the network. Now discuss with your partner and findout which network model will be applied in Supply Chain Management.

Centralized Network: In centralized processing all the terminals are controlled by a single processor (CPU) and any command can be fulfilled by a single processor**.**

Decentralized Network: In decentralized processing, there are different CPU connected on the network and each processor can do its job independent of each other.For example, in a Net cafe, all computers can perform their own tasks.

Distributed Network: In this type of processing different CPU are connected to the network and are controlled by single CPU. For example in air reservation system there exists different terminals and processing is done from many locations and all the computers are controlled by the single main processor.

Benefits of Supply Chain Management

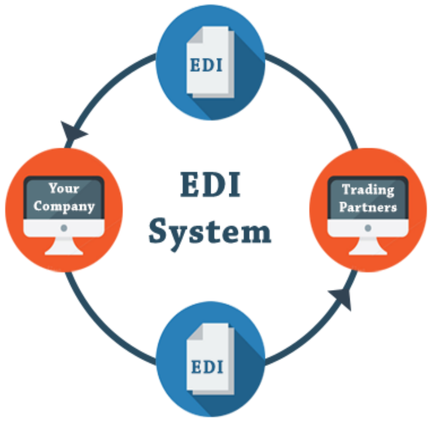
- ✓ Develops better customer relationship and service
- ✓ Creates better delivery mechanisms for products & services in demand with minimum delay
- ✓ Improvises productivity and business functions
- ✓ Minimizes warehouse and transportation costs
- ✓ Minimizes direct and indirect costs
- ✓ Assists in achieving shipping of right products to the right place at the right time
- ✓ Enhances inventory management, supporting the successful execution of just-in time stocks

- ✓ Assists companies in adapting to the challenges of globalization, economic upheaval, expanding consumer expectations, and related differences
- ✓ Assists companies in minimizing waste, driving out costs, and achieving efficiencies throughout the supply chain process.

4.5 Electronic Data Interchange (EDI)

Electronic Data Interchange (EDI) involves the swapping of business documents in a standard format from computer-to-computer. It presents the capability as well as the practice of exchanging information between two companies electronically rather than the traditional form of mail, courier, & fax. The major advantages of EDI are as follows:

- ☞ Instant processing of information
- ☞ Improvised customer service
- ☞ Limited paper work
- ☞ High productivity
- ☞ Advanced tracing and expediting
- ☞ Cost efficiency
- ☞ Competitive benefit
- ☞ Advanced billing



Agile vs. Reverse Supply Chain

Agile Supply Chain can be defined as a chain of supply that has the potential to respond to changing requirements in a way that accelerates the delivery of ordered goods to customers. In simple words, supply chain agility is a custom adopted by many companies for choosing a dealer. Speed and accuracy are also signature marks of this type of supply chain.

Reverse Supply Chain states the evolution of products from customer to merchant. This isthe reverse of the traditional supply chain evolution of products from merchant tocustomer.Reverse logistics is the process of planning, executing, monitoring and controlling theefficient and effective inbound flow and storage of secondary goods and informationrelated to the purpose of recovering value or proper disposal. Some examples of reversesupply chain are as follows:

- ☞ Product returns and handling product displacement
- ☞ Remanufacturing and refurbishing exercises
- ☞ Management and sales of surplus

Model Questions

1. Explain in detail about Supply Chain Management.
2. Give an account on stakeholders involved in Supply Chain Management with reference to Municipal Waste Management Process.
3. Explain in detail about impact of Globalization in Supply Chain Management.
4. Give an account on the risk and governance issues associated with ERP?
5. Describe about Supply Chain Network Models.
6. Distinguish between Agile and Reverse Supply Chain. Which model could be applied in Waste Management?
7. What are the benefits of Supply Chain Management?
8. Write short notes on Electronic Data Interchange (EDI)?
9. What is meant by Demand and Supply needs?
10. Formulate a Supply Chain Model to foster Swachh Bharat Mission in your village.

Key Words

Enterprise Resource Planning, Business Process Reengineering, Supply Chain Management

Further Reading/References

📖Laudon, J.P and Laudon, K.C. (2007).Management Information System. (10th edn.), Pearson Education:India

💻http://www.tutorialspoint.com/– Supply Chain Management

💻https://www.wirc-icai.org/– Western India Regional Council of the Institute of Chartered Accountants of India – Enterprise Resource Planning

Chapter 5Security and Ethical Challenges

Information Technology is changing the face of contemporary World. The IT has not only connected the World at one single platform but it is also helping in the integration of various traditional societies into modern societies. Information systems raise new and often perplexing security and ethical problems. This is truer today than ever because of the challenges posed by the Internet and electronic commerce to the protection of privacy and intellectual property. Information technology has raised new possibilities for behavior for which laws and rules of acceptable conduct have not yet been developed.

Today, information technology is introducing changes that create new security and ethical issues for societies to debate and resolve. Increasing computing power, storage, and networking capabilities— including the Internet—can expand the reach of individual and organizational actions and magnify their impacts. The ease and anonymity with which information can be communicated, copied, and manipulated in online environments are challenging traditional rules of right and wrong behavior. Ethical issues confront individuals who must choose a course of action, often in a situation in which two or more ethical principles are in conflict.

1. Cyber Security and Ethics
2. Emerging Technologies
    i. Internet of Things (IoT)
    ii. Blockchain Technology
    iii. Digital Humanities
3. Best Practices in Waste Management

5.1 Cyber Security

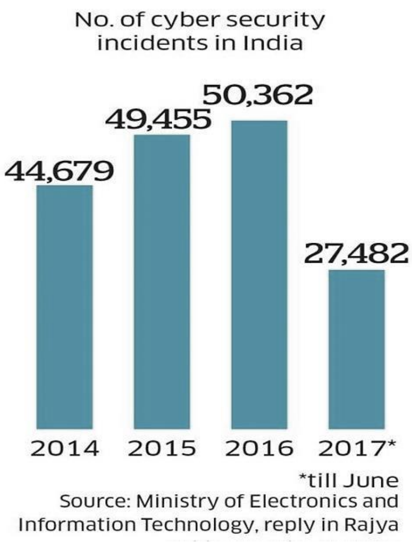
Cyber Security (also referred as Information Technology Security) are the techniques of protecting computers, networks, programs and data from unauthorized access or attacks that are aimed for exploitation. It refers to the way the system is defended against unauthorized access, use, disclosure, disruption, modification, perusal, inspection, recording or destruction.The internet was born around 1960's where its access was limited to few scientists, researchers and the defense only. Internet user base have evolved exponentially. Initially the computer crime was only confined to making a physical damage to the computer and related infrastructure. Around 1980's the trend changed from causing the physical damaging to computers to making a computer malfunction using a malicious code called virus. Till then the effect was not so widespread because internet was only confined to defense setups, large international companies and research communities. In 1996, when internet was launched for the public, it immediately became popular among the masses and they slowly became dependent on it to an extent that it has changed their lifestyle.

The GUIs were written so well that the users don't have to bother how the internet was functioning. They have to simply make few click over the hyper-links or type the desired information at the desired place without bothering where this data is stored and how it is sent over the internet or whether the data can accessed by another person who is connected to the internet or whether the data packet sent over the internet can be snooped and tempered. The focus of the computer crime shifted from merely damaging the computer or destroying or manipulating data for personal benefit to financial crime.

There are two major aspects of Information System Security –

- Security of information technology used – securing the system from malicious cyber-attacks that tend to break into the system and to access critical private information or gain control of the internal systems.

- Security of data – ensuring the integrity of data when critical issues, arise such as the natural disasters, computer or server malfunction, physical theft etc. Generally an off-site backup of data is kept for such problems.



Components in Cyber Security

Application Security

It encompasses the measures or counter-measures that are taken during the development of life-cycle to protect applications from threats that can come through flaws in the application design, development, deployment, upgrade or maintenance. Some basic techniques used are:

- Input parameter validation

- User/Role Authentication & Authorization
- Session management, parameter manipulation & exception management
- Auditing and logging

Information Security

It protects information from unauthorized access to avoid identity theft and to protect privacy. Major techniques used to cover this are:

- Identification, authentication & authorization of user
- Cryptography.

Disaster RecoveryPlanning

It's a process that includes performing risk assessment, establishing priorities, developing recovery strategies in case of a disaster. Any business should have a concrete plan for disaster recovery to resume normal business operations as quickly as possible after a disaster.

Network Security

It includes activities to protect the usability, reliability, integrity and safety of the network. Effective network security targets a variety of threats and stops them from entering or spreading on the network. Network security components include:

- Anti-virus and anti-spyware
- Firewall, to block unauthorized access to your network
- Intrusion prevention systems (IPS), to identify fast-spreading threats, such as zero-day or zero-hour attacks, and
- Virtual Private Networks (VPNs), to provide secure remote access.

Guaranteeing Information Security

In the twentieth century, India saw an impetus in Information Technology (IT) and an enormous growth in e-commerce. Both these sectors ride on and reside in cyberspace involving electronic transactions, software, services, devices and networks which are highly susceptible to cyber-crimes. Hence to ensure its safety, cyber-security has become one of the most compelling priorities for the country. Some key aspects to guarantee information security are

- Preventing the unauthorized individuals or systems from accessing the information.
- Maintaining and assuring the accuracy and consistency of data over its entire life-cycle.
- Ensuring that the computing systems, the security controls used to protect it and the communication channels used to access it, functioning correctly all the time, thus making information available in all situations.
- Ensuring that the data, transactions, communications or documents are genuine.
- Ensuring the integrity of a transaction by validating that both parties involved are genuine, by incorporating authentication features such as "digital signatures".
- Ensuring that once a transaction takes place, none of the parties can deny it, either having received a transaction, or having sent a transaction. This is called 'non-repudiation'.
- Safeguarding data and communications stored and shared in network systems.

Activity 1 – Discursive

Scan the QR Code to Watch the Video

Watch this video to understand the notion of Cyber Security. Collaborate with your partner and list the recent cyber-attacks witnessed by India. Ascertain the counter measures taken so far by CERT-In.

Indian Computer Emergency Response Team (CERT-In)

CERT-In is operational since January 2004. The constituency of CERT-In is the Indian Cyber Community. CERT-In is the national nodal agency for responding to computer security incidents as and when they occur. In the recent Information Technology Amendment Act 2008, CERT-In has been designated to serve as the national agency to perform the following functions in the area of cyber security:

- ☞ Collection, analysis and dissemination of information on cyber incidents.
- ☞ Forecast and alerts of cyber security incidents
- ☞ Emergency measures for handling cyber security incidents
- ☞ Coordination of cyber incident response activities.
- ☞ Issue guidelines, advisories, vulnerability notes and whitepapers relating to information security practices, procedures, prevention, response and reporting of cyber incidents.
- ☞ Such other functions relating to cyber security as may be prescribed.

National Cyber Security Policy 2013

India had no cyber security policy before 2013. It was in 2013 that a national daily newspaper cited documents leaked by NSA whistleblower Edward Snowden that much of the National Security Agency surveillance was focused on India's domestic politics and its strategic and commercial interests. This caused a furor amongst the people and the Government which unveiled a National Cyber Security Policy 2013 on July 2nd, 2013 by Department of Electronics and Information technology (DeitY) that aims at protecting public and private infrastructure from cyber-attacks and cyber-crimes.

It also intends to safeguard critical information such as personal information, financial & banking information, and sovereign data. The Cyber Security Policy 2013 rendered a strong vision to secure the critical infrastructure and build a resilient cyberspace for citizens, business, and government. The policy also intends to circumvent any resultant economic instability arising due to cyber-attacks.

However, as society today is getting more and more dependent upon technology, chances of crime based electronic offenses are bound to increase. The Cyber Security Policy cannot ensure 100% sanity from crime but definitely is a step towards the right direction. For greater security, private and public companies will have to take the responsibility collectively to ensure safety of their customers' information and other confidential data. Highlights from the National Cyber Security Policy 2013 are as follows:

- ✓ Set up of a 24×7 National Critical Information Infrastructure Protection Centre (NCIIPC) for obtaining strategic information regarding threats to ICT infrastructure, creating scenarios for a response, resolution and crisis management through effective predictive, preventive, protective, response and recovery actions.

- ✓ Creation of a task force consisting of 5,00,000 cyber security professionals in next five years through capacity building, skill development and training.
- ✓ Provision for fiscal schemes and incentives to encourage entities to install, strengthen and upgrade information infrastructure with respect to cyber security.
- ✓ Designation of CERT-In as the national nodal agency to coordinate cyber security related matters and have the local (state) CERT bodies to co-ordinate at the respective levels.
- ✓ All organizations to designate a CISO and allocate security budget.
- ✓ Use of Open Standards for Cyber Security.
- ✓ Development of a dynamic legal framework to address cyber-security challenges (Note: The National Cyber Security Policy 2013 does not have any mention of the IT Act 2000)
- ✓ Encouragement of wider use of Public Key Infrastructure (PKI) for government services.
- ✓ Engagement of info-security professionals / organizations to assist e-Governance initiatives, establish Centers of Excellence, cyber security concept labs for awareness and skill development through PPP – a common theme across all initiatives mentioned in this policy.
- ✓ Apart from the common theme of PPP across the cyber security initiatives, the policy frequently mentions of developing an infrastructure for evaluating and certifying trustworthy ICT security products.

Information System and Ethics

Information ethics can be defined as the branch of ethics that focuses on the relationship between the creation, organization, dissemination, and use of information, and the ethical standards and moral codes governing human conduct in society.

Information ethics provides a critical framework for considering moral issues concerning informational privacy, moral agency (e.g. whether artificial agents may be moral), new environmental issues (especially how agents should behave in the info sphere), problems arising from the life-cycle (creation, collection, recording, distribution, processing, etc.) of information (especially ownership and copyright, digital divide and rights). As the Information systems bring about immense social changes, threatening the existing distributions of power, money, rights, and obligations. It also raises new kinds of unethical measures being practiced.

Code of Ethics and Professional Conduct

- ✓ Strive to achieve the highest quality, effectiveness, and dignity in both the process and products of professional work.
- ✓ Acquire and maintain professional competence.

- ✓ Know and respect existing laws pertaining to professional work.
- ✓ Accept and provide appropriate professional review.
- ✓ Give comprehensive and thorough evaluations of computer systems and their impacts, including analysis and possible risks.
- ✓ Honor contracts, agreements, and assigned responsibilities.
- ✓ To be honest and realistic in stating claims or estimates based on available data.
- ✓ To reject bribery in all its forms.
- ✓ To improve the understanding of technology, its appropriate application, and potential consequences.
- ✓ Improve public understanding of computing and its consequences.
- ✓ Access computing and communication resources only when authorized to do so.
- ✓ To assist colleagues and co-workers in their professional development and to support them in following this code of ethics.

Model Questions

1. Explain in detail about Cyber Security and its components.
2. Narrate some measures to safeguard information security.
3. Write short notes on
    a. CERT-In
    b. Code of Ethics and Professional Conduct
4. Give an account on National Cyber Security Policy 2013. Substantiate your opinion whether it needs to be upgraded?

Activity 2 – Conceptualization

Do a quick research on the types of computer viruses and how could you avoid them!

May 2017 – WannaCryRansome Attack

Ransomware is malicious software that infects a computer, blocks the user's access to his/her files and demands a ransom to be paid in return for granting access to the files again. Attacks have been on the rise lately with an increase of 300% during 2015-16. Recent WannaCryransomware attack was considered one the biggest cyber-attacks in history and impacted over 150 countries.

These attacks have brought to light just how vulnerable we currently are to cyber-attacks. It has been made clear that the average home user is not as safe one may think. Following are some of the reasons why cyber criminals target home and unorganized sector users –

- They do not have data backups
- They lack basic cyber security awareness, making them prone to scams run by cyber criminals and also to further manipulation by them
- Most of the software they use is not up-to-date
- They lack proper cyber security solutions
- They rely on luck rather than caution to keep them safe online
- Even when cyber security solutions are present they are often only antiviruses which often fail to spotransomware until it is too late

Live Display Screen of 'Ransomware'

Although the odds may look bleak for the average user, there are things we can do to make our computers safer and much less prone to cyber-attacks.

Locally, on the PC

- Don't store important data only on my PC

- Have 2 backups of my data: on an external hard drive and in the cloud – Google Drive/etc
- Google Drive/OneDrive/etc. application on the computer should not be turned on by default. Only open them once a day, to sync your data, and close them once this is done
- The operating system and the software you use should be up to date, including the latest security updates
- For daily use, don't use an administrator account on your computer. Instead use a guest account with limited privileges
- Turn off macros in the Microsoft Office suite – Word, Excel, PowerPoint, etc
- Remove the following plugins from my browsers: Adobe Flash, Adobe Reader, Java and Silverlight. If you absolutely have to use them, set the browser to ask you if you want to activate these plugins when needed
- Adjust your browser's security and privacy settings for increased protection
- Remove outdated plugins and add-ons from your browsers. Only keep the ones you use on a daily basis and keep them updated to the latest version
- Use an ad-blocker to avoid the threat of potentially malicious ads

Online behavior

- Never open spam emails or emails from unknown senders
- Never download attachments from spam emails or suspicious emails
- .Never click links in spam emails or suspicious emails.

Despite efforts, my computer has been infected with a ransomware, what should I do now?

- Immediately shut down your computer and its connection to the internet to prevent encryption of data.
- In case your data has already been encrypted, avoid paying the ransom. 1 out of 4 users who paid the ransom never got their data back. Paying the ransom only serves to encourage the cyber criminals that their scam is working.

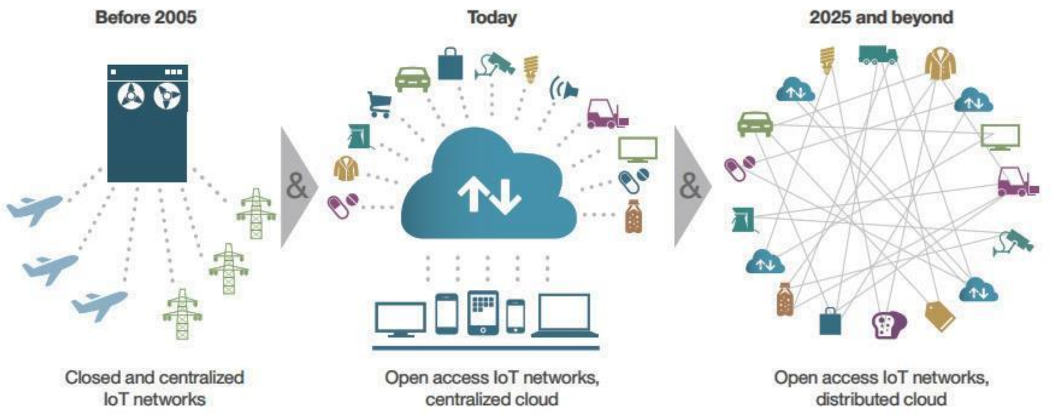
There are many tools released by cybersecurity experts that allow you to get your data back without having to the ransom. These tools do not work with all variants of ransomware but they are worth trying out.

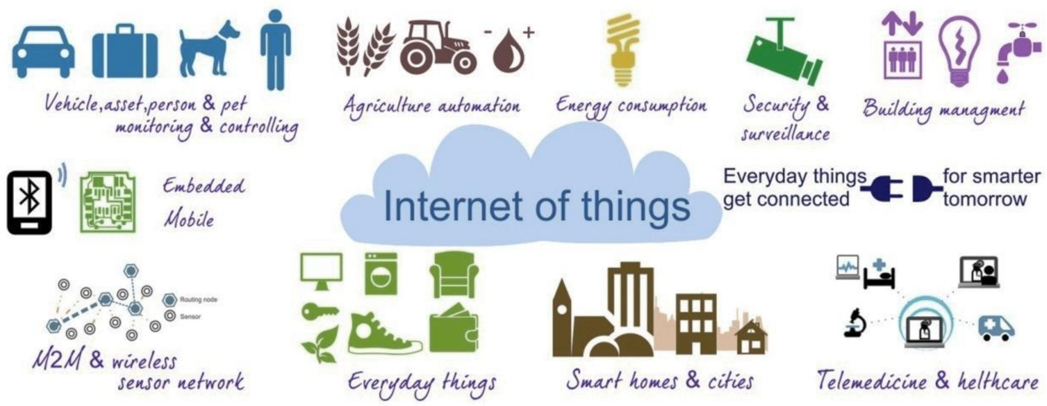
5.2 Emerging Technologies

Internet of Things (IoT)

The Internet has been in existence for over 40 years now and the term "Internet-of-Things" (IoT) has been in use since large scale adoption of RFID began a decade ago. IoT can be defined in many different ways, and it encompasses many aspects of life from connected homes and cities to connected cars and roads, roads to devices that track an individual's behavior and use the data collected for push services.

The IoT enables things to communicate about themselves and their environment with other things and computers and allow them to participate in business processes and everyday lives of human beings. For instance, with emergence of IoT hospitals are advocating for self-monitoring of patients. Self-monitoring gives the patient greater freedom and independence for their health and frees the equipment for emergency purposes for the patients.





IoT is a new revolution of the Internet and can be said as expansion of internet services. It provides a platform for communication between objects where objects can organize and manage themselves. By examining current technology research and by exploring future application scenarios, the IoT has enormous benefits.

Internet-of-Things – Combining Ubiquity, Cloud, Analytics and more

A tree can tweet for help when an illegal logger approaches. Pillboxes can text the chemist for a refill. A phone can become a fitness monitor. The Internet-of-Things (IoT) is here: the internet has become communication backbone connecting the virtual world of computing devices with the physical world comprising real-world entities and things.

Estimates indicate that some 12 billion devices are already connected to the internet. This figure is expected to rise to almost 50 billion by 2020. A recent McKinsey study reveals that linking the physical and digital worlds could generate anywhere from $4 trillion to $11.1 trillion a year in economic value by 2025.

Key factors creating this new excitement about Internet of Things are

1. Sensors: Today there are low cost but highly capable sensors driven by development of new sensing technologies; there are newer kinds of materials; and costs of semiconductors for computing and communication are falling. We can sense and observe diverse real world phenomena at costs that are highly affordable.

2. Communications: Advancement in communication technology today allows sensors to connect to the Internet using various kinds of wired and wireless communication technologies and network protocols.

3. Tools: Information mining is better. An array of tools, platforms and analysis techniques can process large amounts of sensor data and present meaningful insights, recommendations and control actions to end users.

Activity 3 – Visualization

Interact with your partner and conceptualize a garbage collection methodology which shall harness ICT and consecutively foster the Swachh Bharat Mission.

4. Devices: There are some innovative devices through which one can send data and receive insights: it could be a mobile phone or a fridge, a car or bike. The connection between things and humans has thus been established via sensors and devices.

1. **Internet of Things**
2. **Machine-to-Machine**
3. **Sensor Web**
4. **Industrial Internet**
5. **Cyber Physical Systems**

Internet-of-Things (IoT): Internet-of-Things is a network of uniquely addressable and interconnected physical objects having embedded sensors, actuators and data communication capabilities using standard communication protocols. The network could optionally be Internet.

Machine-to-Machine (M2M): M2M refers to automatic data transmission between devices with no human in the path. M2M is a term commonly used by communication service providers to refer to services provided by them that are not consumed by human subscribers directly such as mobile telephony (P2P or Person to Person). The difference between IoT and M2M is that in IoT, the focus is on physical object or real-world entity, whereas in M2M focus is on the device.

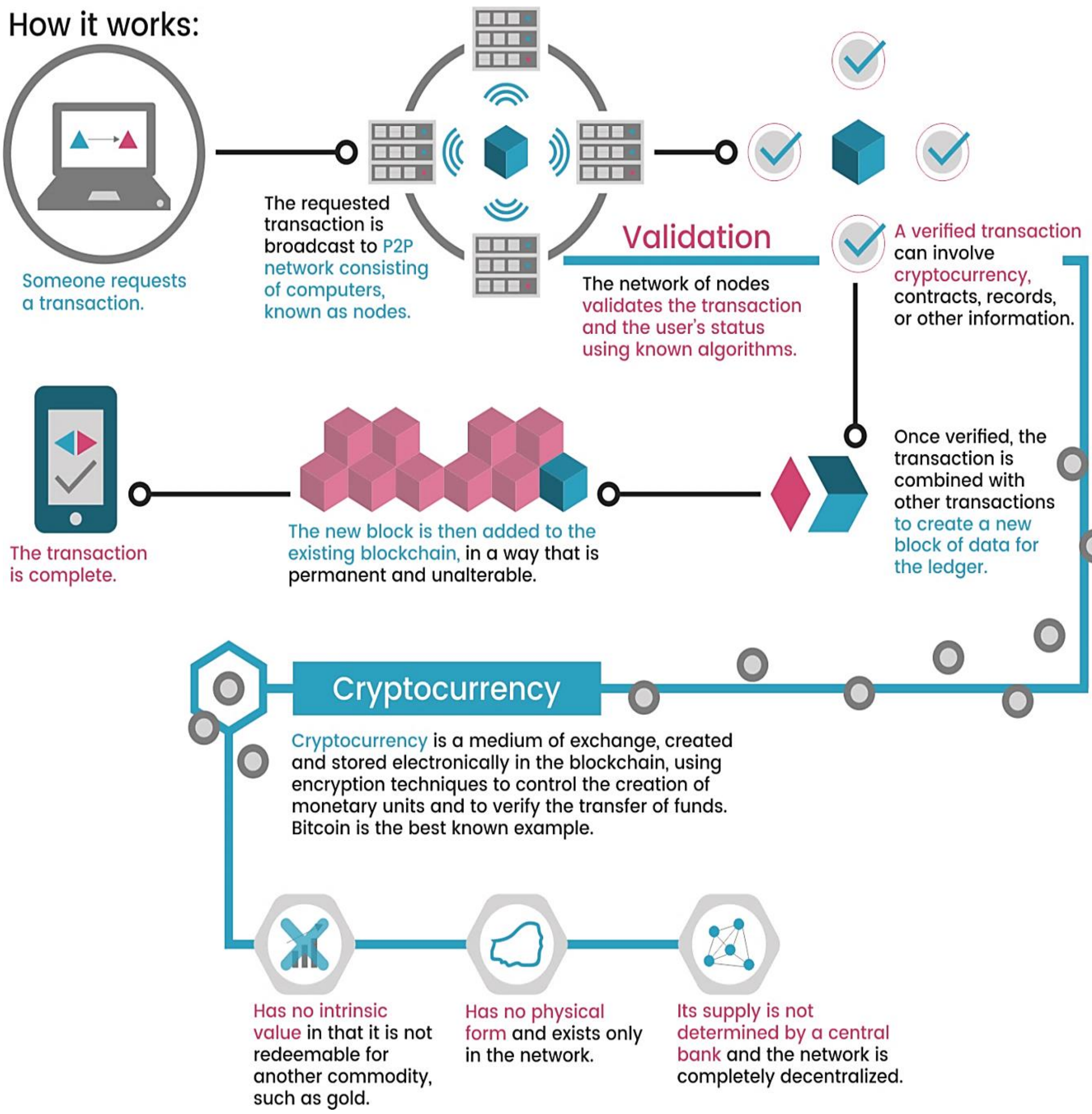
Sensor Web: Sensor Web refers to the use of standard WWW protocols for integrating and accessing sensors and devices. This term has been in use in academic research community and in the geospatial technology community for long. Devices, sensor observations and sensor related resources are viewed as web resources – no different from any other web resource. We can see that Sensor Web is a special case of IoT

Industrial Internet: Industrial Internet refers to continuous monitoring and data acquisition from large industrial equipment, machines, facilities and other high value assets followed by big data analytics and delivery of actionable intelligence and visualization to human operators. The focus is clearly on large industrial equipment as opposed to common everyday objects or consumer devices.

Cyber Physical Systems (CPS): As defined by the National Science Foundation of USA - "Cyber-physical systems are engineered systems that are built from and depend upon the synergy of computational and physical components". In CPS, the focus is clearly on control systems comprising of a network of computational elements that in turn interact with and control physical processes. The control loop affects the physical process which in turn affects the computations. CPS has been a subject of academic research for over a decade.

Block Chain Technology

Blockchain is a system for maintaining distributed ledgers in a way that allows organizations like government set-up who opt for greater transparency and accountability on ledger updates. Instead of using a central third party (audits) or an offline reconciliation process, blockchain uses peer-to-peer protocols.

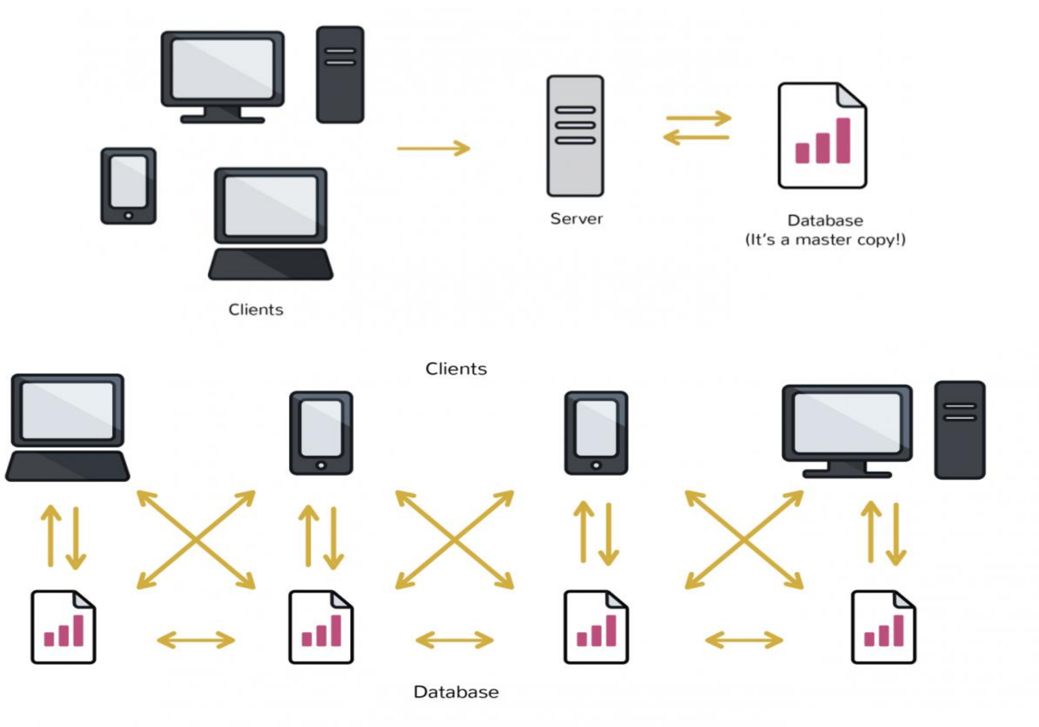


Source: electronicproducts.com

As a distributed ledger, blockchain provides a near real-time and indelible record that's replicated among the participants. It has the potential to fundamentally transform how global business transactions are conducted. Currently, few business-to-business transactions are routed through third parties to ensure their integrity and protection. However, these third parties can introduce delays and add costs.

Blockchain Technology enables the participants in a trusted business network to transact directly, while still ensuring the validity and non-repudiation of their transactions. Once the proposed transactions are validated and agreement is reached on their results, blockchain participants record them in cryptographically linked blocks that cannot be repudiated. By storing blocks of information that are identical across its network, the blockchain cannot be controlled by any single entity and has no single point of failure.

Central vs. Distributed Database



Blockchain is a distributed ledger that can be directly shared by a group of nontrusting parties without requiring a central administrator. In contrast, a traditional (SQL or No SQL) database is controlled by single entity. It's an important difference that means:

- Every node in the blockchain independently verifies and processes every transaction. A node can do this because it has full visibility into database's current state, the modification requested by a transaction, and digital signature which proves transaction's origin
- Blockchainpowered transactions are extremely fault-tolerant due to their redundancy
- Data is directly shared across boundaries of trust, without a central administrator
- Updates are agreed upon by the participants before they are committed, as opposed to a typical database environment where the updates are committed by each party and then reconciled through cumbersome (and often offline) processes.

The overall performance of a blockchain is near real-time because there are no delays from a central clearing/reconciliation processing, where reviews often take place overnight or over multiple days.

Notion of b-Governance

The term 'b-Governance' was first coined by Dr. BM Krishna at 21st National e-GovernanceConference held at Hyderabad;b-Governanceis acknowledged as a major breakthrough in fault-tolerant distributed computing. Rationale of b-Governance is decentralized trust or trust-by-computation. It represents the shift from trusting people to trusting mathematics with irreversible and tamper-proof public records repository for the documents, contractsand assets. Formidable innovation applied by this technology is that, the network is open and participants do not need to know or trust each other to interact:electronic transactions can be automatically verified and recorded by nodes of the network through cryptographic algorithms, without human intervention, central authority, point of control or third party. Even if some nodes are unreliableor malicious, the network is able to identify transactions and protect the ledger from being tamperedthrough mathematical mechanism called proof-of-work, i.e., validation majority (trust).

Illustration on Blockchain Technology

Wikipedia's digital backbone is similar to the highly protected and centralized databases that governments or banks or insurance companies keep today. Control of centralized databases rests with their owners, including the management of updates, access and protecting against cyber-threats. The distributed database created by blockchain has fundamentally different digital backbone. This is most distinct feature of blockchain technology.

Wikipedia's 'master copy' is edited on a server and all users see the new version. In the case of a blockchain, every node in the network is coming to the same conclusion, each updating the record independently, with the most popular record becoming the de-facto official record in lieu of there being a master copy.

Transactions are broadcast, and every node is creating their own updated version of events. It is this difference that makes blockchain technology so useful – It represents an innovation in information registration and distribution that eliminates the need for a trusted party to facilitate digital relationships.

Yet, blockchain technology, for all its merits, is not a new technology. Rather, it is a combination of proven technologies applied in a new way. It was the particular orchestration of three technologies (Internet, private key cryptography and a protocol governing incentivization) that made the bitcoin creator Satoshi Nakamoto's idea so useful.

Significances of Blockchain Technology

- Enabling trust in peer-to-peer B2B transactions, while avoiding the cost and risks of intermediaries
- Reducing manual, error-prone information exchange and processes across the enterprise boundaries

- Avoiding the cost and delays of offline reconciliations
- Reducing cross-ERP discrepancies resulting in settlement risk and poor records
- Decreasing the cost and high risk of fraud from cross-company transactions
- Improving real-time information visibility within a trading ecosystem

The result is a system for digital interactions that does not need a trusted third party. The work of securing digital relationships is implicit — supplied by the elegant, simple, yet robust network architecture of blockchain technology itself.

Activity4 - Food for Thought

a *RFID tag*______
b ______________
c ______________
d ______________
e ______________

Watch this video about the Envac's automated waste collection system for pre-sorted waste, which is installed in the Valla torg residential area at Stockholm, Sweden.It is actually a part of the EU project GrowSmarter. Your task is to listthe technological buzz words discussed in the video; subsequently try to do a quick research on those words. E.g.) Radio-frequency identification (RFID) tag.Then have an interaction with your partner on how you could harness the Internet of Things, Blockchain Technology, and Big Data technologies in Waste Management.

Scan the QR Code to Watch the Video

Digital Humanities

The word “Digital” denotes electronic technology that generates stores and processes data in terms of binary states: positive (1) and non-positive (0). The data transmitted or stored within the digital technology is expressed as a string of 0's and 1's. Each of these state digits is referred to as a bit. Prior to digital technology, the electronic transmission was limited to the analog technology, which conveys data as electronic signals of varying frequency or amplitude that are added to the carrier waves of a given frequency. But today, we talk about advent of quantum computing (that uses qubits in superposition of state).

Digital Humanitiescan be looked upon as a “Social Undertaking” as it harbors networks of people who have to work together, argue, compete and collaborate towards a desired sustainable output. Humanities on the other hand are the social sciences that teach us how people have created their world; how they in turn are created by it. In nutshell, Digital Humanities ideates to blend the missing link between Humanities and e-Governance with

intent to rediscover the methodology, socio-economic, political and the epistemological relevance involved in strategic policy making; stakeholders and technology.

> “Society is not determined by technology, nor is the technology determined by society. Both emerge as two sides of the socio-technical coin”– WiebeBijker

Traits of Socio-technologist

- Make use of emerging technologies to rethink what "Management” is all about (inculcate e-Mindset).
- Collaborate with people across various disciplines and stakeholders to explore innovations in Management
- Aspire to experiment with the new pedagogies and research approaches made possible by upcoming technologies
- Initiative mindset to develop the instruments and technologies that are needed for our own strategy, project management and decision making
- Harness technology in a bid to foster outcomes rather thinking on procedures

⏱Activity 5 –Thought Provoking

Smartphone games are a vital medium, one which offers a rich arena for creative experimentation with the larger cultural issues and emerging digital-physical platforms – at the heart of the e-Governance today. One such laudable example is the game 'Guardians of the Skies', unveiled by DISHA (Indian Air Force) to attract patriotic youth. Can you ideate some strategy in similar fashion for 'Clean India'?

Garbage Collection Game @Google Play

Model Questions

1. Explain in detail about Internet of Things (IoT) and its application in Waste Management.
2. Describe about Blockchain Technology and its significances.
3. Write short notes on
    a. b-Governance (Blockchain Governance)
    b. Digital Humanities
4. Illustrate an innovative proposal for social entrepreneurship in rural sector.
5. Illustrate an innovative proposal for setting-up rural household waste management project.

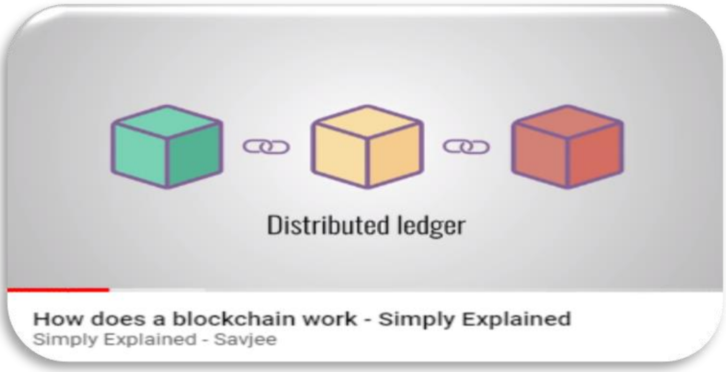
⏱ Activity 6 – Brainstorming

Internet of Things

Scan the QR Code to Watch the Video

Watch this video to understand the working principle of Internet of Things. Discuss with your partner and choose an area in rural sector where you could implement the IoT applications and ameliorate the socio-economic conditions in an inclusive manner.

Blockchain Technology



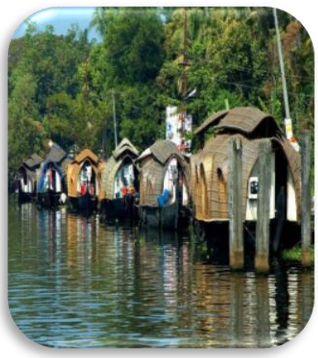
Scan the QR Code to Watch the Video

Watch this video to understand how Blockchain technology works. Search in YouTube about the applications of Blockchain Technology in Supply Chain Management and find out whether Blockchain Technology could be applied in Waste Management.

5.3 Best Practices in Waste Management

India generates 62 million tonnes of waste every year, of which less than 60% is collected and around 15% processed. With landfills ranking third in terms of greenhouse gas emissions in India, and increasing pressure from the public, the Government of India revised the Solid Waste Management after 16 years. According to the Press Information Bureau, India generates 62 million tonnes of waste (mixed waste containing both recyclable and non-recyclable waste) every year, with an average annual growth rate of 4% (PIB 2016). The generated waste can be divided into three major categories: Organic (all kind of biodegradable waste), dry (or recyclable waste) and biomedical (or sanitary and hazardous waste). At this conjuncture, it's prudent to choose and implement a right strategy for waste management. Some of the best practices under the Swachh Bharat Mission of the Government of India are illustrated below:

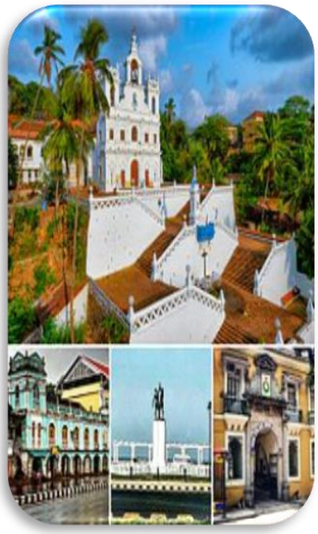
Kochi Model



The Kochi model reflects the best practices on source segregation of waste as exemplified by the Kochi Municipal Corporation. The case study shows how source segregation, composting, stringent legal system coupled with multi-stakeholder participation leads to effective waste management in urban places which are devoid of adequate landfill spaces.

Scan the QR Code to watch thedocumentary

Panaji Model



The Panaji model explains how the vision of a city for attaining zero landfilling has been successfully translated into reality. The entire city segregates waste into a minimum of 6 fractions. The dry waste is further segregated into 18-20 fractions for recycling, organic waste is composted and dry waste rejects sent for co-processing among others good practices. One vision, stable leadership, repeated and targeted campaigns for different user groups and continuous innovation to overcome the challengesof new waste streams have helped Panaji achieve this success.

Scan the QR Code to Watch theDocumentary

Gorai Model

The Gorai model details out the need for scientific closure of a dumpsite by the Municipal Corporation of Greater Mumbai. It captures briefly the technical process involved with a special focus on the communities' perspective. The module showcases the overall improvement in the standards of living, local economy, environment, and the biodiversity of the region before and after the scientific closure.

Scan the QR Code to Watch theDocumentary

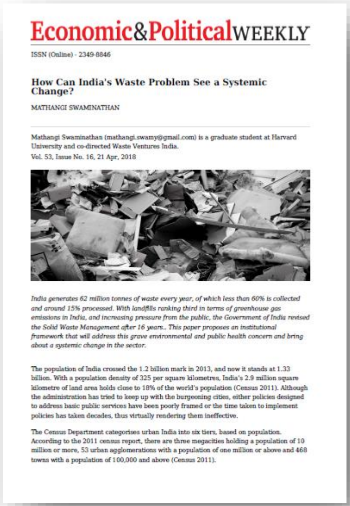
Vijayawada Model

The Vijayawada Municipal Corporation has showcased the simple and effective management of organic waste through decentralized vermicomposting facilities. The module details out the step by step guide to vermicomposting technique - its operation, maintenance, pre and post care. It also highlights the positive outcomes of vermicomposting for replication by other urban local bodies.

Scan the QR Code to Watch theDocumentary

⏱Activity 7 –Thought Provoking

Dicuss with your partner whether India's wastemanagementproblem shall see a systemic change?



Economic&PoliticalWEEKLY

ISSN (Online) - 2349-8846

How Can India's Waste Problem See a Systemic Change?

MATHANGI SWAMINATHAN

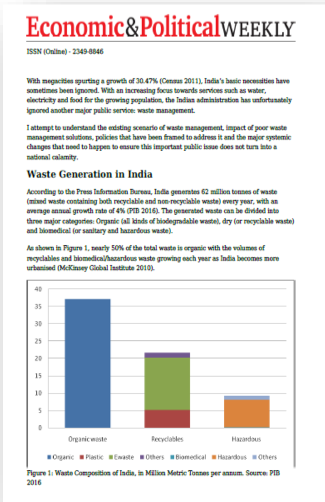
Mathangi Swaminathan (mathangi.swamy@gmail.com) is a graduate student at Harvard University and co-directed Waste Ventures India.

Vol. 53, Issue No. 16, 21 Apr, 2018

India generates 62 million tonnes of waste every year, of which less than 60% is collected and around 15% processed. With landfills ranking third in terms of greenhouse gas emissions in India, and increasing pressure from the public, the Government of India revised the Solid Waste Management after 16 years.. This paper proposes an institutional framework that will address this grave environmental and public health concern and bring about a systemic change in the sector.

The population of India crossed the 1.2 billion mark in 2013, and now it stands at 1.33 billion. With a population density of 325 per square kilometres, India's 2.9 million square kilometre of land area holds close to 18% of the world's population (Census 2011). Although the administration has tried to keep up with the burgeoning cities, either policies designed to address basic public services have been poorly framed or the time taken to implement policies has taken decades, thus virtually rendering them ineffective.

The Census Department categorises urban India into six tiers, based on population. According to the 2011 census report, there are three megacities holding a population of 10 million or more, 53 urban agglomerations with a population of one million or above and 468 towns with a population of 100,000 and above (Census 2011).



Economic&PoliticalWEEKLY

ISSN (Online) - 2349-8846

With megacities spurting a growth of 30.47% (Census 2011), India's basic necessities have sometimes been ignored. With an increasing focus towards services such as water, electricity and food for the growing population, the Indian administration has unfortunately ignored another major public service: waste management.

I attempt to understand the existing scenario of waste management, impact of poor waste management solutions, policies that have been framed to address it and the major systemic changes that need to happen to ensure this important public issue does not turn into a national calamity.

Waste Generation in India

According to the Press Information Bureau, India generates 62 million tonnes of waste (mixed waste containing both recyclable and non-recyclable waste) every year, with an average annual growth rate of 4% (PIB 2016). The generated waste can be divided into three major categories: Organic (all kinds of biodegradable waste), dry (or recyclable waste) and biomedical (or sanitary and hazardous waste).

As shown in Figure 1, nearly 50% of the total waste is organic with the volumes of recyclables and biomedical/hazardous waste growing each year as India becomes more urbanised (McKinsey Global Institute 2010).

Figure 1: Waste Composition of India, in Million Metric Tonnes per annum. Source: PIB 2016

Scan the QR Code to read this article

5 Innovative Waste Management practices India should adopt from the World

Generating almost 62 million tonnes of garbage every day, India has been among the top 10 countries generating the highest amount of Municipal Solid Waste. Out of the total waste generation, more than 45 million tonnes of waste remains untreated, which is a whopping 72%. Waste management is the foremost value India needs to adopt if it has to achieve the goal of 100 per cent cleanliness by October 2019. Countries like Germany, Australia and USA have set examples of innovative waste management and India can definitely take inspiration from these practices.

The United States of America: Robot's Act of Collecting Waste: Powered by sun and strong river current, the eco-friendly robotic machine picks up garbage and debris from the Baltimore River and deposits the waste into a dumpster barge which is built into this machine. Within a period of 3 years, Mr. Trash Wheel has successfully removed 1.1 million pounds of garbage.

Australia: Bins that help in Segregation, Recycling and Composting: SmartBelly bins treats most of its garbage by segregating the waste at the collection point and then undergoes process of composting, treating most of its waste. Bigbelly (SmartBelly or BigBelly) bins automatically create extra space for garbage when the bin is full. More garbage space means fewer collection trips, lower costs and fewer emissions. One of the major advantages of these bins is that they connect individual bins to garbage collectors that results in a more efficient management of waste.

Germany: Biodegradable ‘Leaf Plates' Curbs Plastic Pollution: Inspired by India's traditional custom of eating on leaves, Leaf Republic, a company in Germany is into stitching creeper leaves that come in from India. These cost effective plates serve as an alternative to plastic plates cutting down on plastic pollution. There are eco-conscious companies in India too who are trying to make such eco-friendly and biodegradable plates but the trend is yet to catch on.

Brazil: Use Plastic to Decorate Your House: Did you know a plastic bottle can take up to 1000 years to decompose? A design studio Rosenbaum in Brazil helps and motivates people to reuse their plastic waste in beautifying people's houses; educates people on how to effectively reuse plastic.

Columbia: Rewards to Recycle Plastic: The country produces around 28,800 tonnes of solid waste per day, with 10,000 tonnes of this waste being generated in the main cities of Bogotá, Cali, Medellín and Barranquilla. To tackle the plastic waste, authorities installed ECOBOT-Vending Machines in shopping malls, institutions and other public spaces. Every time someone deposits a plastic bottle or the bottle caps, they receive restaurant coupons or movie tickets or simply shopping dollars.

Model Questions

1. Describe some best practices in Waste Management being implemented in India.
2. Give an account on any two countries’ innovative waste management model.
3. How can India's Waste Management problem lead to systemic change?
4. Illustrate a case study and elucidate its best practices insocial entrepreneurship.
5. Construct a Waste Management System – WMS(from your own idea) and substantiate what innovative practices and technologies you would incorporate in it.

Key Words

Cyber Security, Internet of Things, Blockchain Technology, Digital Humanities, Innovation

Further Reading/References

📖Haag S., Cummings,M., and Phillips, A. (2008). Management Information Systems (6th edition.), Tata McGraw Hill: India

💻http://www.tutorialspoint.com/– Cyber Security and Ethical Challenges

💻https://www.nceg.gov.in/ – National e-Governance Conference Portal

– Internet of Things (IoT)

– Blockchain Technology

– Digital Humanities

Block 2
Hotel Waste Management

Swachhta Action Plan

Mahatma Gandhi National Council of Rural Education

Department of Higher Education

Ministry of Human Resource Development, Government of India

Hyderabad - 500004

Contents

Chapter 1 Hotel waste
1.1 Overview of Hotel Waste
1.2 Types of Waste in Hotels
1.3 Steps of Effective Waste Management in Hotels
1.4 Waste streaming
1.5 Benefits of Waste Reduction

Chapter 2 Waste management
2.1 Characterization of waste
2.2 Rethink, Reduce, Recycle, Reuse
2.3 Information and Education
2.4 Impact of waste generation on environment
2.5 Waste Management Tool

Chapter 3 Food waste reduction
3.1 Food waste statistics
3.2 Waste mapping
3.3 Food minimization strategy
3.4 Causes of food waste generation
3.5 Reducing plate waste

Chapter 4 Good practices
4.1 Good practices
4.2 Prevention and Reduction of food waste
4.3 Recovery of food waste
4.4 Recycling
4.5 Energy recovery from food waste

Chapter 5 Waste Audit in Hotels
5.1 Auditing of Waste in Hotels
5.2 How to Perform a Waste Audit
5.3 Tools Used to Conduct Waste Audit
5.4 Restaurant Food Waste Reduction Ideas
5.5 Audit process for waste minimization

Hotel waste management – An Introduction

As one of the world's largest economic sectors, Travel & Tourism creates jobs, drives exports, and generates prosperity across the world. Generally speaking, waste from the hospitality industry consists of both wet (organic/biodegradable) and dry waste. The wet waste consists primarily of food waste (Wagh, 2008), which can account for more than 50% of the hospitality waste (Curry, 2012) and up to one third of all the food served within the hospitality sector (Marthinsen et al., 2012). Hotels are one of the major sources of solid waste generation, for reducing the volume of the waste, (Kirk 1995) focused on purchasing policies (develop partnership, products with sensible packing), waste management (minimize waste in the operation, reuse and recycle) and waste disposal (partnership with disposal companies, sound disposal methods) by hotel to meet environmental responsibility and reduce the burden of waste. Considering the significant role of the hotel industry in terms of waste generation(half a pound to 28.5 pounds of trash per day per room) and the fast growth of the industry, adopting a number of environmental best practices with quantifiable measures, including areas of benchmarking and auditing, financial analysis to facilitate informed decision making, and operational training, becomes important due to certain factors such as increasing regulation and rising utility costs (Goldstein and Primlani, 2012). The hospitality sector, in general, can be defined as "businesses such as hotels, bars, and restaurants that offer people food, drink, or a place to sleep" (Cambridge Dictionaries Online, 2014).

Solid waste in hotels has many components, including paper, food, various metals, plastics, aluminum, and glass. In a recent waste generation study, wastes from 25 hotels were examined. The statistics showed that from 1991-1993 the hotel waste consisted of 46% food waste, 25.3% paper, 11.7% cardboard, 6.7% plastics, 5.6% glass, and 4.5% metals. This gives a picture of the variety of waste that can be produced by only a small number of hotels in a city. When looked at with a zero-waste attitude, these figures show the opportunities for both resource recovery and waste reduction. Implementing a solid waste reduction program in a hotel can create significant cost savings in waste hauling fees while creating a more environmentally friendly hotel. This is especially true as solid waste becomes a more significant environmental issue and landfill fees increase. Often hotels hesitate to establish programs in solid waste management because of the coordination and cooperation needed among management, employees, and guests. However, the cost benefit is an incentive.

Chapter 1- Hotel Waste Management

1.1 Overview of Hotel Waste

Hotels are chief consumers of resources, and also huge generator of waste. There is a tremendous growth in the Hotel Industry. WTTC report on "Travel and Tourism Economic Impact 2017 India" shows that India is contributing to 6.9 % to the world GDP (Afsanehsadat, SeyedMohsen, 2016). Thus, a number of international players in hotel industry have started their ventures in India. Hotel industry has both opportunities and challenges; wastage of food at mass level is one of them. The levels of food waste from hotels and restaurants must be handled scientifically or otherwise it would lead to environmental impact.

Since hotels use a very high number of natural resources from energy to food, it is essential that sustainable practices must be adopted. Managing huge amounts of waste generated is one of the major concerns to be addressed. In a hotel, major part of revenue is generated from the kitchens of different outlets which mean a large amount of food waste is generated. The generation of this waste and managing it is not only a financial problem but also environmental problem too. Since the waste produced in hotel is bio degradable in nature, it requires large landfills to discard the resources. It increases the cost of managing food wastes and it impacts environment by producing methane gas which is a contributor to greenhouse effect. It also leads to the destruction of flora and fauna in the nearby areas because of the toxins released by the waste.

Objectives

- To know the types of hotel waste produced and ways to handle them
- To know how this initiative can save economy of the hotels
- To know how the hospitality industry across world is taking up the CSR task through case studies

Structure

1.1 Overview of Hotel Waste

1.2 Types of Waste in Hotels

1.3 Steps of Effective Waste Management in Hotels

1.4 Waste streaming

1.5 Benefits of Waste Reduction

To Do Activities

- Visit a restaurant and understand types of food waste they generate and how they manage effectively in minimizing the same.
- Ask students to prepare a note on the visit and submit
- Outline a defined area and in groups collect data in the following format and present the outcomes of your study. Petrol stations- serving food, Fast food establishments, restaurants, street

vendors, hotels, cafés, bars, canteens, independent, canteens, self-operated private, public canteens/ food services

Why Manage Waste at your Hotel?

a. A waste management programme will help you reduce the amount of waste you produce, saving materials, resources and energy.
b. You often pay twice for the waste you produce – firstly in the form of packaging and secondly to dispose of it.
c. On average, a hotel creates around 1kg of waste per guest per night. This soon mounts up if you multiply it by the number of guest nights each year, as does the cost to dispose of it.
d. Your waste disposal costs are likely to increase steadily due to diminishing landfill capacity and the cost of collections.
e. Waste legislation on business and households is becoming increasingly stringent, especially in the European Union.
f. Many items of waste have a value because they can be recycled into something else. You may be able to make money from your hotel's waste.
g. Often at least 30 per cent of a hotel's solid waste stream can be sorted for recovery and recycling. Hotels in the Scandic chain for example sort their waste into up to 22 separate categories!

With the objective of providing best services and profit maximization, the industry is forced to provide with high quality and quantity or variety of food portions to survive the competition. In the process, it leads to large amount of food getting wasted. Similarly, when the customer leaves the food in the plate due to high portion or any other reason, it is again deposited as waste. There is cost involved in disposal and transport of waste and in labour. The hotel industry needs to look into efficient ways of reducing cost.

Food waste in the Hotel industry is a burning issue to be handled with. Proper guidelines and training has to be provided for efficient ways of managing wastes in Hotels. There is a huge requirement to develop a holistic framework for waste management. In hotels most of the food wastes are compostable. The effective waste management not only helps the organization to work for an eco-friendly environment but also helps them to earn profit out of it.

Waste management is such a critical issue which requires the attention of public as well government authorities. Currently, there are improper waste management practices in hotels and lack of infrastructure, underestimates of waste generation rates, inadequate management and technical skills, improper collection, and route planning are responsible for poor collection and transportation of municipal solid wastes.

The reasons can be:

- Lack of appropriate planning.
- Purchase and preparation of too much food.
- Errors in industrial processing and following food safety policies
- Managerial, financial and technical constraints
- Over-preparation of food in restaurants, hotels and the food service industry
- Over-merchandizing and over-ordering in food stores and supermarkets
- Consumer behavior

Most restaurants, hotels and the food service industry have a tendency of over-preparing food. While the intention is good, especially in expectation of high customer volume, over-preparation often leads to wastage. There are two main kinds of waste discarded in hotels.

Organic Waste (Wet Waste): cooked and uncooked food, fruits and flowers (which are natural products)decompose quickly.

Inorganic (Dry Waste): manmade or manufactured products include plastics, rubber, metal, glass, cloth,paper, and packaging. If these different types of wastes are kept unmixed, each of them can be reused or recycled if they are collected and managed separately.

Table 1.1 Causes of Food Waste

CAUSES OF FOOD WASTE	
Pre-consumer	**Post-consumer**
Unidentified demand	**Large portion sizes**
Overstocking	
Inefficient production	**Inefficient service model**
Poor communication	
Staff behaviour	
Unskilled trimming	**Customer's menu acceptance**
Over-merchandising	
Food Safety	

Considering the significant role of the hotel industry in terms of waste generation(half a pound to 28.5 pounds of trash per day per room) and the fast growth of the industry, adopting a number of environmental best practices with quantifiable measures, including areas of benchmarking and auditing, financial analysis to facilitate informed decision making, and operational training, becomes important due to certain factors such as increasing regulation and rising utility costs (Goldstein and Primlani, 2012). This study helps to understand the waste generation and its management for estimating the monetary benefits of recycling for the industry and the environment. Findings of this study support the instrumental stakeholder theory.

The expansion in hospitality sector operations is complemented by an expansion in its waste management operations. More waste usually translates into a greater environmental footprint and therefore more harm to the ecosystem.

Fig 1.1 Waste Management in Hotel

For example, a hotel guest is estimated to generate up to 1 kg of waste per day on an average (International Hotel Environmental Initiative, 2002), and this amounts to millions of tons of waste being generated worldwide annually. Therefore, the importance of studying the hotel waste management in order to minimize the waste cannot be overemphasized.

Waste Management –Objectives

a)Reduce The best way to improve waste management is to create as little waste as possible by not purchasing it to begin with.

b)Recover You need to set up systems to collect and sort the waste so that it can be reused or recycled.

c)Reuse Consideration will need to be given to where certain items can be reused, or whether they can be sold or donated to organisations outside the hotel that can reuse them.

d)Recycle Many hotels, restaurants and tourism establishments already have some system in place for sorting and collecting everyday waste items such as bottles, cans, cardboard and paper for reuse or recycling. Have you considered all the waste you generate and what else might be recycled? What happens to your used batteries, plastic bottles, wine corks, bathroom amenities or cooking oil for example?

Reduction of Waste at the Source Point

Waste management program would help in reducing the level of waste generation and increase efficient utilization of materials, energy and water resources. In hotels, owners often pay twice for the waste; firstly in the form of packaging and secondly for their disposal. Many stuffs/items of waste are also valuable in nature, can be recycled into other items. Hotel owners may make money from their generated wastes. Around 30% of a hotel's solid waste can be sorted, reused, recycled and recoverable in nature (International Tourism Partnership Report, 2008). Therefore, it's a need of an hour to manage the waste of a hotel industry for protecting and conserving 25 natural resources and the environment.

The first and foremost option for any waste reduction is reducing the generation of waste at source. To begin with the hotelier must do a preliminary research on the culture of food habits, customer preferences, in flow of the customers, their tastes and food standards of the regional demand and plan accordingly. Also, the locality, place, type of city must be considered while planning the location of a hotel. That will also have an impact on the quantity and quality of food to be prepared. This preliminary research would help the hotelier in reducing waste generated.

Good waste management can make good business sense. Minimising waste can provide competitive advantages to a hotel in a few ways: Improved Resource Efficiency & Reduced Disposal Costs. Hotels consume and pay for resources (raw materials, consumables, energy, water, manpower) that translate into sales revenue. Waste management enables you to identify the sources, types and quantities of waste you produce. The process will help you identify areas where simple actions can be taken to minimise waste, save money and achieve long lasting sustainable waste management. Waste is generated as a by-product and cost money to treat or dispose of. This is represented as shown below.

- Raw materials & consumables
- Energy & water
- Manpower & time Business Process Services & Products
- Solid/liquid waste
- Wasted energy

Recover- Most people have seen perfectly good food thrown away at a restaurant or dinner party and wished there was a way to get it to people in need. Food recovery captures food donations from businesses and transports it to organizations that feed the hungry, such as food banks and soup kitchens. The Roadmap demonstrates that food recovery can double nationwide, increasing by roughly 1.8 billion meals (1.1 million tons). Common barriers to food recovery include liability concerns among food businesses, fragmented food safety regulations, a lack of transportation and storage infrastructure capacity, and the extra financial burden associated with food donations. Food recovery networks differ widely by region and geography. Rural communities often face higher transportation costs to reach people in need, while urban communities may lack food sourcing and procurement channels from farms and food manufacturers.

As a rule, the nearer to the origin of waste that recovery occurs, the less sorting and processing will be needed before the material can be recycled. Begin by identifying opportunities to recover materials from waste material. There are numerous schemes for collecting and recovering the contents of batteries, particularly NiCd batteries. Although almost all paper is recyclable, most successful programmes concentrate on the recovery of only one or two 'grades' of paper from the paper waste. A conventional hotel office generates about 14 kg of waste paper per employee per month, and around one third of this (4.6 kg) is high grade recyclable paper that can be conveniently recovered.

Reuse

Hotels should ensure that the wastes that are generated in the form of liquid and solids can be reused. For e.g. water used for cleaning utensils, washing hands can be recycled and used for gardening. Food waste can be used for composting and will become natural fertilizers for plants. Methane is emitted from rotten substances, where waste can be salvaged and used to produce bio gas. Care should be taken to see if the waste generated can be reused before disposal.

Terminology and Techniques

Biodegradable-A biodegradable material can be broken down or degraded by micro-organisms in nature. This leads to the release of heat, carbon dioxide, organic residues and methane.

Compaction- Waste crushers and compactors can help reduce the cost of transporting waste for recycling or for landfill where this is charged by volume. Some units also bale and lift the compacted waste. When purchasing equipment, look for a high compaction ratio.

Commingled Waste- This is a term used to describe unsorted recyclable or general waste.

COMPOSTING-Organic matter such as vegetable and fruit peelings, egg shells, used tea and coffee bags, weeds or grass clippings are ideal materials for recycling back into the ground as compost. The greater the variety, the better the compost – too much soft material will become slimy and foul-smelling, while too much tough material can take too long to rot down. Never put raw fish or meat or cooked food waste in your composting bin or anything that will not decompose.

Cullet-Crushed glass.

Duty Of Care-A requirement that anyone dealing with waste, from production through storage to transportation, must take all reasonable steps to ensure that the waste is handled by licensed contractors and disposal sites and must prevent pollution or harm to anyone as a consequence of waste. In many countries this is enforceable by law and can result in fines.

Food waste can be defined as organic waste which has its origin in food or inputs in food production. We can divide between avoidable and unavoidable food waste. Avoidable food waste was edible at some point prior to disposal (e.g. slice of bread, plate residues etc.) The avoidable food waste from hospitality sector could be divided in waste from the kitchen (e.g. preparation of meals) and waste from the guests (plate residue). Unavoidable food waste is not-edible food waste from preparation and consumption (e.g. bones, egg shelf, coffee grounds etc.) In this project we use the terms of avoidable food waste and edible food waste as synonyms.

Hazardous or Special Wastes- Wastes which are hazardous to human health or the environment and consequently require special treatment or disposal. They must not be sent to landfill. These wastes include toxic, poisonous, corrosive, explosive, flammable, ecotoxic and infectious materials.

Landfill-The process of burying waste in specially constructed pits or landfill sites. In most countries a landfill taxis imposed on waste disposal authorities and groups sending waste to landfill sites.

Materials Recovery Facilities (MRFs)-These are centralised recycling or reclamation facilities that further process source-separated recyclables or mixed waste (including tin cans, glass and plastics) for selling to materials reprocessors as 'commodity grade' materials.

Vermicomposting Or Worm-Composting A form of composting that uses earthworms (available from angling shops) to convert organic kitchen waste into compost. Compost can be used as a soil conditioner, fertiliser, mulch or as an alternative to peat.

WASTE EXCHANGES- Materials or waste exchanges list different companies' wastes so that they are made available for use byother companies either through purchase or freecollection.

Recycle

It involves converting the waste in to a marketable or reusable product. For e.g. the used oil in the hotels are sent refineries and is recycled and sold as a second grade product in the market for reuse. Recycling is the least favorable method and is used only if reduce and reuse options are not applicable. Three major steps for recycling are:

- Collection of solid waste
- Processing and manufacturing of the products into reusable products

Purchasing of the products which are made up of reprocessed materials, and can be reutilized.

Recycling programs for hotels are focusing on collection of recyclable materials from waste stream of different areas of the hotel. Before boarding on a waste-segregation programme, the type of material can be collected from local waste and recycling contractors. In many countries, recycling and waste management programmes are relatively well advanced; waste may be separated into various categories. Implementing recycling actions for items wherever practically possible must be done. Sometimes, local conditions may inhibit the many actions of recycling.

For example, many countries lacking infrastructure for recyclable elements coming from waste streams like plastic bottles.The steps outlined are not difficult and can be fulfilled by the hotel industries for managing their waste. But, the hotels do require a commitment of the management and staff to manage their waste.Theymust spare time for implementing the waste management strategies. If a hotel is green hotel, then the message should pass to all potential guests that the hotel management, staff, and corporation all believe that environment conservation and protection is an important factor during the hotel operations. This message can play a powerful role.

Case study

- SonevaFushi has built two Adams Retort biochar ovens, which are used to convert woody waste to charcoal for barbeques and the pizza oven, and biochar to fertilize the soil.
- Glass is crushed and used as a replacement for sand in concrete making. A hotwire cutter enables the team to cut up Styrofoam boxes that are reused for insulation.
- Metal is collected and sent off the island for recycling.
- In an effort to support its neighbouring islands, in 2013 SonevaFushi received over 4.5 tonnes of plastic bottles and metal cans which it compacted for recycling.

Fig 1.2 Food waste recycling

In Hotels / Restaurants or even in home we produce kitchen or food (meal) waste but now you can recycle this to organic compost through organic waste recycling machine. Machine will biodegradable the waste and convert this into soil amendment products like compost. So no more Food waste problem in our society and recycle your food waste to organic waste compost through our organic waste composting machines within 24 hours and make a green environment around you.

1.2 Types of Waste in Hotels

Multiple types of waste tend to be generated at individual locations. The relative percentage of each of these different waste types also varies by type of food (Refer Fig 1.1). Solid waste is a key concern in the hospitality industry. Typically, a hotel guest can produce 1 kg of waste a day that accumulates to thousands of tonnes of waste annually. Small hotel operators show little interest in reducing / recycling waste due to lack of awareness on waste management, and also because of belief that it is too expensive and time consuming. The below table 1.2 shows different types of non-hazardous waste generated in the hotels.

Fig 1.3Percentage of Food Waste in Hotels

Table 1.2 Types of non-hazardous waste generated in the hotels

Type	Components	Source
Household Wastes	Food / Kitchen waste, used or dirty paper and wrapping, plastic wrapping or bags, composted wrappers	Hotel's different departments
Cardboard	Packing	Hotel's purchasing and other departments
Paper	Printed documents, brochures, menus, maps, magazines, newspaper	Administration, reception, guests room, restaurants
Plastic	Bags, bottles (that did not contain hazardous material), house hold goods, individual portion wrappers for various products	Kitchen, restaurants, bars, guest rooms
Metal	Tin cans, jar lids, soda cans, food containers, mayonnaise, mustard and tomato puree tubes, aluminium packing	Kitchen, restaurants, bars, guest rooms
Glass	Bottles, jars, flasks	Kitchen, restaurants, bars, guest rooms
Cloth	Table cloth, bed-linen, napkins, clothes, rags	Kitchen, restaurants, bars, bathrooms, guests
Wood	Wooden packing pallets	Purchase department
Organic waste	Fruit and vegetable peelings, flowers and plants, branches, leaves, grass	Kitchen, restaurants, bars, guests, room, gardens

Before embarking on a waste-separation programme, find out which material can be collected by local waste and recycling contractors. In countries where recycling programmes and waste management are relatively well advanced, waste may have to be separated into several categories. b Try to implement recycling actions wherever practically possible. Local conditions may limit what you can do. For example some countries lack the infrastructure for recycling elements of the waste stream such as plastic bottles. c Review how you can eliminate or reduce use. It is better for your bottom line to minimise the use of items so that you avoid having to separate them into waste streams and paying to dispose of them.

For example:

- Avoid the use of plastic straws.
- Use containers with lids in preference to plastic wrap, cling film or foil.
- Use refillable containers for soap, cleaners and foodstuffs.
- Substitute reusable glass bottles for plastic ones.
- Use cloth or canvas bags or baskets for laundry, shoe polish, etc. instead of plastic bags.
- Use mugs in preference to paper cups, and paper cups rather than polystyrene.
- Maximise the use of computers/electronic mail to reduce paper use. Ask yourself if you really need to print out the document.
- Make and use your own compost, where feasible. d Implement recycling at source to make the

sorting process more efficient – for example put divided waste bins with compartments for paper, cans and glass in guest rooms. Housekeeping trolleys should have similar compartments so that sorting can be carried out in situ. e Look at what can be reused in the hotel or by external organisations:

● Worn towels, sheets and tablecloths can be re-used as cleaning cloths and dusters or turned into aprons.

● Reuse computer and other paper as notepaper.

● Donate used and surplus items to schools or charitable organisations instead of throwing them away, such as donating partially-used guest shampoo, conditioner and bath gel to homeless shelters and charities.

● Reuse leftover pads and pencils from meeting rooms.

● Use straw and shredded paper or other degradable material for packaging.

● Use cloth napkins in preference to paper ones. If you do use paper ones, they can be composted after use unless they are badly soiled.

● For occasions and festival decorations use live, rooted trees that can be replanted afterwards. If you cannot obtain a tree with roots, chip it for composting. ● Avoid using waste disposal units that grind kitchen waste before putting it down the drain. They require a lot of water to work effectively and increase the burden on waste water treatment. They can also cause odours and attract rodents.Food waste from hotels comes from a variety of sources such as

- Spoiled or out of date food
- Peelings & trimmings
- Inedible by-products, e.g. bones, coffee grounds, tea leaves
- Kitchen error
- Plate waste

There will be food waste even in the best-run kitchens**.** The objective must be to reduce the quantity of food wasted at source than planning for disposal of waste**.** If the materials are used with care, it can save lot of money. Decreasing the cost of waste disposal is very crucial factor to be considered. It can start with:

- Using refillable dispensers for soaps, shampoos, and conditioners
- Using washable cloth products and dishware instead of disposable ones
- Using water filters instead of plastic bottles
- Reducing and reusing supplies packaging materials
- Reducing the number of paper products
- Switching to LED lights

1.3 Steps for Effective Waste Management in Hotels

Waste management is also known as waste disposal. It is an activity / action required to carry out from inception to disposal.

Characterization and Quantification of Waste in the Hotel Industry

It is important to categorize the types and quantity of waste produced by every department of the hotel industry so that it is managed properly. For example, office waste (like papers, documents, brochures), household waste (jars, bottles, cardboard), organic waste (vegetable and fruit peels, flowers) can be segregated in color-coded bins for easy and hassle-free waste management.

Understanding Waste Hierarchy

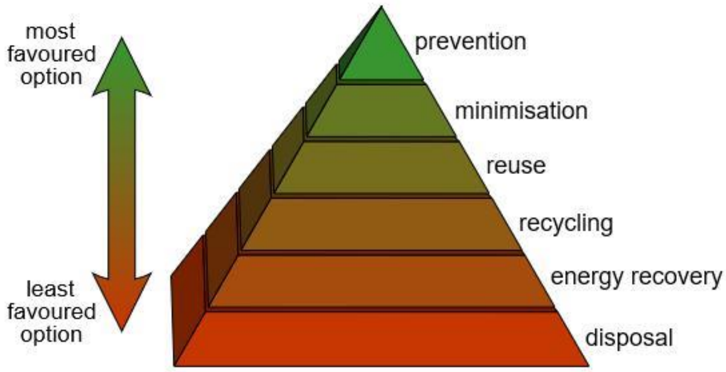


Fig 1.3 Waste Hierarchy[9]

As the saying goes, "Prevention is better than cure", the above figure (Fig 4.2) on waste hierarchy shows the most favoured option to be followed in any hotel industry which means prevention is better than disposal. It provides option to manage waste by prevention, minimization, reuse, recycle, recovery and disposal which prevent a lot of waste from going to the waste stream.

- Prevention means minimising / avoiding the amount of waste generated. Some of the things to follow could be,
- Don't buy things that you don't need
- Buy products with better packaging which can be refilled or reusable
- Choose products that use the least hazardous materials

Materials should be re-used to the greatest possible through substitution and postponing. Recovery is the most important part of the whole process because some value of the material can be retrieved through recycling. The last step is disposal which generally involves landfill and incineration of waste.

Data Analysis

Hotel industry generates a lot of waste and most of the time it is sent to the landfills without being treated properly. The first step in managing the data analysis of waste is to perform waste audit. Waste audit is identifying the process of productivity from waste management practices in hotels.

Step 1 Carry out a Waste Audit

The most important step is waste audit which may be done at any time without the need for external help. This step involves critical manual checking at all the areas of a hotel producing waste. At this level, measures can be taken for efficient utilization of waste. A checklist can also be prepared for self-evaluation of the waste. Tools like the Environmental Walkthrough can also be developed especially for small scale hotels in order to provide exact and useful information regarding the saving of water, energy and other useful materials.

Another tool is small hotel environmental assessment that involves analyzing and understanding the situation by a team. The specialized team reviews all the facilities, operation procedures, baseline performance and prepare a comprehensive list of best alternative practices. The team also submits a report on the best practices and opportunities for reducing, restoring, recycling and reusing waste and also provides a list of guidelines for implementation.

Step 2 Set Priorities and Goals

After self- evaluation and identifying source and type of waste generated, quantify the recyclable materials that are currently discarded. Create a list of items disposed at each location, disposal method used, and the quantities involved.

After self-evaluation and identification of alternative practices for improving waste management in a hotel, priorities must be set right to implement most attractive measures by following the schedule and action plan with assigned responsibilities and also by setting target dates.

Step 3 Continuous Improvements and Investments

After implementation of waste management practices, it must be monitored and evaluate if the set standards are different from the implementation of practices. If there is a gap identified, corrective measures to be taken to improve the efficiency of the system. Hotel industry can save their huge amount of money by purchasing reusable products. Initially, it might incur costs but in the long run it will offer substantial savings. The important benefit of waste reduction is saving money and conservation of natural resources.

Case Study: When leftovers don't go into the trash (Article, The HinduVarda Sharma)

"Feeding India" is an NGO that collects excess food from all sorts such as individuals, weddings, restaurants, corporate offices, caterers, canteens and households and feed the food to less privileged or orphans. The volunteers collect the food; check the quality by tasting it two times. Once, when collecting the food and second, before donating it to the needy. It serves 10, 000 to 15,000 meals across the country daily. On some days it may go up to 45000. Feeding India runs three vans to collect and donate food from set locations each day to serve food. In many regions 24/7 refrigerated vehicle moves around the city collecting and donating excess food. Their Volunteers are called 'super heroes' and 'hunger heroes'. While super heroes regular paid workers (seven in number), hunger heroes only participate in volunteer drives and events. They have around 3500 volunteers with its presence in 40 cities across the country serving 3.5 million meals. If we have many such NGO's in the country, it would reduce wastage of food in large quantities and it reaches the needy.

1.4 Waste Streaming

Waste streaming is a highly effective way of reducing waste. Segregation of waste or sorting from the different areas facilitates waste management. The measures include classification, collection andeasy identification of the waste generated. These include:

- Kitchen and bar area: bins colour coded for easy clearing and segregation
- Accommodation staff : trolleys with two separate bags for segregated collection
- Guest accommodation bins: bathroom bin signposted as contaminated waste bin and bedroom bin clearly marked with the recycle sign for paper and plastic recyclables –
- Guest books should also have information on the hotels Reduction, Recycling and minimisation policies
- Clear plastic bags to be used for easy identification of waste type

All new staff should be fully briefed in the benefits of segregation, the use of these bins and also aware of the Hotels environmental policies.

You will need to discuss any proposed programme in advance with the housekeeping department,night cleaners and employees who will be expected to participate. The more convenient thesystem is for them, the greater the level of success.It is essential to follow fire and other safety regulations. This means ensuring protection from fireat the intermediate and final storage points, keeping all aisles and fire routes clear, and providingappropriate equipment for the compacting, lifting and transportation of collected materials.

1.5 Benefits of Waste Reduction

Before we begin waste management we need to understand where the waste comes from, its qualitative and quantitative nature. This can be ascertained from the trash itself, enabling hotels to build a business case for waste reduction, identify new opportunities for recycling and food waste programs. The journal of Waste management says that the revenues generated by the waste management would cross the $60 million mark by 2018 however there are only a few who consider this as an industry. Many companies are looking forward to associate themselves with this industry and are ready for a long term investment. The benefits of waste management are manifold as listed below:

- The practice is highly lucrative, lowers waste management costs
- saves space and reduce clutter
- Keeps the environment clean and fresh, thereby reducing Carbon footprint
- Saves the Earth and conserves energy, reducesthe impact on the environment
- Creates employment and generate revenue

Summary

Managing of wastes in hotel is a big challenge and huge concern to be dealt with. Since the preparation of food depends on the inflow of customers, demand of the customers, planning must be done carefully by analyzing the trends. Hoteliers have to carry out a study to understand the culture, tastes and market of customers and plan accordingly to minimize the waste of food.

Self Assessment Questions

- What are the different types of waste a hotel could generate?
- Discuss the measures to be taken for minimizing the waste
- Rich people buy more food and cook more food than they need. Why is this? Is enough work being done to understand the underlying dynamics behind this?
- Let's look at an example of how our motivations conflict – the wish to avoid wasting money or good food may be overshadowed by a desire for convenience because we lead busy lives. We might have good intentions but we fail to act on them. Are we mentally capable of prioritising such concerns when confronted with immediate life challenges?

Further Readings

- Video link, https://wastewise.be/2014/04/appetite-for-reduction-behaviour-change-and-food-waste ,Accessed on 16.02.2019 at 2.30 am.
- Afsanehsadat Omidiani ,Seyed Mohsen Hashemi Hezaveh, Waste Management in Hotel Industry in India: A Review, International Journal of Scientific and Research Publications, 2016 Volume 6, Issue 9, 670-680.
- Reducing and managing food wastes in Hotels, 2014,http://www.greenhotelier.org/know-how-guides/reducing-and-managing-food-waste-in-hotels/Accessed on 16.02.2019 at 2.30 am.
- World Travel and Tourism Council, THE ECONOMIC IMPACT OF TRAVEL & TOURISM MARCH 2017 Report.
- When the leftovers don't go into thrash, Varda Sharma, https://www.thehindu.com/news/cities/mumbai/when-the-leftovers-dont-go-into-the-trash/article17745964.ece, Acecessed on 16.02.2019 at 2.30 am.
- https://hospitalityfoodwaste.wordpress.com/2013/04/17/food-waste-in-the-hospitality-industry/ , Accessed on Nov 28, 2018 @ 18:00
- Waste Management in the Hospitality Industry https://study.com/academy/lesson/waste-management-in-the-hospitality-industry.html , Accessed on Nov 28, 2018 @ 15: 30
- Managing Waste In The Hospitality Industry https://www.youtube.com/watch?v=nDL-Dd39GFg, Accessed on Nov 28, 2018 @ 15:35
- How one hotel is reducing food waste, https://www.youtube.com/watch?v=6gEdzt5D0AU, Accessed on Nov 28, 2018 @ 15:40

- GREEN HOTELS: Opportunities and Resources for Success Written by Sarah Alexander and Edited by Carter Kennedy Zero Waste Alliance September 2002.

References

- Curry, R. 2012. The Composition of Waste Disposed of by the UK Hospitality Industry (No. RES093-001). Waste and Resources Action Programme (WRAP), United Kingdom.
- Goldstein, K.A., Primlani, R.V. 2012. Current trends and opportunities in hotels sustainability. In: HVS Global Hospitality Services, Available at: https://www.4hoteliers.com/features/article/6618,
- Accessed on Feb 15, 2019 @ 19:49.
- Kirk , D. 1995. Environmental management in Hotels. International Journal of Contemporary Hospitality Management, Vol. 7(6), pp.3–8
- Marthinsen, J., Kaysen, O., Kirkevaag, K. 2012. Prevention of Food Waste in Restaurants, Hotels, Canteens and Catering. Nordic Council of Ministers, Copenhagen, Denmark.
- Wagh, V. 2008. Management of Hotel Waste [WWW Document]. Maharashtra Economic Development Council. http://www.karmayog.com/cleanliness/ hotelwaste.htm (accessed 29.01.13.). Wagh V. Management of Hotel Waste- Get involved in your city and locality. published by NGO- Karmayog, Mumbai.
- Pirani, S. I. and Arafat H. A. 2014. Solid waste management in the hospitality industry: A review. Journal of Environmental Management, 146, 320e336

Chapter 2- Waste Management

Introduction

The term 'Waste Management' collectively means the management of waste from its inception to the final stage of disposal. Thus, as one single unit it encompasses right from the collection, disposal, recycling, to which the processes of monitoring and regulation. There are specific regulations and monitoring ways based on the legal framework that also relates to guidance and recycling the waste. The typical methods of managing wastes are divided into several categories such as reduction and reuse, recycling, feeding animals, fermentation, composting, landfills, land application, and incineration. Most of these methods have been proposed by the ASEAN member states in order to minimize the number of disposable materials.

Reducing your waste and material efficiencyare directly linked. If you are more efficient with materials in your hotel, less waste will be produced.There are many ways to improve material efficiency to reduce waste. First you should identify materials used in your hotel. These will be in areas such as guest bedrooms, kitchen, office materials, bar/restaurant and maintenance. Also establish the kinds of waste you produce and identify whether this waste is hazardous or must be separated from other waste. You should consider green procurement. This simply means choosing to buy products and services for your business that are less harmful to the environment**.** It includes buying products made from recycled materials and buying goods locally to reduce your carbon footprint. Examples include environmentally friendly versions of stationary, toilet paper, cleaning products and electronics

Objectives

- To characterise the waste produced at source
- To reduce your impact on the environment
- Develop a waste management tool

Structure

2.1 Characterization of waste

2.2 Rethink, Reduce, Recycle, Reuse

2.3 Information and Education

2.4 Impact of waste generation on environment

2.5 Waste management tool

To Do Activities

- Visit a restaurant/hotel and enlist the waste generated
- Tabulate and generate an approximate quantification
- Ask students to prepare a note hazardous and non hazardous waste generated

- Do a case study analysis of any hotel.

2.1 Characterization of waste

Waste generated from the hospitality sector has a major impact on the environment, due to the fact that many of the establishments which make up this sector, such as hotels, use large quantities of consumer goods as part of their operations (Bohdanowicz, 2005). The large amounts of food waste generated by the hospitality sector can also not be ignored. Various studies have shed some light on the typical waste types generated at hotels. For instance, aluminum, plastics, glass, steel, cardboard and food waste were cited as being the main components of hotel waste in some studies (Axler, 1973; Kirk, 1995). As per another study (Zein et al., 2008), the components of hotel waste along with their sources are shown in Tables 1.2 and 2.1, which show non-hazardous and hazardous types of waste, respectively. It must be remembered, though, that these are not exhaustive lists of the components, although they do mention all of the most significant components.

Table 2.1 Types of hazardous waste in the hotel industry [based on the wok of Zein et al., 2008]

Frying oil	**Kitchen, Restaurants**
Mineral oil	**Maintenance service**
Pain and solvent residues	**Maintenance service**
Flammable material (gas, petrol, etc)	**Kitchen, garden, maintenance service**
Fertilizers and chemicals (insecticides, fungicides, herbicides)	**Garden**
Cleaning chemicals	**Maintenance service**
Ink cartridges	**Administration**
IT Disks and CD's	**Administration, guest rooms**
Batteries	**Maintenance service, administration, guest rooms**
Cleaning chemicals and solvents used in dry cleaning	**Laundry room**
Fluorescent lights, neon tunes and long-life bulbs	**Maintenance service**

An older source published in 1973 mentioned how, in general, guest rooms generated about 0.91 kg of waste per day, while quality dining rooms and the hotel kitchen produced about 0.45 kg of waste per guest meal served. The waste generation rate depends on many variables such as the hotel type, guest attributes, guest and employee activities, and occupancy rate (Snarr and Pezza, 2000). About 95% of a restaurant's general waste could typically be recycled or composted (Nielsen and Green Restaurant Association, 2004), and as is clear from the solid waste breakdown, the fraction of organics in restaurant waste is almost double that of hotels. Since hotels have more expansive operations, it is expected that they would generate a greater proportion of other types of wastes such as paper and plastics, than restaurants.

Cooking oils are either liquid (e.g. refined and unrefined vegetable oils) or solid (e.g. lard, dripping and hydrogenated vegetable oils). Disposal is often not covered by special requirements or regulations although legislation (for example in the UK) demands that all commercial hot food premises be fitted with a mechanism to trap or separate grease, oil and other substances that can block drains. Regular dosing with enzymes can be helpful in breaking down any fats that do find their way down sinks. Oil and grease can pose a threat to vegetation and wildlife if allowed to enter water courses. Many countries provide a national oil collection network for caterers and restaurants. When cool, collect used cooking oil in a secure container, avoiding contamination with other liquids such as water. It can then be collected by a specialist company for cleaning and blending for use in animal feed, soap or cosmetics production and, increasingly, to make bio-fuels. Austria for example runs a scheme enabling kitchen fat to be collected and turned into bio diesel and biogas energy.

2.2 Rethink, Reduce, Recycle, Reuse

Businesses in the hospitality industry can recycle significant quantities of material. Hotels can reduce the weight of their waste by 16 per cent. This increases to 30 per cent for the waste produced by pubs and up to 98 per cent for nightclubs. The solution to waste management is adapting these measures in the local context. As per Union Ministery of State for Environment, Forests and Climate Change all hotels and restaurants will also be required to segregate biodegradable waste and set up a system of collection to ensure that such food waste is utilized for composting / biomethanation.

Fig 2.1 Rethink, Reduce, Recycle, Reuse (Dan Ruben 2011)

Reduce - means a consistent and persistent effort to reduce the amount of waste created in a hotel like reduce packaging waste by purchasing in bulk

Restaurants: washable table cloths and dinnerware, reusable coffee filters, condiments in bulk dispensers, use filtered water assembly or bulk dispenser instead

- Refillable amenity dispensers can replace soap, lotion, shampoo and conditioner bottles
- Highly concentrated cleaning supplies
- Switch from incandescent to fluorescent lights—they last 5x longer. Or use LED bulbs—they last 25x longer.
- Use carpet squares so you can replace just the areas that are stained or worn
- Modular mattresses allow hotels to replace just the mattress tops Eliminate un-requested newspapers Copy paper: require documents to be doublesided; use a smaller font and margins
- Ask hotel suppliers to reduce excess packaging
- Permanent mugs for staff

Case study- SonevaFushi

- In 2008 the resort banned imported water and produced its own drinking water using reusable glass bottles. This practice has prevented the production of an estimated 550,000 plastic bottles**.**
- The room amenities such as soap, shampoo and body lotion are offered in ceramic reusable containers, instead of disposable packaging.

All these efforts have enabled the resort to reduce total waste on the island and to see an increase in the amount of waste recycled from 27% in 2008 to 81% today.

Recycle- reduces the amount of waste that ends up in landfill

- Ensures that waste is used wherever possible as raw material to make new products
- Conserves natural resources
- Limits pollution
- Donate food waste
- Compost food with garden waste

Reuse- means to find ways to reuse what you normally throw away

- Maintain and repair appliances so they last longer and function efficiently
- Repair broken fixtures, fittings and furniture
- Reuse storage containers
- Buy products with recycled content like recycled paper or toilet roll
- Refill product containers wherever possible
- Donate old items like old clothes/uniforms or furniture to local charities

The food recovery ecosystem requires three pillars to scale: 1) enabling policy that financially incentivizes donations from businesses while providing standardized food safety regulations, 2) education for businesses on donor liability protections and safe food handling practices, and 3) logistics and infrastructure to transport, process, and distribute excess food.

Example: Setting up a Paper Recycling Programme

Although almost all paper is recyclable, most successful programmes concentrate on the recovery of only one or two 'grades' of paper:

- white paper (A4 and other bond, photocopying, ink jet and laser paper for example)
- mixed paper (other kinds of office paper, magazines and newspapers).

High quality white paper is in high demand in Continental Europe and elsewhere and most of the UK's white paper collected by paper brokers is sold to Germany or Holland. It can be used by mills as a virgin pulp substitute, reducing demand for trees throughout the world. Mixed paper is taken to a special facility where it is recycled back into high-grade copier paper, and sold back to consumers.

Market prices tend to be higher for white paper than for mixed paper as mixing grades reduces the value to that of the lowest grade in the mix. Most waste paper dealers insist on a certain quantity before they will collect, so you will need to have space to store it between pick-ups. Some will collect unseparated white and mixed paper but there is usually a charge so it is better to separate it at source. If your hotel is too small to run a paper recycling programme on its own, you might consider forming a joint venture with neighbouring hotels and businesses.

2.3 Information and Education

The environmental impact of the Hotel Industry can be minimized through the Education of the staff and training in waste management. Information and Education are the most important factors in the development of an effective waste management system. Getting staff on board with your waste reduction and management strategy is key. Work out right from the start who to involve, and ensuring that together you make it work. It takes time to create new processes and habits so make sure staff know why you are doing what you are doing. See the case study on The Bingham above. Get their buy in. Make it easy. Train and retrain staff. It can be hard to get all staff together for training, so consider what alternatives you can provide. Whitbread's 'Say No to Landfill' training modules are online so staff can do it at a time that suits them read the story and try to imbibe the same on a local Hotel.

Importance of Education in the Hotel Industry

- The overall quality in the hotel industry depends on education.
- Sustainable development of tourism demands an efficient national policy of education.

• Education of staff presents both the first and the last link in the chain of competitiveness and business success.

• Staff education comprises the most important factor that both directly and indirectly reflects the competitiveness of tourism products. Only educated staff enables the development of new technologies, innovative products and services.

• Education in the hotel industry helps to raise the quality of services provided in the industry.

• Investment in the staff education is inevitable for a hotel striving to meet the guests needs

In order for any food waste-reduction program to be successful, management must work to catalyze a culture shift among employees. A food waste-reduction program will fall short of its potential if the staff hasn't bought in to the idea.

The *Hotel of the Past* blames employees for wasting food. If it starts to measure its food waste, its staff may not track it accurately out of fear of punishment from managers.

The *Hotel of the Future* recognizes that over 90 percent of staff want to take action to reduce food waste, and it harvests this interest. Managers at the *Hotel of the Future* embed the importance of waste reduction and tactics to achieve it into their standard training and operating procedures. Guidance from leadership may come in the form of daily staff meetings, casual conversations, formal training, or even peer learning opportunities. Staff are rewarded for accurately and consistently tracking waste.

Review Progress on the Plan each Month

Speak to staff and get their feedback on the progress being made. This will keep people involved and motivated. Measure the amount of waste produced regularly and work out how much money is being saved.

Share your Good Work with Staff, Consumers and Industry

Don't forget to thank staff and keep them motivated. Rewards are excellent to recognise the efforts they have made.Keep up-to-date on all the good practice being carried out by other businesses by looking online, e.g. the WRAP site or initiatives local to you. Apply anything you learn to the plan and update it regularly.

Share your case studies with others on Twitter, use the hashtag #foodwaste to make sure others see your story, and to search for and link to relevant organisations.You could also share them on blog sites at Considerate Hoteliers and on Green Hotelier. You might also choose to get external recognition for your achievements through awards and certifications, such as the UK the Chartered Institute of Wastes Management **(**CIWM) Awards**,** Carbon Trust Waste Standard**,** as achieved by Whitbread, or by signing the Hospitality and Food Service Agreement - a voluntary agreement to support the sector in reducing waste and recycling more.

2.4 Impact of Waste Generation on Environment

For the hospitality industry, the waste created by daily operations is an ongoing challenge. In addition to incurring the costs of waste disposal, hotels need to also allocate valuable back-of-the house space for waste to be stored and sorted. There are other concerns as well, namely the health and safety of those coming into contact with the waste, and the noise created by waste compaction and collection.Much of the waste created in hotels is generated from within the kitchen (organic food waste, packaging, aluminum cans, glass bottles, corks and cooking oils), or from the housekeeping department (cleaning materials and plastic packaging). Waste is not only created in guest rooms but also in public areas, hotel gardens (engine oils, pesticides, paints and preservatives to grass and hedge trimmings) and offices (toner cartridges, paper and cardboard waste). And refurbishment and renovation projects undertaken at the hotel contribute further to the waste generated by the property.

The waste management system in India is fairly unorganized. The waste management system in India is shared with residential waste collection, industrial waste collection and commercial waste collection. An estimated 74% of commercial waste generated was contributed by Hotels reports a study in Bangalore (*CREED Working Paper Series No 24, 1999)*.From a sustainability perspective, the improvement of waste management practices of the hospitality industry is a pivotal part of its overall green strategy. This issue must be addressed not only by the staff of the establishments at the different stages of operation (front-of-house, back-of-house, etc.), but also the administration must draw out strategies which would encourage guests to generate less waste. Though the latter is addressed more easily in some places than others, due to the nature of the guests frequenting the property and their ecofriendly tendencies, this is something which eventually needs to be addressed by hotels and restaurants all over the world. This is especially true when considering food waste, due to the fact that it is a type of waste that is very difficult to reuse, and so once generated by the guest, there is little the staff can do to reuse it. Yes, it may be used to produce compost or renewable energy, but this is generally not considered as favorable an alternative as being used to feed people, as emphasized by the 'food use hierarchy' (Pirani, S. I., & Arafat, H. A. 2014)

2.5 Waste Management Tool

Though sustainable practices are becoming more and more popular, changes in policy and regulation, followed by proper enforcement and monitoring, are still seen as the most effective ways to bring about measurable change throughout an entire country (Ball and AbouTaleb, 2010). As an example, restaurateurs in Japan have urged the state to be more proactive if they would like to see the restaurants implement ecofriendly practices in a more effective manner (Kasim and Ismail, 2012). Ways to improve waste management at the site:

- Know what materials you're producing. Conduct an audit of your estate with your waste management team
- Demand transparency of all the action plans taken with reference to the 3Rs
- Are your bins really collecting waste, proper segregation at each step is the key to a good waste management programme

Set your objectives very clearly in accordance with the hotel policy and actively engage your employees for the same. The guideline of the Waste Management tool describes and analyses key steps for managing waste. It provides practical advice, knowledge and technical tools for waste management, applying low-cost practices to prevent or reduce waste, and save money.The waste management tool describes and analyses key steps to manage waste. It provides practical advice, knowledge and technical tools for waste management applying low cost practices to prevent or reduce waste and save money. It has a multifold approach as shown in Figure 2.2.

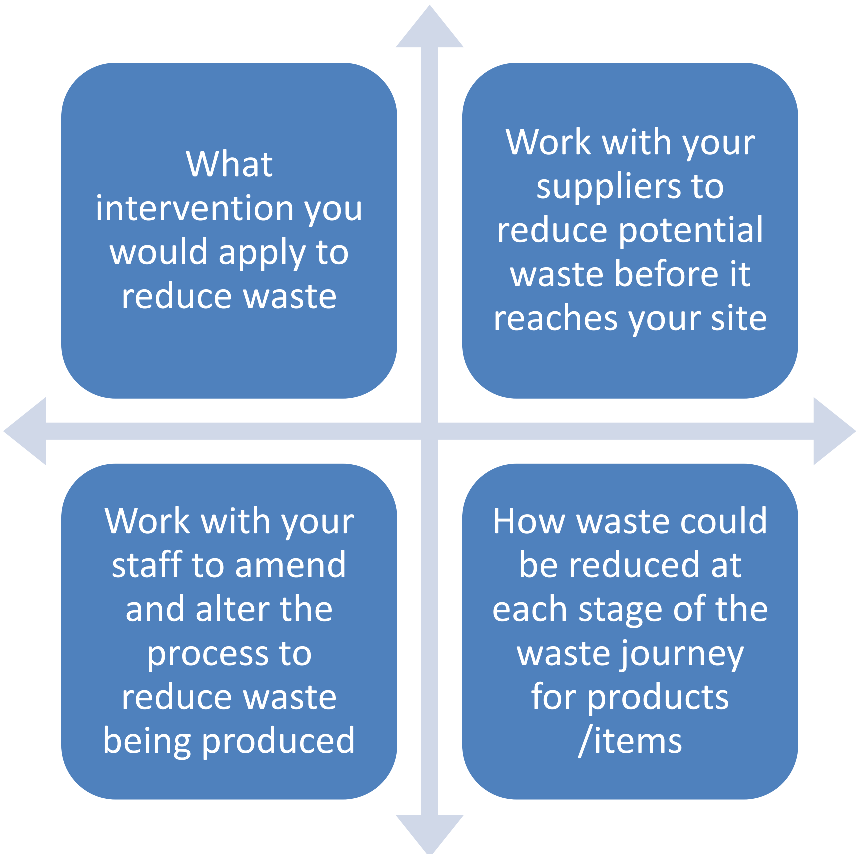


Fig 2.2 Implementing interventions

Table 2.2 Waste management tool
Step1 Map overall hotel waste production
Identify the amount of waste being currently produced Identify the waste management facilities present on site Outline existing waste contractors and costs
Step 2Map out for each department and area the following
Any existing waste / recycling policies Existing guest communications provided or common guest feedback received The different types of waste produced The amount of general waste being produced The amount of waste that ends up recycled or is reused/repurposed Staff training relating to the environment or waste and recycling management
Step 3Map out the waste journey for atleast 3 items
Focus on key departments offices, housekeeping, kitchens, maintenenace, liesure facilities Identify opportunities for reducing waste at each stage of the Waste 'Journey' Develop action plans, prioritise and assign responsibilities Start implementing interventions
Step 4Outline priorities and activities for waste reduction
Allow staff to be as creative and broad when completing this activity Develop clear action plans for implementing the most applicable ideas Ensure you develop a measurement technique for each idea or intervention Identify which of the staff ideas will bring greater benefit Review what you have achieved (on a weekly, monthly and annual basis)
Step 5 Record progress and review activities
Communicate your results Make new plans for the future

Setting up a recycling scheme in your hotel

Once you have found a suitable waste contractor, the next step is to consider how a recycling scheme will work in your business. This includes:

- deciding on the location and labelling of recycling containers
- arranging the collection schedule with the contractor
- employee involvement and training - staff members must understand what materials are being recycled and where they should put them
- launch and promotion - so that staff are clear about when to start using the service

Fig 2.3. Recycled paper products

We cut trees or green forests just to product a single sheet of paper but why not recycling the same paper again without hurting our beautiful green environment but now you can recycle waste paper into paper bricks and our paper recycling machinery which can be used for reproduction of any material like card boards, handicraft materials from waste paper.

Summary

As per the observations of the hotel waste generated by hotels, around 70 to 75 % of the hotel waste is biodegradable and gets mixed with all the other type of waste when dumped at the collection spots. Also the waste which is collected directly by the corporation or private contractors gets mixed with all the other type of non biodegradable waste at the dumping ground. Any waste management strategy will take into account the hierarchy of waste management with a number of things that can be done before recycling. Also an occupational health study of waste workers would increase knowledge about the impact on health of working with biodegradable and non-biodegradable waste streams.

Self Assessment Questions

- What materials will you recycle?
- Do you want the materials collected by the waste contractor, or can you transport them to the waste facility?
- Is the service suitable for the size of your business? If you produce very little waste, you may not need a weekly scheduled collection.
- How will you collect and store the materials for recycling?
- How will you pay for the service? For example, is there an annual charge or a fee each time containers are emptied?
- How will your glass be collected? It will normally be best to separate colours at your site.

- **Resources**
- [1]https://www.nibusinessinfo.co.uk/content/recycling-waste-your-hotel
- Recycling Guidebook for the Hospitality and Restaurant Industry, Metropolitan Washington Council of Governments, Department of Environmental Programs, www.p2pays.org/ref/05/04032.pdf
- EPA WasteWiseProgram:www.epa.gov/osw/partnerships/wastewise/about.htm

Further reading

- Pirani, S. I., & Arafat, H. A. (2014). *Solid waste management in the hospitality industry: A review. Journal of Environmental Management, 146, 320–336.*

References

- Axler, B.H., 1973. Sanitation, Safety, and Maintenance Management. Bobbs-Merrill, Indianapolis.
- Ball, S., AbouTaleb, M., 2010. Benchmarking waste disposal in the Egyptian hotel industry. Tourism Hosp. Res. 11, 1e18. http://dx.doi.org/10.1057/thr.2010.16.
- Bohdanowicz, P., 2005. European hoteliers' environmental attitudes: greening the business. Cornell Hotel Restaur. Adm. Q. 46, 188e204. http://dx.doi.org/10.1177/0010880404273891.
- Dan Reuben, Waste management for hotels and restaurants, https://www.ct.gov/deep/lib/deep/p2/business_industry/hospitality/fall2011workshop/waste_management_for_hotels_and_restaurants.pdf, Acecessed on 16.02.2019 at 2.13 am.
- Kasim, A., Ismail, A., 2012. Environmentally friendly practices among restaurants: drivers and barriers to change. J. Sustainable Tour. 20, 551e570. http://dx.doi.org/10.1080/09669582.2011.621540.Snarr, J., Pezza, K., 2000. Recycling Guidebook for the Hospitality and Restaurant Industry [WWW Document]. The Metropolitan Council of Government (COG). http://infohouse.p2ric.org/ref/05/04032.pdf (accessed 18.02.14.).
- Pieter van Beukering, MadhushreeSehker, ReyerGerlagh and Vijay Kumar, Analysing Urban Solid Waste in Developing Countries: a Perspective on Bangalore, India March 1999, *CREED Working Paper Series No 24.*
- Waste Management in the hotel industry and its importance Cyprus Sustainable Tourism Initiative – CSTI 8 June 2017, http://rethink.com.cy/images/PDFs/WastemgtCSTI.pdf, Acecessed on 16.02.2019 at 2.21 am.
- Zein, K., Wazner, M.S., Meylan, G., 2008. Best Environmental Practices for the Hotel Industry [WWW Document]. Sustainable Business Associates. http://www.atf-2015.com/waste-management-in-new-built-hotels (accessed 7.02.19 at 20.50pm).

Chapter 3 Food Waste reduction

Introduction

In the process of delivering best services and achieving profits, the Hotel industry is forced to provide with high quality and quantity of food portions to survive the ongoing competition. In the process high quality food for presentation and taste is prepared in large amounts. Variety also leads to the production of a large quantity of food that is wasted in the process. The large of food allows the customer to indulge in excess leaves resulting in food wastage while in some cases a large portionsizeresults in plate waste. Since there are various steps where food waste is generated there is cost involved such as disposal and transport of waste and labor costs. The hotel industry needs to look into efficient ways which can bring savings to cost incurred and help in waste management. The food related waste is one of the major challenges for hotel industry as well for the society also. Due to the lack of proper guidelines and training the food waste is becoming a burning issue for the stake holders.

Objectives

- To outline a waste mapping program in hotels
- To devise strategies to work towards zero waste reduction

Structure

3.1 Food waste statistics
3.2 Waste mapping
3.3 Food minimization strategy
3.4 Causes of food waste generation
3.5 Reducing plate waste

To Do Activities

- Visit a nearby hotel or restaurant and generate a waste map
- Co-ordinate with alocal agency that is managing waste from the hospitality business in your area
- Tabulate the actual waste reduction strategy of a local Hotel/Restaurant

3.1 Food Waste Statistics

The hotel industry has been looking at resource efficiency for a long time. The focus has been on saving electricity and wasting less water, and projects to tackle these inefficiencies have become widely adopted. It is only recently, however, that operators have been waking up to the opportunities offered by the reduction of food waste.Food waste is now becoming increasingly prominent on the hospitality agenda. Accor Hotels set a bold target of reducing food waste by 30% by 2020 across all their hotels. The American Hotel & Lodging Association (AHLA) launched a pilot project aimed at preventing food waste within the US hotel sector, and the Pacific Asia Travel Association (PATA) started a regional campaign to reduce food waste. Costa Cruises recently became the first cruise line to make a public food waste reduction target.Food waste is bad for the environment, but it is also negative from an economic point of view. It costs the hospitality sector more than 100 billion dollars every year. Here are the top three reasons why hotel operators should take food waste seriously.

Cut Costs and Save Money

When looking at the cost of food waste, operators often only consider its disposal cost. This, however, is just a fraction of the total cost to the business. Between them, the cost of the food itself and the labour that went into preparing it contribute nearly 90% of the total cost of food waste.Hotel kitchens traditionally budget 3-5% of food purchasing costs to be written off as unavoidable food waste. Working with large brands like AccorHotels, however, we have found that kitchens actually waste between 5% and 15% by value of the food they have purchased. Two-thirds of the avoidable food waste occurs before it gets to the customer's plate. Although this may seem like yet another problem to contend with, it is actually a great opportunity to be realised. Employing digital tools to help measure and manage waste can consistently cut food waste in half and thereby significantly reduce your costs.

Increase your Profile as a Sustainable Brand

The hotel sector is becoming increasingly aware of the importance of addressing food waste. The industry has also noted that consumers prefer to be associated with more ethical brands. According to research by Booking.com, more than half of travellers consider eco-friendly practices when choosing a hotel. Operating your hotel more responsibly and introducing sustainable practices such as recycling waste, conducting energy audits and buying local and seasonal ingredients can help increase your hotel's popularity among customers. Food waste gives you another option, and an opportunity to get ahead of the pack. Moreover, by focusing on food waste prevention hotels can lead the way in achieving the UN Sustainable Development Goals. Among other objectives, these seek to halve global food loss by 2030, and becoming a part of this global effort can really help to differentiate your hotel as a sustainable organisation.

Help the Environment and Reduce your Carbon Footprint

A third of the food produced for human consumption is lost or wasted before is eaten. The environmental cost of producing all that food for nothing is staggering. It's carbon footprint is estimated to be around 3.3 billion tonnes of CO_2 equivalent. If food waste was a country, it would be the third largest carbon dioxide emitter in the world after China and the USA. The good news is that by simply reducing food waste, the hotel industry can contribute to the environment by helping to decrease this gap between the amount of food we produce and how much we actually eat. The costs of reducing food waste are low - in fact, you will be saving money - but the potential benefits are significant. Reducing food waste in this context can be seen as a quick win with little risk to the hotel operators and should be prioritised accordingly.

Case Study: A business Opportunity, not a Challenge

At Winnow, we create technology that helps chefs measure, manage and reduce food waste. Over the past four years we have partnered with hundreds of kitchens, saving them money and reducing their environmental footprint at the same time. We would encourage all hotel operators to see food waste as an opportunity to significantly cut costs while also contributing the environment. In a competitive marketplace and with increasingly demanding guests, there has never been a more important time for hotels to run with maximum efficiency.

Statistics states the following:

- Roughly one third of the food produced in the world for human consumption every year — approximately 1.3 billion tonnes — gets lost or wasted each year[1]
- Every year, consumers in rich countries waste almost as much food as the entire net food production of sub-Saharan Africa[2]
- 842 million people in the world do not have enough to eat[3]
- When food rots it creates methane (CH_4) which has 21 times the global warming potential of carbon dioxide[4]
- If food waste was a country, it would be the world's 3rd largest emitter of CO_2 (FAO, UN)
- Every time food is wasted, the water, energy, time, manpower, land, fertilizer, fuel, packaging and MONEY put into growing, preparing, storing, transporting, cooking the food is wasted.

Waste mapping for all types or organizations is gaining popularity around the world, from places such as India (Green Yatra NGO, 2014) to South Australia (Blue Environment Pty Ltd and Tonkin Consulting, 2012) and Finland (P€aiv€arinta et al., 2004).Various publications are available online which have outlined the benefits of waste mapping and how it may be implemented (Cox,2002; WRAP UK, 2013a,b). It is reported that with waste mapping, an organization can usually be expected to reduce expenses by an amount equivalent to at least 1% of its turnover at little or no cost (Envirowise, 2009). With regards to the hospitality sector in particular, though examples of waste mapping have been cited (Owen et al., 2013), it is difficult to find any documents which report the precise impacts of having implemented waste mapping. This is to be expected as a result of the fact that this is a relatively new trend in the area of waste management. Food waste mapping can also specifically be used to reduce the waste generated by a property.

Table-3.1 Various practices to manage the food waste in hotel industry[1]

Portion Control	**Proper Storage**
FIFO Practice	Compost Services
Demand Forecasting	Training
Recycling	Separate Food Wastage Bin
Waste Reduction	Surplus Food for Staff Meals

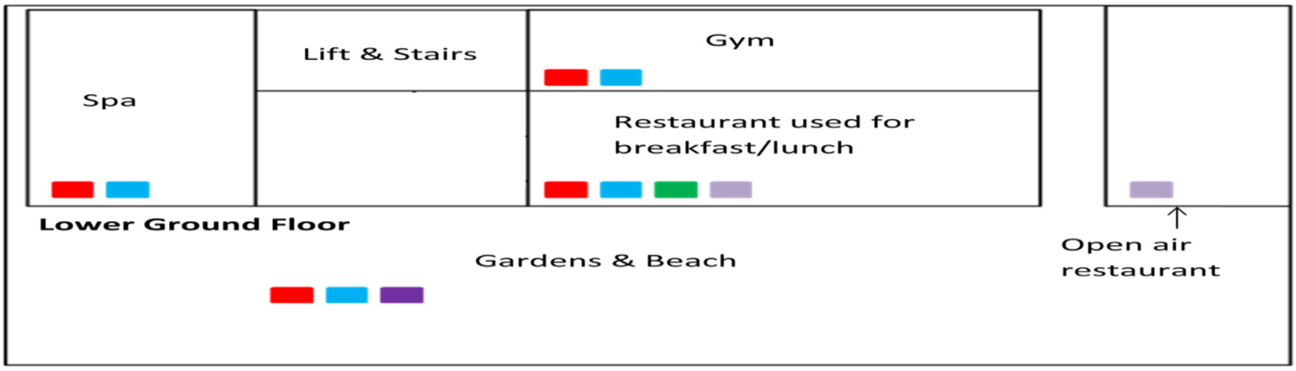
[1] http://www.unep.org/wed/2013/quickfacts/

[2] http://www.unep.org/wed/2013/quickfacts/ |

[3] http://www.wfp.org/hunger/stats |

[4] http://epa.gov/climatechange/ghgemissions/gases/ch4.html|

[5] FAO 2013



Key	Waste Type
(red)	Non-recyclable waste
(blue)	Plastic
(green)	Cartons
(light purple)	Food waste
(purple)	Garden waste

Figure-3.1 A waste map for a part of a typical hotel (reproduced with permission from the Cyprus Sustainable Tourism Initiative; (Owen et al., 2013)).

With respect to the hospitality sector, waste mapping involves monitoring waste generation at a property in terms of which types of waste are generated, in what amounts, and in which locations. A waste map is subsequently created to reflect this data. The property can subsequently plan its waste management operations in a more efficient manner Fig. 3.1 shows an example of a waste map for a part of a typical hotel property. The colored boxes show which types of waste are being generated in various locations, as explained in the map key.

3.2 Waste Mapping Procedure

The waste mapping process, in terms of how the map can be used once generated, is explained in more detail in Fig. 3.2 Areas where the maximum amounts of waste are generated may be focused on in order to make the most significant difference in the amount of waste sent to the landfill by the hotel. The inputs refer to the products and goods entering into the system at that particular location in the hotel while the outputs refer to the factors which contribute to waste generation at that particular location as well. By analyzing the inputs and outputs, the flow of resources can be comprehended and any hidden costs associated with the waste can be identified and calculated. This would make possible the identification of strategies which may be employed to achieve both financial and environmental benefits.

Once these benefits have been quantified, they may be arranged in order of priority and then integrated into the hotel's future waste management strategy accordingly. Through waste mapping, opportunities for collaboration between different sections of the hotel which produce similar waste can also be highlighted. (Owen et al., 2013).

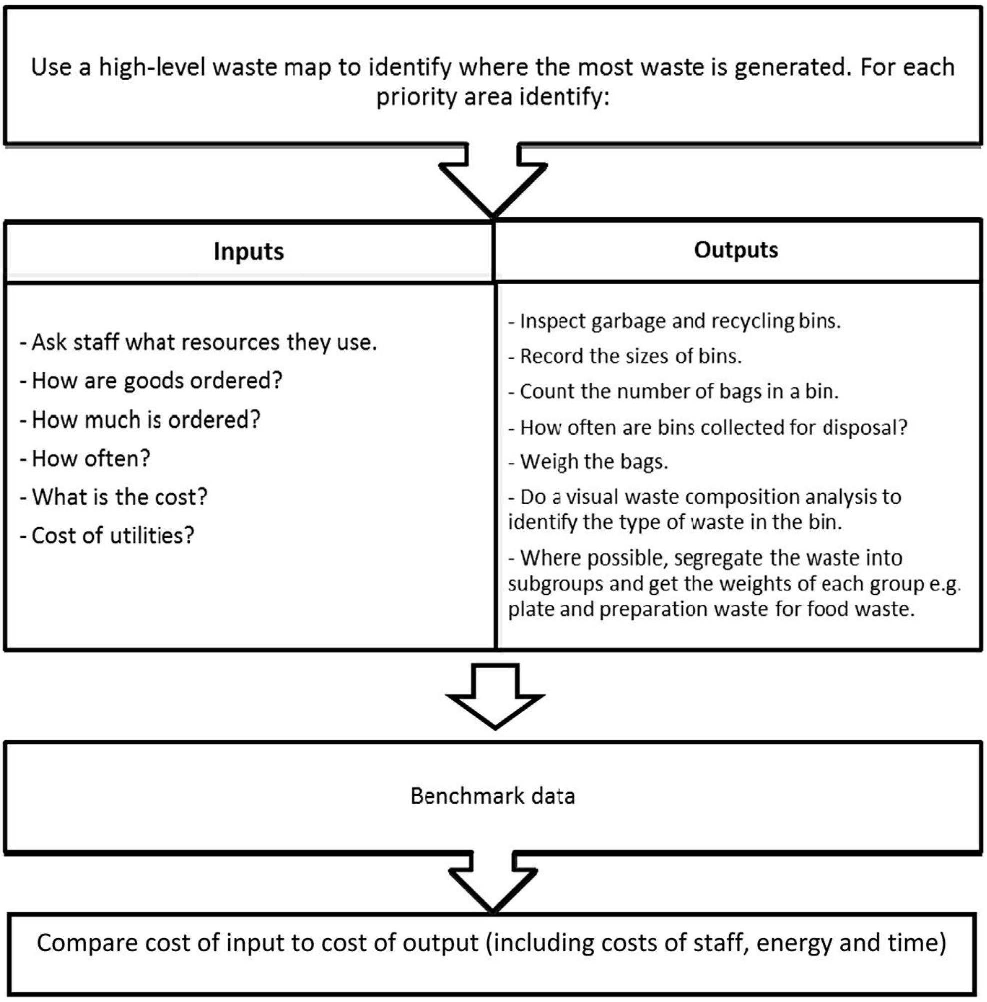


Fig 3.2 The waste mapping procedure [based on the work of Owen et al., 2013].

3.3 Food minimization strategy

Running a foodservice operation requires a lot of thinking. You have to order ingredients on time, balance your finances, and manage your staff amidst a world of other concerns. As important as it is to consider what food you're making, it's equally important to think about what happens to food that's left uneaten. According to Feeding America, America produces an estimated 70 billion tons of food waste each year. This is something your customers care about, as demonstrated by food waste statistics. A study by Unilever, revealed that 72% of U.S. diners said that they care about how food waste is handled. 47% are concerned enough that they would be willing to spend more money to eat at a place that actively tries to reduce its food waste production. This makes it all the more important to find ways of reducing food waste not only in America but all around the world.

Strategies to minimize food waste in the hospitality sector can be implemented. These include checking deliveries to ensure that food is free from contaminants, packaging is not damaged, and perishable food has a sufficiently long expiry date; sourcing ingredients locally where possible; ensuring that the first-in-first-out approach is applied for the ingredients inventory; storing all fruits and vegetables in wire crates to allow for air circulation; avoiding over trimming during preparation; and minimizing the quantity of bread and starters portions provided prior to the meal. A basic strategy which needs to be followed before any effective food waste reduction can take place is waste monitoring. This monitoring may be as simple as visual checks to as complex as measuring the quantity of each type of food group which is thrown away. An example of how waste monitoring can make a difference is presented by the Intel Company. The company's corporate cafeterias decreased their pre-consumer food waste by 47% as a result of the implementation of a waste monitoring system (Neary, 2010).There are two main factors to take into account as you track your food waste. You need to consider how much food is being wasted and how many people are coming through your restaurant. By gathering data for both of these variables, you can get a better sense of what your biggest source of waste is.

Food log system-Provide your staff with a simple sheet of paper where they can keep track of what's being thrown out, why it's being thrown out, and how much is wasted. As an alternative, there are waste tracking systems like LeanPath that use a specially designed scale with touch screen terminal and computer software to track how much food you're throwing out without the hassle of a pencil and paper. Also, be sure to keep a second log system for post-consumer waste, or food customers pay for but don't eat. This type of waste is much more difficult to control because, ultimately, if that toddler at table 3 doesn't want the broccoli his mom ordered for him, odds are good that you're going to get it back, untouched, when they leave. Still, it's well worth evaluating what is being thrown out and how much this amounts to. Gathering as much data as feasibly possible will only help you when it comes time to evaluate the results and make changes to how your operation handles food waste.

Seek Food Waste Solutions

Once you know what's being wasted, talk to your staff and try to think of ways to improve. What are the biggest contributors to food waste in your kitchen? Why are specific items thrown out? These are the questions that should be in the back of your mind as you look at the data.

An easy way to think about next steps is to break up your waste types into three categories:

- **Pre-consumer waste -** food that doesn't even leave the kitchen
- **Post-consumer waste -** food that's purchased by a customer, but not eaten
- **Disposables -** things like paper goods, plastic utensils, and packaging

It's Easy Being Green – Case study

Pom Pom is a web-based recycling platform that helps people to dispose off recyclable waste in a responsible manner. What's great is that the Pom Pom service also pays you back for your waste management initiative; it is one of a kind 'Trash to Cash' service that pays you for your unwanted recyclable trash. Founded by Deepak Sethi and Kishor K Thakur, POM POM service has started its operations in South Delhi. According to government data, Delhi is among the top ten largest plastic waste producing cities in the country. To address the growing waste concerns of the city, Pom Pom started converting recyclables into raw form, which can be used to create new different products. The best part is that this startup is just a call away. One can also put in the request via the mobile app.

Next, consider the following options and determine which ways make the most sense to implement as solutions to each type of waste:

Ways to Reduce Pre-Consumer Food Waste

Pre-consumer waste is the area where you likely have the most opportunity for positive change because there are many factors within your control when it comes to ordering, storing, and prepping your ingredients as well as how you handle surplus ingredients.

- **Evaluate inventory -** If you find that food sits around too long in storage, make sure you're not ordering too much.

- **Maximize shelf life -** If ingredients you need are going bad before you have a chance to use them, make sure perishables are being properly stored so that you're not wasting ingredients before they are even cooked.
- **Find ways of repurposing ingredients -** Try making day-old bread into croutons, or put leftover turkey meat into a soup. Similarly, an innovative chef will be able to transform excess ingredients into a daily special.
- **Train staff to reduce waste -** Make sure your staff knows how much ingredients cost. Train them to treat each ingredient as if they bought it with their own money. Proper preparation techniques also help to reduce waste of perfectly good food.
- **Keep your stock organized -** Make sure that your perishables are getting used in a timely manner by developing a refrigerator rotation system. Many restaurants call this the "first in, first out," system. Use stickers with the packaging date clearly written, or Use First" written in large letters to help staff to recognize exactly which products need to be used quickly to prevent spoilage.
- **Offer staff meals -** If there's just a small amount of ingredients left that won't be enough for another dinner service, you can give it to your staff for free. Feeding your staff raises morale and prevents good food from being thrown away.
- **Consider donating food -** If you have items that are still safe for consumption but, for one reason or another, can't be used, a local food bank may appreciate your contribution to feeding people in your community. Programs like Feeding America make it easy to put those unsellable leftovers to good use. Food banks will sometimes even come to your establishment and pick up food for free, and you can claim these charitable donations on your tax return.
- **Food scraps can be used for animal feed-** Many local farmers will provide low cost or free pickup for food scraps, which can be fed to hogs or other animals. If you go this route, you will want to make sure you are following any local, state, or federal regulations on what can and can't be used for animal feed. It presents another chance to help out the local economy while cutting back on your own food waste at the same time. The EPA offers a guide covering some additional ways to do this.

3.4 Causes of Food Waste Generation

According to (Baldwin & Shakman, 2012), pre-consumer food waste is often caused by the reasons stated in Table 3.2. This table below is the summary of the main causes of food waste in the hospitality industry introduced by Baldwin and Shakman in the book "Greening Food and Beverage Services". The causes are categorised into two types: pre-consumer and post-consumer.

Table 3.2 Causes of pre-consumer and post-consumer food waste (Baldwin &Shakman, 2012)

<table>
<tr><th colspan="2">Causes of Food Waste</th></tr>
<tr><th>Pre-consumer</th><th>Post-consumer</th></tr>
<tr><td>Unidentified demand</td><td rowspan="2">Large portion sizes</td></tr>
<tr><td>Overstocking</td></tr>
<tr><td>Inefficient production</td><td rowspan="3">Inefficient service model</td></tr>
<tr><td>Poor communication</td></tr>
<tr><td>Staff behaviour</td></tr>
<tr><td>Unskilled trimming</td><td rowspan="3">Customer’s menu acceptance</td></tr>
<tr><td>Over-merchandising</td></tr>
<tr><td>Food Safety</td></tr>
</table>

Food waste is any material that is discarded before or after consumption**.** It is important to shed some light on the reasons why so much food waste is generated in the first place and what factors affect this generation Figure 3.4. Amongst these reasons are poor stock rotation, inappropriate storage of stock, over preparation, poor preparation, and inadequate portion control techniques (Mackenzie et al., 2011). There is also a relationship between the quality of the food served and the waste generated. Fine dining outlets would serve smaller portions of high quality food, reducing food waste. At the same time, such outlets tend to cook dishes from scratch, leading to much more preparation waste on their premises (as compared to when food is procured half prepared, etc.). Yet another determinant of the amount of food waste in a hospitality establishment is the frequency of delivery of ingredients to the hotel/restaurant. More frequent deliveries mean smaller inventories and less wastage due to spoilage. However, this leads to greater costs for the property and so oftentimes the establishments may have to choose buying in bulk despite the risk of greaterwaste. In addition, many high-end hospitality properties pride themselves on the food variety they provide to their guests. More serving dishes tend to lead to more waste. Moreover, this experimentation with new recipes may lead to more waste being generated IN THE kitchen (throwing cooked food away directly as it did not turn out as good as expected).

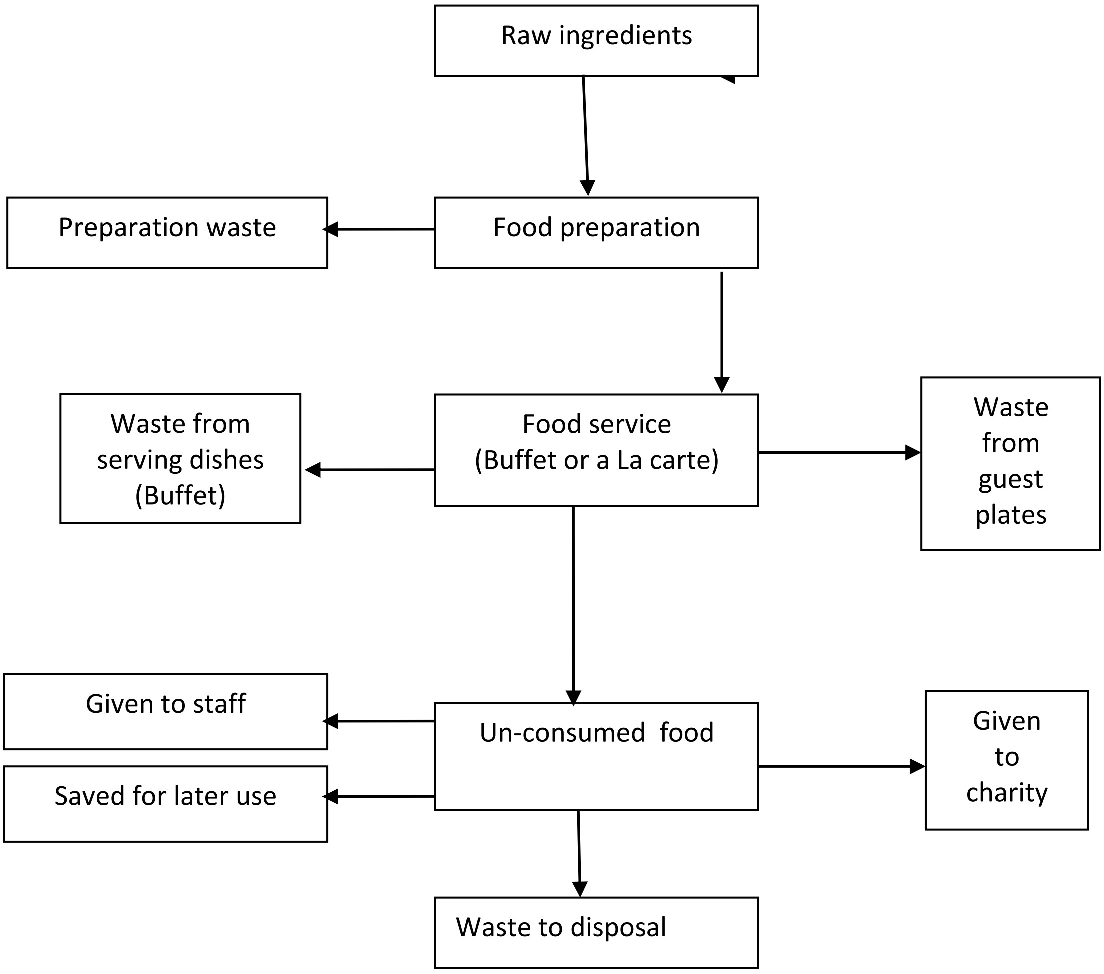


Fig 3.4 Causes of food waste generated

The first and most common cause of food waste is unidentified demand. Kitchen operators sometimes have problems to estimate the number of guests they are going to serve and guess what menu will be the most suitable and cost-effective. If the restaurant offers 6 a wide range of menu and changes them very often, this can be a struggle. In order to improve the forecast, studying the customers' preferences and other factors such as seasonality, weather patterns, and local competition is very necessary. Overstocking is another reason why food service points have to put food to waste. Some restaurants do not want to tell their customers that they cannot fulfill an order, as a result, they end up preparing more than they actually need. This margin of error method might work in many situations but too large margin prediction can lead to waste. Besides, inefficient production procedures also create a great amount of food waste in restaurants. Chefs often refer batch cooking to a method to food waste reduction, however, it depends on the time of the day as well as the size of the batch. For example, the schedule for the breakfast buffet is from 7 am to 10 am and the hotel wants to offer food until 10 am. Yet, the demand is low as it is near closing time. If the hotel still keeps the habit of batch cooking despite the fact that closing time is drawing near, it can create a huge amount of leftover. To prevent creating an unwanted amount of waste, they could offer cook-to-order model or present their food in smaller containers and change the display. Additionally, poor communication among restaurant employees can lead to food waste generation. Communication between the front and the back of the house is very important because when miscommunication happens, due to several reasons such as the physical layout of the operation, language or cultural gaps or limited time, it can result in failure in regulating food production.

Staff behaviour also plays an important role in food wastage control. Staff behaviours can either reduce or contribute to food waste. For example, if a recipe requires four and a half kilograms of beef and the beef package just comes in 5 kilograms, the chef cannot separate the package and leave the rest unused but use up the whole bag of meat. This action does not come with bad intention, however, it has led to an unexpected amount of food waste. Another staff-related cause of food waste is unskilled trimming. Vegetables, fresh fruits, and meat need to go through trimming and preparing phase to be ready for use. Staff members should acquire appropriate kitchen skills training and anticipate skills to produce food without creating so much waste. Furthermore, over-prioritizing merchandising creates an enormous amount of food waste. It is understandable that operators want their merchandising products to stay fresh, beautiful, and plentiful on the shelves. Nevertheless, this can result in an excessive amount of products wasted by the end of the day. On the other hand, although food safety comes as the first priority at any food service point, it contributes immensely to the dispose of food. Food with any issues regarding timing, temperature or handling should be discarded for the consumers' health reasons. Still, lessons should be learned from the mistakes so that they will not be repeated again. In terms of post-consumer food waste, Shakman lists three main reasons. The first reason is large portion sizes. More than often, the portion sizes are way bigger than what the customers can actually consume. In addition, inefficient service model can generate a significant amount of food excess. Self-service food points such as cafeterias, buffet restaurants, and other non-commercial food service operations allow their guests to take more than what they can eat. Also, customer's menu acceptance can contribute to waste in a sense that when customers do not enjoy some part of the condiments, some certain ingredients, or the quality of the served food, they usually refuse to finish their meals. (Baldwin &Shakman, 2012)

3.5 Reducing Plate Waste

The control of portion sizes is also a very substantial factor. Hotels and restaurants must ensure that their serving sizes are big enough to please the customer, while not so large that they cannot be finished and waste is generated. Of course, appetites vary from one person to another and so cooking the right amount in such a way that all guests are pleased is virtually impossible. Other factors which greatly contribute to the production of food waste in the hospitality sector include the style of food service and the inaccurate forecasting of consumer demand. For instance, the "ala carte" style of service is known to generate less waste than the buffet style of service (Hackes et al., 1997). In terms of consumer demand, while the establishments try to be as accurate as possible in their demand forecasts to avoid over-spending on ingredients, not having enough food to fulfill customer demand is not a risk most establishments are willing to take and so they prefer cooking an extra percentage of food to be safe. Reducing plate size has also been shown to help decrease food waste, In buffet-type restaurants, posting signs telling guests that they can help themselves to the buffet more than once may also help.

The ratio of food waste generated from customer leftovers is shown in Figure 3.5. Certainly, it is the diversity in menu offered in restaurants that affects the food waste from plates. However, it is clear that customers are likely to leave salads, starchy food such as potato, rice or pasta, and also bread. Main courses do not tend to get wasted (Silvennoinen, et al., 2015)

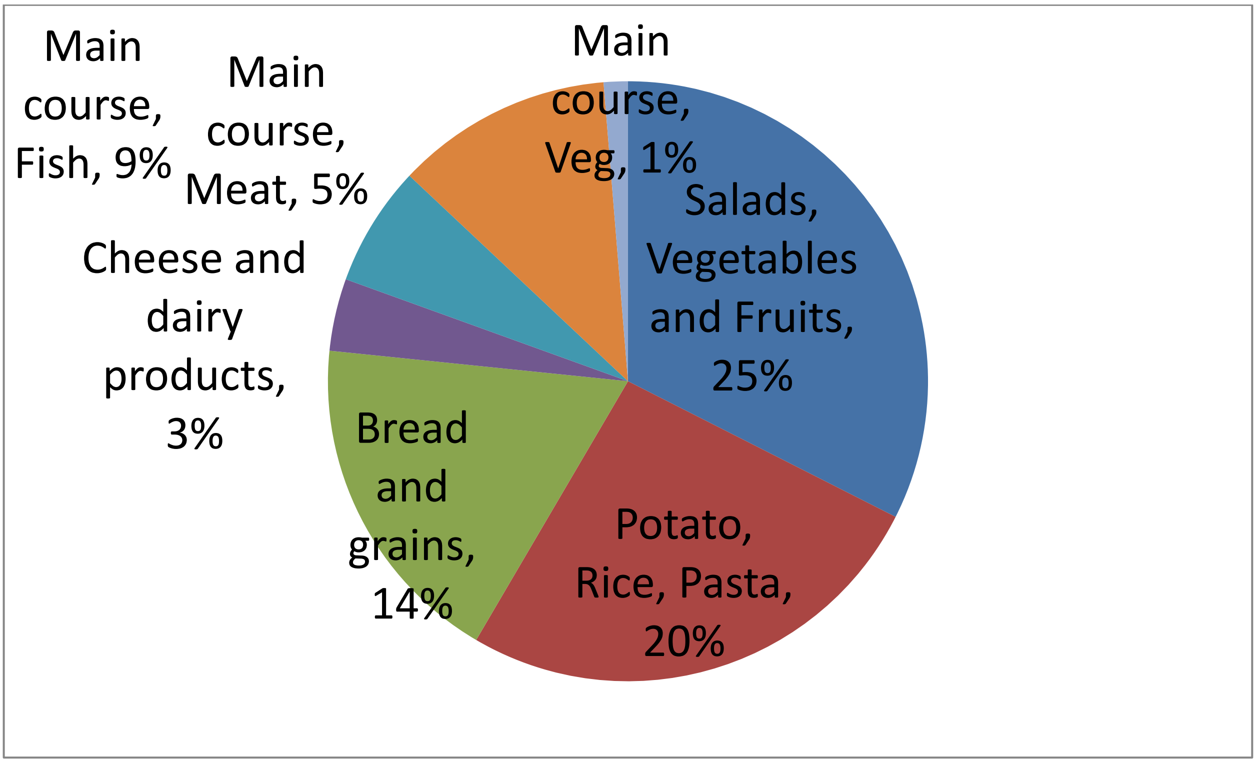


Fig3.5 Ratio of food waste generated from customer leftovers

Summary

There is a need for characterization and quantification of solid waste in the hospitality sector, food waste is the most significant component of hospitality waste, being approximately 40% of the waste from hotels and 60% of the waste from restaurants. Various global organizations, initiatives, and legislations targeting waste food reduction in the hospitality industry have led to solid waste minimization. One such strategy is waste mapping, a relatively new approach to waste management but has the potential to help significantly decrease the waste generated in the hospitality sector. Waste management in the hospitality industry has improved considerably in the past 15years. The sustainability of the hospitality sector depends upon the managers of the various establishments which make up this sector.

Resources

World Travel and Tourism Council "Economic Impact Report" 2017.

References

- Afsanehsadat Omidiani ,Seyed Mohsen Hashemi Hezaveh, Waste Management in Hotel Industry in India: A Review, International Journal of Scientific and Research Publications, 2016 Volume 6, Issue 9, 670-680.
- Baldwin, C. J. &S hakman, A., 2012. Food Waste Management. In: Greening Food and Beverage Services: A Green Seal Guide to Transforming the Industry. Washington D.C.: Green Seal Inc., pp. 57-58
- Bartone, C. 2000. Strategies for Improving Municipal Solid Waste Management: Lessons from a Decade of World Bank Lending. Bangkok, Thailand: International Workshop on Creating Sustainable Cities through Urban Environmental Management, Asian Institute of Technology, 6-8 March 2000.
- Cox, P., 2002. Waste Mapping. University College Northampton.
- Creedon, M., Cunningham, D., Hogan, J., 2010. Less Food Waste More Profit: A Guide to Minimising Food Waste in the Catering Sector. Clean Technology Centre, Cork Institute of Technology, Ireland.
- Curry, R. 2012. The Composition of Waste Disposed of by the UK Hospitality Industry (No. RES093-001). Waste and Resources Action Programme (WRAP), United Kingdom.
- Dilbag Singh, Amandeep, Food Waste Management: Study of Indian Hotel Industry, International Journal of Creative Research Thoughts (IJCRT) Volume 6, Issue 1 February 2018, 1383-1385.
- Envirowise, 2009. Waste Mapping: Your Route to More Profit, http://www.wrap.org.uk/sites/files/wrap/WRAP_Waste_Mapping_Guide.pdf, Accessed on 16.02.2019 at 1.40 am.
- Ferris, D.A. (1995). A comparison of methodologies used for waste characterization in foodservice operations, Dissertation. Kansas State University, Manhattan, KS.
- Hackes, B.L., Shanklin, C.W., Kim, T., Su, A.Y., 1997. Tray service generates more food waste in dining areas of a continuing-care retirement community. J. Am. Diet. Assoc. 97, 879e882. http://dx.doi.org/10.1016/S0002-8223(97)00213-7.
- HVS 2012, Hotel Room Supply, Capital Investment and Manpower Requirement by 2021.

- J.A. Rudmi Chehanika Sandaruwani and W.K. Athula C. Gnanapala / Procedia Food Science 6 (2016) 133 – 135.
- Kirk, D. 1995. Environmental management in Hotels. International Journal of Contemporary Hospitality Management, Vol. 7(6), pp.3–8
- Mackenzie, Murray & Cheung, Catherine & Law, Rob. (2011). The Response of Hotels to Increasing Food Costs due to Food Shortages. Asia Pacific Journal of Tourism Research. 16. 395-416. 10.1080/10941665.2011.588869.
- MSW Manual. 2000. Manual on municipal solid waste management. Government of India, Ministry of urbandevelopment
- National Restaurant Association. (2000). 2000 Restaurant Industry Pocket
- Neary, M., 2010. Food Waste Prevention Case Study: Intel Corporation's Cafes [WWW Document]. City of Hillsboro and Oregon Department of Environmental Quality. http://www.leanpath.com/docs/FoodWastePrevention_DEQ.pdf (accessed 19.03.14.).
- Nusbaum, E. F. (1977). A study of Waste from a Commercial Kitchen. M.S thesis at Cornell University.
- Owen, N., Widdowson, S., Shields, L., 2013. Waste Mapping Guidance for Hotels in Cyprus: Saving Money and Improving the Environment [WWW Document].The Travel Foundation; Cyprus Sustainable Tourism Initiative. http://media.visitcyprus.com/media/b2b_en/News_Releases/Waste_Mapping_Guidance_Hotels.pdf (accessed 18.02.14.).
- Pryce, A. (2001). Sustainability in the hotel industry. Travel and Tourism Analyst. 6. 95-114.
- SAVE FOOD: Global Initiative on Food Loss and Waste Reduction, Food and Agriculture organization of the United Nations, http://www.fao.org/save-food/resources/keyfindings/en/ Accessed on 16.02.2019 at 2.05 am
- Shanklin, C.W. (1998). The role of dietitians in environmental protection. In Proceedings: The2"' Asian Congress ofDietetics, pp. 104-109, Asian Dietetic Assoc., Seoul, Korea.
- Sanaa I. Pirani, Hassan A. Arafat, Solid waste management in the hospitality industry: A review, Journal of Environmental Management, Volume 146, 15 December 2014, Pages 320-336
- Silvennoinen, K., 2016. Finland – Country Report on national food waste policy, Helsinki: European Commission (FP7), Coordination and Support Action – CSA.
- Vikas Mohan, Bansal Deepak, Sharma Mona (2017). Reduction and management of waste in Hotel Industry.International journal of engineering research and application, Vol 7 issue 7 pp34-37.
- Dan Ruben, Executive Director, Boston Green Tourism
- https://www.webstaurantstore.com/article/140/how-to-reduce-waste-in-restaurants.html

Chapter 4 Good Practices

Without change, the hospitality industry's environmental footprint will only expand as international tourism is expected to grow 4 to 5 percent in 2018. By 2030, the United Nations World Tourism Organization (UNWTO) anticipates the travel and tourism industry will need to sustainably manage a daunting 1.8 billion international tourists. Effective waste management practices will become critical to maximizing profits and reducing resource consumption. The average person in the U.S. generates more than 4 pounds of waste per day and landfill costs are on the rise. In 2017, the average price to dispose municipal solid waste (MSW) increased 3.5 percent from 2016 to $50.60 per ton. While hospitality industry leaders recognize the need for change, they face unique challenges – a transient workforce, multiple cultures under one roof, and a waste stream as diverse as a small city's. But, with a little perseverance, gumption, and creativity, hoteliers will find that their trash holds the key to cost savings and opportunity.

Food waste is as a component of the waste stream of the hospitality sector. Therefore, no ecofriendly waste management solution for the hospitality sector can be complete without some policy and/or action plan related to food waste. It is known that of all the different types of waste, food waste is one of the most important materials to divert from landfills due to the fact that it decomposes to create methane, a potent greenhouse gas which significantly contributes to climate change (United States Environmental Protection Agency, 2012).

Objectives

- To enlist the good practices for waste reduction in Hotels
- To work out strategy to reduce waste and maximize recovery

Structure

4.1 Good practices

4.2 Prevention and Reduction of food waste

4.3 Recovery of food waste

4.4 Recycling

4.5 Energy recovery from food waste

To Do Activities

- Enlist good practices and measures adopted by local eateries in your local area
- Study eco hotels who have attained a zero waste policy

4.1 Good Practices

Hospitality food waste has been defined as food that is unwanted and disposed of, such as leftovers from guest plates and peels from meal preparation that occur during cooking (Pirani & Arafat, 2016). Wang et al. (2017) posit that hospitality food waste should exclude non-edible items that occur during the cooking and consumption process, such as bones and seeds, residual oils, natural flavourings and colorants. The best, most cost-effective and environmentally friendly solution is to stop food becoming waste or surplus in the first place - being eaten is always the best option for food! However, food you cannot use does not always need to become waste. Distinguish between 'surplus food' and 'waste'. Even the best-run kitchens generate some food waste, so what you can't reduce, prioritise for treatment as per the Figure 4.1. Legislation and availability of local services will also affect your choice of options so check locally and apply the best option according to the food recovery hierarchy above.

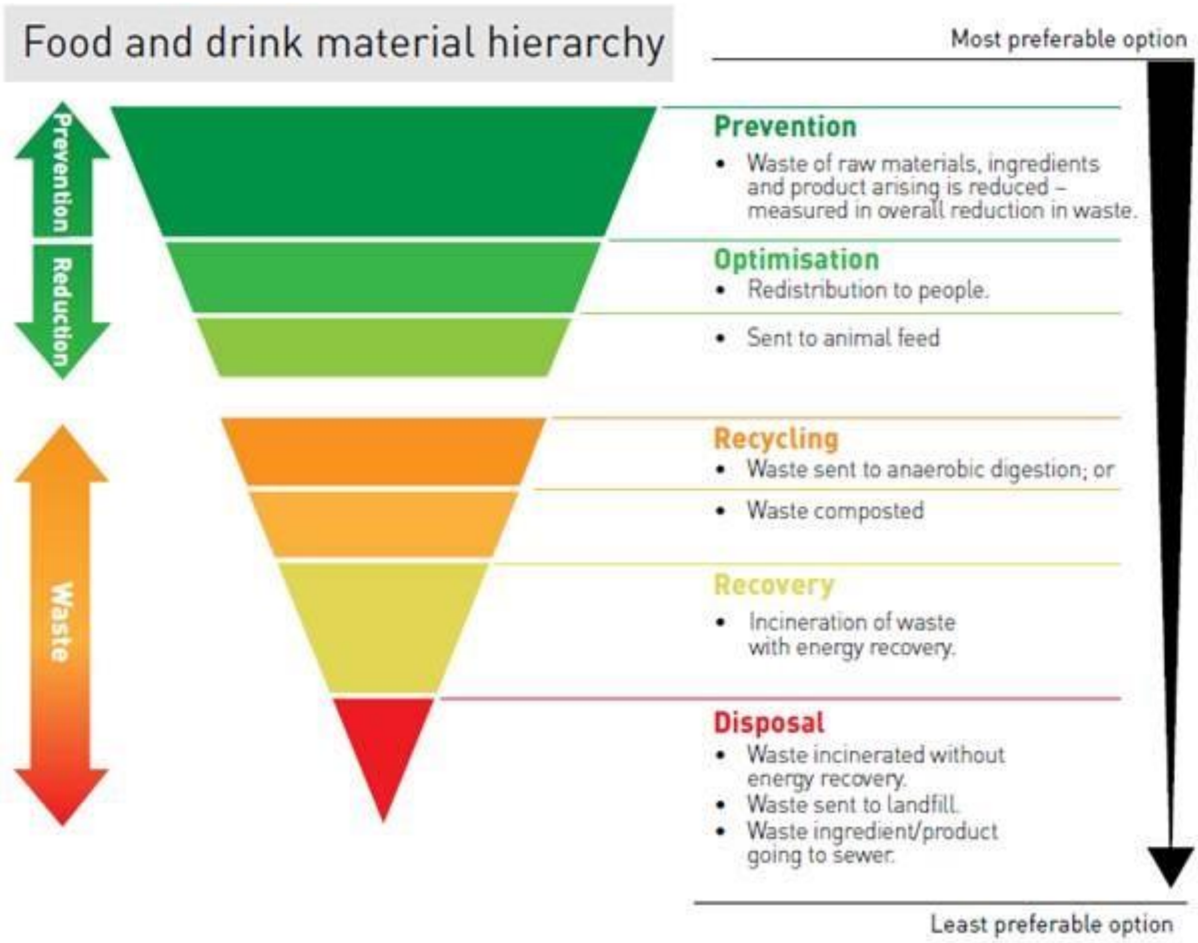


Fig 4.1 Solutions for treatment and disposal of waste

At this point it would also be advisable to be aware of the classification of food waste as in the following table.

Table 4.1 Classification of food waste

Type of waste/origin of waste	Kitchen waste, preparation and cooking	Serving waste, left from cooked and prepared meals	Customer plate leftovers
Food waste Originally edible (OE)	Spoiled products, incorrectly prepared food, expired date products	Overproduction, food left from the buffet	Food leftovers by customers on plate
Bio waste Originally inedible (OIE)	Inedible parts of vegetables, coffee grounds and bones	Inedible parts of vegetables, bones	Vegetable peelings, bones

Cost savings can be achieved through various procedures such as (1) planning of purchasing and design of menu, (2) storage of food materials, (3) handling of food materials, (4) donation of surplus food, and (5) recycling of food waste. Your greatest savings and gains will come from first focusing on waste avoidance and reduction, followed by reuse and recycling. Good practices for hotel sector are as enlisted in Table 4.2

Table 4.2 Good practices for waste reduction in Hotels

Steps	
Planning	Primary steps to avoid or reduce food waste at source.
Storage	
Handling	
Donation	Secondary steps to reuse surplus food and recycle unavoidable food waste respectively
Recycling	
Training and Education	Ancillary steps to render support to food waste reduction efforts.
Monitoring and Audit	
Partnership	

4.2Prevention and Reduction of Food Waste

Up to a third of all food is discarded or spoiled prior to consumption, according to the Food and Agriculture Organization of the United Nations. That's a stark contrast to the 800 million people around the world who do not have enough food. Even worse is the fact that 19 percent of all the waste found in landfills which contributes to the production of greenhouse gases is made up of food.Hotelsare not immune to this issue of food waste. Only a bit more than half of the food that hotels serve in a buffet is actually eaten, not only contributing to waste but also further hurting the already slim profit margins in the foodservice industry by throwing away the remaining 40 percent of food (ReFed, 2016).

Table 4.3 Steps to avoid food waste at source

PLANNING-Policy Formulation • Develop food waste management policy with clear objectives, procedures and goals, or embed food waste management in companies' Environmental Policy/ Environmental System Purchasing • Avoid over-purchasing, over-stocking and unnecessary spoilage • Inspect food quality upon delivery Menu Design • Properly plan and regularly review menu • Obtain feedback from guests on their preferences for portion size and meal types; effectively forecast customers' demand on food • Provide lighter portion for dishes in the menu according to customers' need • Proactively offer different portion options
STORAGE • Adopt FIFO (first-in-first-out) system for stored food • Store food with proper control of stock level, conditions, approaches & procedures, etc. • Return unused food back to refrigerator immediately • Inspect and maintain proper functioning of storage facilities regularly HANDLING • Avoid over-trimming in the preparation of bulk meats and whole vegetables • Make good use of surplus food and/or food trimmings for second dish • Reuse pre-consumption food • Properly handle and prepare food (including procedures, temperature, personal hygiene, pest control and equipment handling, etc.) to prevent contamination and to minimize spoilage

Waste prevention is the highest priority in the waste hierarchy according to the revised EU Waste Framework Directive. According to the directive member states must develop waste prevention programmes to be issued no later than December 2013. Food waste prevention can also be linked to the new EU plans for a resource-efficient Europe – a Flagship initiative under the Europe 2020

Strategy. According to the communication from the Commission to the European Parliament some concrete ambitions for 2020 were proposed (Norden, 2012):

- 20% reduction in the food chain´s resource input
- Disposal of edible food waste should have been halved
- This work on resource efficiency is again linked to the process of Sustainable production and consumption within EU

The two main factors that need to be taken into account when tracking food waste are how much food is being wasted and how many people are visiting a restaurant. This gives a better idea of where the biggest source of waste is. A food log system helps keep track of what is being thrown out, why it's being thrown out, and how much is wasted. The next step is to keep an inventory of food sits around too long in storage and make sure that the hotel is not over-ordering to maximize the shelf life of perishable products. Train staff to be waste-conscious and efficient, and create a food waste strategy with the help of the hotel's chef to minimize waste in ways such as repurposing ingredients. Preventing spoilage can prove to be a major source of reduction in food waste as listed in Table 4.3.

Table 4.4 Conserving resources at storage and handling

Review stock management and food delivery processes for food items with a short shelf life. Ensure stock is rotated as new deliveries come in (first in, first out). Store stock correctly at the right temperature, in the right packaging, labelled and with dates Using some pre-prepared, frozen or dried ingredients can reduce wastage. And remember, you can freeze most foodstuffs – even eggs! Be familiar with reservations forecasts and do not over-order or over-prepare. Is 20% extra a good buffer on a busy day? Can another 20% be kept frozen for contingencies? Track the menu for slower-moving dishes. Customers don't need too many choices and keeping the menu simple reduces the possibility of waste. Be imaginative with your menus-Consider what perishable ingredients or trimmings can be used in different ways, e.g. fish trimmings or bones for stock, bread for breadcrumbs or croutons, ingredients for pate & soups, etc., and plan menus accordingly to use these ingredients, e.g. by offering daily specials. And why not offer potatoes with skin on? Excess preparation and ingredients close to their use-by date could be made available for staff meals.

Monitor the portion sizes served to guests through staff observations. Manage customer expectations by preparing and serving dishes exactly as described on the menu. Track the popularity of each dish and cook accordingly. Encourage diners to take any of their leftover food home with them. Also, consider offering staff meals or donating the remainder of the food. Get the hotel's team onboard with the challenges of implementing a food waste strategy. Make the team aware of the problem of food waste and implement strategies that will change how things are traditionally done in the kitchen.

Collaborating as a team is critical to putting a strategy into action. Also, considering the turnover levels in the foodservice industry, it is important to having food waste management training in place for new staff.

4.3 Recovery of Food Waste

Food recovery captures food donations from businesses and transports it to organizations that feed the hungry, such as food banks and soup kitchens. The Roadmap demonstrates that food recovery can double nationwide, increasing by roughly 1.8 billion meals (1.1 million tons). Common barriers to food recovery include liability concerns among food businesses, fragmented food safety regulations, a lack of transportation and storage infrastructure capacity, and the extra financial burden associated with food donations. Food recovery networks differ widely by region and geography. Rural communities often face higher transportation costs to reach people in need, while urban communities may lack food sourcing and procurement channels from farms and food manufacturers.Identify donation opportunities arising from food preparation (pre-consumption food) and surplus food based on local requirements and/or established guidelines. Donate surplus food to food recycling banks or charitable organizations in compliance with local requirements and/or established guidelines. Identify recyclable and non-recyclable food waste for ease of separating and collecting food waste for recycling. Below are five ways to reduce food waste and better manage a hotel's food production. The best way to use excess food is to feed hungry people. Many charities around the world will collect excess food, including prepared food, to provide for the needy, though note there may be various legal and health and safety requirements to check with your legal team and with the charity in question. Many hotels and companies small and large, including Hilton Worldwide, have risen to the challenge. The process will depend on the market and capabilities of the food bank. Identify food banks or agencies that can accept prepared food and then identify hotels in the area they operate that might want to participate. The food bank or agency can then work with the hotel to determine the types of food they can take and the process for storing. In many cases it is easier to freeze and schedule regular (e.g. weekly) pick-ups. Some organisations may be able to pick up the same day and maintain the heated or cooled product directly to the end recipient but arranging logistics for small regular donations can be difficult. Note that the existing food banking infrastructure/economics is set up to maximize large volumes of non-perishable items from donors like grocers or manufacturers, so accommodating relatively smaller donations and perishable food can be challenging, but it is worth exploring and is a very rewarding activity. The act of donating leftover food in hospitality establishments to the needy or an agency is the norm in many places. Various organizations around the world are engaging in collecting untouched leftover food from hospitality establishments and distributing that food directly to individuals in need example "Annakshetra Foundation" in India.

The food recovery ecosystem requires three pillars to scale:

1) enabling policy that financially incentivizes donations from businesses while providing standardized food safety regulations,

2) education for businesses on donor liability protections and safe food handling practices, and

3) logistics and infrastructure to transport, process, and distribute excess food.

4.4 Recycling

Recycling is a resource recovery practice that refers to the collection and reuse of waste materials such as empty beverage containers. The materials from which the items are made can be reprocessed into new products. Material for recycling may be collected separately from general waste using dedicated bins and collection vehicles, a procedure called curb side collection. In some communities, the owner of the waste is required to separate the materials into various different bins (e.g.,for paper, plastics, metals) prior to its collection. In other communities, all recyclable materials are placed in a single bin for collection, and the sorting is handled later at a central facility. The latter method is known as "single-stream recycling" (OECD, 2007; Wilson et al., 2006). The most common recycled material from hotels include aluminum such as beverage cans, copper such as wire, steel from food and aerosol cans, old steel furnishings or equipment, polyethylene and PET bottles, glass bottles and jars, paperboard cartons, newspapers, magazines and light paper, and corrugated fiberboard boxes. This can be useful in generating substantial revenue in terms of savings of hauling fee and salvage value of the waste, apart from savings to environmental degradation. In addition, a major portion of the waste include recoverable materials that are organic in nature, such as plant material, food scraps, and paper products. It can be recovered through composting and digestion processes to decompose the organic matter. The resulting organic material is then recycled as mulch or compost for agricultural or landscaping purposes. Also, waste gas from the process (such as methane) can be captured and used for generating electricity and heat (Federation of Canadian Municipalities, n.d.; UNEP, 2005). Choose the most appropriate waste management solution for your needs. When entering into a contract for food waste recycling, or other waste collections, make sure that the service meets your requirements and won't incur additional costs. Make sure you ask the right questions. Ask the waste management contractor for your data. Having data on how much waste is going to landfill, being recycled or going to AD will help to understand current levels of recycling. This information can then be used to identify further opportunities. Monitor how this changes on a regular basis. Do the maths. Recycling waste doesn't attract landfill tax and may cost less. If you are already recycling packaging, it's worth speaking to the waste contractor about other services including food waste collections. Get staff on your side. Engage staff to recycle more by helping them to understand which waste goes in which bin. It is key for staff to 'buy in' to initiatives so that they see the benefits. This will encourage participation and help increase recycling rates. Work together. Consider working with neighbouring businesses to procure food waste and recycling collections, where appropriate. There may be efficiencies/economies of scale to be made by working together. Where larger scale is needed, see what you can do on a national or industry scale.

Fig 4.2 Recycling of soap bars by an NGO Sundara

The recycling process for soap bars takes a total of seven minutes. The outer layer is scraped down so no part that has touched someone's skin is reused. The bar is then sanitized with a bleach and alcohol solution as well as a sanitizing tablet donated by Sealed Air, a chemical company. The bars are shredded down, sprayed with the sanitizing solution again, and placed in a soap press that compacts them into blocks. The new bars are then cut into smaller pieces and readied for distribution. Through outreach, solicitation, and partnerships, bars of soap are collected by housekeeping in some 30 hotels. It takes time to get hotels on board—in Mumbai alone, Sundara works with 20 hotels but could take on 60. Each housekeeper is given a special bag or bin to collect the used bars of soap, which are then dropped off at various workshops, where they go through a sanitizing process. About 25 percent of Sundara's soap goes to urban slums, and the other 75 percent goes to rural villages. To date, almost 16,700 bars of soap have been handed out.

Sundara works with a network of 30 schools to distribute the soap to students, and it also works with medical clinics. Sundara representatives deliver the soap to the schools and clinics and provide instruction on hand washing and hygiene. The organization's largest workshop is in Mumbai.

Recycling offers the most scalable path to reducing food waste nationally, enabling 9.5 million tons of annual waste diversion — nearly three-quarters of the total Roadmap potential. Recycling food waste through distributed or centralized processing diverts food scraps from landfills and transforms it into beneficial soil amendments, clean biogas, or animal feed. Municipalities have increased interest in food waste recycling due to shrinking landfill capacity, improving economics, and greater awareness of positive environmental impacts. Many programs are driven by state and local policies, including landfill bans, renewable energy incentives, and direct economic incentives. Food waste is typically combined with other organics recycling programs such as lawn clippings and manure. A municipal recycling program depends on three elements to remain healthy: homes and businesses that consistently put food scraps into separate bins, haulers that have enough economic incentive to pick up separate loads of food scraps and deliver them to recycling facilities, and processing facilities that remain profitable through sufficient access to feedstock material, financing, and end markets.

4.5 Energy Recovery from Food Waste

Organic waste or the food waste from hotels can be very useful when mixed with the green waste or horticulture waste to produce good quality compost and soil conditioner. This organic or natural compost is very useful for the long-term sustainability of the soil and produces healthy fruits and vegetables on a continuous basis. Most of the time this waste goes to the landfill because it gets mixed with non-compostable waste material like plastic and aluminum foil etc. It is also observed that hotels do not segregate them at the source. A common reason may exist from lack of commitment due to being unaware about the benefits to the business and environment, and a proper facility to process it. A probable solution is to create a regional infrastructure, which can handle this type of waste. It was observed that tons of dry leaves during the fall season can be turned to rich organic compost, if a mechanism can be created to bring the abundant food waste (wet waste) from the hotels and restaurants and processed properly.

Composting- Hotel organic waste can be reduced by composting as a best alternative. It is a biological process of decomposition of organic wastes within certain condition like proper ventilation, temperature, moisture and carbon and nitrogen ratio(MSW Manual, 2000). Composting is nature's way of recycling wherein organic waste, such as food waste and garden clippings, is biodegraded and turned into valuable fertilizer. In its simplest form, the advantages to composting are twofold; it reduces the amount of solid waste in your trash and, when used in a garden, it fertilizes the soil and is a perfect soil conditioner. Composting is basically depending on the nature of waste and its decomposition process. In the manual of municipal solid waste management (MSW manual, 2000) there are two methods of composting describes i.e., aerobic and anaerobic. Compost bins can be purchased or made simply from wire mesh and lined with old carpet or cardboard for insulation. Open bins must be covered with carpet or plastic sacks to keep out the rain, positioned away from the building and made rodent-proof. In hot and/or dry climates, it is necessary to moisten the material occasionally with water so that it can decompose. The compost should be ready for use after 6–12 months, when it has turned dark brown and smells sweet and earthy.

A great variety of bins for hygienic, odourless composting are now available, including in-vessel units for mixed food waste, so it is worth researching the market. Some units are designed to be buried in the ground and are able to produce compost in just a few weeks. Apart from that another form of composting is vermicomposting, in which various species of earthworm are used to convert organic waste into manure (Nath, 2014). The same can be used to derive/recover.

Fig 4.3 Composting of food waste at SonevaFushi

Through extensive recycling efforts SonevaFushi is able to recycle over 81% of its solid waste. How does the luxury resort in the middle of the Indian Ocean do this in a country with almost no municipal waste facilities?

From the Hotel it was found that they have developed a state of the art waste management facility called Eco Centro, at the property with the recycling mantra Waste-to-Wealth. The key to their achievement is taking care of organic waste. Typically 50% of waste for hotels is organic. The team has set up a forced aeration composting system that handles all food waste and elements of the garden waste. By adding air to the composting piles they are able to speed up the composting process and produce rich nutrient soil. With the nutrient compost, they has been able to develop an extensive network of Herb & Vegetable Gardens - 3,000 m^2on what otherwise is sandy and salty soil not suitable for growing crops - supplying the kitchen with 9,000 kg of fresh produce per year. It is built on permaculture and organic principles. 100% of herb requirements and about 30% of salads are supplied from the garden, reducing carbon emissions from imports. For the chef it is great to be able to work with fresh ingredients and one regular guest comment is how good the rocket salad tastes. This is of course attributed to the fact that it comes straight from the garden and has not been transported for several days before it gets to the guest plate. One of its restaurants – Fresh in the Garden - is even built over one of the Herb & Vegetable Gardens. For the team working at Eco Centro, waste was seen as a resource and they created value from what others regard as waste. Anaerobic Digestion-It involves the breakdown of biodegradable material in the absence of oxygen by micro-organisms called methanogens. The process of AD provides a source of renewable energy, since the food waste is broken down to produce biogas (a mixture of methane and carbon dioxide), which is suitable for energy production. The biogas can be used to generate electricity and heat to power on-site equipment and, where the infrastructure exists, the excess electricity can be exported to the National Grid.

Biofuel from waste cooking oil Oil and grease can pose a threat to vegetation and wildlife if allowed to enter water courses. Many countries provide a national oil collection network for caterers and restaurants. When cool, collect used cooking oil in a secure container, avoiding contamination with other liquids such as water. It can then be collected by a specialist company for cleaning and blending for use in animal feed, soap or cosmetics production and, increasingly, to make bio-fuels. Austria for example runs a scheme enabling kitchen fat to be collected and turned into bio diesel and biogas energy. In many places it is a legal requirement that oils and fats from frying processes are collected. Oils can be put to great use by being recycled into biofuels for vehicles. The volumes produced by a hotel can be significant, for example The Savoy London's kitchen oil recycling scheme to biofuel averages around 1,800 litres per quarter. Many commercial services exist, many which pay for fats, so check what's available in your locality.
Other measures include Incineration and garbage disposal.

Case study: At Le Manoir au Quat' Saisons, recycles waste fats (oils and butters from cooking) using a local company called Arrow Oil, who supply Fat Bins (Le Manoir and Arrow Oil split the cost of purchasing the bins 50-50). These are stored in a separate outdoor refrigerated unit to stop unwanted smells, leakages and pests and are collected on a weekly basis. The fat is recycled into biofuel; Arrow Oil then gives us 25p per litre [in 2012] back. The biofuel currently fuels Arrow Oils transportation. Le Manoir comment; "This project was a great success…and results already show a great saving from recycling the fats. It also has eased our manual handling techniques and is a cleaner more efficient system of storage. In 2011 17,290 litres of cooking oil was reclaimed from Le Manoir, this gave our Eco Brigade & staff welfare fund £2247.70 + VAT. Some of this money has then been invested back into kick starting our conversion of our light bulbs into LED bulbs."

Incineration

This is also known as combustion where the waste is burned at high temperatures to convert it to gaseous and residue products. The advantage of this method is the ability to reduce the amount of waste and also decreasing the space required for a landfill. This thermal treatment of waste uses the incinerators to convert the materials into steam, heat, gas, and ash. In the South East Asia, the countries lack adequate space for creating new landfills and therefore the incineration process is being considered as the best option.

Garbage Disposal

A garbage disposal is an electric unit that is used to dispose of soft food waste by grinding and flushing them down the drain. It has been one of the agendas of various environmental conservation meetings and forums all over the world. The new hotels in the Southeast Asian countries are being encouraged to use garbage disposal to dispose of their food waste products. This will reduce overloading the already limited number of landfills. Garbage disposals grind food stuff and mix with water, and then the liquid waste is flushed and directed into the sewer line through the main drain (Azilah, 2006).

Measure your food waste-Case study

For a trial period, e.g. A week, start collecting food waste in three separate bins (one each for preparation, spoilage and plate waste), where appropriate, to understand where and why this waste arises. Weigh them daily to find out where the most food waste is being generated. This should include food that would otherwise have ended up in the sink disposal unit. Remember that this is going to present a challenge to staff to do things differently so preparation is key – make sure staff understand why you are doing this and get on board.

You can record this on a Food Waste Tracking Sheet (see above), available via WRAP or US EPA. Try to monitor and track food waste, including monitoring the composition of plate waste.

wrap Working together for a world without waste

Food Waste Tracking Sheet

Unilever Food Solutions Inspiration every day

Use this tracking sheet to record the amount of food waste generated in the kitchen during 3 typical days or over a longer period for a complete picture. Remember every time you fill a 240 litre bin with waste food it is costing your business around £240! This is based on a material bulk density for food waste from http://www.wrap.org.uk/content/kerbside-analysis-toolkit-recycling-and-waste-collections.

1. To get the best information on where your waste is being generated, separate and monitor all food waste for the following three waste streams – a) spoilage, b) preparation waste and, c) Customer plate waste (leftovers).
2. Weigh the amount of food waste that is generated (use kilograms) OR record the number of times you fill the bins in each day (make a mark every time you fill the waste container as overleaf). ***Note***: You will need to work out the volume of the bins you collect the waste in (use litres). You can estimate the volume of a bin by filling it with water using a litre container.
3. If you record the volume of waste, you can also estimate its equivalent weight (see below). Multiply the total volume of waste by 0.55 (a standard factor used to convert volume to weight).
   For example, Waste stream 1: If you use a 5 litre bin and you fill it 5 times, then the weight is estimated as (5 litres x 5 bin fills) x 0.55 = 13.75 kg
4. Ensure all other non-food waste (e.g. plastic, cardboard, etc.) is put into a separate bin ready for recycling.

Day	Date	Spoilage		Preparation Waste		Customer Plate Waste	
		Number of bins filled	Weight (kg)	Number of bins filled	Weight (kg)	Number of bins filled	Weight (kg)
1							
2							
3							
Bin Volume (litres)							
*Total Volume (litres)							
Total Weight (kg) (see 3 above)							

*Total volume (litres) = bin volume x number of bin fills

Fig 4.4 Food waste tracking sheet

Case Study: At The Hyatt Regency London, The Churchill, four staff teams were asked to create short videos on waste handling. All four were played in the staff restaurant, to the amusement of associates who saw their senior managers ridiculing themselves. The success of this strategy was combining a clear message with a lot of fun which staff would talk about and remember.

Summary

Waste production from hotel industries is one of the major issues in Indi because waste is not treated well. Therefore, develop a holistic framework for waste management has important role in the optimization of each waste material in hotel industry. Most of the wastes in hotels are recyclable or compostable. The hospitality industry can not only make environmentally friendly contributions, but also make profits out of a proper recycling practice in a long-term. Waste elimination at source and recycling can saves GHG emission to a large extent. Therefore, it can decrease pollution and slow down global warming, which is a major problem mankind is facing nowadays.

Resources

A textbook of Vermicompost, Vermiwash and Biopesticides, by Keshav Singh Gorakh Nath, 2014.

Prevention of food waste in restaurants, hotels, canteens and catering Jarle Marthinsen and Peter Sundt (Mepex Consult AS) Ole Kaysen (Econet AS) Kathrine Kirkevaag (KlarKommunikasjon) TemaNord 2012:537.

References

- Azilah Kasim (2006) The Need for Business Environmental and Social Responsibility in the Tourism Industry, International Journal of Hospitality & Tourism Administration, 7:1, 1-22, DOI: 10.1300/J149v07n01_01 To link to this article: https://doi.org/10.1300/J149v07n01_01
- ReFedA Roadmap to Reduce U.S. Food Waste by 20 Percent — Executive Summary, 2016 www.refed.com/downloads/Executive-Summary.pdf (Accessed on 15.02.2019 at 21.15)
- http://www.wfp.org/hunger/stats
- http://epa.gov/climatechange/ghgemissions/gases/ch4.html
- Five Ways to Reduce and Manage Food Waste in HotelsBy Erich Lawson, September 11, 2018, https://lodgingmagazine.com/five-ways-reduce-manage-food-waste-hotels/ Accessed 15.02.19
- Food Waste Reduction Good Practice Guide for Hotel Sector Food Wise Hong Kong Campaign May 2013, https://www.foodwisehk.gov.hk/pdf/GPGuide_Hotel_en.pdf (Accessed 15.02.19 at 23.50)
- OECD, 2007. Improving Recycling Markets, Available at: http://www.oecd.org/env/waste/38093900.pdf
- UNEP, 2005. Solid Waste Management. Chapter III: Waste Quantities and Characteristics, Available at: http://www.unep.org/ietc/informationresources/ solidwastemanagementpublication/tabid/79356/default.aspx
- Wilson, D.C., Velis, C., Cheeseman, C., 2006. Role of informal sector recycling in waste management in developing countries. Habit. Int. 30, 797–808.

Chapter 5 Waste Audit in Hotels

5.1 Auditing of Waste in Hotels

Hotel industry generates a lot of waste and most of the time it is sent to the landfills without being treated properly. The first step in managing the data analysis of waste is to perform waste audit. Waste Audit is identifying the process of productivity from waste management practices in hotels.

A first step towards a waste management program is waste audit. Auditor will investigate the audit sheet waste which is classified into recyclable, compostable and inert waste. Recyclable wastes are those which can be processed by alternative techniques or procedure and convert into by-products or any useful material. Compostable wastes like food waste, leftover foods, kitchen waste, etc. are recycled in the form of composting and converted in to manure for gardening. Finally, inert waste like laminated plastic products or mixed waste that are not in the position to convert it in to any valuable item are directly sent to the landfills. Audit was conducted randomly, without any prior notification given to these hotels to ensure unbiased information is obtained and avoid any deliberate action by hotels to manage their recycling status.

Objectives

- To know the importance of waste audit in hotels
- To know how to conduct waste audit and tools needed for it

Structure

5.1 Auditing of Waste in Hotels

5.2 How to Perform a Waste Audit

5.3 Tools Used to Conduct Waste Audit

5.4 Identification of Process of Profitability from Waste Management Practices in Hotels

5.5 Restaurant Food Waste Reduction Ideas

To Do Activities

- Visit a nearby hotel or restaurant and conduct a waste audit and submit a report on the same
- Invite a guest speaker from Hotel Industry and facilitate interaction with students

How to conduct a Waste Audit?[11]

Fig 5.1 Conducting Waste Audit

First step to a waste management program is a waste audit. During a waste audit, the auditor investigates the sources, composition, weight, volume, and destinations of the waste. By learning more about the trash the hotel generates, one can be better informed about the products that contribute to waste and be better prepared to more efficient disposal, saving money and improving green hotel's environmental performance.

How to Start a Waste Reduction & Recycling Program[12]

First step in waste reduction and recycling program is preparing a checklist to evaluate the environmental impact of frequently used products in the Hotel. Checklist will also facilitate in identifying the best disposal method of waste. Table 5.1 shows checklist format for hotel waste.

---

[11]Shroeder (2016) http://www.seradesign.com/2016/02/waste-audits-the-dirty-work-of-office-sustainability/

[12]https://www.ecogreenhotel.com/green_hotels.php

Table 5.1 Hotel Waste Checklist

Product Used	Reduce	Reuse	Recycle	Replace		Product Used	Reduce ReuseRecycleReplace			
Aerosols						Mattresses				
Air Conditioner						Menus				
Aluminium appliances						Metal items				
Batteries						Mirrors				
Bedding						Motor oil				
Bleach						Newspapers				
Bleach Bottles						Office equipment				
Brochures						Oil (kitchen)				
Cans (aluminium)						Oil(engine)				
Cans (tin)						Oven cleaner				
Card						Packaging				
Carpet remnants Cleanser						Paints and solvents				
Corrugated boxes						Pencils and Pens				
Computer Paper						Paper cups,towels				
Cooking oil						Pesticides / herbicides				
Detergent boxes						Photocopyingpaper				

Dishes						Pots and pans				
Disposable pens						Printed matter				
Dry cleaner						Room booklets				
Electrical equipment (e.g. hairdryers, vacuum cleaners irons, kitchen equipment, etc.)						Plastic bags Bottles, buckets, Shower curtains				
Electronic equipment (computers, TVs, mobile phones, etc.)						Shampoo				
Furniture						Shoe bags				
Glass bottles						Stationery				
Laundry bags						Styrofoam				
Leaves / grass clippings						Tissue Paper				
Light bulbs						Toxic and hazardous materials				
Magazines and books						Window envelopes				
Matches						Wood				

After identifying the checklist of products that impact environment, following eight basic steps need to be planned and implemented for waste reduction and recycling program in hotels:

Fig 5.2 Steps in Planning and Implementing a Waste Reduction and Recycling Program

5.2 How to Perform a Waste Audit

To ensure proper management of waste and recycling efforts are carried out, performing multiple waste audits at different seasons during the year is crucial. Here are a few things to note:

1. Ensure proper safety measures. Provide thick gloves to sorters, and make sure everyone has had a tetanus shot. Be sure to inform and educate the hotel's staff on health and safety matters.
2. Ensure proper confidentially measures. The waste stream may contain personal and private information that should be kept confidential.
3. Enlist staff from each hotel department and form your waste reduction team. The help of housekeeping, custodial staff, and waste haulers is invaluable to a successful waste audit. These personnel can assist in gathering your hotel's waste and can also provide logistical insights about your recycling and waste management system.
4. Keep the timing of the audit a secret. By keeping the timing of a waste audit secret, you ensure that the waste you analyze is a truly representative sample of the waste your green hotel generates at a particular time of year. If people are informed in advance of the date of a waste audit, they may increase their recycling efforts or otherwise alter their behavior.

5. Collect waste. Work with waste haulers, staff, and concessions managers to collect the waste. Make sure that everything collected is clearly labelled by date and location.
6. Sort waste. Sort the collected waste by type, noting paper; cardboard; recyclable and non-recyclable plastics, glass, and metals, food waste, batteries, and so on. Make sure to note recyclable materials that have not been diverted for recycling.

Analyze results and make recommendations. What is the composition of your hotel's waste stream? How much can a hotel increase its recycling? By what methods can an eco-friendly hotel increase its recycling? How can waste be collected more efficiently? What are the opportunities to reduce waste generation? How can a sustainable business save money by altering its waste management systems? The below table 5.2 shows a format for conducting Waste audit.

Table 5.2 Basic Audit Form

Waste Item	Approx Annual Quantity		Current Disposal Route	Current Disposal costs per annum (Rs.)	Reduce	Reuse/ Recycle	Replace	Action	Cost (Rs)	Approx Annual Saving (Rs)
	Kg	litres								
Total										

5.3 Tools Used to Conduct Waste Audit

Warm Model

Due to increase in consumption pattern, life style, food habits and culture in India, the organic or compostable wastes in hotels are higher. Since it is usually not segregated at source, it becomes unfit for composting. Thus wastes composted generate low or poor quality of compost. It is because of this reason, the various wastes to energy (WTE) or combustion plants are either shut down or operate at a loss.

Waste materials like aluminium cans, steel cans, all type of papers, cardboard and plastics are easily recycled among hotels in India. Remaining wastes like inert materials and mix waste (non-segregated waste) mainly wet waste, goes to the landfill. In WARM model, the first step is to calculate baseline scenario. It is used to calculate the emission according to current practice of waste disposal. Next step in WARM model is alternate scenario which is suggestive in nature, and shows that if the waste is utilized/managed properly by recycling, composting or combustion depending on the type of waste, can lead to reduction in total emission.

$$\frac{\text{Daily generation (in kgs) x 365}}{1000} = \text{Emission generation ratio}$$

WARM tool recognizes 54 material types as shown in the table below. Warm model is periodically updated as and when new material categories and revisions are made to existing numbers and methodology.

Table 5.3 Types of Material Recognized by WARM[1]

Aluminum Cans	**Food Waste (non-meat)**	**Mixed Recyclables**
Aluminum Ingot	Food Waste (meat only)	Newspaper
Asphalt Concrete	Fruits and Vegetables	Office Paper
Asphalt Shingles	Glass	Personal Computers
Beef	Grains	Mixed Plastics
Branches	Grass	PET (polyethylene terephthalate)
Bread	HDPE (high-density polyethylene)	Phonebooks
Carpet	LDPE (low-density polyethylene)	PLA (polylactic acid)
Clay Brick	Leaves	Poultry
Concrete	LLDPE (linear low-density polyethylene)	PP (polypropylene)
Copper Wire	**Magazines/Third-Class Mail**	**PS (polystyrene)**
Corrugated Cardboard	Medium Density Fiberboard	PVC (polyvinyl chloride)
Dairy Products	**Mixed Metals**	**Steel Cans**
Dimensional Lumber	Mixed MSW (municipal solid waste)	Textbooks
Dry wall	Mixed Organics	Tires
Fiberglass Insulation	Mixed Paper (general)	Vinyl Flooring
Fly Ash	Mixed Paper (primarily from offices)	Wood Flooring
Food Waste	Mixed Paper (primarily residential)	Yard Trimmings

Equivalency Calculator

Equivalency calculator is a tool developed by United States Environment Protection Agency (USEPA). This tool was used to show the optimum utilization of GHG emission to other sector. It may be useful in communicating the greenhouse gas reduction strategy, reduction targets, or at reducing greenhouse gas emissions. It is useful in communicating the GHG reduction strategy and in reducing GHG emissions.

It calculates the emissions of passenger vehicles, gasoline and oil consumed tanker trucks, propane cylinders, burning rail cars, emissions from waste sending to the landfill and emissions from power

[1] https://www.epa.gov/warm/basic-information-about-waste-reduction-model-warm

plants.

Cost Benefit Analysis

Cost benefit analysis, helps in analyzing the potential of waste management and its positive implementation to the hotel industry and also to the environment.

Net benefit = Benefit - Cost

Methods of Waste Treatment

There are various methods for waste treatment according of the nature of waste. There are:

1. Treatment of recyclable waste
2. Treatment of compostable waste

Treatment of Recyclable Waste

Paper waste is treated with repulping technique to convert paper and paperboard products. Plastic waste are treated with the help of Extruder Machine, Injection moulding, Blow moulding, Film blowing and depolymerisation Process (the plastic is melted and chemically broken down) and Fluidized bed reactor to convert into bottles and jar. Metal waste is treated with the help of Ferrous metal shears. Garden waste and food waste is treated with the process of composting and converting in to manure. Textiles waste is treated with the help of remanufacturing process, Lyocell process, Patagonia process and Textile incineration to convert into reusable cloths. Glass waste is treated with Cullet- Glass crusher. Metals waste is treated with the help of Ferrous metal shears. Garden waste and food waste are treated with the process of composting and convert manure from it.

Treatment of Compostable Waste

Hotel organic waste can be reduced by composting as a best alternative. It is a biological process of decomposition of organic wastes within certain condition like proper ventilation, temperature, moisture and carbon and nitrogen ratio. Compost is useful manure and perfect soil conditioner. Composting is basically depending on the nature of waste and its decomposition process. There are two methods of composting describes i.e., aerobic and anaerobic. Apart from that another form of composting is vermin composting, in which various species of earthworm are used to convert organic waste into manure.

Model and Framework Development

A holistic framework is developed to educate hotel industry about the effective waste management is a revenue source. The framework helps in saving costs on local vendors and labor costs for handling waste. Hotel waste management is classified in to profitability aspect and sustainable aspect. Treatment of waste in hotels is a crucial issue to be dealt with. Thus, it is mandatory for hotel industries to develop a complete framework which helps in optimizing the waste generated in the industry and also reduces environmental impact.

Monitoring and Benchmarking Progress

Monitoring the results of completed actions and ongoing efforts are important. Establish check points to monitor the success of each action either daily or weekly or monthly. Benchmarking can help identify opportunities for savings in the hotel and will enable to compare performance against that of similar hotels. An example of a waste benchmark for a luxury hotel in Europe with reasonable recycling facilities might be between 0.6 and 1.2kg of waste per guest per night. To calculate simple waste benchmarks:

- Calculate the volume (litres) or weight (kg) of non-hazardous waste sent to landfill over the last full calendar year. You can find this information on your waste disposal bills, from your waste contractor, or you may need to conduct your own survey.
- Exclude any materials that are separated on-site and recycled but include wastes that are not segregated on site but are recycled by a contractor at a later date.
- Divide the total volume or weight by the number of guest nights spent at the hotel over the past calendar year.

Table 5.4 Waste Benchmarks for Luxury Hotels[2]

Hotel profile	Parameter	Benchmark value for waste produced		
		EXCELLENT	SATISFACTORY	HIGH
Luxury serviced hotels	litres / guest night	< 3.0	< 5.0	< 7.0
	kg / guest night	< 0.6	< 1.2	< 2.0

The above table shows waste benchmarks for luxury hotels. The results fall into three categories as below:excellent, satisfactory and high.

It is recommended that weight (kg) is measured for greatest accuracy.

[2] http://www.greenhotelier.org/wp-content/uploads/2014/09/4-Waste-for-web-1-1.pdf

5.4 Restaurant Food Waste Reduction Ideas

To track food waste in a restaurant there are two main factors to consider, how much food is being wasted and the number of customers coming to the restaurant. By gathering data of these two variables we can understand the bigger source of waste. Three important waste types in a restaurant are Pre-Consumer waste, Post-Consumer waste and Disposables.

Pre-Consumer Waste

It is the waste which can be controlled by ordering, storing, preparing and cooking the ingredients as per requirement and not in surplus. The inventory needs to be evaluated and the ingredients have to be properly stored to maximize their shelf life.

Train staff with proper preparation techniques to reduce waste. Keep the stock organized by using stickers with packaging dates clearly written.

Leftover food can be offered to staff or donate to food banks and the food scrap can be used for animal feed.

Post-Consumer Waste

Consumers in restaurants would not eat all the food that they order and the leftovers typically end up being discarded for disposal. Simply put, Post-Consumer waste is the waste that individuals routinely discard either in a trash can or in a dump by incinerating or pouring down the drain. Below are some of the effective methods hotels could use in reducing Food Waste.

- Changing the menu
- Making hotel purchases wisely
- Educating the staff

- Investing in high-quality kitchen equipment
- Changing serving quantities
- Conducting inventory checks in the restaurant regularly
- Restaurant Waste Recycling
- Encourage guests to take the leftover food with them

Disposables

Disposables are the items which are intended to be thrown away after a single use. Plastic bags, plastic containers, plastic cutlery are the disposable items mostly used in a restaurant which create unnecessary wastage and pose a significant environmental problem. To reduce usage of disposables try to use biodegradable items wherever possible.

Use reusable dishware for serving food. Eliminate excess packaging. Provide training to staff on optimal usage of disposable items. Separate garbage from the food materials and do composting. Plastic bottles, cans, glasses, plates, cardboard and glass waste can be recycled and reused to reduce environmental pollution. Assess food waste regularly so that you can monitor trends and implement any necessary changes.

Food waste is organic and can be completely recycled. It is one of the important renewable energy resources and the most common transport to landfills for composting. Plastic bottles, cans, cardboard boxes, wooden pallets and paper materials can be either reused or recycled. Making a contract with a local company for recycling may earn money from waste generated and can even get a free service of waste transport. And finally buying products made from recycled materials will support recycling programs and contribute to the sustainability of life.

Summary

Waste production from hotel industries is one of the major issues in India because waste is not treated well. Therefore, develop a holistic framework for waste management has important role in the optimization of each waste material in hotel industry. Most of the wastes in hotels are recyclable or compostable. The study shows that hotels can not only make environmentally friendly contributions, but also make profits out of a proper recycling practice in a long-term. Waste elimination at source and recycling can saves GHG emission to a large extent. Therefore, it can decrease pollution and slow down global warming, which is a major problem mankind is facing nowadays.

Proper waste management strategy shows that a thorough literature review along with expert's interviews done by researcher, waste audit form for the calculation of waste volume can be prepared. Then the impact of waste on environment was calculated with the help of WARM Model and equivalency calculator. And the next most important analysis is cost benefit. And the last step is to develop the best framework or model which explains the value of profitability and sustainability. Waste Management is serious issue that needs public awareness and governmental attention immediately.

Self Assessment Questions

Discuss in teams the tools used to conduct waste audit.

Further Reading

- Tupen, Holley (2014), 'Reducing And Managing Food Waste In Hotels', http://www.greenhotelier.org/know-howguides/reducing-and-managing-food-waste-in-hotels/
- International Tourism Partnership (2008): Environment Management For Hotels The Industry Guide To Sustainable Operation
- American Hotel & Lodging Association (AH&LA). 2014. History of Lodging. http://www.ahla.com/content.aspx?id¼4072
- https://www.hotel-online.com/press_releases/release/effective-ways-of-waste-management-in-the-hotel-industry-and-its-importance
- https://www.nea.gov.sg/docs/default-source/resource/3r-guidebook-for-hotels.pdf
- http://www.wrap.org.uk/sites/files/wrap/Food_Waste_Tracking_Sheet_v1.1_0_050115.pdf, Food Tracking Form
- $19,000 saving in food cost- https://www.unileverfoodsolutions.com.au/chef-inspiration/chef-training-and-resources/managing-food-waste/waste-reduction-a-success-story.html

Video Links

- $19,000 saving in food cost - https://www.unileverfoodsolutions.com.au/chef-inspiration/chef-training-and-resources/managing-food-waste/waste-reduction-a-success-story.html , Accessed on Nov 28, 2018 @ 16:00

References

- Baveja G, Muralidharar S, Aggarwal P. Hospital Waste Management - an overview. Hospital today2000; 5(9): 485-486.
- Bio-Medical Waste (Handling and Management) Rules 1998Availablefrom: http://www.moef.nic.in/legis/hsm/biomed.html[Last accessed on 2014 Jan 20].
- Centre for Science and Environment. Bio Medical Waste Rules made stringent. Available from: http:/www.cseindia.org/node/3702[Last accessed on 2014 Jan 20].

- EU Directive on Incineration of Hazardous Waste 2000/76/EC;http://faolex.fao.org/cgi-bin/faolex.exe?rec_id=030016&database=faolex&search_type=link&table=result&lang=eng&format_name=@ERALL
- Mathur P, Patan S, Shobhawat S. Need of biomedical waste management system in hospitals - an emerging issue - A review. Curr World Environ 2012;7:117-24.
- Omidiani, Afsanehsadat and HashemiHezaveh, Seyed Mohsen (2016) Waste Management in Hotel Industry in India: A Review , International Journal of Scientific and Research Publications, 6(9).
- Pasupathi P, Sindhu S, Ponnusha BS, Ambika A. Biomedical waste management for health care industry. Int J Biol Med Res2011; 2: 472-486.
- Shanklin CW, Petrillose MJ, Pettay A (1991) Solid Waste Management Practices in Selected Hotel Chains and Individual Properties. J Hosp Tour Res 15(1):59–74. https://doi.org/10.1177/109634809101500106
- Singh N, Cranage D, Lee S (2014) Green Strategies for Hotels: Estimation of Recycling Benefits. Int J Hosp Manag43:13–22. https://doi.org/10.1016/j.chemosphere.2007.10.024
- Singh, N., Cranage, D., and Lee, S. 2014. Green strategies for hotels: Estimation of recycling benefits. International Journal of Hospitality Management, 43, 13-22.
- Tang, J. 2004. A Case Study of a Hotel Solid Waste Management Program in Bali, Indonesia. http://www.collectionscanada.gc.ca/obj/s4/f2/dsk3/OWTU/TC-OWTU373.pdf
- Vishal Khandelwal, Sushma Khandelwal, Jandel Singh Thakur. Healthcare waste disposal among private dentist in an Indian city: it's time to act. Int J Infect Control2013, v9:i2 doi: 10.3396/ijic.v9i2.016.13.
- WHO (1985). Management of waste from hospitals and other health care establishments. Report on a WHO meeting, Bergen, 28 June-1 July 1983. Copenhagen, World Health Organization Regional Office for Europe (EURO Reports and Studies, No. 97).
- Zein, K., Wazner, M.S., Meylan, and G. 2008. Best Environmental Practices for the Hotel.

Block 3

Bio-Medical Waste Management

Swachhta Action Plan

Mahatma Gandhi National Council of Rural Education

Department of Higher Education

Ministry of Human Resource Development, Government of India

Hyderabad - 500004

सत्यमेव जयते

Where there is Rural Wellbeing there is Universal Prosperity

Contents

Chapter1 Biomedical Waste and Sources
1.1 Introduction to Biomedical Waste
1.2Sources of Biomedical Waste
1.3 Classification of Biomedical Waste
1.4 Color Coding and Guidelines of Segregation
1.5 Types and Responsibilities of Health Care Facilities

Chapter2 Impacts on Health
2.1 Diseases Epidemiology and Mode of Transmission
2.2 Health Impacts due to Biochemical Waste Mismanagement
2.3 Persons at Risk
2.4 Workplace Hazards
2.5 Safety Precautions

Chapter 3 Legal Aspects
3.1 Legislation, Policies and Law for Biomedical Waste Management
3.2 Biomedical Waste Management and Handling Rules
3.3 Safe Disposal of Radioactive Waste Rules
3.4 International Guidelines on Management of Wastes From Hospitals
3.5 Budgeting and Record Maintenance

Chapter4 Steps Involved in Biomedical Waste Management
4.1 Biomedical Waste Management Overview
4.2 Steps Involved in Biomedical Waste Management
4.3 Methods for Segregation and Disinfection of Waste
4.4 Requirements of Common Biomedical Waste Management Facility
4.5 Treatment and Disposal

Chapter 5 Management and Administration
5.1 Collection of Waste
5.2 Infection Control System in Hospital
5.3 Off-site Transportation
5.4 Safety Practices and Emergency Measures
5.5 Waste Minimization and Zero Waste Hospital

Glossary and References

Biomedical Waste Management– An Introduction

Earth is not inherited; it is only to be held in trust for generations to come! Just like natural resources have to be used sensibly whenever required, for the sake of future generations, nature too needs ever to be saved in an ideal way, taking every single vital safeguard that science has defined. The self-centered and careless inclination of humans, harmonizing the present with future has certainly become a difficult task. Additionally, there is a steady irreconcilable situation with matters identifying with environmental protection.

“Everything comes with a price. You can never gain something if you do not sacrifice something of equal value” – Bargain Cost Theory

The past few decades have witnessed the improvement in the medical science and technology to new level of growth which in turn has caused the expansion of health care facilities all over the world. The increase in a number of health-care facilities thus resulted in an increase in the amount of hazardous biomedical waste manifolds. The risk associated with biomedical waste include accidental exposure of medical staff, waste handlers or *safaikaramcharies*, environment, and the general public due to inappropriate waste management and illegal use of disposables.The organized provisions of the medical care to individuals have the moral responsibility to not only cure but also provide care to the ailing individuals. Thus, it is the responsibilityof health care administrators to ensure patient’s health and safety by keeping the health center clean and environmentally sound. On the other hand, it is also important to consider the safety of service providers while providing health care.

An accurate and workable system for the biomedical waste management at the health-care facilities will save the environment and long-term ill effects on human health from the environmental release of toxic substances such as dioxin, mercury, and others.The involvement of finances and costs at every step of handling, management, and final disposal of biomedical waste play a major role in setting up a path for appropriate biomedical waste management. Of the various processes involved in waste management, the construction, operation, and maintenance of equipment for sterilization and disposal of the waste use most part of the overall budget of a health-care facility if the recommendations of Biomedical Waste Management Rules 2016, if strictly implemented.

There are several kinds of waste generated including human anatomical waste, plastic waste in the form of catheters IV sets, etc., animal waste, microbiology and biotechnology related waste (one of the highly infectious waste and if given a medium, grows at a very fast rate), sharps (it cause puncture, can transmit deadly diseases), expired medicines including cytotoxic drugs, solid waste soiled with blood and other body fluids (including cotton swabs), disposable tubing, chemical waste, to name few of them.

Even though millions of tons of biomedical waste are generated throughout the world, 85% of this waste is non-infectious and non-hazardous. However, if the remaining 15% of the waste which is highly infectious and hazardous gets mixed with the non-hazardous waste due to inappropriate ways of management and disposal, the extent of risk of spreading infectious and transmissible diseases increases beyond imagination. Improper disposal of syringes raise the risk of reuse and spread of deadly diseases like HBV, HCV, and HIV.Nowadays, different techniques are available and employed to dispose of various types of biomedical waste including incineration, autoclaving, microwaving are few to name.

In India, the government has drafted rules known as Biomedical Waste (Management and Handling) Rules, 1998 that “apply to all persons who generate, collect, receive, store, transport, treat, dispose, or handle biomedical waste in any form”. These rules are updated time-to-time, and the Government has recently updated these rules as Biomedical Waste Management Rules, 2016.

In India, among the healthcare facilities the knowledge of rules and resources to implement are available but the attitude to implement these rules in practice is found missing. This is may be due to ignorance of the fact that this type of waste can cause havoc to oneself, to the society, and to the environment. Additionally, low adherence to the best practices for biomedical management could also be attributed to poor training and low level of education among the sanitary staff of the hospitals.

Chapter 1-Biomedical Waste and Sources

Introduction

Biomedical waste is defined as “any waste fabricated during the diagnosis, testing, treatment, research or production of biological materials by either animals or mankind. Broadly, the biomedical waste is generated in the hospitals, nursing homes, clinics, blood banks, animal houses, and veterinary institutes. It contains human tissues, organs animals tissues, skeletons, excreted bodily wastes, parts containing blood and wastes generated at veterinary hospitals. Besides this, waste like attenuated or inactivated vaccines, and human and animal cell cultures used during research are also categorized under biomedical waste. Further, disposal of expired medicines also poses a major challenge”. This biomedical waste is generated from a range of health-care facilities including hospitals, dispensaries, pathological laboratories, nursing homes, veterinary hospitals, clinics, blood banks, animal houses, dentistry clinics, and research institutes. The list will not be complete without mentioning households and education institutes.

According to a report from the WHO published in 2015, millions of tons of biomedical waste are generated throughout the world, 85% of this waste is non-infectious and non-hazardous. However, if the remaining 15% of the waste which is highly infectious and hazardous gets mixed with the non-hazardous waste due to inappropriate ways of management and disposal, the extent of risk of spreading infectious and transmissible diseases increases beyond imagination.

Health-care facility means a place where diagnosis, treatment or immunization of human beings or animals is provided irrespective of type and size of health treatment system, and research activity pertaining to it. Broadly, the biomedical waste is generated in the hospitals, nursing homes, clinics, blood banks, animal houses, and veterinary institutes.

Hospitals produce waste, which is increasing over the years in its amount and type. In addition materials which comes in direct contact with biomedical waste are also considered as biomedical waste originators; the list includes needles, syringes, surgical blades, scalpels, blood stained material or cotton balls, and dirtied plasters are a couple of such examples. The disposed medications, used tubing and catheters, chemicals utilized for purification purposes and any waste consequently developed in laboratories and examinations focus upkeep are all biomedical waste as well.Besides sources of biomedical waste discussed above, one source that is most neglected is a household biomedical waste.

Once the waste is generated, it should be segregated appropriately into different categories according to the color coded containers or bags.

Collecting the information about the type of waste and the amount of waste generated from a health-care facility is one of the crucial first steps in biomedical waste management. The proper assessment of quality (i.e. the physicochemical composition of the waste) as well as the quantity of the waste will guide in assessing and evaluating the capacities for containers, storage areas, transportation that would be required for biomedical waste, the disposal methods and facilities needed. Further, the data on quality and quantity of biomedical waste also help the government and hospital authorities in planning, budgeting, figuring incomes from recycling, streamlining of waste-management systems, and assessment of the effect on the environment.

Objectives

- To know about types of biomedical waste so that we know how to handle them carefully.
- To know what are the sources of biomedical waste

Structure

1.1 Introduction to biomedical waste

1.2 Sources of Biomedical Waste

1.3 Classification of Biomedical Waste

1.4 Color coding and guidelines of segregation

1.5 Types and responsibilities of health care facilities

To Do Activities

Visit the health care facilities and explain the students the sources of biomedical waste

Make students do group presentations by allotting topics to them

Invite a guest speaker from a hospital who deals or takes care of biomedical waste and facilitate discussion

1.1 Introduction to Biomedical Waste

Moses Henry rightly said, "*We have not inherited this world from our parents; we have merely borrowed it from our children*."

Biomedical waste is defined as "any waste fabricated during the diagnosis, testing, treatment, research or production of biological materials by either animals or mankind. Broadly, the biomedical waste is generated in the hospitals, nursing homes, clinics, blood banks, animal houses, and veterinary institutes. It contains human tissues, organs animals tissues, skeletons, excreted bodily wastes, parts containing blood and wastes generated at veterinary hospitals. Besides this, waste like attenuated or inactivated vaccines, and human and animal cell cultures used during research are also categorized under biomedical waste. Further, disposal of expired medicines also poses a major challenge". This biomedical waste is generated from a range of health-care facilities including hospitals, dispensaries, pathological laboratories, nursing homes, veterinary hospitals, clinics, blood banks, animal houses, dentistry clinics, and research institutes. The list will not be complete without mentioning households and education institutes.

There are several kinds of waste generated including human anatomical waste, plastic waste in the form of catheters IV sets, etc. animal waste, microbiology and biotechnology related waste (one of the highly infectious waste and if given a medium, grows at a very fast rate), sharps (it cause puncture, can transmit deadly diseases), expired medicines including cytotoxic drugs, solid waste soiled with blood and other body fluids (including cotton swabs), disposable tubing, chemical waste, to name few of them.

In addition materials which comes in direct contact with biomedical waste are also considered as biomedical waste originators; the list includes needles, syringes, surgical blades, scalpels, blood stained material or cotton balls, and dirtied plasters are a couple of such examples. The disposed medications, used tubing and catheters, chemicals utilized for purification purposes and any waste consequently developed in laboratories and examinations focus upkeep are all biomedical waste as well.

According to a report from the WHO published in 2015, millions of tons of biomedical waste are generated throughout the world, 85% of this waste is non-infectious and non-hazardous. However, if the remaining 15% of the waste which is highly infectious and hazardous gets mixed with the non-hazardous waste due to inappropriate ways of management and disposal, the extent of risk of spreading infectious and transmissible diseases increases beyond imagination (Fig1).

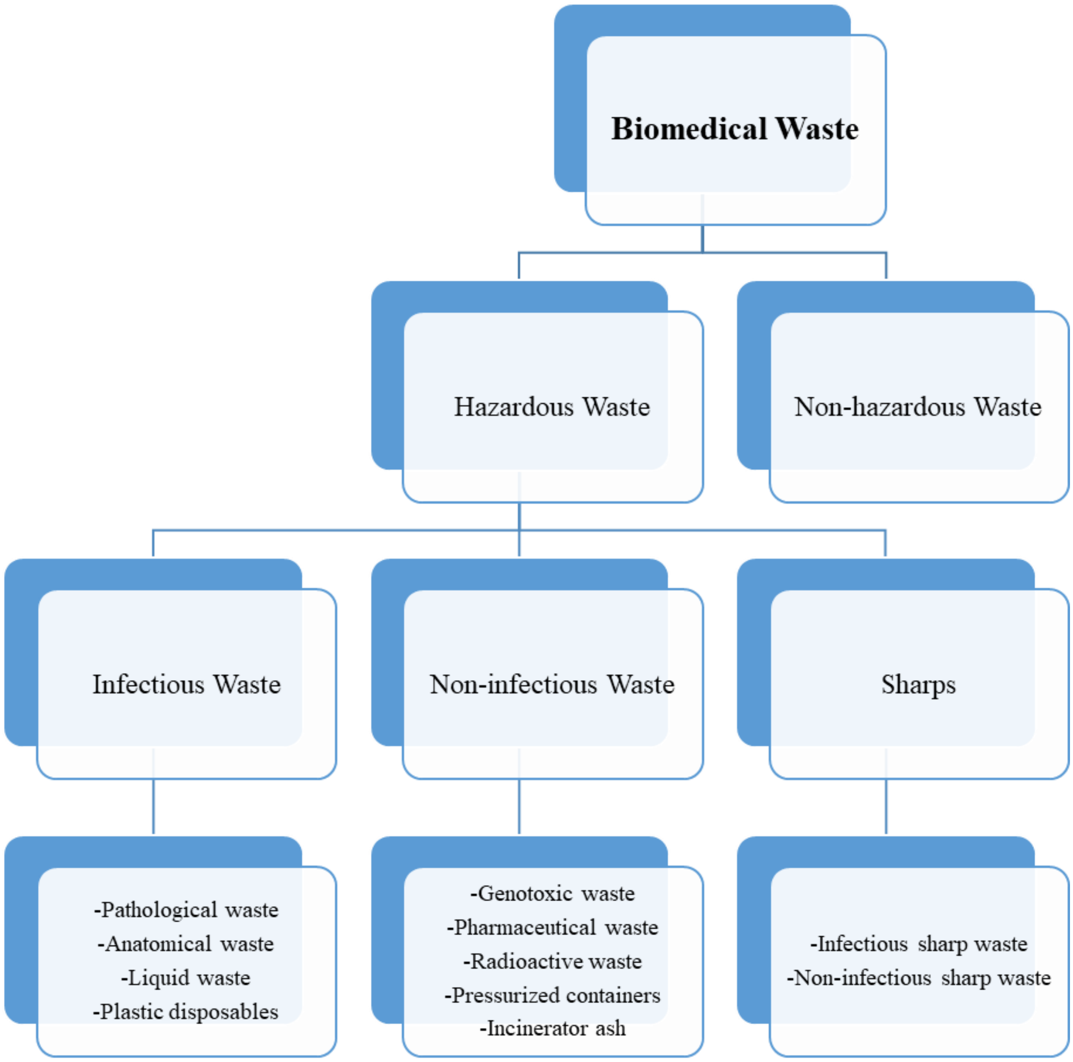


Fig1.1 Classification of Biomedical Waste

As per the official records, the total amount of biomedical waste produced in India is about 484 tons/ day from 1,68,869 health-care facilities (at a rate of 1-2 kg/bed/day in a hospital and 600 gm/bed/day in a clinic). Of this quantum of waste, about 447 tons/day of biomedical waste is treated; 198 common biomedical waste management facilities are functional currently (20 further are under development); 21870 health-care facilities have their own treatment plants while the rest are using the common disposal facilities.

The biggest challenge is the appropriate treatment and disposal of such biomedical waste which causes extensive environmental issues. To protect the environment and maintain the balance of nature developed and developing countries have different standards; developed nations have set down stringent safety standards and measures. The developed countries, Hospital/Biomedical Waste Management units implement the safety standards rigorously adopted from the standard WHO guidelines. However, the developing countries have adopted a casual attitude towards the problems arisen due to such medical waste, thus posing serious damaging effects on the whole community. According to the WHO 2015 guidelines, medical waste management implies routine of minimizing, recognizing, isolating, gathering, taking care of, conveying, stockpiling, treatment lastly transfer of medicinal waste according to the approach of the establishment or government. Nowadays, different techniques are available and employed to dispose of various types of biomedical waste including incineration, autoclaving, microwaving are few to name.

Throughout the world, the management of medical waste generated every year is still at its outset. This topic is still under discussion which causes confusion among the hospitals, practicing medical laboratories (biomedical waste generators), biomedical waste treatment facility operators, policy-makers and the general community, about the proper and safe disposal of this hospital waste. One of the reason could be the lack of responsive and monitoring authorities.

In India, the government has drafted rules known as Biomedical Waste (Management and Handling) Rules, 1998 that “apply to all persons who generate, collect, receive, store, transport, treat, dispose, or handle biomedical waste in any form”. These rules are updated time-to-time, and the Government has recently updated these rules as Biomedical Waste Management Rules, 2016. Considering the health of its citizens, a country should frame its rules and guidelines for biomedical waste management. The world health organization (WHO) has also framed gold-standards guidelines for the appropriate disposal of the waste. Proper implementation of these regulations and regular monitoring in the health-care facilities reduces the risk of biomedical waste associated pollution and diseases by many-folds, thus can help the society in maintaining a better standard of health-care.

Improper disposal of biomedical waste raise the risk of reuse and spread of deadly diseases like HBV, HCV, and HIV. The WHO statistics highlights the fact that in 2010, unsafe injections were responsible for:

1. 33,800 new HIV infections
2. 1.7 million Hepatitis B infections
3. 315,000 hepatitis C infections

Types of Biomedical waste

The biomedical waste is broadly classified as hazardous waste and non-hazardous waste. The *hazardous waste* is the type of biomedical waste that is known to or is suspected to contain infectious material or due to its physical or biological nature it may be harmful to the health of humans, animals, plants, or to the environment. Further, this type of waste requires an additional step of inactivation of the biological material in an approved manner prior to final disposal. The *non-hazardous waste* is a type of waste that does not pose any particular biological, chemical, radioactive or physical hazard to the health of humans, animals, plants, or to the environment. The disposal of non-hazardous waste does not require this additional step of deactivation.

The WHO, in its classification of waste, classifies biomedical waste or hospital waste into the following categories (**Fig2**):

- *Infectious waste*: "waste contaminated with blood and other bodily fluids (e.g. from discarded diagnostic samples), cultures and stocks of infectious agents from laboratory work (e.g. waste from autopsies and infected animals from laboratories), waste from patients in isolation wards and equipment (e.g. swabs, bandages and disposable medical devices), waste that came into contact with infected patients undergoing hemodialysis (e.g. dialysis equipment, disposable towels, gowns, aprons, gloves, etc.), infected animals from laboratories, etc. this type of waste is suspected to contain bacteria, viruses, parasites, or fungi"
- *Pathological waste*: "human tissues, organs or fluids, body parts and contaminated animal carcasses. Healthy body parts are also included in this category even though they are non-infectious"
- *Radioactive waste*: "such as products contaminated by radionuclides with genotoxic effects including radioactive diagnostic material or radiotherapeutic materials. Radioactive waste is generated as a result of in vitro analysis of body tissue and fluid, in vivo organ imaging and tumor localization"
- *Chemical waste*: "chemical waste are the discarded solid, liquid, and gaseous chemicals; for example solvents used for laboratory preparations, disinfectants, and heavy metals contained in medical devices (e.g. cadmium or mercury in broken thermometers or manometers, or dentistry) and batteries"

  Formaldehyde is one such chemical waste which is used to clean and disinfect equipment, preserve specimens, used in pathology, autopsy, dialysis, and nursing units

  X-ray departments of hospitals use photographic fixing and developing solutions; these solutions are also the part of the chemical waste. Further, the list includes a vacuum pump and engine oils, insecticides, rodenticides, acids, alkalis, oxidants, and reducing agents used in the hospitals

Gaseous waste components include gasses stored in pressurized cylinders, or aerosol cans; these containers carry a risk of explosion if incinerated accidently

- *Pharmaceutical waste*: “expired, unused, spilled, and contaminated drugs, prescribed and proprietary drugs, vaccines, and sera; this category also includes the stuff used to handle these pharmaceutical products such as bottles, vials, connecting tubing, gloves, masks, etc.”
- *Sharps*: “sharps include stuff that can lead to cuts or puncture wounds; syringes, needles, disposable scalpels, and blades, knives, infusion sets, saws, broken glass, pipettes, and nails are included in sharps”
- *Genotoxic waste*: “highly hazardous, mutagenic, teratogenic or carcinogenic, such as cytotoxic drugs used in cancer treatment and their metabolites. Faeces, vomit, or urine from patients treated with cytotoxic drugs or chemicals also fall into this category of waste. Other sources of genotoxic waste are the contaminated materials from drug preparation and administration, such as syringes, needles gauzes, vials, packaging, outdated drugs, excess (leftover) solutions, drugs returned from the wards. This is one of the most difficult types of waste regarding safety issues associated with it”
- *Non-hazardous or general waste*: “waste that does not pose any particular biological, chemical, radioactive or physical hazard. Approximately 85% of all waste from health-care facilities is non-hazardous and is similar to municipal solid waste including paper, cardboard, and plastics, discarded food, metal, glass, textiles, plastics and wood”

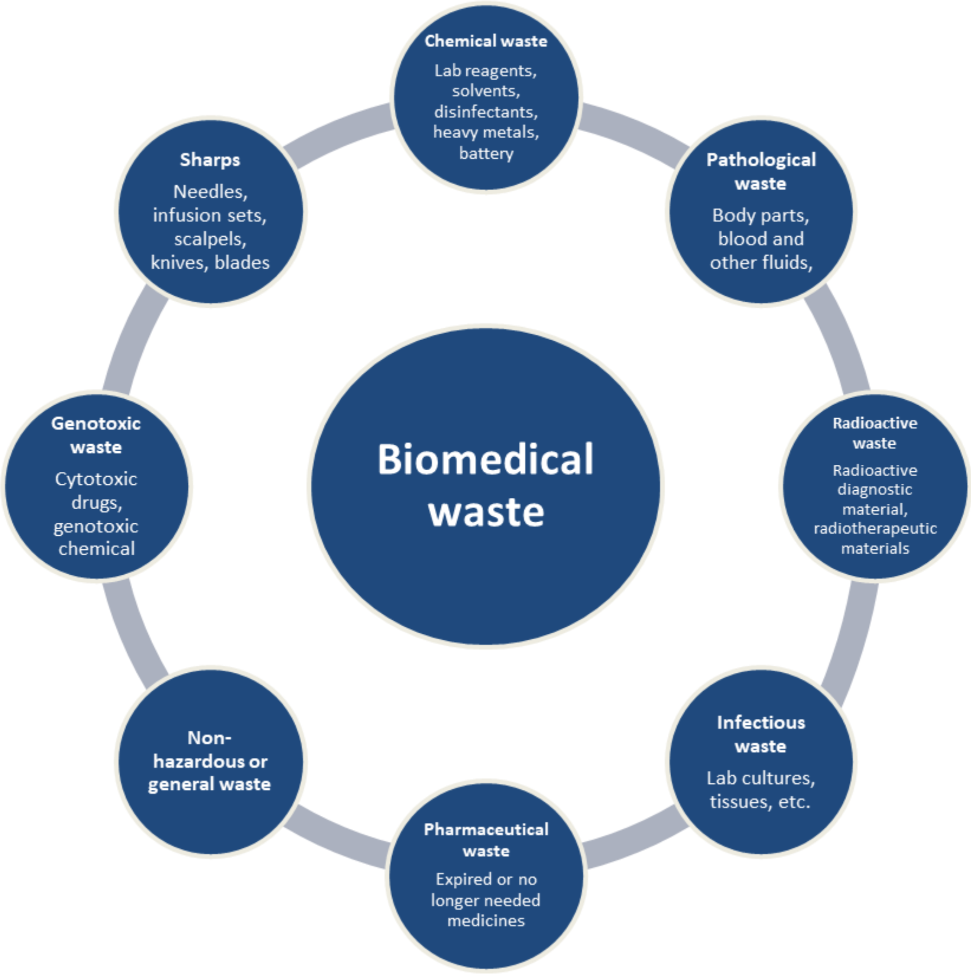


Fig1.1: Types of biomedical waste

1.2 Sources of Biomedical Waste

Hospitals produce waste, which is increasing over the years in its amount and type. The hospital waste, in addition to the risk for patients and personnel who handle them also poses a threat to public health and environment. In addition materials which comes in direct contact with biomedical waste are also considered as biomedical waste originators; the list includes needles, syringes, surgical blades, scalpels, blood stained material or cotton balls, and dirtied plasters are a couple of such examples. The disposed medications, used tubing and catheters, chemicals utilized for purification purposes and any waste consequently developed in laboratories and examinations focus upkeep are all biomedical waste as well.

Besides sources of biomedical waste discussed above, one source that is most neglected is a household biomedical waste. Household biomedical waste, for the most part, comprises of needles and syringes from medications managed at home, (for example, insulin), ruined injury dressings, expendable gloves, and bed sheets or different fabrics that have been presented to bodily liquids. Discarding these materials with consistent household refuse puts waste collectors at danger for harm and contamination particularly from sharps as they can without much of a stretch cut a standard household trash pack.

Table1.1: Biomedical waste from different types of sources

Major sources (hospitals and medical centers)				
	Sharps	**Infectious & pathological waste**	**Chemical, pharmaceutical, & cytotoxic waste**	**Non-hazardous waste**
Medical ward	• Hypodermic needles • Intravenous set needles • Broken vials and ampoules	• Dressings • Bandages • Gauze • Cotton contaminated with blood or body fluids • Gloves and masks contaminated with blood or body fluids	• Broken thermometers • BP gauges • Split medicines • Spent disinfectants	• Packaging • Food scraps • Paper • Flowers • Empty saline bottles • Non-bloody diapers • Non-bloody intravenous tubing and bags
Operation Theatre	• Needles • Intravenous sets • Scalpels • Blades • Saws	• Blood and other body fluids • Suction canisters • Gowns • Gloves • Masks • Gauze and other waste contaminated with blood and other body fluids • Tissues • Organs	• Spent disinfectants • Waste anesthetic gasses	• Packaging • Uncontaminated gowns • Uncontaminated gloves • Uncontaminated masks • Hats • Shoe covers

		• Fetuses • Body parts		
Laboratory	• Needles • Broken glass • Petri dishes • Slides and cover slips • Broken pipettes	• Blood and body fluids • Microbiological cultures and stocks • Tissue • Infected animal carcasses • Tubes and containers contaminated with blood or body fluids	• Fixatives • Formalin • Xylene • Toluene • Methanol • Methylene chloride and other solvents • Broken lab thermometers	• Packaging • Paper • Plastic containers
Pharmacy store			• Expired drugs • Split drugs	• Packaging • Paper • Empty containers
Radiology			• Silver • Fixing and developing solutions • Acetic acid • Glutaraldehyde	• Packaging • Paper
Chemotherapy	• Needles • Syringes		• Bulk chemotherapeutic waste • Vials • Gloves and other material	• Packaging • Paper

			contaminated with cytotoxic agents • Contaminated excreta and urine	
Vaccination campaigns	• Needles • Syringes		• Bulk vaccine waste • Vials • Gloves	• Packaging
Environmental services	• Broken glass		• Disinfectants (glutaraldehyde, phenols, etc.) • Cleaners • Split mercury • Pesticides	• Packaging • Flowers • Newspapers • Magazines • Cardboard • Plastic and glass containers • Yard • Plant waste
Engineering			• Cleaning solvents • Oils • Lubricants • Thinners • Asbestos • Broken mercury devices	• Packaging • Construction or demolition waste • Wood • Metal

			• batteries	
Food services				• Food scraps • Plastic • Metal and glass containers • Packaging
Minor sources				
Physician' offices	• Needles • Syringes • Broken ampoules and vials	• Cotton • Gauze • Dressings • Gloves • Masks and other materials contaminated with blood and other body fluids	• Broken thermometers • Blood pressure gauges • Expired drugs • Spent disinfectants	• Packaging • Office paper • Newspapers • Magazines • Uncontaminated gloves and masks
Dental offices	• Needles • Syringes • Broken ampoules	• Cotton • Gauze • Gloves • Masks and other materials contaminated with blood and other body fluids	• Dental amalgam • Spent disinfectants	• Packaging • Office paper • Newspapers • Magazines • Uncontaminated gloves and masks
Home health care	• Lancets • Insulin injection	• Bandages and other material contaminated with	• Broken thermometers	• Domestic waste

	needles	blood or other body fluids		
Vaccination centers	• Needles • Syringes • Broken ampoules	• Cotton • Gauze • Gloves • Masks and other materials contaminated with blood and other body fluids	• Spent disinfectants • Expired vaccines	• Packaging • Office paper • Newspapers • Magazines • Uncontaminated gloves and masks
Ambulance services, cosmetic piercing	• Needles • Syringes	• Cotton • Gauze • Gloves • Masks and bandages contaminated with blood and other body fluids	• Spent disinfectants •	• Uncontaminated gloves and masks

1.3 Classification of Biomedical Waste

Bio Medical Waste Management Rules, 2016 categorizes the bio-medical waste generated from the health care facility into four categories based on the segregation pathway and color code. Various types of bio medical waste are further assigned to each one of the categories, as detailed below:

Table 1.2: Biomedical waste categories

Category	Type of Waste	Type of bag or container to be used	Treatment & Disposal
(1)	**(2)**	**(3)**	**(4)**
Yellow	• **Human Anatomical Waste**	• Yellow colored non-chlorinated plastic bags	• Incineration • Plasma Pyrolysis • Deep burial*
	• **Animal Anatomical Waste**		
	• **Soiled Waste**		• Incineration • Plasma Pyrolysis • Deep burial* • Autoclaving • Micro-waving/hydroclaving followed by shredding • Combination of sterilization and shredding
	• **Expired or Discarded Medicines**	• Yellow colored non-chlorinated plastic bags or containers	• Expired cytotoxic drugs should be returned back to the manufacturer or supplier for incineration at temperature >1200°C or to common biomedical waste

Category	Type of Waste	Type of bag or container to be used	Treatment & Disposal
			treatment facility or hazardous waste treatment facility for incineration at >1200°C • Encapsulation • Plasma pyrolysis at >1200°C • All other discarded medicines shall be either sent back to manufacturer or disposed of by incineration
	• **Chemical Waste**	• Yellow colored containers or non-chlorinated plastic bags	• Incineration • Plasma Pyrolysis • Encapsulation in hazardous waste treatment facility
	• **Chemical liquid Waste**	• Separate collection system leading to effluent treatment system	• After resource recovery, the chemical liquid waste shall be pre-treated before mixing with other waste water
	• **Discarded linen, mattresses, beddings contaminated with blood or body fluid**	• Non-chlorinated yellow plastic bags or suitable packing material	• Non-chlorinated chemical disinfection followed by incineration or plasma pyrolysis or for energy recovery

Category	Type of Waste	Type of bag or container to be used	Treatment & Disposal
			• In the absence of above facilities, shredding or combination of sterilization and shredding • Treated waste to be sent for energy recovery or incineration or plasma pyrolysis
	• **Microbiology, biotechnology and other clinical laboratory waste**	• Autoclave safe plastic bags or containers	• Pre-treat to sterilize with non-chlorinated chemicals on-site thereafter incineration
Red	• **Contaminated Waste (Recyclable)**	• Red colored non-chlorinated plastic bags or containers	• Autoclaving or microwaving/hydroclaving followed by shredding or combination of sterilization and shredding • Treated waste to be sent to authorized recyclers or for energy recovery or plastics to diesel or fuel oil or for road making • Plastic waste should not be sent to landfill sites
White (Translucent)	• **Waste sharps including metals**	• Puncture proof, leak proof, tamper proof containers	• Autoclaving • Dry heat sterilization followed by shredding or encapsulation in metal

Category	Type of Waste	Type of bag or container to be used	Treatment & Disposal
			container or cement concrete • Combination of shredding cum autoclaving • Sent for final disposal to iron foundries or sanitary landfill or designated concrete waste sharp pit
Blue	• **Glassware**	• Cardboard boxes with blue colored marking	• Disinfection • Autoclaving or microwaving or hydroclaving and then sent for recycling
	• **Metallic Body Implants**	• Cardboard boxes with blue colored marking	

1.4 Color coding and guidelines of segregation

Once the waste is generated, it should be segregated appropriately into different categories according to the color coded containers or bags (Image 1, Table 2).

Image 1.1: Poster describing color-coding of biomedical waste per biomedical waste management 2016 rules (Courtesy: SMS Water Grace Pvt. Ltd.)

Table 1.3: Examples of color coding used in India's neighboring countries and WHO

	WHO	India	Pakistan	Bangladesh	Nepal	Sri Lanka	Bhutan	Myanmar	China
Highly infectious waste	Yellow bags	Yellow bags	Yellow bags	Yellow bags	Brown bags	Yellow bags	Red bags	Yellow bags	Yellow bags
Other infectious waste, pathological waste, and anatomical waste	Yellow bags	Yellow bags	Yellow bags	Yellow bags	Red bags	Yellow bags	Red Bags	Yellow bags	Yellow bags
Sharps	Yellow puncture proof container	White containers	Yellow puncture proof container	Red bags	Red bags	Yellow with red stripes	Red bags	Sharp containers	Red container
Chemical and pharmaceutical waste	Brown bags	Yellow bags	Yellow bags	Blue bags	Red bags	• Nonhazardous: Blue bags • Hazardou	Red bags	Black bags	Yellow with black band

	WHO	India	Pakistan	Bangladesh	Nepal	Sri Lanka	Bhutan	Myanmar	China
						s: Purple bags			bags
Radioactive waste	Lead box	Lead box	Yellow drums	Silver containers	Black containers	Lead box	Lead boxes	Lead boxes	Orange container
General biomedical waste	Black bags	Black bags	White bags	Black bags	• Biodegradable: Green bags • Non-bio-degradable, non-recyclable, non-risk waste: Light blue bags	• Biodegradable: Green bags • Non-bio-degradable non-recyclable, non-risk waste: Black bags	Black bags	Green bags	• Non-infectious dry waste: Black bags • Non-infectious wet waste: Green bags

	WHO	India	Pakistan	Bangladesh	Nepal	Sri Lanka	Bhutan	Myanmar	China
Recyclable contaminated waste	Yellow bags	Red bags	-	-	-	Orange bags	-	-	-
Recyclable non-risk waste	-	-	-	-	Dark blue bags	Orange bags	-	White bags	-
Glassware and metallic body implant	Yellow puncture proof container	Blue boxes	-	-	-	Red containers	-	-	Red container

1.5 Types and responsibilities of health care facilities

Medical Market Research report published on 26 June 2016 highlighted the biomedical waste management market is going to rise at an annual growth rate of 5.9% and will reach 16.2 billion dollars by 2022 from 10.78 billion dollars in 2015. According to the report, one of the contributing factors of growth is the increasing initiatives by regulatory authorities that aim to improve the practices followed for biomedical waste management and the involvement of outsourcing firms and services. As per the data in the report, Asia will demonstrate the highest annual growth rate; contributing countries of Asia are India, China, and Japan.

Health-care facility means a place where diagnosis, treatment or immunization of human beings or animals is provided irrespective of type and size of health treatment system, and research activity pertaining to it. Broadly, the biomedical waste is generated in the hospitals, nursing homes, clinics, blood banks, animal houses, and veterinary institutes. It contains human tissues, organs animals tissues, skeletons, excreted bodily wastes, parts containing blood and wastes generated at veterinary hospitals. Besides this, waste like attenuated or inactivated vaccines, and human and animal cell cultures used during research are also categorized under biomedical waste. The disposed medications, used tubing and catheters, chemicals utilized for purification purposes and any waste consequently developed in laboratories and examinations focus upkeep are all biomedical waste as well. Besides sources of biomedical waste discussed above, one source that is most neglected is a household biomedical waste.

Most of the health-care units outsource various steps including collection, transportation and disposal of biomedical waste to service providers. This waste does not undergo any procedure of disinfection. The health-care units are often unaware of the fate of the wastes once collected by the service providers and majority these dumps were disposed along with other municipal waste. By regular monitoring and inspections, the government is trying hard to ensure that the health-care facilities follow all the rules and regulations.

Responsibilities of these health care facilities

Collecting the information about the type of waste and the amount of waste generated from a health-care facility is one of the crucial first steps in biomedical waste management. The proper assessment of quality (i.e. the physicochemical composition of the waste) as well as the quantity of the waste will guide in assessing and evaluating the capacities for containers, storage areas, transportation that would be required for biomedical waste, the disposal methods and facilities needed. Further, the data on quality and quantity of biomedical waste also help the government and hospital authorities in planning, budgeting, figuring incomes from recycling, streamlining of waste-management systems, and assessment of the effect on the environment. Keeping track of the quantity of recyclable waste generated by the health-care facilities will help in keeping a check on illegal recycling of the waste material. Data on quality or type of waste generated within the facility will help in the procurement of appropriate personal protective equipment, providing the required training especially about the segregation of waste at the source where it is generated; cost-savings can be achieved through this.

The WHO suggests the waste management hierarchy healthcare facilities should follow; this hierarchy highlights the most desirable and the least desirable method of waste management. The hierarchy pyramid was developed keeping in mind the overall benefit on the environment, public health, and financial burden of the healthcare facility from each adopted method. “3Rs” is the most widely recommended strategy for the waste management – *reduce, reuse, and recycle*; reducing the production rate of waste is a preferable method of waste management that reduces the amount entering the waste stream and the subsequent steps. This can be done by avoiding wasteful ways of working (e.g. cleaning the hospital stuff with steam disinfection rather than chemical disinfection). The second most preferable method is to use the materials which can be reused followed by the use of recycling technique.

Examples of Mismanagement of biomedical waste among various types of health care facilities in different parts of India

According to a news reported by DNA India in August 2013, five prominent hospitals in Delhi were inspected (Max Super Specialty Hospital, Fortis Escorts Heart Institute and Research Centre Limited, Dr. Baba Saheb Ambedkar Hospital, Dr. Hedgewar Arogya Sansthan, and Lok Nayak hospital). After the surprise inspection, it was observed that these hospitals were not following the rules specified in the biomedical rules 1998 by the Ministry of Health and Environment, Government of India. As per the news of The Economic Times later in the year 2013, 62 hospitals in Himachal Pradesh were inspected, and inadequacies regarding waste disposal were observed in 32 hospitals including both private and government hospitals; shortcomings were in sorting, temporary storage, and disposal of biomedical waste(30). The Times of India in May 2014 reported that 17 medical institutions in Raipur were given notices by the Chhattisgarh Environment Conservation Board for their mismanagement of biomedical waste generated from their health-care facility. Recently, according to the reports of The Pioneer newspaper, notice to 50 small-size health-care facilities (those having less than 25 beds run by single doctors) of Gurugram has been issued by the Haryana State Pollution Control Board (HSPCB) with a purpose of creating a garbage stock point. By this way, they would be able to segregate biomedical waste from the waste of other hospitals.

The Indian Express in 2016 published a report highlighting the fact that apart from civil hospitals, a huge number of Army hospitals also had the same situation. About 87% of Army hospitals and 61% of Air Force hospitals does not have proper authorization for the management of biomedical waste. Further, serious inadequacies were observed in the management of waste and final disposal among these military hospitals. These hospitals were neither having any disposal mechanisms nor rules and procedures were laid down in this regard.

Adding to the list from The Indian Express 2016 report, Punjab Pollution Control Board issued notices to the two Jalandhar hospitals [SGL Charitable Hospital, Garha and Punjab Institute of Medical Sciences (PIMS)] for their improper waste management which was observed in these hospitals. Among these hospitals deficiencies at the level of adherence to rules and regulations were observed; no separate bins were available to segregate the solid biomedical waste, and the liquid waste was also being disposed of without any prior treatment.

These are some of the examples where state hospitals, both Government and private, were issued show cause notice for inappropriately disposing biomedical waste and not following the biomedical waste management regulations.

According to a report from The Tribune, the situation was found to be worst in the interior areas of India. For example, Malwa region of Punjab is facing a challenge of disposing of infectious and hazardous biomedical waste due to the absence of any waste management plant or incinerator. Hospitals and clinics of the region choose often transport the generated biomedical waste to Ludhiana (nearest disposal facility) for disposal or dump the waste in open places.

New Delhi has a rapidly growing health-care delivery system, both in terms of Government and private sector. Over the years, large scale initiatives have led to the emergence of new hospitals with super-specialties and state-of-the-art facilities. This is primarily because Delhi being the National Capital attracts tourist, and this is coupled with the ever-rising migrant labor class presence. All these factors have increased the demand for additional health-care facilities like pathology laboratories, dental clinics, and dispensaries. The increase in health-care providing facilities contributes to rising quantities of biomedical waste generated in the State.

Globally, the amount of biomedical waste generated is growing at a very fast rate, proper management, and disposal of such waste has become an important issue of discussion for both the Government as well as the health-care facilities.

Specific recommendations for hospital administrators

- Lack of knowledge and awareness of the risks of biomedical waste is one of the reasons of improper waste disposal; educating and increasing awareness of staff of the health-care facilities and waste handlers can minimize the risk health hazards. Training campaigns should be run across the state hospital facilities to educate the staff
- Prophylactically, all waste handlers and *safaikaramcharies* responsible for handling and disposing of biomedical waste and are at risk of exposure to human blood, blood products, or body secretions should be given a course of hepatitis B
- The use of illustrative/attractive posters all over in the health-care facility should be encouraged to raise awareness as well as keep on reminding the rules on a day-to-day basis.
- Hospital administrators should arrange for seminars and training on best practices for biomedical waste management. Along with this, regular refresher courses should be arranged and made mandatory for each professional category within the health-care facility to attend and understand the information
- Regular monitoring of implementation of biomedical waste management comes under the umbrella of responsibilities of hospital administrator that will help in appropriate biomedical waste management
- An occupational health program should be established in each health-care facility by the hospital administrators to take care of immunization, post-exposure prophylaxis treatment and continuous medical surveillance of the medical staff within the health-care facility
- A health education desk should be created to raise awareness to patients and visitors towards hand washing, use of toilets and waste bins of different category and color coding system. The desk should explain the risks of infection from patients, other sources and from certain medical waste. Information by posters and leaflets on hygiene promotion and practice should be displayed in the hospital premises to educate the people
- Within health-care facilities, the monitoring the occurrence of infections while handling the biomedical waste and record keeping are important steps to identify warnings signs of inappropriate biomedical waste management practices or environmental pollution which calls for an immediate action
- The hospital administrators fix the responsibility of the staff to follow the rules; they can even allure the staff by starting the practice of “Star Employee of the Week/Month” for the staff member who follows the rules stringently and in the best way. This can be joined with the program of “Star Department of the Week/Month” to attract the employees to follow the rules and implement them appropriately.

Chapter 2- Impacts on Health

Introduction

Health-care is undoubtedly an inevitable facet of human existence. There have been constant efforts over the years to find new methods, like medications or surgery, not only to increase the longevity but also to maintain good health. However, the irony of the situation is that these health-care establishments, which serve the purpose of safeguarding the health of the humankind, are actually not safe and are posing a threat to safe living. Functioning of any health-care organization generates waste, which needs to be disposed of effectively, without causing harm to the society.

It is the responsibility of health care administrators to ensure patient's health and safety by keeping the health center clean and environmentally sound.Even though millions and billions of tons of biomedical waste are generated throughout the world, 85% of this waste is non-infectious and non-hazardous. However, if the remaining 15% of the waste which is highly infectious and hazardous gets mixed with the non-hazardous waste due to inappropriate ways of management and disposal, the extent of risk of spreading infectious and transmissible diseases increases beyond imagination.

The extent of harm or injury a biomedical waste can cause to the person in contact depends on its characteristics, i.e., whether it contains infectious agent; it is genotoxic; it contains toxic or hazardous chemicals or pharmaceuticals; it is radioactive; or it contains sharps. In developing countries like India, biomedical waste mismanagement like improper segregation at the source of its generation of biomedical waste leading to mixing of hazardous and non-hazardous waste, unsafe injection practices and scavenging at waste disposal sites can cause huge damage to the generations to come.

All persons who come in contact with hazardous biomedical waste either directly or indirectly are at potential risk of getting infected. The list of persons include those working in the healthcare facilities who generate the biomedical hazardous waste or anyone outside the healthcare facility either handle the waste directly or are exposed to such a waste accidently as a result of biomedical waste improper disposal.

Hospital hygiene, infection control, and biomedical waste produced in various health-care facilities are interrelated to each other and are inseparable tasks of a health-care facility. Exposure of unmanaged biomedical waste can cause infectious diseases among the hospital staff (airborne infections or through rodents, flies, cockroaches) and also hampers the hospital hygiene and aesthetic look of the hospital. Hospital-acquired infections or nosocomial infections are the types of infections that spread due to the unhygienic hospital environment and loopholes in infection control within the health-care facility.

Objectives

- To know about types of diseases a biomedical waste mismanagement can cause.
- To know what are the safety precautions we should take to avoid disease transmission

Structure

2.1 Diseases epidemiology and mode of transmission

2.2 Health impacts due to biochemical waste mismanagement

2.3 Persons at risk

2.4 Workplace hazards

2.5 Safety precautions

To Do Activities
Prepare a collage to highlight what are the sources of disease transmission and what kind of disease it can cause
Add the safety precaution for each of these diseases to avoid spread
Visit the hospital and see what are the categories of people are at risk of getting infected due to hazardous biomedical waste and how

2.1 Diseases Epidemiology and Mode of Transmission

***"Everything comes with a price. You can never gain something if you do not sacrifice something of equal value"* – Bargain Cost Theory**

Health-care is undoubtedly an inevitable facet of human existence. There have been constant efforts over the years to find new methods, like medications or surgery, not only to increase the longevity but also to maintain good health. However, the irony of the situation is that these health-care establishments, which serve the purpose of safeguarding the health of the humankind, are actually not safe and are posing a threat to safe living. Functioning of any health-care organization generates waste, which needs to be disposed of effectively, without causing harm to the society.

It is the responsibility of health care administrators to ensure patient's health and safety by keeping the health center clean and environmentally sound. Biomedical waste disposal in the healthcare facilities consumes about 10-20% of its average operating budget. Not only this, majority of the staff working in the health care facilities are involved in some or the other step of biomedical waste production or its management and final disposal. So it is also important to consider the safety of service providers while providing health care. Billions of tons of biomedical waste are created every year all through the world. Rapid pace of urbanization has led to the frequent health related issues to the masses, thus, health-care facilities have mushroomed up, leading to the piling up of biomedical waste.

Even though millions and billions of tons of biomedical waste are generated throughout the world, 85% of this waste is non-infectious and non-hazardous. However, if the remaining 15% of the waste which is highly infectious and hazardous gets mixed with the non-hazardous waste due to inappropriate ways of management and disposal, the extent of risk of spreading infectious and transmissible diseases increases beyond imagination.

The biggest challenge is the appropriate treatment and disposal of such biomedical waste which causes extensive environmental issues. However, if not handled properly, this waste cause water, air, and land pollution and also improper treatment of such waste also leads to the loss of resources. Proper storage, transport, and disposal of very hazardous biomedical waste are areas of concern regarding money- and administrative-related difficulties for veterinarians and producers, especially in remote areas.

As the biomedical waste is highly infectious in nature, mismanagement of such a waste is associated with a danger sign. On the list of most hazardous waste, the biomedical waste secures the second position in the world. Thus, it should be handled carefully and appropriately by the staff trained and well-equipped within an organization. Reason being the hazardous nature of the biomedical waste, every member of the society is affected and multiplies the chances of spreading of disease like HIV, HCV, meningitis, tuberculosis, etc..

The biomedical waste, as discussed above, has to pass through many hands before the final disposal (from patient to healthcare provider, to the support staff, to the *safaikaramcharies*, to waste procurement staff and finally to the disposal staff), the risk of infection from contaminated and hazardous biomedical waste passes along in each step from its initial creation to ultimate disposal. Blood borne viral diseases including human immunodeficiency virus (HIV), hepatitis B, and hepatitis C pass through during this transit. Besides these three deadly infections, there are few other virulent infectious agents on the list, which are generally present in the contaminated biomedical waste. These include multi-drug resistant bacterial organisms such as methicillin resistant staphylococcus aureus (MRSA), extended-spectrum beta-lactamase (ESBL) organisms, and Pseudomonas aeruginosa.

The WHO statistics highlights the fact that in 2010, unsafe injections were responsible for:

- 33,800 new HIV infections
- 1.7 million Hepatitis B infections
- 315,000 hepatitis C infections

Safaikaramcharies or biomedical waste handlers handling who handle the waste at the last stage of disposal are more prone to be infected with HBV than any other healthcare workers, non-medical waste handlers, or the general population. Indirect injection through improperly collected and/or segregated sharp materials is considered to be an occupational hazard for these employees healthcare facilities or other centers where biomedical waste is generated.

Survival of pathogenic microorganisms including HIV, HBV, and HCV and other bacterial microbes in the environment and their ability to cause infections

Although, in general, the disease causing microorganisms' ability to survive in the environment is limited, few microorganisms can stay for long and can lead to infectious disease. The ability to survive in the environment is specific to ear pathogen and its ability to resist the harsh environmental conditions including high temperature, chemical disinfectants, humidity, radiations, availability of organic substrate material, or presence of predators, etc. for example, hepatitis virus is very persistent in dry air. It has the ability to survive for several weeks on any surface. Further, brief exposure of boiling water does no harm to this deadly virus. It has the ability to stay alive even after exposure to some antiseptics and 70% ethanol; it remains infectious when exposed to a temperature of 60°C for up to 10 hours. According to a research conducted by the Japanese Association for Research on Medical Waste, in a hypodermic needle with a blood droplet trapped inside can be a survival medium for an infective dose of hepatitis B or C virus for up to a week.

On the other hand, HIV is much less resistant; it cannot tolerate temperatures beyond 56°C or exposure to 70% ethanol. Even at ambient temperature, it can survive for not more than 3-7 days. Bacterial pathogens are generally less resistant than viral pathogens. Moreover, most of the biomedical waste is not a good media to support the growth of microbes, probably due to presence of high amount of antiseptics and the microbial load in such a biomedical waste is almost equal to the microbial domestic. To a surprise, except for pathogenic cultures or excreta of infected patients, the microbial load of biomedical waste is generally not very high and also the survival rates are low.

Vectors such as rodents, insects, rats, flies, and cockroaches are responsible for spread of pathogenic microorganisms which highlights the need of biomedical waste management both within and outside healthcare facilities. These vectors are the passive carriers of microbial pathogens and their population increases manifold near the mismanaged waste, either biomedical or general waste.

Reports have highlighted the fact that of about 35 million healthcare workers worldwide, more than quarter a million are exposed to HIV risky conditions over a year's period in all the healthcare facilities and about 1000 are likely to be infected with the deadly disease. These type of infections and exposure of healthcare workers can be seen in developing countries as in these countries, the prevalence of blood borne pathogens is very high and the access to safety equipment is limited. On an estimation, about 5% of all the HIV infections among the healthcare workers are due to such occupational exposures; these estimations are less than the actual numbers because lot of such cases go unreported. Although the data is not confirmed, there are reports that in Africa, HIV/AIDs would be the reason of deaths of one-fifth of the healthcare workers over the period of next few years which could be a major loss especially in such countries which are resource constrained. This is one of the problems that need urgent attention. The various routes of infection transmission are summarized in the Figure.

Contact transmission	•Direct contact •Indirect contact •Faecal-oral via food
Blood borne transmission	•Blood transferred through sharps or infected injections
Droplet transmission	•Infectious droplets expelled into the air •Direct droplet transmission •Droplet-to-contact transmission
Air borne transmission	•Microbes being transferred as aerosols through air currents
Vector transmission	•Transmission through insects, arthropods, and other pest

Fig2.1: Major routes of transmission of infections

Common recyclable materials are part of biomedical waste from the healthcare facilities include packaging materials, papers, plastic materials, wooden material, metals, glasses, and construction wastes. However, the major disadvantage of the recycling methods is associated that if unauthorized recyclers get involved in the business then it leads to spreading of infection many-folds. In May 2015, the newswas published highlighting the fact that in Narela Industrial Area of North West Delhi, about 40 industries are running this business illegally. Biomedical waste recycled in these industries includes used syringes, needles, medicine bottles, sample bottles, and tubes made of plastic. Products which are generated in these industries are disposable plates, glasses, ice cream cups, toys, and many more items for daily use. This raises a risk alarm for thousands of healthy people, particularly kids, using these items. Further, the labor employed for segregation of waste in these industries is uneducated and are not aware of the ill effects of touching this type of waste with naked hands and are at the utmost risk of being infected with communicable disease like HCV, HIV, tuberculosis, etc.

Image 0.1: Biomedical waste brought to factories for recycling

Image 0.2: Workers sorting the waste without any personal protective equipment

Image 0-3: Used syringes with needles are lying on floor unprotected

1.1 Health impacts due to biochemical waste management

Healthcare waste includes a large component of noninfectious waste (around 85%) and a smaller proportion of hazardous or infectious waste (about 15%). The extent of harm or injury a biomedical waste can cause to the person in contact depends on its characteristics, i.e., whether it contains infectious agent; it is genotoxic; it contains toxic or hazardous chemicals or pharmaceuticals; it is radioactive; or it contains sharps. In developing countries like India, biomedical waste mismanagement like improper segregation at the source of its generation of biomedical waste leading to mixing of hazardous and non-hazardous waste, unsafe injection practices and scavenging at waste disposal sites can cause huge damage to the generations to come. Some of the effects caused by exposure of hazardous biomedical waste can be seen very early while some of the effects may take years to appear.

Type of health hazards with biomedical waste mismanagement

- Hazards from infectious waste and sharps

According to the WHO, sharps include stuff that can lead to cuts or puncture wounds; syringes, needles, disposable scalpels, and blades, knives, infusion sets, saws, broken glass, pipettes, and nails. The highest load of microorganisms could be found in infectious waste and the communicable disease can spread through sharps very easily. There are various ways by which the pathogens present in infectious waste that spread the diseases may enter the human body via a puncture, abrasion, or cut in the skin, or through the mucous membranes, or inhalation, or direct ingestion. Few of the examples of infections that can be caused due to exposure of biomedical waste are summarized in the Table.

Table 2.2: Infections caused by exposure to biomedical wastes, along with causative pathogens, and associated transmission vehicles

Type of infection	Causative organisms	Transmission vehicles
Gastroenteric infections	Enterobacteria • *Salmonella* • *Shigella* spp. • *Vibrio cholera* • *Clostridium difficile* Helminths	• Feces and/or vomit

Type of infection	Causative organisms	Transmission vehicles
Respiratory infections	• *Mycobacterium tuberculosis* • Measles virus • *Streptococcus pneumonia* • Severe acute respiratory syndrome (SARS)	• Inhaled secretions • Saliva
Ocular infection	• Herpesvirus	• Eye secretions
Genital infections	• *Neisseria gonorrhoeae* • Herpesvirus	• Genital secretions
Skin infections	• *Streptococcus*spp.	• Pus
Anthrax	• *Bacillus anthracis*	• Skin secretions
Meningitis	• *Neisseria meningitidis*	• Cerebrospinal fluid
Acquired immunodeficiency syndrome (AIDS)	• Human immunodeficiency virus (HIV)	• Blood • Sexual secretions • Body fluids
Hemorrhagic fevers	• Junin • Lassa • Ebola • Marburg viruses	• All bloody products and secretions
Septicemia	• *Staphylococcus* spp.	• Blood
Bacteremia	• Coagulase-negative *Staphylococcus spp. (*including methicillin-resistant *S. aureus)* • *Enterobacter* • *Enterococcus* • *Klebsiella spp.* • *Streptococcus* spp.	• Nasal secretions • Skin contact
Candidemia	• *Candida albicans*	• Blood

Type of infection	Causative organisms	Transmission vehicles
Viral hepatitis A	• Hepatitis A virus	• Faeces
Viral hepatitis B and C	• Hepatitis B and C viruses	• Blood and body fluids
Avian influenza	• H5N1 virus	• Blood • Feces

Again, to highlight, the major risk is the transmission of HIV, HBV, HCV and there are evidence reflecting that these viruses are mostly transmitted through injuries from human blood infected syringe needles.

Sharps can affect the human body in two different ways; they not only causes cuts or wounds but lead to disease transmission if infected with loads of viruses or bacteria. Because of the risk sharp waste carries, they are considered as one of the most hazardous waste among all the waste categories.

According to a report by the WHO, the annual incidence rate of HBV infections is very among the healthcare workers due to some or other type of injury from sharps (table).

Table 2.3: Report by the WHO – Annual rate of HBV infections due to injuries from sharp in the USA

Professional category	Annual number of people injured by sharps	Annual number of HBV infections caused by injury
Nurses		
in hospital	17700–22200	56–96
outside hospital	28000–48000	26–45
Hospital laboratory workers	800–7500	2–15
Hospital housekeepers	11700–45300	23–91
Hospital technicians	12200	24

Professional category	Annual number of people injured by sharps	Annual number of HBV infections caused by injury
Physicians and dentists in hospital	100–400	<1
Physicians outside hospital	500–1700	1–3
Dentists outside hospital	100–300	<1
Dental assistants outside hospital	2600–3900	5–8
Emergency medical personnel (outside hospital)	12000	24
Waste workers (outside hospital)	500–7300	1–15

- Hazards from chemical and pharmaceutical waste

According to the WHO definition of chemical waste, it is the waste that includes discarded solid, liquid, and gaseous chemicals; for example solvents used for laboratory preparations, disinfectants, and heavy metals contained in medical devices (e.g. cadmium or mercury in broken thermometers or manometers, or dentistry) and batteries.

There are some of the chemicals or pharmaceutical substances which are being used in various healthcare facilities in one or the other way can be hazardous in nature. Here is the inexhaustive list of such chemicals:

- Toxic
- Genotoxic
- Corrosive
- Flammable
- Reactive
- Explosive
- Shock-sensitive

Such type of chemicals are generally in low quantities but may be present in large quantities in the stock of expired chemicals. They can enter the human body either by direct contact through skin, inhalation, accidental ingestion, or through mucous membrane. In majority of the cases, these chemicals are corrosive in nature and cause burns; other type of hazards through this type of biomedical waste include damage to eyes and burning of mucous membrane of airways.

One another indirect way through which chemicals such as pesticides or disinfectants present in the healthcare facilities can enter the natural ecosystem and can cause damage to the living beings who are part of such ecosystems. Leaking drums or torn sacks of pesticides, pharmaceutical residues, including antibiotics and other drugs, heavy metals such as mercury, phenols, derivatives, and disinfectants and antiseptics during heavy rains, may enter the ground water and contaminate the water system causing diseases to all who consume this contaminated water. They may also enter the ecosystem through the sewage system.

- Hazards from genotoxic waste

According the WHO, genotoxic waste is the highly hazardous, mutagenic, teratogenic or carcinogenic, such as cytotoxic drugs used in cancer treatment and their metabolites. Faeces, vomit, or urine from patients treated with cytotoxic drugs or chemicals also fall into this category of waste. Other sources of genotoxic waste are the contaminated materials from drug preparation and administration, such as syringes, needles gauzes, vials, packaging, outdated drugs, excess (leftover) solutions, drugs returned from the wards. This is one of the most difficult types of waste regarding safety issues associated with it.

The level of impact of harm from genotoxic waste on the human body is governed by two major factors; one is the intrinsic toxic properties of the substance and the second is the duration for which the body is exposed to the substance. The genotoxic substances can enter the human body through inhalation of dust or aerosols (which may happen during the preparation or treatment with such kind of drugs), through the skin, accidental ingestion of food containing cytotoxic drugs, chemicals, or waste. A direct contact with the body fluids or secretions of the patients undergoing a chemotherapy can also expose the body of the healthcare worker to genotoxic substances and causing harm. Chemotherapeutic drugs or genotoxic drugs used for the treatment of cancers are usually carcinogenic and mutagenic; when come in contact with skin or eyes, they are highly irritant in nature, can cause dizziness, nausea, headache, and dermatitis. In addition, exposure to highly active substances can cause harm to a greater extent such as destruction of a tissue.

- Hazards from radioactive waste

According to the WHO, radioactive waste is the waste which is contaminated by radionuclides with genotoxic effects including radioactive diagnostic material or radiotherapeutic materials. Radioactive waste is generated as a result of in vitro analysis of body tissue and fluid, in vivo organ imaging and tumor localization.

As was the case with genotoxic waste, the level of impact of harm from genotoxic waste on the human body is governed by two major factors; one is the intrinsic toxic properties of the substance and the second is the duration for which the body is exposed to the substance. Brief exposure to radioactive substance or waste can cause headache, dizziness, and vomiting. Few of the radioactive substances as genotoxic as well so the nature of harm of both the categories overlap.

Public sensitivity

Besides biomedical waste being a health hazard, there is an issue of public sensitivity, wherein the general public is sensitive towards the anatomical waste, especially the recognizable human body parts. Mismanagement or improper disposal of such a waste are not acceptable visually as well as ritually. People of different cultures or religious beliefs, especially in Asia, have different notions or rituals to dispose the human body wastes including fetuses such as “coffins” or buried in cemeteries through patient’s family and not in open landfills.

One more issue that arises due to improper disposal of biomedical waste is that stray animals like dog, cow, and pigs visit the dumping site and mistakenly eat the infectious waste resulting in spread of infectious agents in the food chain posing more severe threat to the humans.

1.3 Persons at risk

All persons who come in contact with hazardous biomedical waste either directly or indirectly are at potential risk of getting infected. The list of persons include those working in the healthcare facilities who generate the biomedical hazardous waste or anyone outside the healthcare facility either handle the waste directly or are exposed to such a waste accidently as a result of biomedical waste improper disposal.

Scientist at Chandigarh pollution control committee Sushil Dogra said “This can also lead to a higher degree of environmental pollution, apart from posing serious public health risks such as AIDS, hepatitis, plague and cholera. Animals are more exposed to bio-medical waste.”

Majorly, following are the people who are at potential risk:

- Hospital staff including medical doctors, nurses, ward boys, hospital maintenance, and safaikaramcharies
- Patients: patients receiving treatment in the various healthcare facilities
- Visitors or caregivers: persons who are taking care of patients such as family members or the visitors who visit the healthcare facilities to look the patients
- Allied workers: persons who do not work directly at the healthcare facility but work as support service provides such as laundries, waste handling, transportation, etc.
- Workers employed in the common biomedical waste management facilities

The list will not be complete if we do not highlight the below category of people who are under the risk category:

- Rag pickers and waste handlers
- Waste recyclers
- Drug addicts who generally hunt through the waste for used needles and disposed medicines

These persons can be infected in two major ways; one is when they come in direct contact with waste during their daily working lives due to inappropriate biomedical waste management practices. The second is through their reliance on existing biomedical waste practices for their living and daily earnings.

To add this, the hazards associated with the biomedical waste generated from smaller sources such as waste generated from home-based health care should not be neglected as the extent of infection such waste can cause is same to that of the waste generated from healthcare facilities.

Fig2.2: Persons at most risk

To highlight few of such examples, in Sri Lanka, the biggest topic of concern related to biomedical waste mismanagement is the inappropriate and unsafe recycling of needles and syringes. The unsafe recycles syringes puts thousands of children at risk who are immunized through National Childhood Immunization Program.

The way all these people involved and at are risk due to biomedical waste improper disposal has been summarized in the Figbelow (Figure):

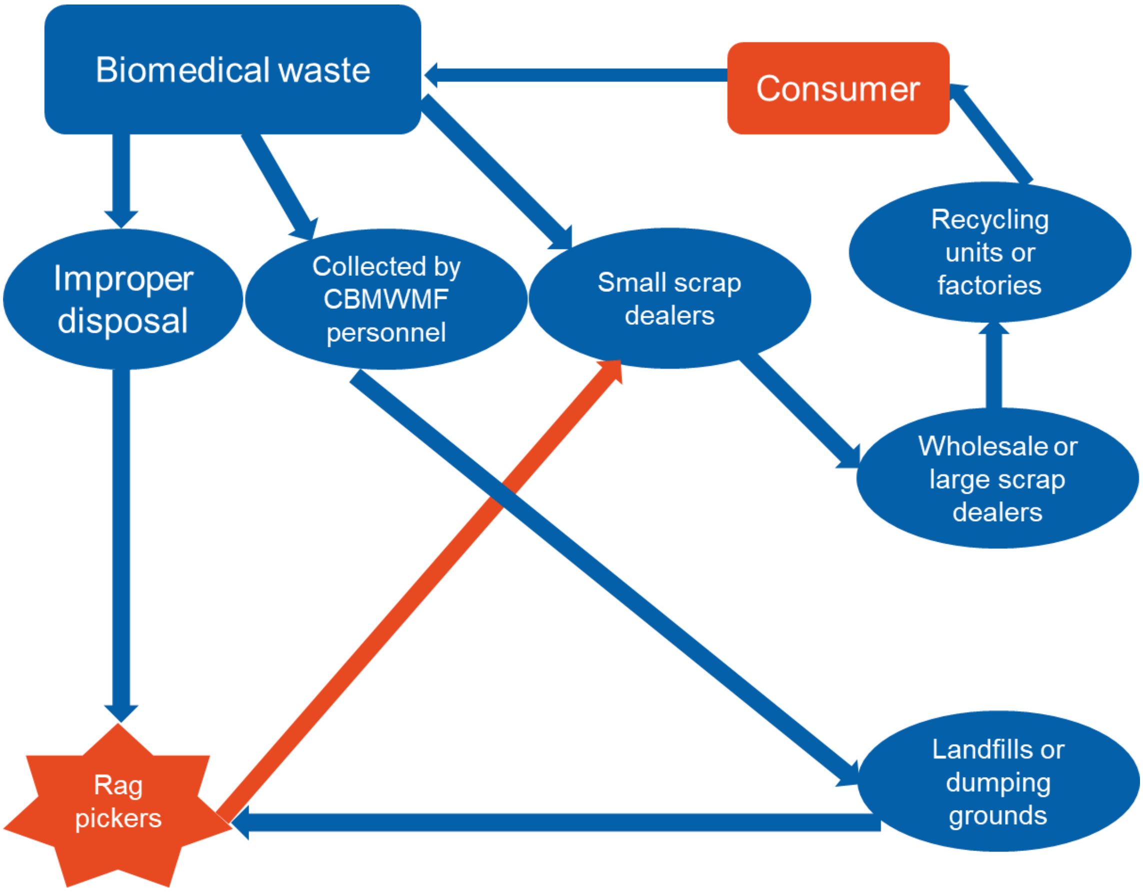


Fig2.3: Overview of people at risk involved in the cycle of biomedical waste management

Prophylactically, all waste handlers and *safaikaramcharies* responsible for handling and disposing of biomedical waste and are at risk of exposure to human blood, blood products, or body secretions should be given a course of hepatitis B and there should be a continuous and regular immunization program within the healthcare facilities to protect the staff getting being infected.

Few years ago, smugglers were caught stealing tons of biomedical waste from PGIMER, Chandigarh. This was being sold to a local scrap dealer. During this transit, the waste was handled without any caution. The biomedical waste was then disposed of in open that was later washed of with rainfall entering the ecosystem.

There are some special group of people who are highly vulnerable to any type of communicable disease or comprise special high-risk population. These include:

- Pregnant women
- Working group above 45 years
- Disabled or persons with previous illness
- High exposures

- With respiratory illness

1.4 Workplace hazards

Types of occupational hazards

Following are the various types of occupational or workplace hazards that can occur due to biomedical waste:

- Physical
- Chemical
- Biological
- Ionising/non-ionising radiation
- Psychosocial
- Ergonomical

Physical occupational hazards

There are various types of physical occupational hazards including noise, vibration, radiation, heat, physical injuries, and lifting heavy objects. The effect from physical hazards include hearing loss, nervous problems, backache, physical disability, heat exhaustion, musculoskeletal disorders, genetic damage, cancers, etc.

Chemical occupational hazards

The source of chemical occupational hazards include chemical cleaners, sterilizers, anesthetic chemicals, expired pharmaceuticals, gluteraldehyde, latex, mercury, heavy metals, volatiles, and plastics. The effects of these chemicals on the persons in direct contact with these chemicals include irritation to sensory organs, headaches, nausea, vomiting, systemic illness, neurological and gastrointestinal disorders, cardiovascular disorder, immune dysfunction, reproductive and personality disorders, disability, and possibly death.

Biological occupational hazards

Bio aerosols, body fluids, soiled linen, bandages, sharps, needle sticks, biowaste are few of the sources of biological occupational hazards. The hazard such biologics can cause are H1N1, hepatitis B, HIV, infections due to other pathogens, common infections, compromised immune system due to repeated exposures, disability, and/or death in acute cases.

Ionising/non-ionising radiation occupational hazard

Radiotracer in therapy, cancer treatment, radiopharmaceutical waste, waste from radio medical procedures, discarded laser equipments comprise the list of ionising or non-ionising radiation occupational hazard. The effects from the exposure of these agents include burns, radiation sickness, cataract, reduction in blood cells, chromosomal aberrations, tumors, skin erythema, cancers, sterility, etc.

Psychosocial occupational hazards

Fatigue, workload demand, problematic intrapersonal relationships, limited career opportunities, poor remuneration, monotony of the job, stress due to fear, poor or limited training in biomedical waste management are some of the sources of psychosocial hazards. The ill effects of these include personality disorders, low self-esteem, anxiety, low motivation, imbalances work-life balance, depression, alcohol-drug abuse, violence.

Ergonomical occupational hazards

Repetitive motions, awkward postures, twisting, ergonomically unfriendly working conditions, bending and lifting weights are associated with ergonomical occupational hazards. The effects of these hazards include oesteoarthiritis of wrist, epicondylitis elbow, back pain, low back pain, and shoulder tightening (temporary or permanent).

There are few examples of accidents that occur very frequently in healthcare facilities. These have been discussed below:

- Blood spillage – the person supposed to clean the area should wear all the personal protective equipments. The area should be cleaned with 5% sodium hypochlorite and then with clean cloth.
- Mercury spillage – with personal protective equipments, the spilled mercury should be handled with two cardboards with an ink filter. This helps in absorption of mercury which can then be transferred to water-filled container and then finally to seal proof bag.
- Chemical spillage – in case of chemical spillage, the affected clothing should be removed; eyes and hands should be cleaned with fresh water for 15-30 min. if the chemical is of inflammable nature, then no electrical appliances should be operated in the vicinity and the affected person should be taken to open air.

The list of occupational hazards will not be complete without discussion the hospital acquired nosocomial infections. Air pollution is one of the consequence of biomedical waste mismanagement that can be of biological, chemical, or radioactive in nature and can affect both the indoor and outdoor environment. Indoor polluted air loaded with pathogens or spores have ability to survive for a long time. Patients and their caregivers are at the highest risk of acquiring these nosocomial infections due to these air-borne pathogens or spores.

1.5 Safety precautions

Hospital hygiene, infection control, and biomedical waste produced in various health-care facilities are interrelated to each other and are inseparable tasks of a health-care facility. Exposure of unmanaged biomedical waste can cause infectious diseases among the hospital staff (airborne infections or through rodents, flies, cockroaches) and also hampers the hospital hygiene and aesthetic look of the hospital. Hospital-acquired infections or nosocomial infections are the types of infections that spread due to the unhygienic hospital environment and loopholes in infection control within the health-care facility. Separation of the source of infection and elimination all the possible routes of transmission of infection are the two main measures to control the transmission of infections among the health-care facilities; general hygiene precautions suggested by the WHO are summarized in Image. The best and the most important step towards the prevention of the spread of nosocomial infections is the proper hand washing; alcohol is the best and fastest disinfectant.

Standard precautions in health care

Background

Standard precautions are meant to reduce the risk of transmission of bloodborne and other pathogens from both recognized and unrecognized sources. They are the basic level of infection control precautions which are to be used, as a minimum, in the care of all patients.

Hand hygiene is a major component of standard precautions and one of the most effective methods to prevent transmission of pathogens associated with health care. In addition to hand hygiene, the use of **personal protective equipment** should be guided by **risk assessment** and the extent of contact anticipated with blood and body fluids, or pathogens.

In addition to practices carried out by health workers when providing care, all individuals (including patients and visitors) should comply with infection control practices in health-care settings. The control of spread of pathogens from the source is key to avoid transmission. Among source control measures, **respiratory hygiene/cough etiquette**, developed during the severe acute respiratory syndrome (SARS) outbreak, is now considered as part of standard precautions.

Worldwide escalation of the use of standard precautions would reduce unnecessary risks associated with health care. Promotion of an **institutional safety climate** helps to improve conformity with recommended measures and thus subsequent risk reduction. Provision of adequate staff and supplies, together with leadership and education of health workers, patients, and visitors, is critical for an enhanced safety climate in health-care settings.

Important advice

- Promotion of a safety climate is a cornerstone of prevention of transmission of pathogens in health care.
- Standard precautions should be the minimum level of precautions used when providing care for all patients.
- Risk assessment is critical. Assess all health-care activities to determine the personal protection that is indicated.
- Implement source control measures for all persons with respiratory symptoms through promotion of respiratory hygiene and cough etiquette.

✔ Checklist

Health policy

- Promote a safety climate.
- Develop policies which facilitate the implementation of infection control measures.

Hand hygiene

- Perform hand hygiene by means of hand rubbing or hand washing (see detailed indications in table).
- Perform hand washing with soap and water if hands are visibly soiled, or exposure to spore-forming organisms is proven or strongly suspected, or after using the restroom. Otherwise, if resources permit, perform hand rubbing with an alcohol-based preparation.
- Ensure availability of hand-washing facilities with clean running water.
- Ensure availability of hand hygiene products (clean water, soap, single use clean towels, alcohol-based hand rub). Alcohol-based hand rubs should ideally be available at the point of care.

Personal protective equipment (PPE)

- ASSESS THE RISK of exposure to body substances or contaminated surfaces BEFORE any health-care activity. **Make this a routine!**
- Select PPE based on the assessment of risk:
  - clean non-sterile gloves
  - clean, non-sterile fluid-resistant gown
  - mask and eye protection or a face shield.

Respiratory hygiene and cough etiquette

- Education of health workers, patients and visitors.
- Covering mouth and nose when coughing or sneezing.
- Hand hygiene after contact with respiratory secretions.
- Spatial separation of persons with acute febrile respiratory symptoms.

Fig2.4: Standard precautions in health care

Training, Education, and Public Awareness

Trained and educated staff members are the stepping stones towards the infection control. Training and education will inculcate a sense of responsibility in the staff about the resource minimization, best practices of using the resources and inspire them to use new and updated skills and machinery for biomedical waste management and avoiding occupational hazards in their day-to-day work. A well-trained staff can also help in educating patients and visitors about the hazards from the waste and encourage them to maintain self- and environmental hygiene. Every healthcare facility should assign a specific budget for the training programs and to arrange the trainers (either from outside agencies or from the internal team). The training materials should frequently be restructured and updated to keep the staff updated and well-defined with the new and improved technologies and methodologies for handling the waste materials; this should be followed-up with refresher training sessions for the staff. The best way to learn anything is to practice, so during the training sessions, hands-on training should be given. Different types of training materials and modules are required for the following health care waste handlers to avoid spread of infections and deadly diseases through mishandling of biomedical waste:

- Health care personnel
- Cleaning staff
- Staff who transport waste
- Treatment plant operators
- Landfill operators

Health-Care Waste Management in Emergencies

Biomedical waste management is a tough task, and it becomes tougher when it comes to an emergency situation like natural disasters. During the time of natural disasters, the risk of spreading of infections increase manifold. Safe management of biomedical waste during the emergency situations has to be done more cautiously and should be done in the following phases:

- *Phase I: Rapid initial assessment*

Immediately after the disaster, an initial assessment is performed to measure the information about the criticality of the situation and immediate needs.

- *Phase II: Emergency response*

The purpose of the emergency response is to avoid any scattering of waste and prevent the spread of secondary infections from the waste not managed properly. Initial assessment helps in allocating the responsibility to the organizations and individuals as applicable for rapid action. It is also suggested that biomedical waste generated during the emergency situation should be segregated as “sharps” and “non-sharp wastes” in two different bins. Further, these bins should be completely covered and protected so that air-borne infections or flying insects don’t spread any kind of communicable diseases. Burial of these wastes is the best possible way of disposing of the biomedical waste in emergency situations; pits and trenches should be used for the safe disposal. Further, during such natural disaster situations, hepatitis B vaccination should be given to all health-care staff and waste handlers as a preventive measure and they all should be alerted and reminded of the risk of infections from mishandling of biomedical waste.

- *Phase III: Recovery phase*

It’s a long-term program re-establish the community in the way it was working before the natural calamity. Further, biomedical waste management should have a place in the contingency plan of health-care sector for the timely action and control, and the government should be prepared for any emergency situation.

In addition to this, there are some issues which can arise in future and poses real threat which includes multi-drug resistant microorganisms (HIV, Ebola virus), pandemics (malaria-carrying Anopheles mosquitoes), climate change (increase in sea levels cause more floods, extremities in temperature), overuse of antibiotics, water and air pollution, lack of availability of empty land to dig out landfill, over usage of disposables and non-recyclable materials, toxic emissions from PVC products or mercury products incineration, new technologies (e.g. digital thermometers) are less toxic but more costly, urbanization and increase in health-care facilities.

Specific recommendations for biomedical waste handlers

- Waste handlers or safaikaramcharies should always clean their hands or other body parts which might have come in contact with the waste using soap and warm water after handling biomedical waste
- Waste handlers or safaikaramcharies should keep in mind that their sores or any open cuts should always be covered while handling biomedical waste
- Wet or dirty bandages of waste handlers or safaikaramcharies should always be replaced with clean and dry bandages
- Latex gloves should always be used while handling the biomedical waste and these should be discarded after use
- An apron should be used to protect oneself from direct contact with risky infectious

biomedical waste; replace the clothes/apron if get soiled with the waste and the soiled clothes should be washed and then sterilized before the next use

- The soiled and dirty floors or carpets should be cleaned and disinfected by waste handlers or safaikaramcharies immediately with using soap and disinfectants or bleach solution and blotting technique
- Syringes, needles, or any other sharps should never be touched with bare hands; broom along with a dustpan should be used to pick up these sharp biomedical waste materials
- In case of occupational accidents and unwanted needle punctures, the waste handlers must undergo post-exposure medical testing and counseling to address the possibility contracting a contagious disease
- Waste handlers or safaikaramcharies should be very cautious while handling the mobile trolley with infectious waste and sharp containers
- Once the infectious waste gets mixed with non-infectious waste; knowingly or unknowingly, any medical staff, waste handlers, or safaikaramcharies should make an attempt re-segregate the waste. Instead, this type of waste should be considered as infectious and hazardous type of waste and the container should be labeled accordingly

Chapter 3- Legal Aspects

Introduction

In order to control the spread of diseases and infections by mismanagement of hazardous biomedical waste, it is becomes mandatory to treat the hazardous waste guided by specific guidelines and approved technologies. Every country, whether developed or developing has various types of laws to govern the biomedical waste management appropriately. These laws and policies vary depending on the type and quantity of the waste generated. The laws also include the rights of the legal entities. These guidelines also monitor and guide the biomedical waste import, export or transit. Further, there is also mention of the budget and financing associated with the biomedical waste among the healthcare facilities of the country. The countries which do not have the country specific laws and policies drafted, they adopt the gold standard the WHO guidelines for the biomedical waste management.

Although there are rules and regulations in place in each and every country, still there are loopholes in the appropriate biomedical waste disposal leading to the spread of deadly diseases. Being aware of the situation, the WHO is looking into the situation and is in constant process of revising the guidelines and making them more and more stringent and also recommend the more efficient, sustainable, pocket-friendly, culturally acceptable, and environment friendly systems for the final disposal of biomedical waste.

Even in the countries which have rules and regulations in place such as India, unethical and unsafe practices like reuse and recycling of syringes and other plastic biomedical waste is increasing day by day which in turn is increasing the risk of spreading communicable viral diseases. One major reason behind this is the unawareness or low training of the waste handlers regarding the risk the biomedical waste carries. Overall, lots of countries are still dumping the biomedical waste, in the unsegregated form, with the general waste in the open dumping grounds; by this, the deadly viruses enter the food chain carries the inevitable health risks.

The key step in workable and environment friendly biomedical waste management system within a country is drafting a national policy. While drafting such policy, all the signed international agreements should be taken onto account along with the international principles that are already in place and are in force to protect the human health along with the environment protection. Further, the final decision making and implementation responsibilities should remain at the political level so that such rules get implemented at all the levels of the community associated with the biomedical waste in any form. These policies are not life-long and require regular review as new technologies emerge and achievable targets along with the environmental conditions change.

Objectives

- To know about types of regulatory laws and policies associated with biomedical waste management
- To know what are the WHO gold standard guidelines for biomedical waste management

Structure

3.1 Legislation, policies and law for biomedical waste management

3.2 Biomedical waste management and handling rules

3.3 Safe disposal of radioactive waste rules

3.4 International guidelines on management of wastes from Hospitals

3.5 Budgeting and record maintenance

To Do Activities

Search the literature and find the laws and policies related pertaining to the biomedical waste management of various developed and developing countries

Make a presentation of the major differences seen across various countries

Show the Best Working Practices of different countries and suggest how these best practices can be implemented in India

3.1 Legislation, Policies and Law for Biomedical Waste Management

Medical Market Research report published on 26 June 2016 highlighted the biomedical waste management market is going to rise at an annual growth rate of 5.9% and will reach 16.2 billion dollars by 2022 from 10.78 billion dollars in 2015. According to the report, one of the contributing factors of growth is the increasing initiatives by regulatory authorities that aim to improve the practices followed for biomedical waste management and the involvement of outsourcing firms and services. As per the data in the report, Asia will demonstrate the highest annual growth rate; contributing countries of Asia are India, China, and Japan.

In every country, to ensure that the health-care waste is disposed properly rendering them non-infectious, stringent rules and regulations need to be drafted with government intervention. National legislation forms the baseline of biomedical waste management practices within a country which implies the legal controls and provides various types of permissions to the different agencies to appropriately dispose the biomedical waste. The legal entity responsible for all these functions is usually the Ministry of Environment or National Pollution Control Board or National Environmental Protection Agency with clear roles and responsibilities allocated. Following the identification of needs and problems prevailing in the country on the management of biomedical waste, these policies and regulations are drafted within the country. Further, these rules also take into the account the available resources and the possible sources of procurement of the additional resources. Most importantly, these policies are framed in such a way that the health-care staff is supposed to describe each of the steps related to the methodologies with the management of biomedical waste.

International Conventions

The major International Conventions that regulate the biomedical waste disposal are discussed below:

The Basel Convention

The Basel Convention is a global convention that controls the movement of hazardous and other wastes across borders. This convention underlies the "prior informed consent" principle which highlights that the shipments with consent are legal and others as illegal. The Basel Convention is the most comprehensive agreement for environment protection from these hazardous waste. Total 170 countries are members of this convention to control the health hazards from the illegal movement of hazardous and infectious waste across borders. Further, the convention ensures the appropriate management and disposal of waste in environment-friendly method with emphasis on minimization of quantities that needs to move across the borders and disposal of waste at the source of generation. This convention highlights the need of treatment and disposal of all the hazardous waste closer to the place of generation and restricting the movement of such wastes.

The Bamako Convention: Preventing Africa from becoming a dumping ground for toxic wastes

According to a report by the United Nations Environment Programme, there were instances where illegal disposal of biomedical waste has caused deaths of people in African countries. About 17 people were killed and thousands were poisoned due to discharge of hundreds of tons of toxic waste in in Abidjan in 2006. In 1988, a similar type of incidence was reported in one of the villages of Nigeria where number of barrels were filled with hazardous waste were found. The leakage from those unsealed barrels caused serious health hazards to the residents living in the vicinity.

After such incidents, the Bamako Convention was signed by 12 African nations to restrict the import of any hazardous and infectious waste from other countries under the Basel Convention. This convention was drafted when it was realized that most developed countries were exporting their toxic wastes to less developed countries of Africa.

The Stockholm Convention on Persistent Organic Pollutants

The Stockholm Convention was enforced in May 2004 with an aim to reduce and, if possible, completely eliminate Persistent Organic Pollutants (POPs). It deals with the issue of environmental pollution with POPs which are released into the environment after the combustible process in incinerators. POPs are the toxic chemicals and have the ability to stay in the environment for long periods due to which they become geographically widely distributed. Once they enter the human body and other living beings, they get accumulated in the fatty tissues. These guidelines suggest the use of alternative methods such as steam sterilization, microwaving, biological treatment, etc. over the incineration procedure for rendering the biomedical waste non-infectious. The convention, to date, covers around fifty such chemical including pesticides and industrial chemicals.

Other International Guidelines related hazardous or biomedical waste management are listed below:

- UN Committee of Experts on the Transport of Dangerous Goods
- UN Economic Commission for Europe
- The environment and sustainable development conferences
- Aarhus Convention of the UN Economic Commission for Europe highlights the need for general public involvement in environmental issues and also allows them to access the information that health authorities have on the environment.

3.2 Biomedical Waste Management and Handling Rules: India

As per the official records, the total amount of biomedical waste produced in the country is about 484 tons/ day from 1,68,869 health-care facilities (at a rate of 1-2 kg/bed/day in a hospital and 600 gm/bed/day in a clinic). Of this quantum of waste, about 447 tons/day of biomedical waste is treated; 198 common biomedical waste management facilities are functional currently (20 further are under development); 21870 health-care facilities have their own treatment plants while the rest are using the common disposal facilities.

In India, concerns regarding the biomedical waste management was raised, and an appeal was made in the Honorable Supreme Court and following the mandate from the Court, the Indian Ministry of Environment and Forests drafted the Biomedical Waste (Management and Handling) Rules in 1998(2). In order to provide the safe and effective health-care facilities to patients and provide the safe environment to work for staff and public, these rules and regulations were framed that guides the appropriate ways of disposal of various types of biomedical waste.

Following the WHO guidelines, Biomedical Waste (Management & Handling) Rules, 1998, highlighted that “it is the duty of the health-care facilities generating biomedical waste to take all necessary steps to ensure that such waste is handled without any adverse effect on human health and the environment. It can do so either in its own treatment facilities or ensure requisite treatment through a common biomedical waste management facility”. Privatization in this sector or Government intervention through a Central Sector Scheme (involves contribution from both Central government and State government) for providing the required funds to set up the common biomedical waste management facilities in the area that can handle and finally dispose of the biomedical waste produced from various hospitals and other health-care facilities in the area. The Pollution Control Boards and/or the Pollution Control Committees (PCCs) of the States are the assigned authorities for taking care of the effective implementation of the biomedical waste management rules. Further, for violation of these rules or health-care facilities not adhering the regulations, these authorities take action against them, under the Environment (Protection) Act, 1986(45).

Amended version of these rules, the Biomedical Waste Management Rules, 2016 has been published in the Gazette of India, Extraordinary, Part II, Section 3, Sub-section (i) on 28th March 2016 by Ministry of Environment, Forest and Climate Change. The new rules have been framed with an aim to make the biomedical waste management more effective and employ the new and updated technologies in this field. Further, the target is to change the overall scenario of waste management in the country and make a cleaner India (Swachh Bharat). While releasing the rules Shri Prakash Javadekar, the then Union Minister of State Environment, Forest & Climate Change said that the

"New Biomedical Waste Management Rules 2016 will Change the way Country Used to manage waste and make a big difference for the Clean India Mission."

The revised rules pitch for segregation of waste. According to these guidelines, Biomedical Waste Management Rules apply to "all persons who generate, collect, receive, store, transport, treat, dispose, or handle biomedical waste in any form including hospitals, nursing homes, clinics, dispensaries, veterinary institutions, animal houses, pathological laboratories, blood banks, Ayush hospitals, clinical establishments, research or educational institutions, health camps, medical or surgical camps, vaccination camps, blood donation camps, first aid rooms of schools, forensic laboratories and research labs and shall not apply to radioactive wastes; wastes covered under the MSW Rules, 2000; lead-acid batteries; hazardous wastes; E-wastes; and hazardous microorganisms".

As per the directions in the Biomedical Waste (Management and Handling) Rules, 1998 and 2016 amendments, duties of every staff member, involved in handling the biomedical waste in one way or the other, are well defined.

Duties of the Occupier

It is the duty of the occupier to guarantee that the biomedical waste is managed safely as suggested by these rules and regulations

Procurement inside the health-care facility premises for a safe, ventilated, and secured area for stockpiling of segregated biomedical waste in appropriately colored bags or containers according to the color coding defined in Schedule I and to guarantee that there should not be any auxiliary handling, pilferage of recyclables or accidental dissipation or spillage by animals. Further, the biomedical waste from such premises should be transported directly to the common waste management facility or for treatment and disposal

- Health-care facilities should make a provision for on-site pretreatment, through disinfection or sterilization, of the laboratory, microbiology discard, blood samples, and blood bags as described by the WHO or National AIDS Control Organization (NACO) guidelines and then this waste should be sent to the common waste management facilities for final disposal
- Eliminate utilization of chlorinated plastic bags, gloves, and blood bags within a time limit of 2 years from the date of publication of these rules
- Discard or dispose the non-biomedical solid waste according to their respective waste management rules
- Treated biomedical waste should not be mixed with municipal waste
- Training of all health care workers and waste handlers about the biomedical waste management at the beginning of their job and at least once every year after that; annual

report should comprise of details of training programs organized, strength of trained and untrained staff

- For prophylaxis and safety of the health-care workers and waste handlers, immunization for protection against diseases which can be transmitted through biomedical waste handling (such as Hepatitis B and tetanus) should be taken care by the occupier as specified in the National Immunization Policy
- A Barcode system should be developed for the bags or containers loaded with biomedical waste to track their movement out of premises within 1 year from the date of the notification of these rules
- Liquid chemical waste should be segregated and pre-treated at the source before mixing it with other effluents. It should be disposed of according to the Water (Prevention and Control of Pollution) Act, 1974
- Occupational safety of all the health care workers and waste handlers involved in handling the biomedical waste is the responsibility of the occupier; along with providing suitable and sufficient personal protective equipment
- Arranging a health care check-up and maintaining the health records of health care workers and waste handlers handling the biomedical waste at the beginning of their job and at least once every year after that
- Maintaining proper records should be the responsibility of the occupier. The amount of biomedical waste generated on daily basis according to the categories and color coding specified in Schedule I of the rules should be recorded and these records should be displayed on the website on monthly basis
- A system of recording inadvertent accidents that happens at the time of biomedical waste handling including injuries from sharps, mercury spills, or fire accidents, etc. should be done. Further, an annual report should be submitted to the prescribed authority
- Every health-care facility should have a website within 2 years of from the date of publication of these rules and annual report of biomedical waste should be displayed on their website
- The prescribed authority should be informed immediately in case any gap in the functioning of the common biomedical waste management facility and they turn up to collect waste on the agreed timelines or on regular basis
- If the health-care facility is equipped with ≥30 beds, set up a biomedical waste management committee that should monitor and review the appropriate functioning of the health-care

facility. The committee should submit the minutes of their biannual meeting to the prescribed authority along with the annual report

  - If the health-care facility is equipped to handle ≤30 beds, a qualified person is assigned to handle all the activities
  - For a period of 5 years, maintain the records related to every cycle of incineration, hydro, or autoclaving
  - For existing incinerators, basic standards for treatment and disposal should be met, as specified in Schedule II (for retention time and Dioxin and Furans), within 2 years of from the date of publication of these rules

Duties of the operator of a common biomedical waste treatment and disposal facility: It shall be the duty of every operator to -

- It is the responsibility of the operator to ensure that the collected biomedical waste is transported, handled, warehoused, treated, and disposed properly and all guidelines should be followed as issued by the government or the Pollution control board
- It is the duty of the operator to ensure that the biomedical waste is collected from occupier well on time and as per the finalized schedule under the act
- Within one year of notification of the rules, a system for handling the biomedical waste through bar coding and global positioning should be established
- The prescribed authorities should be immediately informed about the health-care facilities who are not cooperating in the proper disposal of waste and not handling the biomedical waste according to the segregation color scheme highlighted in the guidelines
- All workers working at the biomedical waste management facility and handling the waste should receive proper training at the beginning of their jobs and at least once every year after that
- It is the duty of the operator to assist the occupier in conducting training for biomedical waste management
- Medical examination and prophylactic immunization (for disease such as hepatitis B, tetanus, etc.) of the operator and workers of the biomedical waste management facility at the beginning of their jobs and at least once every year after that is the responsibility of the operator; further, proper records of medical examination and immunization should be maintained
- Proper supply of equipment and materials required for handling the biomedical waste should be made available to all the workers working at the biomedical waste management facility

- Create an arrangement of reporting of occupational accidents (including injuries from sharps, mercury spills, fire accidents, etc.) that may happen while handling the biomedical waste and prophylactic or remedial actions taken after these accidents should also be recorded. The annual reports of these records should be submitted to the prescribed authorities
- Keep a log for every for its treatment equipment as per the weight of batch to be treated; type of biomedical waste to be treated along with time, date, and span of treatment cycle and total duration of operation
- Operator should allow the occupier (who is handing over the waste for treatment) to have a look whether the disposal technologies employed are per the rules or not
- Operator should upload the details such as authorization, treatment, and annual report on the website
- After complete sterilization and mechanical mutilation of recyclables such as plastics and glass, it should be handed over to recyclers having registration with State Pollution Control Board or Pollution Control Committee
- If requested by occupier, operator should supply the non-chlorinated plastic colored bags
- Biomedical waste should be collected on holidays as well
- For a period of 5 years, maintain the records related to every cycle of incineration, hydro, or autoclaving
- For existing incinerators, basic standards for treatment and disposal should be met, as specified in Schedule II (for retention time and Dioxin and Furans), within 2 years of from the date of publication of these rules
- According to the management and handling rules, 1998 and 2016 amendments, treatment and disposal of biomedical waste should be undertaken as follows:
- Treatment and disposal of biomedical waste should be performed as per the Schedule I and in compliance with the standards specified in Schedule II
- The segregated waste should be handed over to common biomedical waste management facility by the occupier for final disposal; laboratory and highly infectious biomedical waste should be pre-treated using autoclave or microwave technique
- On-site treatment and disposal facility should not be established if the common biomedical waste management facility service can be availed at a distance of 75 km
- If the common biomedical waste management facility is not available, on-site treatment and disposal facility (incinerator, autoclaves, microwaves, shredder, etc.) should be established following authorization from the prescribed authority

- If a new technology for waste disposal is introduced (either at health-care facility of waste management facility), the occupier or the operator should request the Central Government to lay down the operating standards for the technology; following this, the Central Government should lay the standards and operating parameters for the new technology and be published in the Gazette
- Before the start of any common biomedical waste management facility, the operator should set up the mandatory equipment such as incinerator, autoclave or microwave, shredder and effluent treatment plant with the treatment facility.
- Each occupier should eliminate utilization of non-chlorinated plastic bags within 2 years from the date of notification of these rules; after the tenure of 2 years, those chlorinated plastic bags should not be utilized for storing and transporting of biomedical waste. Further, the occupier or the operator should not dispose these plastic bags using incineration and the bags used for storing and transporting the biomedical waste should be in compliance with the Bureau of Indian Standards
- After complete sterilization and mechanical mutilation of recyclables such as plastics and glass, they should handed over to recyclers having registration form the prescribed authority
- It is the responsibility of the occupier or the operator to maintain a record of recyclable wastes referred to in sub-rule which are disposed through auction or sold; these records should be a part of annual report to be submitted to the prescribed authority
- Mercury and lead waste should be disposed of according to their respective guidelines

3.3 Safe Disposal of Radioactive Waste Rules

Radioisotopes for diagnostic and therapeutic applications have been used since ages among the tertiary care hospitals. The appropriate disposal of radioactive waste is a special task in the overall biomedical waste management from any healthcare facility. Radioactive waste management should be done in such a manner that the radioactive exposure to any individual including patients, radiation worker, and general public and the overall environment should be at the minimum level and should be under the prescribed safe limits. Atomic Energy (Safe disposal of radioactive waste) rules of 1987 broadcasted by the Indian Central Government Atomic Energy Act 1962 are the guidelines which underlies the guide to dispose the radioactive waste. Any healthcare facility which is planning to use radioisotopes for diagnostic or therapeutic purposes should have the sufficient infrastructure and resources to manage the waste generated during such procedures and keep the radiations within the safe limits. Healthcare facility premises should be monitored regularly for the radiation levels and the radiation workers should be well-equipped with the personal safety equipments so as to protect themselves for the effects of radiations. Further, such workers should be well-trained about the harms these radiations can cause. An important aspect linked to the proper radioactive waste management includes records management to regularly maintain the quality and quantity of radioactive waste generated and the associated method of storage and disposal. Each healthcare facility dealing with radioactive materials should have a radiation safety officer should be appointed and play an important role in managing such hazardous waste.

Storage and disposal of radioactive waste is strictly regulated. These types of wastes should not be disposed in regular trash cans or pouring it down drains. The radioactivity of such type of wastes declines with time, so these type of wastes have to be stored for long periods, for some cases, even for 50 years, before these could be safe for disposal.

Following are the types of radioisotopes which are generally used in nuclear medicine department of the healthcare facilities:

- Technetium-99m (Tc-99m)
- Iodine-131 (I-131)
- Iodine-125 (I-125)
- Iodine-123 (I-123)
- Flourine-18 (F-18)
- Tritium (H-3)
- Carbon-14 (C-14)

In India, there are around 200 nuclear medicine centers including positron emission tomography (PET) centers. Of these medical centers, majority of this waste is in the liquid form followed by solid waste and a very minimum quantity of gaseous waste. The solid waste generated in such healthcare facilities majorly include the syringes, needles, infected cotton swabs, vials, infected gloves, and other absorbent materials. Clothing and utensils of such patients also constitute the solid radioactive waste.

There are three major categories of radioactive waste:

- Low-level radioactive waste (LLW)
- Intermediate-level radioactive waste (ILW)
- High-level radioactive waste (HLW)

To note, disposal of low-level radioactive waste is very straightforward and can be done safely and almost anywhere. On the other hand, storage of used fuel or high-level designated radioactive waste is normally done under water for a minimum of five years and then final disposal in dry storage. Deep geological disposal is widely agreed to be the best solution for final disposal of the most radioactive waste produced.

Overall, there are two stages where a care has to be taken with radioactive waste; these are collection and final disposal. As is the case with every other hazardous biomedical waste, the radioactive waste should also be identified and segregated at the source of generation within the area of work. Radioactive waste collection bins should be foot operated lined with polythene bags designed for collecting the radioactive waste and dedicated polythene carboys (large globular bottles with a narrow neck) for radioactive liquid waste; glasswares should be avoided to collect any radioactive waste. Each of the package or container should clearly label the quality and quantity of the radioactive waste along with the details of its activity. Few of such healthcare facilities have the incinerators and also have authorization to dispose the radioactive waste which is combustible in nature using the incinerators but that should also be done after proper segregation of combustible and incombustible radioactive waste.

Following steps should be undertaken to store the radioactive waste in general:

- All the radioactive wastes should be separated by isotope and its physical form.
- A specific location should be designated for the storage of radioactive wastes.
- The area and the collection containers should be labelled with a "RADIOACTIVE" warning symbol.
- Shielding should be used while handling the radioactive waste and also around the storage area of the radioactive waste
- Special shielding should be considered while handling and storing high-activity or high-energy isotopes
- A completed tag should be attached to all the containers storing radioactive waste in the storage area highlighting that the waste is "RADIOACTIVE"
- The containers should always be closed and temper proof; further the exteriors of such containers should also be clear and free from any type of contamination

Disposal of gaseous radioactive waste

For the disposal of gaseous or volatile radioactive sources such as Iodine-131, Iodine-125, Xenon-133, Carbon-14, Hydrogen-3, Nitrogen-13, Technetium-99m aerosols release vapors which are radioactive in nature and need special precautions. For such type of substances, containers are opened under fume hoods under the supervision of radioactive safety officer. These hoods are generally developed to elute all the gas fumes into the atmosphere after getting passed through charcoal and particulate air filters within the ducts.

Disposal of excreta and urine of patients being treated with radioisotopes

Patients who are being treated with high doses of radioisotopes are kept in isolation wards within the healthcare facilities till the stage when the radioactivity levels reaches to a minimum acceptable limit. The urine and excreta of such patients are not allowed to enter the sewerage system directly; these are first stored in customized and radioactivity safe storage tanks through PVC pipes. These tanks are built within the healthcare facility premises but in an isolated area with low public footprints. Such types of tanks are leak proof and corrosion free and does not allow radioactive emissions to pass through. After a storage period of around 2 months and checking the emission levels in this waste, the tanks are connected and emptied in the sewerage system.

Management of cadavers with radioactive remains

In a situation where a patients under treatment with radioisotopes dies within the healthcare facility, it becomes the responsibility of the healthcare workers to dispose the body in such a way that the emission activity is within the safe limits. If any particular organ is loaded with radioisotopes, then such organ or organs are removed from his body through autopsy under the supervision of radiation safety officer and body is handed over to the family members for the last rights. However, in case the whole body is loaded with the radioisotopes and the radioactivity is high, the dead body is retained within the healthcare facility for the tenure until the activity declines and reached within the safe limits. Further, these type of situations should be informed to Atomic Energy Regulatory Board for record keeping.

Record keeping

A formal logbook or record book should be maintained within the healthcare facility to record the various details related to radioactive materials including:

- Quality and quantity of the radioisotopes purchased
- Details of radioactive waste generated along with its type and activity levels
- Radioactivity levels of the waste at the time of final disposal
- Radioactivity levels of the effluent present in the storage before being discharged into the sewerage system
- Details of the persons who are administering the radioisotopes
- Details of the healthcare worker who is taking care of the final disposal of the radioactive waste
- Details of the death of any patients who died while on treatment with radioisotopes

Bhabha Atomic Research Center (BARC) has drafted Atomic Energy (Safe Disposal of Radioactive

Wastes) Rules, 1987. Within these rules, there are specific roles and duties allocated to each person involved during the course of radioactive material usage and final disposal. These rules have been summarized below:

Restrictions on the disposal of radioactive waste – according to these rules,

- none of the person is allowed to dispose the radioactive waste unless he is authorized from the competent authority to do so.
- He/she is not allowed to dispose the radioactive waste in any other location or quantity different from what is mentioned by the authority.

Duties of the authorized person – as per these rules,

- authorized person is responsible to ensure that disposal of the radioactive waste is being done in accordance with the regulations;
- records are maintained in appropriate fashion; within the healthcare facility, all the requirements mentioned in the Radiation Protection Rules, 1971 are met;
- occurrence of any hazardous accident is avoided;
- environmental surveillance of the healthcare facility premises to evaluate any risk from radioactive emissions should take place regularly and the corresponding records are being maintained and reports should be submitted to the competent authorities on quarterly basis
- reports from any hazardous emergency accident should be forwarded to the competent authority
- further, the competent authority should be informed in case of the resignation of the radiological safety officer or the waste disposal installation is closed

Duties of the Radiological safety officer – according to the BARC rules, duties of the radiological safety officer are summarized as:

- He/she should train the healthcare worker about the ways to handle and dispose the radioactive wastes safely and how to take the necessary steps to ensure the safety of others and activity remains within limits
- Inform the healthcare worker about the hazards associated with the radiations and the safety measures he should take to minimize the ill effects due to radiations and
- Ensure that regular surveillance of the environment take place so that all the radiation workers and the environment is protected
- Regularly perform the radioactivity tests on the wastes to check their radioactivity

- To check the safety and competency of the areas or premises designated to be used for handling, conditioning, storing, or disposal of radioactive waste
- To check the calibration of personal protective equipments used by radioactive material handlers at any step
- To provide the remedial measure in case of radiation hazards
- All hazardous situations should be informed to the competent authority
- To ensure that Radiation Protection Rules 1971 are being followed

3.4 International Scenario World Health Organization Guidelines on Management of Wastes from Hospitals wastes

According to the WHO, the term health-care waste includes all the waste that is generated from health-care facilities, research centers,and/or research laboratories after the various types of medical procedures. In addition to this, health-care waste also includes the waste generated during the course of treatment undertaken in the home (e.g. self-administration of insulin).

The WHO committee provides the guidelines for below-listed topics to tackle the issue of appropriate management of solid wastes from health-care facilities:

- Definition and description of biomedical waste
- Risk associated with biomedical waste
- Regulatory aspects of biomedical waste
- Planning of biomedical waste management
- Biomedical waste minimization strategies including reuse and recycling
- Segregation, collection, storage, and transportation of biomedical waste
- Treatment and final disposal methods
- Economics of biomedical waste management
- Health and safety practices for medical staff and waste handlers
- Hospital cleanliness and infection control
- Training, education, and public awareness
- Biomedical waste management in emergencies

Definition and Characterization of Biomedical Waste

According to the WHO guidelines, hazardous health-care waste is categorized as:

- Sharps waste
- Infectious waste
- Pathological waste

- Pharmaceutical waste
- Cytotoxic waste
- Chemical waste
- Radioactive waste

Risks Associated with Biomedical Waste

The risk from biomedical waste is due to the following characteristics of waste:

- Existence of infectious agents in the biomedical waste
- Load of genotoxic or cytotoxic waste
- Presence of toxic or hazardous chemicals or pharmaceuticals
- Presence of radioactive substances
- Presence of used sharps and syringes

If exposed, possible risks associated with the inappropriate handling of biomedical waste are threatning for individuals, society, and the environment. In the list of most risky wastes, the most menacing is the poorly managed sharps followed by infectious, chemical, and pharmaceutical waste; radioactive waste holds the last position in the list due to strict guidelines laid by the respective governments. To overcome the risks associated with these biomedical wastes, the best method is to reduce or minimize the generation of waste, whenever possible.

Legislative Aspects of Biomedical Waste

To have an effective system to guide and control the appropriate handling and disposal of biomedical waste, government intervention is a must. Development of national policy for managing the biomedical waste by a ministry is the first and the foremost step in the direction of controlling hazards from the biomedical waste. National policy must be developed keeping in mind the needs of the country along with the capitals and facilities available in the country. Followed by the national policy are the legislation and the strict regulations that explain in detail the expectation from each member of the waste management chain.

To develop the national policy, the below listed five guiding principles are considered:

I. The "Polluter" principle: The producer of the waste is responsible, both lawfully and monetarily, to dispose of the waste in a safe and environment-friendly method
II. The "Precautionary" principle: In case there are chances of any fatal

or

unalterable harm to the surroundings, lack of full scientific certainty should not be used as a reason to delay any preventive action and save the environment.

III. The "Duty of care" principle: Any person involved in the whole process of management of biomedical waste is ethically responsible for completing the respective step with utmost care

IV. The "Proximity" principle: Treatment and disposal of the biomedical waste should be done at the closest site to its source where the waste is generated which reduces the risks in transportation of the waste

V. The "Prior informed consent" principle: This principle highlights the need of reiteration of hazards and risks of hazardous waste to the affected stakeholders (personals involved in waste transportation and personal at the waste disposal facilities).

Health-care waste management planning

The national plan is based on the biomedical waste management options available in the country; this will help in decision-making and providing a budget for the implementation of the national plan for additional resources and development of new disposal facilities.

According to the WHO guidelines and Basel Convention, following six objectives should be covered under planning:

- Legal and regulatory framework should be developed for the biomedical waste management
- Within health-care facilities, waste management practices should be streamlined
- Specific budget and workforce should be allocated specifically for waste management
- Capacity building and training measures should be launched
- Monitoring plan should be in action
- Reduction in pollution from waste management should be targeted

Biomedical waste minimization strategies including reuse and recycling

According to the WHO guidelines, waste minimization is the first and foremost approach that should be targeted. Wherever applicable, using the waste items for secondary use, either in the same format or after minor modulations, is the next recommended step, followed by using recyclable materials. If none of these steps could be reached out, then the least preferable option of final disposal of the waste through different techniques should opt.

Segregation, collection, storage, and transportation of biomedical waste

General principles suggested by WHO that needs to be followed during the process of biomedical waste management starting from waste generation till the final disposal:

- The foremost principle - reinforce the segregation of biomedical waste at the place of generation into different portions. The segregation is guided by their nature and damage they lead to and also as per the method of their final disposal. Further, the guideline specifies that the person who produces the waste is accountable/bound to segregate the waste as per the suggested guidelines. Waste is segregated as:
    - Non-hazardous general waste
        - Recyclables
        - Biodegradable waste
        - Non-recyclable waste
    - Hazardous waste
        - Used sharps
        - Potentially infectious items (tunings, bandages, disposable medical items, swabs, and tissues)
- For each segregated waste type, separate bins should be available in each area where the waste is generated (Table)

Table 3.1: WHO-recommended segregation scheme with color-coding

Type of waste	Color of container and markings	Type of container
Highly infectious waste	• Yellow • "HIGHLY INFECTIOUS," with biohazard symbol	• Strong • Leak-proof plastic bag, or container capable of being autoclaved
Other infectious waste, pathological waste, and anatomical waste	• Yellow • Biohazard symbol	• Leak-proof plastic bag or container
Sharps	• Yellow • "SHARPS," with biohazard symbol	• Puncture-proof container
Chemical and pharmaceutical waste	• Brown • Appropriate hazard symbol	• Plastic bag or rigid container
Radioactive waste	• Labeled • Radiation symbol	• Lead box
General biomedical waste	• Black	• Plastic bag

- Once filled, the containers should be labeled properly for collection
- If the waste is not collected frequently, a closed temporary storage area should be present inside or close to the health-care facility
    - The main consideration for the interim or short-term storage is that this area should be located away from patients and public access, but on the other hand, it should be close to the medical area to avoid long transportation
- Any mixing of infectious and non-infectious wastes should not take place in the whole process of management of biomedical waste
- Before final treatment and disposal of waste, collected waste is transported to central storage sites
    - To transport the waste from health-care facility to disposal site, if possible, separate stairways or elevators should be used
    - Black painted waste transportation trolleys should be used for non-hazardous waste only

- Yellow painted waste transportation trolleys should be used for infectious waste along with the sharps waste
- Boxes should be used for the transportation of chemical and pharmaceutical wastes
    - Genotoxic pharmaceutical waste should be stored and transported with special precautions and not to be stored along with other non-hazardous pharmaceutical waste
- Appropriate labeling should be used inside the central storage facilities according to the hazard level
- Separate storage zones should be available in the central storage facilities for the following types of hazardous wastes:
    - Explosive waste
    - Corrosive acid waste
    - Corrosive alkali waste
    - Toxic waste
    - Flammable waste
    - Oxidative waste
    - Halogenated solvents
    - Non-halogenated solvents
- Storage containers for the radioactive waste should be made radiation dispersion proof and such containers should be protected with lead shielding marked with "RADIOACTIVE WASTE."
- Employees employed for collecting and transportation of the biomedical waste should always be well equipped with personal protective equipment

- Whosoever involved in waste handling among health-care facilities should be made aware of the risks and hazards along with the safety procedures related to the biomedical waste
    - Drivers of waste transportation vehicles should be well-trained and well-aware of the risks and hazards related to the biomedical waste. Further, they should be trained for the emergency situation, for example, spillage of any waste or any vehicular accident
    - Waste transportation vehicles should be labeled with a biohazard symbol, name and address of the waste management facility, emergency contact number should be printed; the vehicle should be well equipped with personal protective equipment, tools, and disinfectants to handle any emergency situations or accidental spillage

Treatment and Disposal Methods

In order tosafeguard the environment and reduce the health impacts from biomedical waste, the hazardous waste is treated before final disposal. There are multiple guiding factors which help in deciding the waste treatment methodology. Some of these factors are – waste characteristics, technology capabilities, safety issues, environmental factors, cost involved, availability of skills and resources for technology, installation and infrastructure requirements, treatment efficiency, etc. Following are the five basic types of methodologies used for treatment of hazardous biomedical waste to render them non-infectious:

- Thermal processes
    - This is the most common process used across the world
        - Low-heat designs
        - High-heat designs
    - The low-heat process involves the use of high temperature (100°C to 180°C) enough to cause the destruction of microorganisms. However, the temperature is not too high to cause combustion or pyrolysis
- Chemical processes
    - Chemical disinfectants (chlorine dioxide, bleach, lime solution, ozone gas, etc.) are used
    - Waste shredding, grinding, or mixing is used prior to chemical disinfection to increase the area of exposure
    - For pathological and anatomical waste of human and animals, heated alkali is used
- Irradiation processes
    - Electromagnetic radiations are used to render the biomedical waste non-hazardous
    - This type of process carries the risk of occupational exposure to electromagnetic radiations
- Biological processes
    - Waste treatment with the use of enzymes, worms, or burial of biological waste
- Mechanical processes
    - Shredding, grinding, mixing, and compaction is the type of technologies under the category of mechanical processes
    - These processes do not destroy any pathogens present in the waste so before exposing the waste to any mechanical process; the waste is treated and made non-infectious

- These type of processes are combined with any of the above-listed methods to achieve the complete destruction of the waste

Table 3.2: Summary of different methods of biomedical waste sterilization

Method of sterilization	Suitable for	Not suitable for
Autoclave	• Cultures • Stocks • Sharps • Materials contaminated with blood and limited amount of fluids • Isolation and surgery waste • Laboratory waste • Soft waste (gauzes, bandages, drapes, gowns, and bedding)	• Large anatomical waste (human body parts) • Volatile and semi-volatile organic compounds • Chemotherapeutic waste • Mercury • Other hazardous chemical waste • Radiological waste • Large and bulky bedding material • Large animal carcasses • Sealed heat-resistant containers
Integrated steam-based treatment systems (advanced autoclaves, hybrid autoclaves, advanced steam treatment technologies)	• Cultures • Stocks • Sharps • Materials contaminated with blood and limited amount of fluids • Isolation and surgery waste • Laboratory waste • Soft waste (gauzes, bandages, drapes, gowns, and bedding)	• Large anatomical waste (human body parts) • Volatile and semi-volatile organic compounds • Chemotherapeutic waste • Mercury • Other hazardous chemical waste • Radiological waste • Large and bulky bedding material • Large animal carcasses • Sealed heat-resistant containers
Microwave treatment technologies	• Cultures • Stocks • Sharps • Materials contaminated with blood and limited amount of	• Volatile and semi-volatile organic compounds • Chemotherapeutic waste • Mercury • Other hazardous chemical waste

Method of sterilization	Suitable for	Not suitable for
	fluids • Isolation and surgery waste • Laboratory waste • Soft waste (gauzes, bandages, drapes, gowns, and bedding) • Animal waste • Tissues	• Radiological waste
Dry-heat treatment technologies	• Glassware and reusable instruments • Small amounts of sharps • Soft “red bag” wastes (gauze, bandages, gloves, etc.) • Small amounts of liquid waste such as dressings soaked with blood or body fluids	• Liquids in bulk quantities • Volatile and semi-volatile organic compounds • Chemotherapeutic waste • Mercury • Other hazardous chemical waste • Radiological waste • Human or animal body parts • Cultures • Stocks • Isolation waste
Chemical treatment technologies	• Medical equipment • Floors • Walls • Treating liquid waste such as blood, urine • Stools, or hospital sewage • Microbiological cultures and sharps • Stocks • Liquid human and animal waste including blood and body fluids • Isolation and surgery waste	• Volatile and semi-volatile organic compounds • Chemotherapeutic waste • Mercury • Other hazardous chemical waste • Radiological waste

Method of sterilization	Suitable for	Not suitable for
	• Laboratory waste • Soft wastes (gauze, bandages, drapes, gowns, bedding, etc.)	
Incineration	• Human tissues • Dense fibrous tissue • Laboratory waste like cartilage, bone, blood, muscle tissue, skeletal, cardiac waste, carcass, animal carcass, animal dead body • Microbiology laboratory wastes	• Chlorinated plastics • Pressurized gas containers • Reactive chemical waste • Silver salts • Waste containing mercury, cadmium or other heavy metals • Sealed ampoules or vials • Radioactive materials

Preferable and recommended methods of disposal for specific waste categories are summarized in table below.

Table 3.3: Summarization of methods for disposal of specific biomedical waste categories

Waste type	Disposal method
Sharps	• Using onsite mechanical/electric needle cutters • Mincing of the treated parts • Burial of the metal pieces into the burial pits • Re-melting the plastics wastes for recycling
Anatomical waste, pathological waste, placenta waste, contaminated animal carcasses	• Burial in special burial sites • Specially designed incinerators
Pharmaceutical waste	• Expired medicine should be to the manufacturer • Encapsulation and burial in a sanitary landfill • Chemical decomposition • Dilution in large amount of water and final discharge into a sewer (vitamins, cough syrups, intravenous solutions, eye drops) • For large quantities, incineration should be used
Cytotoxic waste	• Return to original supplier • High-temperature incineration • Chemical decomposition
Low-level radioactive waste	• Decay in storage • Return to supplier • Long-term storage at an authorized radioactive waste disposal site

3.5 Budgeting and Record Maintenance

Overall, tremendous investment is expected to be required to clean billions of huge amounts of biomedical waste that has been dumped crosswise over world. A joint study conducted by ASSOCHAM and Velocity concluded that by 2022, the per day approximately 775.5 tons of biomedical waste will be generated in India; the current rate is 550.9 tons per day – about 7% rise every year. This report features the requirement for stringent checking and assessment system to guarantee safe and compelling management of biomedical waste.

Director General of Health Services of the Delhi highlighted the fact that biomedical waste management in a safe and effective manner is a part of legal responsibility as well as social duty. The major hurdles in the path of appropriate biomedical waste management are the lack of concern, mindfulness or awareness, self-motivation and of course the cost factor and by 2025, Indian waste management market is anticipated to reach USD 13.62 billion.

The task of monetary incentive to the increases and misfortunes in ecological setting has increased significant significance in the ongoing past. In current time of an unnatural weather change, a great social advantage cost investigation before establishment of a venture can be gainful for counteractive action of further disintegration since, it gives precise measure of advantages and expenses of an undertaking to be introduced.

Economics of Biomedical Waste Management

Short-term savings by allocating insufficient funds for health-care waste management eventually leads to more financial losses due to long-term effects of the waste on society and environment. Budget planning and finance management is required at each and every step associated with biomedical waste management starting from waste segregation till the final disposal of the waste. According to the WHO guidelines, during budget allocation, available and cost resources should be taken into account at a health-care facility level, common biomedical waste management facility level, and national level. Minimization of the waste generated is the best method to control the financial burden on any health-care facility.

The organizations are hesitant to contribute or burn through cash either to counteract or to control the contamination levels that are making inconceivable harm the condition. This might be because of three noteworthy potential outcomes; they would prefer not to decrease their benefit: (i.e., such measures are costlier to embrace, particularly when there is no motivating force) they have not evaluated the genuine harm to the general public or nature around them (for example the issue of estimation of ecological harm turns out to be troublesome when it is immaterial or they are in no chance influenced by such contamination levels, that is absence of learning, data and mindfulness about the harms of the contamination from one viewpoint and absence of comprehension about the social just as monetary estimations of conservation of regular habitat on the other.

The involvement of finances and costs at every step of handling, management, and final disposal of biomedical waste play a major role in setting up a path for appropriate biomedical waste management. Of the various processes involved in waste management, the construction, operation, and maintenance of equipment for sterilization and disposal of the waste use most part of the overall budget of a health-care facility if the recommendations of Biomedical Waste Management Rules 2016, if strictly implemented.

As per the "polluter pays" principle of the WHO, the overall biomedical waste management generated is the financial liability of each healthcare facility. The costs involved in waste collection, segregation, packaging and on-site handling of the biomedical waste are all part of internal costs. On the other hand, the salaries paid to the labor and supplies costs, costs related to off-site transport of biomedical waste, its treatment and final disposal all constitute the external costs associated with biomedical waste management.

The overall healthcare facility establishment budget's significant part is being represented by the costs involved in construction, its operation, and maintenance of the systems required for appropriately manage biomedical waste and need special heading while budget allocation. According to the WHO report, the elements of total costs are summarized below (Figure) and these heads needs special attention during the time of investment. Waste minimization, segregation, and recycling are some of the recommended steps for cost-effectiveness of the biomedical waste management process and can reduce to cost of the waste disposal. Waste minimization has benefits in terms of cost-cutting at each step of biomedical waste management including segregation, collection, and final treatment. The WHO report has also provided a summary of construction of an incinerator (Fig3. 2).

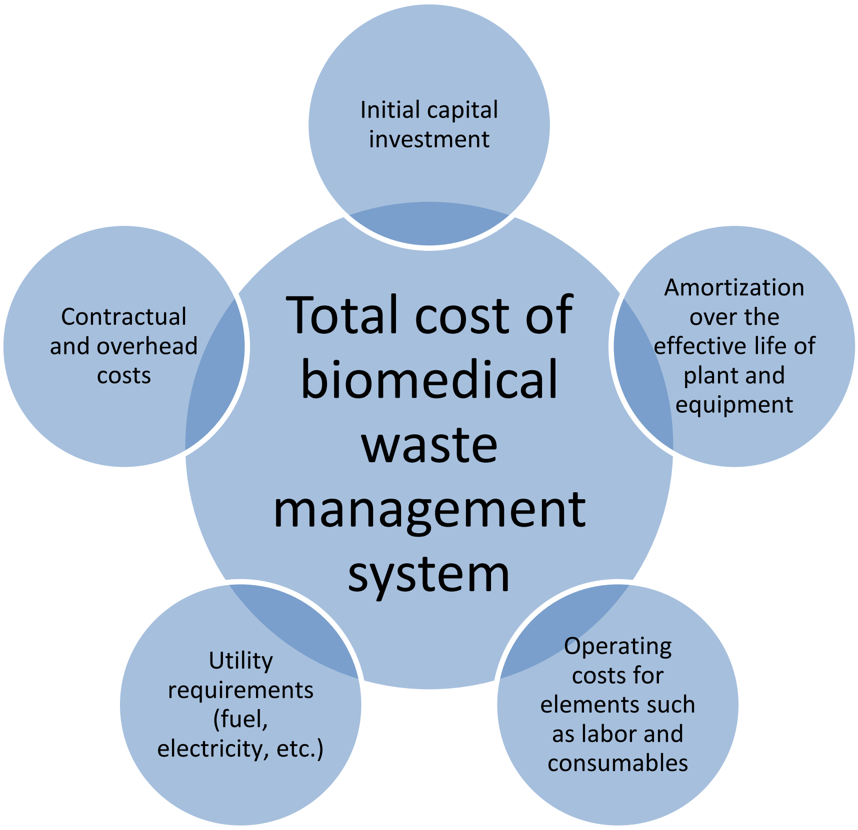


Fig3.1: Total costs of a biomedical waste management system

Fig3.2: WHO summary of costs of construction and operation of a biomedical waste incineration plant

Site
Cost of land
Rights of way
Site preparation and infrastructure
Provision of utilities to site

Consultancy fees
Environmental/waste management consultant
Engineering
Architectural
Legal fees

Construction costs
Incinerator building
Waste storage room
Offices

Incinerator
Cost of incinerator
Freight and storage charges

Waste transport costs
Waste collection trucks
Bins/containers for transporting waste from hospitals to incinerator site

Equipment costs
Trolleys for collecting waste bags from wards
Bag holders to be located at all sources of waste in hospitals
Weighing machines for weighing waste bags
Refrigerators for storage of waste if necessary

Financing charges
Interest
Taxes
Accounting and audit fees

Direct operating costs
Manpower requirements (manager, operators, drivers, . . .)
Yellow bags with tags for infectious wastes
Black bags for non-risk waste
Sharps containers
Transportation costs
Utilities (fuel, water, electricity)
Chemicals (for flue-gas cleaning)

Indirect operating costs
Training
Incinerator maintenance and parts replacement
Vehicle maintenance
Uniforms and safety equipment
Ash disposal cost
Compliance monitoring of flue-gas emissions
Project management and administrative costs for the organization responsible for the execution and long-term operation of the project

Chapter 4-Steps Involved in Biomedical Waste Management

Introduction

As quoted by Alfred Lord Tennyson "*knowledge comes but wisdom lingers*". The quote somewhat corroborated with the findings of this study that can be encapsulated after this rigor and extensive research. As a matter of fact, most of the hospitals and staff managements were aware of procedures of handling biomedical waste, albeit, paradoxically all of them show absolute negligence when it comes to practice. Thus, it is the need of an hour that regulatory authorities should keep a tight rein to control on the waste management industries.

World Health Organization (WHO) provides a detailed guidelines for all hospitals to comply to ensure safe medical waste disposal management. These are (a) Waste Minimization at source by reuse, recover, and stock management; (b) Waste Segregation by categories and sharps; (c) Waste Identification by color coding for different wastes; (d) Waste Collection and storage by routine program; (e) Waste Transfer by following chalked pathway from generation to disposal sites and use enclosed vehicle (f) Treatment option by both burn and non-burn ways.

The past few decades have witnessed the improvement in the medical science and technology to new level of growth which in turn has caused the expansion of health care facilities all over the world. The increase in a number of health-care facilities thus resulted in an increase in the amount of hazardous biomedical waste manifolds. The risk associated with biomedical waste include accidental exposure of medical staff, waste handlers or *safaikaramcharies*, environment, and the general public due to inappropriate waste management and illegal use of disposables. Not only this, emissions and ashes after burning the biomedical waste in incinerators also affect the surroundings including plants and animals. However, this does not mean that use of incinerators should be banned. The never ending the war of protecting the environment, reducing the risks, and that too at low cost will continue.

An accurate and workable system for the biomedical waste management at the health-care facilities will save the environment and long-term ill effects on human health from the environmental release of toxic substances such as dioxin, mercury, and others.

Objectives

- To know about steps involved in the process of biomedical waste management.
- To know how the common biomedical waste management facilities operate.

Structure

4.1 Biomedical Waste Management overview

4.2 Steps involved in biomedical waste management

4.3 Methods for Segregation and disinfection of waste

4.4 Requirements of common biomedical waste management facility

4.5 Treatment and Disposal

To Do Activities

Visit the health care facilities and see the different steps involved at the different stage of biomedical waste management including collection, segregation, temporary storage, final transport
Make students do group presentations to discuss the steps to make the process more cost-effective and safe disposal metho

1.1 Biomedical Waste Management overview

Collecting the information about the type of waste and the amount of waste generated from a health-care facility is one of the crucial first steps in biomedical waste management. The proper assessment of quality (i.e. the physicochemical composition of the waste) as well as the quantity of the waste will guide in assessing and evaluating the capacities for containers, storage areas, transportation that would be required for biomedical waste, the disposal methods and facilities needed. Further, the data on quality and quantity of biomedical waste also help the government and hospital authorities in planning, budgeting, figuring incomes from recycling, streamlining of waste-management systems, and assessment of the effect on the environment. Keeping track of the quantity of recyclable waste generated will help in keeping a check on illegal recycling of the waste material. Data on quality or type of waste generated will help in the procurement of appropriate personal protective equipment, providing the required training especially about the segregation of waste at the source where it is generated; cost-savings can be achieved through this.

World Health Organization (WHO) provides a detailed guidelines for all hospitals to comply to ensure safe medical waste disposal management. These are (a) Waste Minimization at source by reuse, recover, and stock management; (b) Waste Segregation by categories and sharps; (c) Waste Identification by color coding for different wastes; (d) Waste Collection and storage by routine program; (e) Waste Transfer by following chalked pathway from generation to disposal sites and use enclosed vehicle (f) Treatment option by both burn and non-burn ways. WHO suggests the waste management hierarchy that highlights the most desirable and the least desirable method of waste management (Figure). The hierarchy pyramid was developed keeping in mind the overall benefit on the environment, public health, and financial burden from each adopted method. “3Rs” is the most widely recommended strategy for the waste management – *reduce, reuse, and recycle*; reducing the production rate of waste is a preferable method of waste management that reduces the amount entering the waste stream and the subsequent steps. This canbe done by avoiding wasteful ways of working (e.g. cleaning the hospital stuff with steam disinfection rather than chemical disinfection). The second most preferable method is to use the materials which can be reused followed by the use of recycling technique.

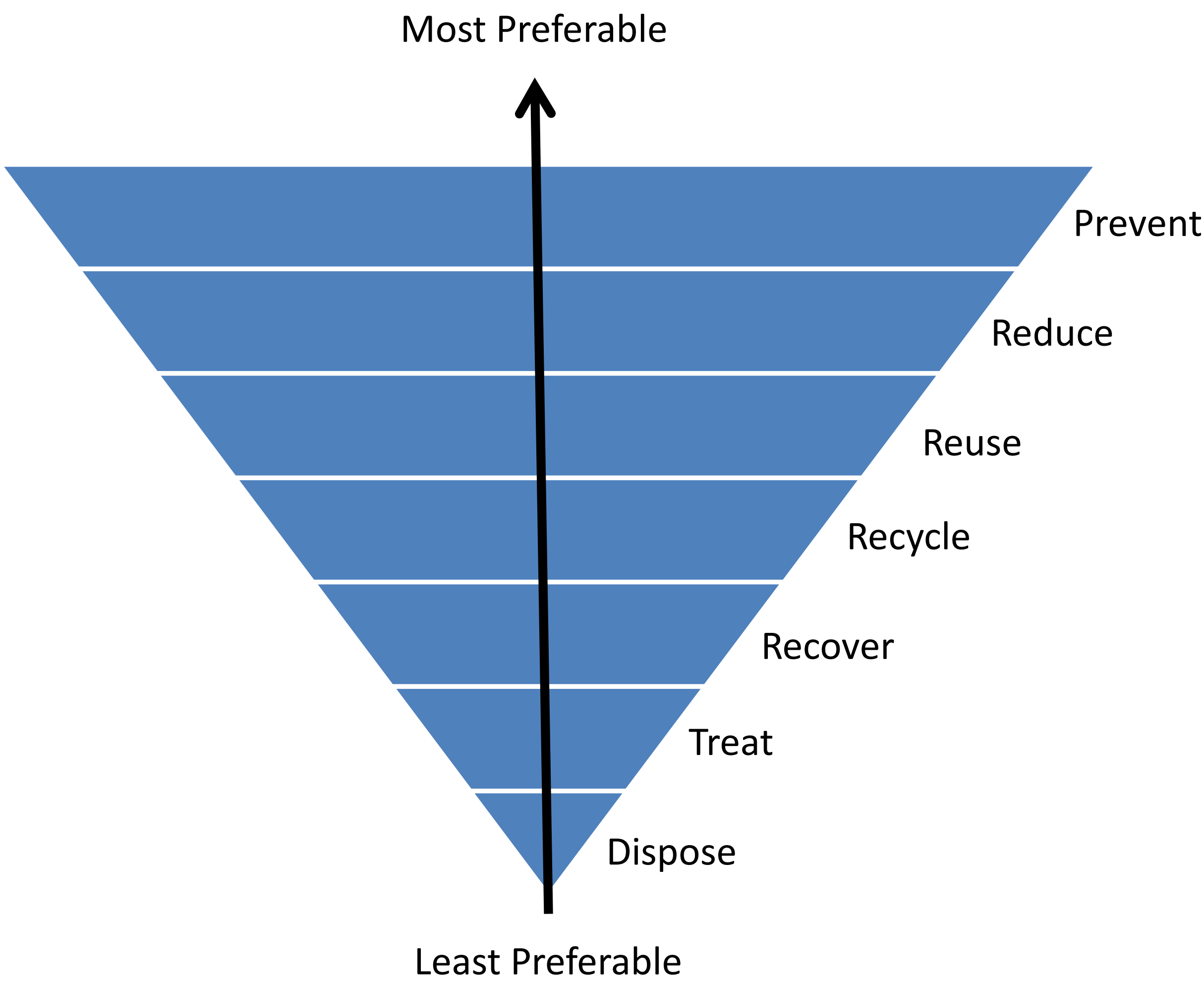


Fig4.1: The suggested rules and hierarchy for waste management (WHO)

In India, there are well-defined rules for the biomedical waste management (Biomedical Waste Management Rules 1998). However, there are gaps in appropriate waste management (Image). Recently, these rules have been updated, and some major changes are reflected in the new rules(46).

From time-to-time, Pollution Control Board's inspections highlight the need for proper implementation and monitoring of these rules. However, every inspection raises question marks on the hospital working.

Image 4.1: Biomedical waste lying outside Lok Nayak Hospital

Recently, on May 07 2016, the warning has been issued to the state government for mismanagement of bio-medical waste which was observed by Jammu and Kashmir Pollution Control Board. According to the report, none of the hospitals in the valley were following the prescribed rules and regulations for segregating the bio-medical waste from the general waste and heaps of waste containing used syringes, tubes, IV sets, bandages, and saline bottles are lying near the hospitals. The hospital authorities cited insufficient funds for the mismanagement of the bio-medical waste.

On May 04 2016, Karnataka State Pollution Control Board (KSPCB) conducted surprise visits in hospitals across the city to assess the state of biomedical waste. The results of the inspections revealed a careless approach in terms of segregation and treatment of biomedical waste. In some of the hospitals, the biomedical wastes were being mixed with the unsegregated waste which renders the general waste as hazardous waste. According to the KSPCB chairman Mr. Laksman “If such waste is handled by personnel at the waste management plant, it could make them sick.” Notices have been issued to the hospitals stating that failing with the norms; hospitals will be punished with criminal charges. Similarly, Maharashtra Pollution Control Board is working on generating a list of health-care facilities not abiding by the Biomedical Waste Management Rules and is in the process of sending notices to 300 erring health-care facilities and labs.

Image 4.2: Unsegregated waste stacked in piles observed during KSPCB visit in hospitals

However, recently, it has been observed that State Governments and the Pollution Control Boards are strict with the health-care facilities and are seriously looking for ways to reduce the pollution from biomedical waste.

In Dehradun, directions have been given by the government to various health care providers to get them registered with the municipal corporation of Dehradun which handles the disposal of bio-medical waste. Further, the health care facilities not following the directions would be facing the actions from a municipal corporation which has decided to penalize violators(51).

In Chennai, the National Green Tribunal’s Southern Bench has ordered a CB-CID inquiryinto the illegal sale of solid biomedical waste by hospitals. The case came to light when it was found that a private hospital is selling its biomedical waste at Rs. 49/kg to a vendor(52).

Delhi Government has taken the initiative to ensure the proper disposal of biomedical waste. Currently, there are two licensed common biomedical waste management facilities which take care of disposing the biomedical waste from both government and the private hospitals of New Delhi. The Delhi Pollution Control Committee (DPCC) and the environment department of Delhi are working to involve more firms to handle the waste appropriately. Further, they are proposing to set up CCTVs at all the sites where the waste is picked up, autoclaved and finally disposed of to have better control over the system.

As a matter of fact, most of the hospitals and staff managements are aware of procedures of handling biomedical waste, albeit, paradoxically all of them show absolute negligence when it comes to practice. Thus, it is the need of an hour that regulatory authorities should keep a tight rein to control on the waste management industries.

In Asia, there are few best practices in terms of biomedical waste management and has been recognized by the WHO also for these practices and setting up an example for other countries for "eco-friendly biomedical waste management". Bir hospital, Kathmandu started a Health Care Waste Management Program in collaboration with an NGO Health Care Foundation-Nepal (HECAF) to generate energy from waste and to provide safe health care to the environment and the patients visiting the hospital through waste recycling and waste decomposition (vermicomposting) after sterilization and disinfection.

The past few decades have witnessed the improvement in the medical science and technology to new level of growth which in turn has caused the expansion of health care facilities all over the world. The increase in a number of health-care facilities thus resulted in an increase in the amount of hazardous biomedical waste manifolds. The risk associated with biomedical waste include accidental exposure of medical staff, waste handlers or *safaikaramcharies*, environment, and the general public due to inappropriate waste management and illegal use of disposables. Not only this, emissions and ashes after burning the biomedical waste in incinerators also affect the surroundings including plants and animals. However, this does not mean that use of incinerators should be banned. The never ending the war of protecting the environment, reducing the risks, and that too at low cost will continue.

4.2 Steps Involved in Biomedical Waste Management

Steps involved in an appropriate biomedical waste management process are as follows:

- Waste collection
- Segregation
- Transport and storage
- Treatment and disposal
- Transport to final disposal facility
- Final disposal

According to the management and handling rules, 1998 and 2016 amendments, segregation, packaging, transportation, and storage of biomedical waste should be undertaken as follows:

- Untreated biomedical waste should never be mixed with any other kind of waste
- Segregation of biomedical waste should be done at the source point before its storage, transportation, and any kind of disposal and the segregation should be done according to the Schedule I of the guidelines; the containers or bags used for segregation of waste should be labeled in accordance with Schedule IV (Image)

- As per the new 2016 guidance, bar codes and global positioning systems should be incorporated within one year's time frame; this should be done by the occupier and the common biomedical waste treatment facility both
- The operator of the common biomedical waste treatment facility is responsible for transporting the waste from the health-care facility premises to the biomedical waste treatment facility; the transportation of waste should be done in vehicles appropriately labeled according to the Schedule IV of the guidelines (Image)
- The vehicles used for transportation of infectious biomedical waste should meet the standards specified by the State Pollution Control Board or Pollution Control Committee along with the Motor Vehicles Act, 1988
- Storage period should not exceed beyond a period of 48 hrs for untreated human anatomical waste, animal anatomical waste, soiled waste, and biotechnology waste
    - For any reason if a situation arises to store such waste beyond the specified period, it is the duty of the occupier to ensure that it is stored properly; also the occupier should keep the prescribed authorities well-informed about the situation
- According to the 2016 rules, it is mandatory to pre-treat by sterilization or disinfection the microbiology and all other clinical waste before packaging and transportation; the WHO guidelines should be followed – sterilization to Log 6 or disinfection to Log 4

SCHEDULE I

Table 4.1: Biomedical waste categories and segregation method, the collection method, their treatment and final disposal options

Category	Type of Waste	Type of bag or container to be used	Treatment & Disposal
	(2)	**(3)**	(4)
Yellow	(a) **Human Anatomical Waste**	Yellow colored non-chlorinated plastic bags	• Incineration • Plasma Pyrolysis • Deep burial*
	(b) **Animal Anatomical Waste**		
	(c) Soiled Waste		• Incineration • Plasma Pyrolysis • Deep burial* • Autoclaving • Micro-waving/hydroclaving followed by shredding • Combination of sterilization and shredding

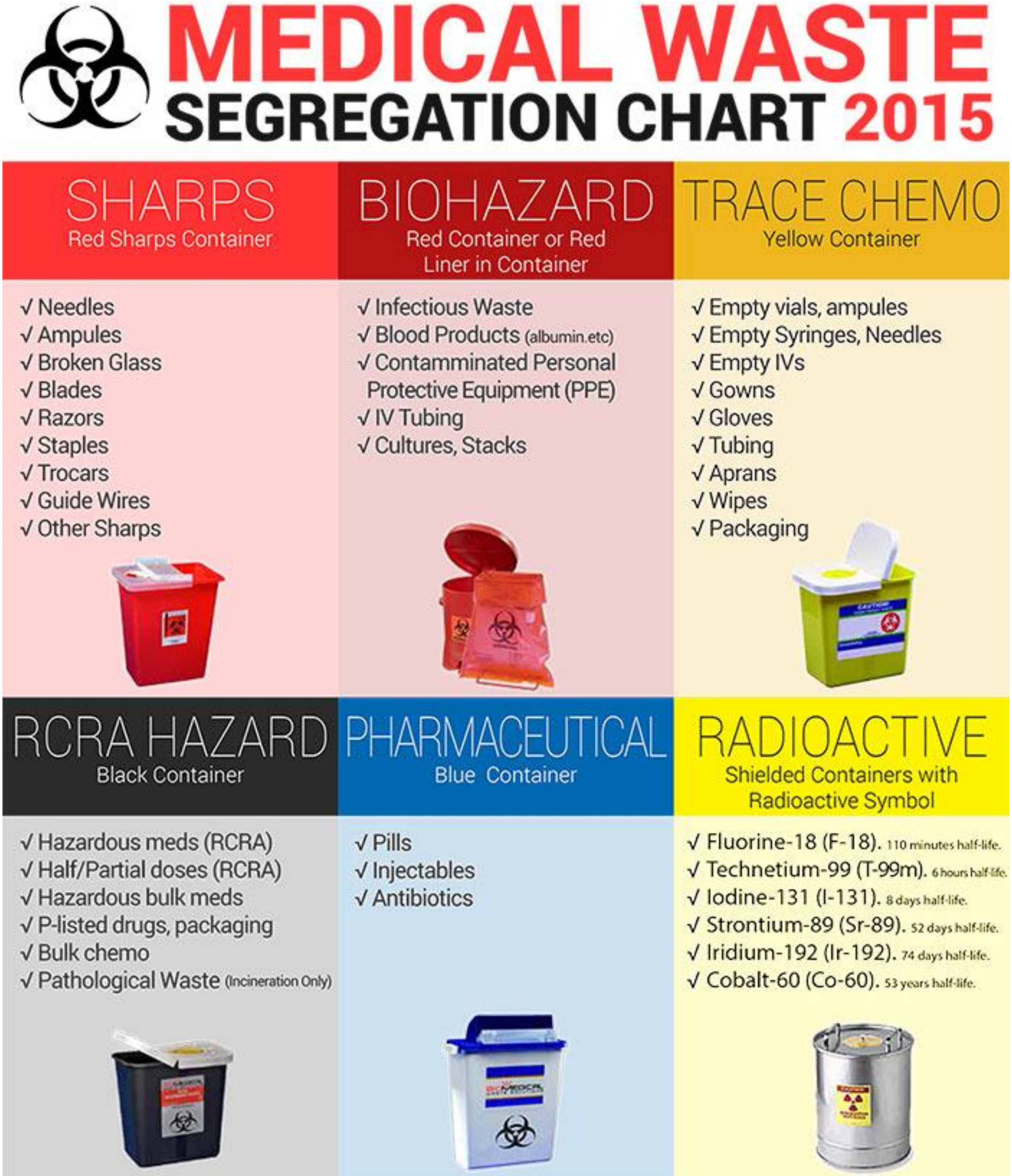
Category	Type of Waste	Type of bag or container to be used	Treatment & Disposal
	(d) Expired or Discarded Medicines	Yellow colored non-chlorinated plastic bags or containers	• Expired cytotoxic drugs should be returned back to the manufacturer or supplier for incineration at temperature >1200°C or to common biomedical waste treatment facility or hazardous waste treatment facility for incineration at >1200°C • Encapsulation • Plasma pyrolysis at >1200°C • All other discarded medicines shall be either sent back to manufacturer or disposed of by incineration
	(e) Chemical Waste	Yellow colored containers or non-chlorinated plastic bags	• Incineration • Plasma Pyrolysis • Encapsulation in hazardous waste treatment facility
	(f) Chemical liquid Waste	Separate collection system leading to effluent treatment system	• After resource recovery, the chemical liquid waste shall be pre-treated before mixing with other waste water
	(g) Discarded linen, mattresses, beddings contaminated with blood or body fluid	Non-chlorinated yellow plastic bags or suitable packing material	• Non-chlorinated chemical disinfection followed by incineration or plasma pyrolysis or for energy recovery • In the absence of above facilities, shredding or combination of sterilization and shredding • Treated waste to be sent for energy recovery or incineration or plasma pyrolysis

Category	Type of Waste	Type of bag or container to be used	Treatment & Disposal
	(h) Microbiology, biotechnology and other clinical laboratory waste	Autoclave safe plastic bags or containers	• Pre-treat to sterilize with non-chlorinated chemicals on-site thereafter incineration
Red	**Contaminated Waste (Recyclable)**	Red colored non-chlorinated plastic bags or containers	• Autoclaving or microwaving/hydroclaving followed by shredding or combination of sterilization and shredding • Treated waste to be sent to authorized recyclers or for energy recovery or plastics to diesel or fuel oil or for road making • Plastic waste should not be sent to landfill sites
White (Translucent)	**Waste sharps including metals**	Puncture proof, leak proof, tamper proof containers	• Autoclaving • Dry heat sterilization followed by shredding or encapsulation in metal container or cement concrete • Combination of shredding cum autoclaving • Sent for final disposal to iron foundries or sanitary landfill or designated concrete waste sharp pit
Blue	**(a) Glassware**	Cardboard boxes with blue colored marking	• Disinfection • Autoclaving or microwaving or hydroclaving and then sent for recycling
	(b) Metallic Body Implants	Cardboard boxes with blue colored marking	

*Disposal by deep burial is allowed only in those areas (rural or remote areas) where there is no access to common biomedical waste treatment facility

Notes: 1. Color coding of waste categories with multiple treatment options as defined in Schedule I, shall be selected depending on treatment option chosen, which shall be as specified in Schedule I.

2. Waste collection bags for waste types needing incineration shall not be made of chlorinated plastics.



3. Categories 8 and 10 (liquid) do not require containers/bags. 4. Category 3 if disinfected locally need not be put in containers/bags.

Image 4.3: Medical waste segregation chart 2015

Schedule IV

Image 4.4: Label for Biomedical Waste Containers/Bags

Image 4.5: Biohazard, radiation, and chemical hazard symbols

Radiation symbol

Biohazard symbol

Corrosive substances

Highly inflammable substance

Toxic substances

Harmful substances

Explosive substances

Irritant substances

Oxidizing substances

Substances Dangerous for environnent

Substances causing specific organ toxicity

Image 4.6: Labels inside the storage facility

Restricted entry

Biohazard sign for infectious and sharps waste

Toxic sign for chemical and hazardous pharmaceutical waste


No eating or drinking


No smoking

Image 4.7: Labeling of the biomedical waste transport vehicles

Flammable liquids

Oxidizer

Poison

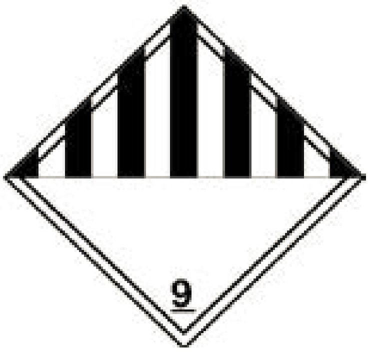
Infectious substances

Radioactive material Category – I White

Radioactive material Category – II Yellow

Radioactive material Category – III Yellow

Corrosive substances Category – I White



Miscellaneous Dangerous Substances Category – I White

4.4 Requirements of Common Biomedical Waste Management Facility

A Common Bio-medical Waste Treatment and Disposal Facility (CBWTF) is a set up built to treat and finally dispose the biomedical waste generated from the member healthcare facilities. The waste collected from these healthcare facilities has some component of hazardous waste which is first render non-infectious and then sent for final disposal. The waste in these centers is treated in a way that the waste pose minimal adverse effects on human health and overall environment.

The Bio-medical Waste Management Rules, 2016 provides the following specifications for the common biomedical waste management facility:

- On-site treatment and disposal facility should not be established if the common biomedical waste management facility service can be availed at a distance of 75 km
- If the common biomedical waste management facility is not available, on-site treatment and disposal facility (incinerator, autoclaves, microwaves, shredder, etc.) should be established following authorization from the prescribed authority
- If a new technology for waste disposal is introduced (either at health-care facility of waste management facility), the occupier or the operator should request the Central Government to lay down the operating standards for the technology; following this, the Central Government should lay the standards and operating parameters for the new technology and be published in the Gazette
- Before the start of any common biomedical waste management facility, the operator should set up the mandatory equipment such as incinerator, autoclave or microwave, shredder and effluent treatment plant with the treatment facility.

Duties of the operator of a common biomedical waste treatment and disposal facility: It shall be the duty of every operator to -

- It is the responsibility of the operator to ensure that the collected biomedical waste is transported, handled, warehoused, treated, and disposed properly and all guidelines should be followed as issued by the government or the Pollution control board
- It is the duty of the operator to ensure that the biomedical waste is collected from occupier well on time and as per the finalized schedule under the act
- Within one year of notification of the rules, a system for handling the biomedical waste through bar coding and global positioning should be established
- The prescribed authorities should be immediately informed about the health-care facilities who are not cooperating in the proper disposal of waste and not handling the biomedical waste according to the segregation color scheme highlighted in the guidelines

- All workers working at the biomedical waste management facility and handling the waste should receive proper training at the beginning of their jobs and at least once every year after that
- It is the duty of the operator to assist the occupier in conducting training for biomedical waste management
- Medical examination and prophylactic immunization (for disease such as hepatitis B, tetanus, etc.) of the operator and workers of the biomedical waste management facility at the beginning of their jobs and at least once every year after that is the responsibility of the operator; further, proper records of medical examination and immunization should be maintained
- Proper supply of equipment and materials required for handling the biomedical waste should be made available to all the workers working at the biomedical waste management facility
- Create an arrangement of reporting of occupational accidents (including injuries from sharps, mercury spills, fire accidents, etc.) that may happen while handling the biomedical waste and prophylactic or remedial actions taken after these accidents should also be recorded. The annual reports of these records should be submitted to the prescribed authorities
- Keep a log for every for its treatment equipment as per the weight of batch to be treated; type of biomedical waste to be treated along with time, date, and span of treatment cycle and total duration of operation
- Operator should allow the occupier (who is handing over the waste for treatment) to have a look whether the disposal technologies employed are per the rules or not
- Operator should upload the details such as authorization, treatment, and annual report on the website
- After complete sterilization and mechanical mutilation of recyclables such as plastics and glass, it should be handed over to recyclers having registration with State Pollution Control Board or Pollution Control Committee
- If requested by occupier, operator should supply the non-chlorinated plastic colored bags
- Biomedical waste should be collected on holidays as well
- For a period of 5 years, maintain the records related to every cycle of incineration, hydro, or autoclaving

For existing incinerators, basic standards for treatment and disposal should be met, as specified in Schedule II (for retention time and Dioxin and Furans), within 2 years of from the date of publication of these rules

For reference: Details of a common biomedical waste management facility in New Delhi

SMS Water Grace BMW Pvt. Ltd. is one of the modern facilities which are responsible for disposing of all the waste generated from approximately 2000 hospitals of Delhi. SMS Water Grace BMW Pvt. Ltd. is the only authorized company by Delhi Pollution Control Board in whole Delhi to dispose of the biomedical waste; it is a joint venture of SMS Infrastructure Ltd. group and Government of NCT of Delhi. The facility is equipped with two incinerators with the capacity of 500kg/hr, an autoclaving Facility of 300 kg/batch, shredding facility of 300 kg/hour, an effluent treatment plant (ETP) with capacity 100 kiloliters per day with ZERO DISCHARGE, rainwater harvesting facility and GPS tracking systems fitted in the transport vehicles for live tracking of vehicles carrying biomedical waste. In order to handle the biomedical waste load and run all the machinery of the facility is equipped with 85 staff members along with 29 vehicles for waste collection from the health-care facilities.

The staff members immunized on a quarterly basis with tetanus and Hepatitis B vaccine and are given extensive training for appropriate waste management on yearly basis with refresher courses being arranged on regular basis. Further, to take care of the employees handling the biomedical waste in this facility, proper personal protective equipment are provided and are being used by the staff. This includes the use of aprons, head caps, face masks, hand gloves, and long gumboots.

Table 4.2: Types of hospitals and other health-care facilities enrolled under work scope of SMS Water Grace BMW Pvt. Ltd., New Delhi

Type of Health-care facility	Units	Number of beds
Delhi Government Hospitals	27	8142
Delhi Government Dispensaries	232	0
ESI Hospitals	**2**	**900**
ESI Dispensaries	19	0
MCD Hospitals & MCW Centre	**153**	**2310**
Central Government Hospitals, Dispensaries	**29**	**1531**
Private Hospitals	527	13889
Private Clinics, Laboratories, Blood Banks, Veterinary Clinics, Dentistry Clinics	**1357**	**0**
Research Laboratories	31	0

The total waste generated from government health-care facilities is approx. 150 metric ton - 160 metric ton per month while this number ranges from 110 metric ton - 120 metric ton per month from private health care establishments in Delhi.

Every day the facility starts with cleaning and disinfecting the facility surface with lime powder. The incinerators are then loaded with “yellow” category waste and the waste is burned at around 1000°C. The gasses from the burning of waste is mixed with water and allowed to cool down. The effluent thus generated is allowed to settle and then allowed to pass through the effluent treatment plant to produce the clean water which is then used again for cleaning the gasses produced in further cycles of the incineration ensuring limited water wastage. The sludge left after water treatment is buried in the burial pits designated for this.

The ash from the incinerator, after testing, is dumped at the specified place for landfill disposal. The ash that comes out of the incinerators after burning the yellow waste is being tested every month. Till the testing and approval of the ash sample, the ash is stored in specified room allocated for it within the facility premises. The tests performed on the ash are as follows:

- Physical state
- Color
- Texture
- Paint Filter Liquid (PFL) Test – To determine the presence of free liquids is a sample as free liquids are forbidden from landfill disposal
- Bulk density
- Calorific value
- Flashpoint
- Moisture content
- Loss on Drying (LOD) @ 1050°C
- Loss on Ignition (LOI) @ 5500°C
- Ash content @ 9000°C
- pH

For the plastic waste or “red” category waste, autoclaves are used. A belt is used to load the waste into the autoclave. This plastic biomedical waste (red-waste including tubings, bottles, intravenous tubes and sets, catheters, urine bags, syringes [without needles and fixed needle syringes], and gloves) after being collected from various health-care facilities are autoclaved at 121°C for 45 min. Followed by the complete cycle of autoclaving, these plastic wastes are sent to the shredder for shredding into granules and these granules are then filled in bags. The filled bags are transported to

VK Plastic Enterprises, New Delhi (the authorized recycler of biomedical waste from Delhi Government) for recycling. The amount of plastic granules which is transported for recycling is about 80-90 metric ton per month.

The sharps and needles ("white" category waste) are buried at assigned burial sites. The "blue" waste including glasses and empty ampoules are first treated with acid. These waste materials are kept dipped in the acidic solution for a day to make then non-infectious and then finally these materials are washed with water.

This common biomedical waste management facility also holds the responsibility of educating and making the individual health-care facilities aware of segregating and storing the wastes in scientifically appropriate manner and ways to comply with the applicable regulations. For this, they arrange the seminars in hospitals and other health-care facilities of the area.

Interestingly, in Delhi a common practice of selling of plastic biomedical waste to an unauthorized personals for higher prices instead of disposing it through the common treatment facility at fixed rate, is followed which is a very serious issue and challenge in setting the system of biomedical waste management in order.

Examples of the machinery inside the common biomedical waste management facilities

Image 4.8: Incinerator in SMS Water Grace (Courtesy: SMS Water Grace Pvt. Ltd.)

Image 4.9: Shredding machine in SMS Water Grace (Courtesy: SMS Water Grace Pvt. Ltd.)

Image 4.10: Effluent treatment plant in SMS Water Grace (Courtesy: SMS Water Grace Pvt. Ltd.)

Image 4.11: Fleet of waste collection vehicles of SMS Water Grace (Courtesy: SMS Water Grace Pvt. Ltd.)

4.5 Treatment and Disposal

Diverse strategies are utilized to dispose of distinctive sorts of biomedical waste. These methods are discussed below:

Incineration

Incineration is one of the oldest methods for the treatment of biomedical wastes. The burning of biomedical waste to gasses and ashes is incineration. This technique is used to dispose of both infectious ("red bag") medical wastes and also the non-infectious, general housekeeping wastes. Incineration works on the principal of oxidization; oxidization of waste and hazardous microorganisms under high temperature takes place and renders them destroyed or denatured. The ashes generated during the incineration process are landfilled. This method has a disadvantage of emitting hazardous gasses such as CO_2, CO, dioxins, and furans leading to air pollution. According to the US Environmental Agency, “medical waste is the third largest source of dioxin air emission and adds to around 10% of mercury discharges to the environment from human actions”.

Autoclaving

Autoclaving is one the modern techniques employed for treating the biomedical wastes. In this method, pathogens and micro-organisms present in the biomedical waste are inactivated by the use of steam, moisture, heat, and pressure. This method is used for disposal of disposables, microbiological waste, and sharps. The autoclaving method of waste treatment has been associated with a disadvantage that following type of waste cannot be treated through this technique:

- Anatomical waste
- Pathological waste
- Radioactive waste
- Organic solvents
- Laboratory chemicals
- Chemotherapy waste

Another issue with the autoclaving method is that the process can aerosolize chemicals which might be the part of biomedical waste and these chemicals can be later released free into the environment once the autoclave is opened.

Mechanical or Chemical Disinfection

Chemical disinfection is a method in which chlorine compounds are used to treat medical waste. Chemical disinfection technique in combination with a mechanical process, such as shredding or maceration methods are used; a combination of these methods confirms adequate exposure of the chemicals to all portions of the waste. Liquid waste generated after the chemical disinfection method is safe to be discharged into the sewer system.

Microwaving

Shredding of waste is the first step in this type of waste disposal technique. In the second step, the water is mixed with waste which is being shredded, and this is then subjected to microwaves. Microwaving works on the principle of the thermal effect of electromagnetic radiations that results in microbial inactivation. However, microwaving is not a suitable technique for following types of wastes:

- Cytotoxic waste
- Hazardous or radioactive wastes
- Contaminated animal remains
- Body parts
- Large metal items.

Irradiation

A cobalt exposure is given to the biomedical waste for disposal by this method and the resulting gamma radiations generated by the cobalt helps in inactivating the microorganisms. This technique is not utilized because of the high-costelement, and there is a danger of radiation exposure to workers operating the facility.

Hydroclaving

Hydroclaving is a technique that works on the principle of steam treatment with fragmentation and finally drying of the residual waste. Autoclaving and hydroclaving works on the same principle except that during hydroclaving, the waste is exposed to indirect heat through steam circulated in the outer jacket of the chamber.

Biological Process

In this method of waste disposal, enzymes are used for treating the waste. The biological reaction will decontaminate the waste and cause the destruction of all the organic constituents of waste and leaves only non-infectious waste.

Encapsulation

This process involves the filling of containers with waste, mixing it with an immobilizing material and then finally closing and seal locking the container. Encapsulation is done when the containers containing three-fourth the quantity of sharps, pharmaceuticals, and chemical waste, an immobilization material is added into it. The final mixed stuff is then allowed to be air dried, and the containers are closed and seal locked after which they are disposed of safely, generally by dumping them in landfills. Encapsulation technique is associated with an advantage that it reduces the risk of scavengers from gaining any access to the hazardous and infectious waste.

Sanitary Landfill

Sanitary landfill is a technique which is developed to protect the environment by keeping the waste away from the environment; so that it should not contaminate the soil, surface, and groundwater. By this air pollution is limited and direct contact with the general community is restricted. The method is suitable for infectious waste and pharmaceutical waste.

Burial

Special pits are mined to bury the hazardous waste. Burial technique is generally recommended in those health-care facilities which have minimal programs for biomedical waste management, especially in remote areas, in temporary campsites, or in areas experiencing exceptional hardship.

Inertization

This method is usually suitable disposal method for pharmaceuticals and incinerated ash with heavy metal content. In this technique, the health care waste is mixed with cement and other substances in a composition of 65% waste, 15% lime, 15% cement, and 5% water. This mixture is then allowed to set into cubes or pellets which are then shifted to an appropriate storage site or the mixture in a liquid state can be used to cover the landfill. This technique helps in reducing the risks associated with contamination of toxic substances seeping into the ground water, and also it prevents scavenging.

Plasma pyrolysis

Plasma pyrolysis is another technology that is used for disposing of the biomedical waste in an environment-friendly way. Through plasma pyrolysis, organic waste is converted into marketable and profitable derivatives. The intense heat generated by the plasma pyrolysis leads to disposal of a wide range of waste including hazardous biomedical waste by ionization. After coming in contact with plasma-arc, biomedical waste is broken into CO, H_2, and hydrocarbons; these gassesare then burned and produce a very high temperature.

Recycling of Biomedical Waste

Recycling is the making of biomedical waste inactive or non-infectious, using any of the methods discussed above and it is another method of waste disposal. Recycling is an environment-friendly procedure, and this technique is encouraged as it is also a source of revenue. This is a useful technique only if it is ensured that the waste which is being recycled is well-treated through autoclaving followed by shredding into plastic granules and rendered non-infectious before recycling. Common recyclable materials which are part of biomedical waste from the health-care facilities include packaging materials, papers, plastic materials, wooden material, metals, glasses, and construction wastes.

However, the major disadvantage of the recycling methods is associated that if unauthorized recyclers get involved in the business then it leads to spreading of infection many-folds. In May 2015, the newswas published highlighting the fact that in Narela Industrial Area of North West Delhi, about 40 industries are running this business illegally. Biomedical waste recycled in these industries includes used syringes, needles, medicine bottles, sample bottles, and tubes made of plastic. Products which are generated in these industries are disposable plates, glasses, ice cream cups, toys, and many more items for daily use. This raises a risk alarm for thousands of healthy people, particularly kids, using these items. Further, the labor employed for segregation of waste in these industries is uneducated and are not aware of the ill effects of touching this type of waste with naked hands and are at the utmost risk of being infected with communicable disease like HCV, HIV, tuberculosis, etc. Further, added to this, there are some materials which are part of biomedical waste but can be reused such as furniture items of the hospitals, dishes, computer parts, printer and printer parts. Further, there is some waste which is compostable - flowers, food waste from kitchen services and plant waste from grounds.

Chapter 5 - Management and Administration

Introduction

To avoid any kind of biomedical waste accumulation, it should be collected and transported to a temporary storage area within the health-care facility on a regular basis before being treated or removed. All the collected biomedical waste should be stored in the temporary waste storage area dedicated within the health-care facilities until it is finally transported to a designated off-site common biomedical waste treatment facility. This area must be marked with a warning sign. Storage facilities for waste should be suitably established within the health-care facility; however, such temporary waste storage areas should be located away from patient rooms, laboratories, hospital function/operation rooms or any public access area. The storage facility should be lockable, hygienic and appropriately signposted.

There should be a direct collection route from the point of waste collection to the waste storage facility. Road size, conditions, and population size of the area should guide the type of waste collection vehicle to ensure efficient waste collection and transportation. Biomedical waste collection should be done in such a way that it prevents any damage to the container, or leakage or scattering of solid waste within the collection area. The persons collecting or transporting the waste should take care that the waste is not scattered anywhere either during collection or transportation of waste. To collect sharps and infected waste, special cardboard containers, with foldable lid and irreversible lock should be used and finally packed in another external package with the words 'Infectious sharp, cutting hazardous hospital waste'. Records should be maintained for the amount and type of waste handed over to the waste collection vehicles along with the registration of the vehicle within the health-care facility and the final disposal entities.

Biomedical waste is a reservoir of infectious microorganisms, which can cause contamination and infections through various vectors. One of the major burden on patients, society, and even the healthcare facility management is the healthcare associated infections.

As there are two broad categories of biomedical waste, hazardous waste and non-hazardous waste; the hazardous waste needs special attention at every step of the biomedical waste management including the final treatment and disposal. Treatment and disposal of hazardous biomedical waste can be done both onsite and offsite, however the decision of using the onsite facility or offsite common biomedical waste management facility is majorly guided by the country's own policies and rules and in India, it is recommended to use the common biomedical waste management facility if the healthcare facilities falls within the radius of 75 km of the area of common biomedical waste management facility.

Implementing the biomedical waste management and handling rules and regulation in a stringent manner will help in waste minimization and will prevent the unnecessary usage of resources at every stage of biomedical waste disposal. This will be done by selecting the materials which are less wasteful or less dangerous; use of physical cleaning methods and not using the chemicals for cleaning purposes; centralized purchasing; expired chemicals and drug back process, ordering the materials in small batches; keeping a track of expiry date of the products allowing usage of old products first; last but not the least is appropriate segregation of waste at the source of its generation. This step of segregating hazardous waste from the general waste is the most important step in waste minimization and should be done by the waste producers.

Objectives

- To know about steps involved in the process of safe handling of the biomedical waste and infection control within the healthcare facilities.
- To know how the measures of waste minimization and concept of ZERO WASTE HOSPITAL.

Structure

5.1 Collection of waste

5.2 Infection control system in hospital

5.3 Off-site transportation

5.4 Safety practices and emergency measures

5.5 Waste Minimization and Zero Waste Hospital

5.1 Collection of waste

Biomedical waste should be collected and stored prior to treatment in such a way that it reduces the possibility of interaction with humans, animals, or the environment. Biomedical waste containers are generally imprinted with the universal three-sided biohazard symbol.

The general rules to be followed for biomedical waste collection and steps to be followed for safe handling of the biomedical waste are as follows:

- No waste containers should be collected (from wards to temporary storage area or from temporary storage area to waste collection vehicles) without proper labelling from the source site

- Waste bins/containers should be placed at all locations where the waste is generated within the hospital premises (Image)

Image 5.1: Waste bins for hazardous waste

Image 5.2: Waste handler collecting the waste from waste bins

- Waste should be collected in the color-coded bags or color-coded bins
- Color-coded bags with biomedical waste should never be kept directly in the waste collection vehicle, they should always be placed in the similar color-coded bags, containers, or bins
    - If bag is used for waste collection, tie the neck tightly
    - All the dustbins or containers used to collect the waste should have lids to cover the waste during all the steps of biomedical waste management including collection and transportation of the waste
- The designated personnel should collect the waste containers by a routine program through the designated route as a part of the waste management plan
- Damaged or leaking containers should never be used to collect any form of biomedical waste
- Sanitary staff and sweepers, while handling the waste, should be loaded with personal protective equipment (masks, gloves, boots, aprons, and leg protectors) (Figure)

Fig5.1: Personal protective measure that should be used for safe handling of biomedical waste

- It is the duty of sanitary staff and sweepers that,
  - At least once daily collection of waste is there in the hospital
  - Ensure that the waste bags should be collected only after appropriate labeling (type of waste, point of production, date, ward, symbols)
  - Waste containers/bins should have the instructions pasted or printed over them
  - Waste container should be labeled with some basic information's, say about its waste category, weight of the waste materials, date of collection, and site of waste production
  - Once the 3/4th filled bags are removed, they should be replaced immediately with new bags of the same type and the container should be properly cleaned before the new bag is fitted
  - Avoid throwing, dragging over floor or holding the bottom of the containers
- Waste collection trolleys should be used for on-site transportation of the waste. Such trolleys should be 3-4 wheeled, easy to load and clean with no sharp edges; this trolley should be cleaned on a regular basis
- Road size, conditions, and population size of the area should guide the type of waste collection vehicle to ensure efficient waste collection and transportation
- Collection of Sharp biomedical waste should be done with maximum precaution
- Careful loading of the waste bags to avoid any punctures or tears on the trolleys should be ensured
- Separate colored trolleys should be used for transportation of non-hazardous waste and hazardous biomedical waste

- Frequency of waste collection, size, and location of containers and bags should be reviewed on regular basis
- A stock of new collection bags should always be available at the source of waste generation
- The collected waste should be transported to the storage area using the shortest possible route without any kind of halts in between
- To prevent any littering of waste, the biomedical waste collection and transportation vehicles should be covered
- For any specific waste, separate waste collection vehicles should collect the waste at separate collection schedules than rest of the waste
- If there is spillage of waste from the container (accidental/damage of bin), gently collect the waste into a bin, soak the area with 2% Lysol solution, wait for 30 minutes, then wash and wipe
- Records should be maintained for waste transportation and details of the vehicles carrying the waste from waste collection point to common biomedical waste treatment facility should be recorded
- After use, all vehicles should be cleaned and disinfected
- Central storage facility should be easy to access for collection vehicles. However, it should be secure enough to block the unauthorized access including animals, insects, and/or birds
    - This area must be marked with a warning sign.
- Storage facilities for waste should be suitably established within the health-care facility; however, such temporary waste storage areas should be located away from patient rooms, laboratories, hospital function/operation rooms or any public access area. The storage facility should be lockable, hygienic and appropriately signposted.
- They must be kept secured at all the times.
- Infectious biomedical waste should be stored in any conditions which carries a risk to health and should not be stored for more than 5-30 days from the moment the container is closed

Collection of Sharp waste needs special attention:

- Sharps should be placed in specific cardboard or plastic boxes which are puncture proof and leak proof
- Sharps boxes should be designed with a small opening so that items can be dropped in, but no item can be removed
- Box should be of yellow color with red stripes and have the biohazard symbol on it

Further, the healthcare facilities are responsible for providing:

- Designated storage areas equipped with sufficient lighting, ventilation, and should have provisions and tools to manage any contamination due to any spillage within the storage area
- The storage area of collected waste should have a water supply for cleaning purposes
- Waste security and restriction of access to authorized persons is another responsibility of the healthcare facility administrator
- Waste collection vehicles should have easy access to the waste storage areas
- The storage areas should be protected from sun, rain, strong winds, and floods
- The temporary waste storage areas should be designed in such a way that it can be cleaned regularly, easy to maintain the hygienic standards and also easy to manage the post-spill decontamination
- Stock of cleaning tools, personal protective equipment, and extra waste collection bags/containers should be placed close enough to the storage area
- Bio-degradable general and hazardous waste should not be stored for long periods and should be removed within 24 hours to minimize microbial growth, putrefaction, and odors
- Segregation should be well maintained in the storage area

In addition, health and safety of the cleaner and *safaikaramcharies* is also very important and following steps should be considered:

- All the cleaning staff, biomedical waste collection staff and waste handler should trained about biomedical waste related risk
- Healthcare facility administrators should issue the personal protective materials to all the waste handling staff in timely manner and also encourage their staff to wear these personal protective materials while collecting and handling the biomedical waste
- Immunization of the worker under occupational safety program especially against Hepatitis-B virus and Tetanus is one of most recommended step in the process of safe handling of the biomedical waste
- It is the responsibility of all the healthcare facility staff including the administrators to ensure reporting of any accident happened and also to get the post-exposure prophylactic treatment
- All the service providers should receive the trainings to deal with injury and exposure
- In case of any accident, immediate reporting to the designated authority should be done
- Further, the items involved in accidents should be identified and removed from the place of accident immediately through safe handling

- Immediate first aid measures should be given to the affected person
- Record keeping of such accidents should be done for future reference and to take necessary protective actions
- Healthcare facility administrators should ensure periodical medical checkup system for all the staff persons involved in handling of the biomedical waste at any step of biomedical waste management
- Last but not the least step in safe handling of the biomedical waste is the medical surveillance

Overall, there should not be mixing of any infectious, pathological, toxic or hazardous drug, and chemical wastes during the waste collection step. The waste handler should transport the biomedical wastes as per the classification rules from the point of collection to the internal temporary storage area according to the pre-specified schedules and designated routes each day. Dumping or piling up of the biomedical waste at the non-collection or non-temporary waste storage areas is strictly prohibited; further it is not allowed to mix such waste with the general municipal waste. In Indian scenario, as the number of common treatment plants is less compared to the waste generated per day per area, the collection systems are inadequate.

5.2 Infection Control System in Hospital

Biomedical waste management is a fundamental part of hospital hygiene and infection control. Biomedical waste is a reservoir of infectious microorganisms, which can cause contamination and infections through various vectors. One of the major burden on patients, society, and even the healthcare facility management is the healthcare associated infections. Frequency of life-threatening infections such as severe acute respiratory syndrome and infectious diseases such as plague and tuberculosis has been increasing day by day which highlights the need for effective infection control programmes among healthcare facilities.

One of the primary concerns of any healthcare facility is to control the spread of any kind of secondary disease and minimize the number of healthcare associated infections. There are some components which are present in the environment of a healthcare facility that actually promotes the growth and spread of infectious diseases. The potential carriers of infection contamination within a healthcare facility range from air within the premises to the people including staff, patients, visitors, caregivers. Nowadays, as most of the modern medical procedures are invasive in nature, it provides an optimum environment for the growth and development of infections within the healthcare facilities and increases the chance of infections multi-fold. The quantity of medical procedures performed in ongoing decades has expanded, opening patients up to diseases at entry point locales.

There are likewise various demonstrative instruments and other restorative gadgets utilized in the treatment of illness. It is more critical than any time in recent memory for medical clinics to guarantee that infectious diseases don't spread (Figure).

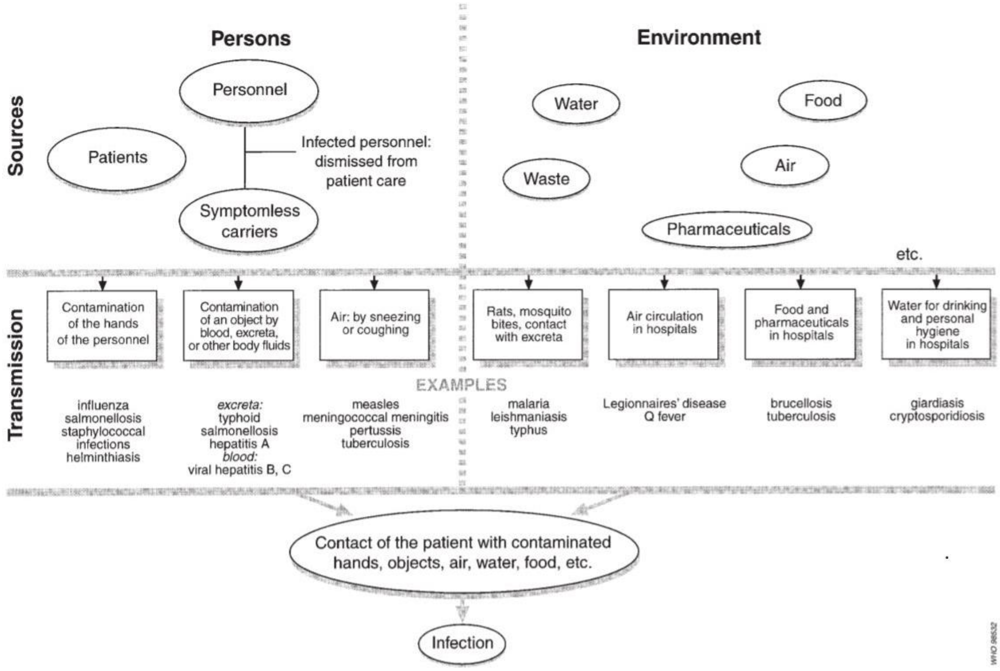


Fig5.2: Spread of infections (Source WHO guidelines)

Infection Control in Healthcare

An infection control system is considered effective when it restricts the spread of any kind of infection among patients, caregivers or the members of hospital staff. In addition, other signs of an effective and efficient infection control includes reduction in patients' morbidity and mortality due to secondary infection during the hospital stay, overall reduction in length of hospital stay, and the associated treatment cost. Steps taken by healthcare facilities to mitigate the issue of spread of infectious diseases within these facilities is called infection control system. It has been estimated that over a period of a year, there are about 1.7 million preventable illness spread. Some of the basic steps that healthcare facilities take to prevent further spread of infectious diseases include: ensuring hand hygiene compliance and ensuring an appropriate environment condition for medication, vaccines, and biological material. Compliance can be improved by posting signboards in key locations and providing reminders for the healthcare workers to wash their hands at all the appropriate locations within the healthcare facilities. Categories of infection control practices are summarized below:

A. Standard precautions which applies to all patients irrespective of patient diagnosis and infectious status. It prevents infection transmission from

   a. Patients to staff members of the healthcare facilities
   b. Staff members of healthcare facilities to patients
   c. Patient to patient
   d. Hospital environment to patient
   e. Biomedical waste to general public

B. Transmission based specific precautions are the precautions which are specific to the mode of transmission of infection such as air-borne infections, droplet transmitted infections, and infections transmitted through contact

Standard precautions are the basic precautions to provide a high level of protection to patients, caregivers and the overall staff members of the healthcare facilities. These precautions are guided as:

- Hand hygiene – hand washing with antiseptics
- Use of personal protective equipments including gloves, masks, aprons etc., while handling, blood, body fluids, excretions etc.
- Patient care equipments and infected linen should be handled cautiously
- Needle or sharp prick injuries should be avoided
- Spills-management and environment cleaning should be considered
- Biomedical waste management in the best possible way

According to the WHO, essentials of the standard precautions to be used in the care of all patients are summarized in the Figure.

A. **Hand washing**
- Wash hands after touching blood, secretions, excretions and contaminated items, whether or not gloves are worn. Wash hands immediately after gloves are removed, between patient contacts.
- Use a plain soap for routine hand washing.
- Use an antimicrobial agent for specific circumstances.

B. **Gloves**
- Wear gloves when touching blood, body fluids, secretions, excretions, and contaminated items. Put on clean gloves just before touching mucous membranes and non-intact skin.

C. **Mask, eye protection, face shield**
- Wear a mask and eye protection or a face shield during procedures and patient-care activities that are likely to generate splashes or sprays of blood, body fluids, secretions, and excretions.

D. **Gown**
- Wear a gown during procedures and patient-care activities that are likely to generate splashes or sprays of blood, body fluids, secretions, or excretions.

E. **Patient-care equipment**
- Ensure that reusable equipment is not used for the care of another patient until it has been cleaned and reprocessed appropriately.

F. **Environmental control**
- Ensure that the hospital has adequate procedures for the routine care, cleaning, and disinfection of environmental surfaces.

G. **Linen**
- Handle used linen, soiled with blood, body fluids, secretions, and excretions in a manner that prevents skin and mucous membrane exposures, and that avoids transfer of microorganisms to other patients and environments.

H. **Occupational health and bloodborne pathogens**
- Take care to prevent injuries when using needles, scalpels, and other sharp instruments or devices.
- Use ventilation devices as an alternative to mouth-to-mouth resuscitation methods.

I. **Place of care of the patient**
- Place a patient who contaminates the environment or who does not assist in maintaining appropriate hygiene in an isolated (or separate) room.

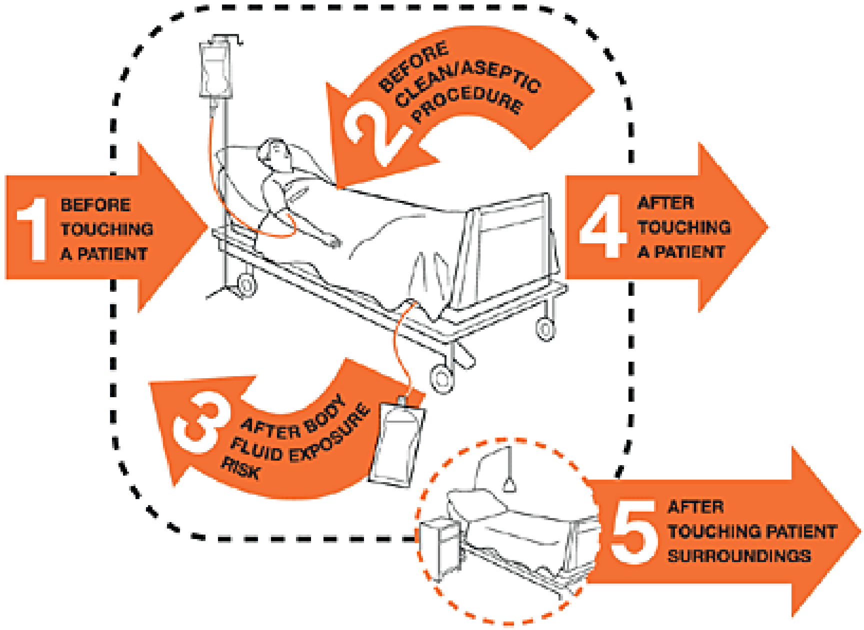
Fig5.3: Essentials of the standard precautions

Hand hygiene is one of the most basic and most important step in the chain of infection control within the healthcare facility. Contamination of hands with deadly infectious agents can happen by contact with patient having infection, patient's environment and surroundings or contact through other healthcare workers infected by infectious agents. There are chances of cross-contamination through hand where infection from one site to another site in the same patient can happen and following the practice of hand hygiene before any type of contact with patient help in washing off all the infectious agents from hands reduces the chances of risk of spreading of infections and cross-contamination.

The WHO has developed the '5 moments for hand hygiene' in 2009 (Figure); the features of these guidelines are as follows:

- The duration of hand hygiene measures
- The exposure of all surfaces of hands and wrists to the preparation used
- The use of rubbing to create friction
- Ensuring that hands are completely dry

Fig5.4: 5 moments for hand hygiene



5.3 Off-site Transportation

Treatment of hazardous and infectious biomedical waste can be done onsite or offsite of healthcare facilities. However, the decision to dispose the biomedical waste at onsite or offsite location sometimes become a debatable issue; both has some pros and cons. Onsite biomedical waste disposal requires finances, planning, land, capacity for installation, operation, and maintenance. Further, such decisions are guided by policies and rules drafted in each country. In India, the offsite disposal of biomedical waste is preferred compared to the onsite treatment.

In some of the countries, mobile incinerators have been tested for disposing the biomedical waste which helps small hospitals and clinics to dispose the hazardous biomedical waste onsite without the step of transporting the infectious waste within the country. These mobile incinerators gave satisfactory results and were capable of disposing the waste at a rate of 30 kg/hour with the permissible limits of air pollution. However, there is a need to highlight that the decision of onsite (i.e., within the healthcare establishment) or offsite (i.e., at the common biomedical waste management facility) biomedical waste disposal is guided by national rules and policies.

The WHO has provided some initial specifications for onsite and offsite incinerators which can be considered while considering the waste disposal technologies. These specifications for small scale incinerators are:

- Capacity 200–1000kg/day
- Manually loaded and de-ashed daily or every 2–3 days
- A shovel or a vacuum cleaner to remove the ashes
- Combustion process under automatic control

The various activities involved in operating small scale incinerators are summarized below:

- Removal of ashes left inside the pyrolytic chamber (after cooling down).
- Loading of waste packages to be incinerated.
- Ignition of fuel burner in post-combustion chamber.
- Ignition of the pyrolytic fuel burner to start waste burning in the pyrolytic chamber.
- Pyrolysis of waste and monitoring of gas production.
- Monitoring high-temperature burning of gas inside post-combustion chamber.
- Stopping the fuel burners after completion of waste and gas burning, and letting the incinerator cool down.

Figure5.5: Activities involved in operation of a pyrolytic small-scale incinerator (Source: WHO)

The specifications of the offsite large-scale incinerator as specified by the WHO are as follows:

- Capacity 1–8 tonnes/day
- Operating continuously
- Automatic loading
- Automatic de-ashing devices

- A waste disposal engineer
- Facilities for cleaning and disinfection transportation equipments and carriage vehicles

In addition to the above specifications, the WHO has provided some recommendations on the location of such large-scale incinerators as well. These state that such type of set-up should be done in the industrial areas designated for hazardous plants with proper road access and adequate power and water supplies. Further, such incinerators should be located at least 500 m away from household areas.

According to the Biomedical Waste Management and Handling Rules 2016, India, there should not be any secondary handling or pilferage of biomedical waste should be done at the healthcare facility. As per these rules, if the common biomedical waste treatment facility is available within a radius of 75 km of healthcare facility, then the biomedical waste should not be treated onsite within the healthcare facility and should be disposed only through the common facility through a designated operator. All the public healthcare establishments falling within the reach of 75 kilometres of common biomedical waste treatment facility are not allowed to establish their own treatment and disposal facility and should dispose all the biomedical waste through the services provided by the common biomedical waste treatment facilities.

There is special recommendation for the for the laboratory and highly infectious biomedical waste that should be pre-treated onsite to render them non-infectious before being sent to the common biomedical waste treatment facility for final treatment and disposal.

In addition, there are public healthcare establishments that are in rural areas or do not fall in the radius of 75 km of common biomedical waste treatment facility. These healthcare facilities can also use the common facilities and the services provided by the common biomedical waste treatment establishments located beyond 75 km after getting the approvals from the concerned authorities. In case that is not possible to use such facilities, the biomedical waste generated from such healthcare facilities should be disposed onsite through captive treatment or deep burial pits as authorized by the competitive authorities as per the guidelines.

The Biomedical waste Management and Handling Rules 2016 specifies the recommendations for both onsite and offsite treatment and disposal methods for all the waste categories according to the colour coding. These specifications have been summarized below:

Table 5.1: Ways of offsite and onsite waste treatment methods

Waste category	Type of waste	Offsite treatment	Onsite treatment
Yellow Waste	(a)Human Anatomical Waste (b)Animal Anatomical Waste (c) Soiled Waste (d)Expired and Discarded Medicine (e) Chemical Waste (f) Chemical Waste (g) Discarded Linen, Mattresses, beddings contaminated with Blood, body fluids, routine mask and gown (h)Microbiology, Biotechnology and Other Clinical Laboratory Waste	No pre-treatment of waste is required to be carried out at the health care facility. Yellow category waste should be stored in central storage point and must be handed over to CBWTF. It is mandatory for each health care facility that dead foetus waste should be handed over to CBWTF in yellow bag with a copy of the official Medical Termination of Pregnancy (MTP) certificate from the Obstetrician or the Medical Superintendent/ SMO/ CMO of the HCF. All the expired and discarded medicines including cytotoxic drugs expired `cytotoxic drugs are either returned back to the manufacturer or are handed over to the CBWTF to be disposed of through incineration at temperature > 1200°C. Disinfect the waste linen with non-chlorinated chemical disinfection and hand over to the CBWTF operator for final disposal by incineration. The waste mattresses should be cut into pieces and disinfected and can be sent to the CBWTF operator for final disposal by incineration. The waste mattresses shall not be sold or auctioned. Used bed sheets that are not soiled and re-usable can be sold or auctioned only after washing and disinfection. Disposable (single use non-linen based) masks and gowns, after use shall be treated as yellow-c (soiled waste).	Disposal should be done through Plasma Pyrolysis unit or twin chambered compact incinerator with 2 seconds retention time in secondary combustion chamber and adequate air pollution control devices to comply with revised emission norms prescribed under BMW Management Rules, 2016. Disposal of the waste in the deep burial pit should not be practiced unless the hospitals is located in rural or remote isolated place. Use of deep burial pit should be as authorised by the respective SPCB/PCC. Copy of official MTP certificate from the MO I/C for foetus below the vitality period must be kept with the HCF. Expired and discarded medicines are required to be sent back to manufacturer or can be disposed though nearest common biomedical Waste or Hazardous waste incinerators with prior intimation to SPCBs/PCCs. This waste can also be disposed through twin chambered captive incinerator with 2 seconds retention time in secondary combustion chamber, which can withstand a temperature of 1200°C and having adequate air pollution control devices to comply with emission norms. The chemical liquid waste of the hospital must be collected through a separate collection system

		Pre-treatment by disinfection before handing over the waste to CBWTF operator. Pretreatment can be done by autoclave / microwave / Hydroclave. Pre-treatment can also be done by using non-chlorinated chemical disinfectants like aldehydes, lime based powders or solutions, ozone gas, ammonium salts and phenolic compounds. The pre-treated waste bags should be handed over to CBWTF operator on daily basis.	for pre-treatment. Hospitals with large standalone labs shall install separate drainage system leading to pre-treatment unit prior to mixing the same with rest of the wastewater from hospital for further treatment. For middle and small healthcare facilities having no system of separate drainage/collection system, the liquid waste is required to collect on-site in containers for pre-treatment before mixing the same with other wastewater. Silver X ray film developing fluid should be given or sold to the authorized recyclers for resource recovery, else it should be handed over to CBWTF as yellow (e) chemical waste. Depending on type of chemical effluent generated, pre-treatment should comprise of neutralization/precipitation, followed by disinfection prior to mixing with rest of the wastewater from hospital. Prior to mixing with rest of the hospital effluent, disinfection should be done preferably by passing the effluent through UV sterilizer rather than using disinfecting chemicals since use of chemicals may affect performance of biological treatment in down-stream. The waste mattresses after cutting into pieces and disinfected with non-chlorinated chemicals and can be incinerated in captive incinerator or can be disposed as General waste in dry bins in cities having RDF or waste to Energy Plants. Pre-treated waste should be disposed off by a HCF by installing twin chambered compact incinerator with 2 seconds retention time in

			secondary combustion chamber and adequate air pollution control devices to comply with revised emission norms prescribed under BMW Management Rules, 2016. Pre-treated waste can be disposed in captive deep burial pits in case of the hospitals located in remote in rural or isolated places. Use of deep burial pit should be as authorised by SPCB/PCC.
Red Category	Plastics generated from disposable items	Contaminated recyclable waste containing mainly plastics and rubber shall be put in red coloured non chlorinated plastic bags and containers. Syringes after removing/cutting the needles should also be put in this category. Vacutainers/vials with blood samples should be pre-treated and disposed as yellow-h category waste. No onsite treatment of Red category waste is required. All such waste is needed to be sent to CBWTF for final treatment and disposal.	All the recyclable waste generated from the HCF must be sterilised using autoclaving/microwaving /hydro-calving followed by shredding or mutilation or combination of sterilisation and shredding. Recyclable waste must never be disposed of along with general waste in dry stream and same is required to be disposed of only through registered or authorised recyclers or to waste to energy plants or plastics to diesel or fuel oil or for road making, whichever is possible.
White Category	Needles and sharps	After collection in puncture proof, leak proof, tamper proof container, handover the waste to CBWTF without any alteration or onsite treatment.	Sharps waste should be disinfected either with autoclaving or dry-heat sterilization or a combination of autoclaving cum shredding and then to be finally disposed to concrete pit; or sanitary landfill or steel foundry
Blue Category	(a) Glassware (b) Metallic Body Implants	Dispose of the empty glass bottles by handing over to CBWTF without any onsite treatment. The residual chemicals in glass bottle should be collected as chemical waste in yellow coloured container / bags and over to CBWTF as yellow(e) waste.	The waste glass bottles / broken glass has to be sterilized or disinfected (either by autoclaving or microwaving or hydroclaving or by Sodium Hypochlorite Solution) followed by soaking & washing with detergent prior to sending it for recycling. Broken glass should also be disinfected

			and if the same cannot be given/or sold for recycling it can be disposed in sharps pit. The residual chemical in glass bottle should be collected as chemical waste in yellow coloured container / bags as yellow(e) waste and send the same to either a CBWTF or common hazardous waste Treatment and Disposal Facility. Glass vials with positive controls should be pre-treated and disposed as yellow(h) waste. Metallic body implants should be disinfected (either by autoclaving or microwaving or hydroclaving or by Sodium Hypochlorite Solution) and later washed with detergent prior to sending/sold to metal recyclers.

5.4 Safety practices and emergency measures

The health-care facility should, as per the legislative norms, rules and regulations, draft and implement the rules for the appropriate management of the biomedical wastes, man force and the resources required, assign their duties, and the ways to tackle the emergency situations such as flowing, leakage, spreading and accidents from biomedical wastes within the health-care facilities.

Health & safety Practices, Usage of protective equipment

Biomedical waste management and handling rules and regulations should always include the provision to continuously monitor the healthcare workers' safety through appropriate handling of the biomedical waste at any step of biomedical waste management from collection to final disposal. The essential health and safety measures are as follows:

- Training of the workers: proper trainings help the healthcare workers to understand the risks associated with biomedical waste and the usage of personal protective equipments
- To provide the personal protective equipment
- To run the preventive immunization programmes along with medical surveillance

Personal protective equipment (PPE) is clothing or equipment designed to be worn by someone to protect them from the risk of injury or illness. Employees employed for collecting and transportation of the biomedical waste should always be well equipped with personal protective equipment. The staff should be trained to perform their duties properly and safely; they should be educated about the hazards and health risks associated with the mishandling of the waste; they should have the proper personal protective equipment and clothing and also they should be encouraged to use the equipment on a regular basis.

Personal protective equipments are the special equipments worn by healthcare workers working in healthcare facilities and handling the biomedical waste; these equipments act as barrier between the person who is wearing it and the germs or infectious agents present around him. Wearing the personal protective equipments reduce the chance of exposure to infectious agents and spread deadly diseases. Within the healthcare facility, the environment is loaded with microorganisms, the use of personal protective equipments helps further spread of these pathogens and protect the patients and healthcare workers from infections. All the hospital staff members, patients, caregivers, and visitors should be encouraged to use the personal protective equipments when there will be contact with blood or other bodily fluids.

Types of personal protective equipments are (Figure):

- Gloves

- Masks
- Eye protection includes face shields and goggles
- Clothing includes gowns, aprons, head covering, and shoe covers

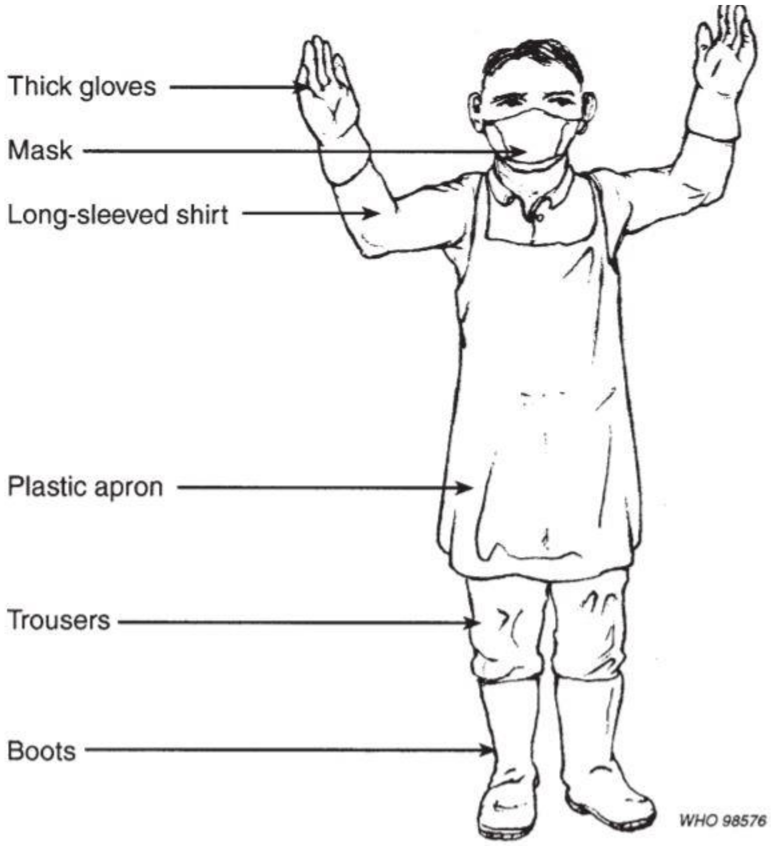


Fig5.7: Recommended protective clothing for biomedical waste transportation (Source: WHO)

Special personal protective equipments are required while handling some cancer drugs, these special equipments are called cytotoxic personal protective equipments. These include wearing a gown with long sleeves and elastic cuffs. These gowns should keep liquids from touching the skin. Further, this includes shoe covers, goggles, and special gloves.

Health-care waste management in emergencies

Drivers of waste transportation vehicles should be well-trained and well-aware of the risks and hazards related to the biomedical waste. Further, they should be trained for the emergency situation, for example, spillage of any waste or any vehicular accident.

Waste transportation vehicles should be labelled with a biohazard symbol, name and address of the waste management facility, emergency contact number should be printed; the vehicle should be well equipped with personal protective equipment, tools, and disinfectants to handle any emergency situations or accidental spillage.

The WHO has specified a list of steps that should be undertaken while clearing up the spillages of potentially hazardous substances. These state that if the spillage is associated with any risk of further splashing the, eye protectors and masks should be used along with overall apron and gloves as person protective equipment. Further, if the accidental spillage has some toxic dusts or gases, ashes from incinerator or similar residues collected after cleaning of contaminated equipments, then respirators or gas masks should be used to keep away the gases from inhalation. The spillage residues should be cleaned and safely repacked as completely as feasible especially the mercury residues and any other infectious materials. After the recovery of all the residual material, the floor should be cleaned again using the disinfectants.

Biomedical waste management is a tough task, and it becomes tougher when it comes to an emergency situation like natural disasters. Safe management of biomedical waste during the emergency situations has to be done in the following phases:

- Phase I: Rapid initial assessment
    - Immediately after the disaster, an initial assessment is performed to measure the information about the criticality of the situation and immediate needs.
- Phase II: Emergency response
    - The purpose of the emergency response is to avoid any scattering of waste and prevent the spread of secondary infections from the waste not managed properly. Initial assessment helps in allocating the responsibility to the organizations and individuals as applicable for rapid action. It is also suggested that biomedical waste generated during the emergency situation should be segregated as “sharps” and “non-sharp wastes” in two different bins. Further, these bins should be completely covered and protected so that air-borne infections or flying insects don’t spread any kind of communicable diseases. Burial of these wastes is the best possible way of disposing of the biomedical waste in emergency situations; pits and trenches should be used for the safe disposal. Further, during such natural disaster situations, hepatitis B vaccination should be given to all health-care staff and waste handlers as a preventive measure and they all should be alerted and reminded of the risk of infections from mishandling of biomedical waste.
- Phase III: Recovery phase
    - It’s a long-term program re-establish the community in the way it was working before the natural calamity.

Further, biomedical waste management should have a place in the contingency plan of health-care sector for the timely action and control, and the government should be prepared for any emergency situation

5.5 Waste Minimization and Zero Waste Hospital

Implementing the biomedical waste management and handling rules and regulation in a stringent manner will help in waste minimization and will prevent the unnecessary usage of resources at every stage of biomedical waste disposal. This will be done by selecting the materials which are less wasteful or less dangerous; use of physical cleaning methods and not using the chemicals for cleaning purposes; centralized purchasing; expired chemicals and drug back process, ordering the materials in small batches; keeping a track of expiry date of the products allowing usage of old products first; last but not the least is appropriate segregation of waste at the source of its generation. This step of segregating hazardous waste from the general waste is the most important step in waste minimization and should be done by the waste producers.

According to the WHO guidelines, waste minimization is the first and foremost approach that should be targeted. Wherever applicable, using the waste items for secondary use, either in the same format or after minor modulations, is the next recommended step, followed by using recyclable materials. If none of these steps could be reached out, then the least preferable option of final disposal of the waste through different techniques should opt. Minimization of the waste generated is the best method to control the financial burden on any health-care facility.

The foremost principle - reinforce the segregation of biomedical waste at the place of generation into different portions. The segregation is guided by their nature and damage they lead to and also as per the method of their final disposal. Further, the guideline specifies that the person who produces the waste is accountable/bound to segregate the waste as per the suggested guidelines. Waste is segregated as:

- Non-hazardous general waste
  - Recyclables
  - Biodegradable waste
  - Non-recyclable waste
- Hazardous waste
  - Used sharps
  - Potentially infectious items (tunings, bandages, disposable medical items, swabs, and tissues)

Certain practices within the healthcare facilities help in significant reduction of biomedical waste that is generated in these facilities. These practices include:

- Source reduction – purchase in small batches, purchase of materials which are less wasteful and less hazardous
- Recyclable products – use of products which could be recycled
- Good management and control practices – control practices should be applied to chemicals and pharmaceuticals
- Waste segregation – to minimize the quantities of hazardous waste, careful segregation practices should be implied

Biomedical minimization for the most part benefits the waste producer or the healthcare administrator in terms of cost reduction: cost to buy the materials and for waste treatment and transport are decreased furthermore, the liabilities related with the transfer of hazardous waste are decreased.

Source reduction

- Purchasing reductions: selection of supplies that are less wasteful or less hazardous.
- Use of physical rather than chemical cleaning methods (e.g. steam disinfection instead of chemical disinfection).
- Prevention of wastage of products, e.g. in nursing and cleaning activities.

Management and control measures at hospital level

- Centralized purchasing of hazardous chemicals.
- Monitoring of chemical flows within the health facility from receipt as raw materials to disposal as hazardous wastes.

Stock management of chemical and pharmaceutical products

- Frequent ordering of relatively small quantities rather than large amounts at one time (applicable in particular to unstable products).
- Use of the oldest batch of a product first.
- Use of *all* the contents of each container.
- Checking of the expiry date of all products at the time of delivery.

Fig5.8: Examples of policies and practices that encourage waste minimization (Source: WHO)

To address the issue of rising amount of biomedical waste, a company from The Netherlands has come up with an integral **zero waste hospital waste-water management process**. In this process, the cycle runs in such a way that there is not contact with the contaminated waste. According to this technology (patented), single-use disposable are made from biodegradable products such as corn starch. This technology has currently been tested in developing and replacing plastic bedpans and urinals which are then disposed off using shredder and replace the need of bedpan washer and sanitizer. The shredded waste along with the effluents from toilets, showers, and sinks are then sent to purification plants within the healthcare facilities. The solid waste from these purification plants is reduced by anaerobic digestion resulting in production of biogas which is then utilized for powering the plant. The water which is free from all the medicines, or pathogens or other substances can be reused.

Stakeholders of Waste Management

Fig5.9: Stakeholders of waste management

Glossary of Terms

- Authorization means permission granted by the authority for the generation, collection, reception, storage, transportation, treatment, disposal or any other form of handling of biomedical waste by these rules and guidelines issued by the Central Government or, as the case may be, the Central Pollution Control Board
- Authorized person means an occupier or operator authorized by the prescribed authority to generate, collect, receive, store, transport, treat, dispose or handle biomedical waste by these rules and the guidelines issued by the Central Government or, as the case may be, the Central Pollution Control Board
- Biologicals mean any preparation made from organisms or micro-organisms or product of metabolism and biochemical reactions intended for use in the diagnosis, immunization or the treatment of human beings or animals or research activities pertaining to it
- Biomedical waste means any waste, which is generated during the diagnosis, treatment or immunization of human beings or animals or in research activities pertaining to it or in the production or testing of biologicals, including the categories mentioned in Schedule I to these rules
- Biomedical waste treatment and disposal facility means any facility wherein treatment, disposal of biomedical waste or processes incidental to such treatment and disposal is carried out and includes common treatment facilities
- Chemicals refer to for example solvents used for laboratory preparations, disinfectants, and heavy metals contained in medical devices (e.g. mercury in broken thermometers) and batteries
- Genotoxic waste refers to highly hazardous, mutagenic, teratogenic or carcinogenic, such as cytotoxic drugs used in cancer treatment and their metabolites
- Handling the biomedical waste includes the generation, sorting, segregation, collection, use, storage, packaging, loading, transportation, unloading, processing, treatment, destruction, conversion, or offering for sale, transfer, disposal of such waste
- Health-care facility means a place where diagnosis, treatment or immunization of human beings or animals is provided irrespective of type and size of health treatment system, and research activity pertaining to it

- Infectious waste refers to waste contaminated with blood and other bodily fluids (e.g. from discarded diagnostic samples), cultures and stocks of infectious agents from laboratory work (e.g. waste from autopsies and infected animals from laboratories), or waste from patients in isolation wards and equipment (e.g. swabs, bandages, and disposable medical devices)
- Major accident means accident occurring while handling of biomedical waste having potential to affect large masses of public and includes toppling of the truck carrying biomedical waste, accidental release of biomedical waste in any water body but exclude accidents like needle prick injuries, mercury spills
- Management includes all steps required to ensure that bio- medical waste is managed in such a manner as to protect health and environment against any adverse effects due to handling of such waste
- Non-hazardous or general waste refers to waste that does not pose any particular biological, chemical, radioactive or physical hazard
- Occupier means a person having administrative control over the institution and the premises generating biomedical waste, which includes a hospital, nursing home, clinic, dispensary, veterinary institution, animal house, pathological laboratory, blood bank, health-care facility and clinical establishment, irrespective of their system of medicine and by whatever name they are called
- Operator of a common biomedical waste treatment facility means a person who owns or controls or operates a common facility for the collection, reception, storage, transport, treatment, disposal or any other form of handling of biomedical waste
- Pathological waste refers to human tissues, organs or fluids, body parts and contaminated animal carcasses
- Pharmaceutical waste refers to expired, unused and contaminated drugs and vaccines
- Prescribed authority means the State Pollution Control Board in respect of a State and Pollution Control Committees in respect of a Union territory
- Radioactive waste refers to such as products contaminated by radionuclides including radioactive diagnostic material or radiotherapeutic materials
- Sharps refer to syringes, needles, disposable scalpels, and blades, etc.
- Waste refers to useless, unused, unwanted or discarded material

- Waste management facility is a facility which is used for the collection, storage, treatment, management recycling or disposal of waste

References

1. Acharya A, Gokhale VA, Joshi D. Impact of biomedical waste on city environment: Case study of Pune, India. IOSR Journal of Applied Chemistry. 2014;6(6):21-7.
2. Agarwal D. Neglected dimension of health care system: Biomedical waste. International Journal for Scientific Research & Development. 2015;3(8):131-2.
3. Anand C. The Hindu. Hospitals yet to master handling of biomedical waste Bengaluru2016. Available from: http://www.thehindu.com/news/cities/bangalore/hospitals-yet-to-master-handling-of-biomedical-waste-in-bengaluru/article8552459.ece.
4. Azad S. The Times of India. Private clinics, path labs ignore order to register with civic body Dehradun2016. Available from: http://timesofindia.indiatimes.com/city/dehradun/Private-clinics-path-labs-ignore-order-to-register-with-civic-body/articleshow/52801205.cms.
5. Babanyara YY, Ibrahim DB, Garba T, Bogoro AG, Abubakar MY. Poor medical waste management (MWM) practices and its risks to human health and the environment: A literature review. International Journal of Environmental, Chemical, Ecological, Geological and Geophysical Engineering. 2013;7(11):780-7.
6. Babu BR, Parande AK, Rajalakshmi R, Suriyakala P, Volga M. Management of biomedical waste in India and other countries: A review. Journal of International Environmental Application & Science. 2009;4(1):65-78.
7. Bhawsar S. Microbial growth substrates. Biotech Articles. 2011:1.
8. Bhutan Business. Hazardous waste production see an alarming rise but no specific policy to regulate it 2011. Available from: http://businessbhutan.bt/hazardous-waste-production-see-an-alarming-rise-but-no-specific-policy-to-regulate-it/.
9. Bhutan Observer. Tough regulation starting April to contain waste Bhutan2012. Available from: http://bhutanobserver.bt/print.aspx?artid=5547.
10. Biswal S. Liquid biomedical waste management: An emerging concern for physicians. Muller Journal of Medical Sciences and Research. 2013;4(2):99-106.
11. Biswas A, Amanullah ASM, Santra SC. Medical waste management in the tertiary hospitals of Bangladesh: An empirical enquiry. ASA University Review. 2011;5(2):149-58.
12. Britannica Encyclopedia. New Delhi, National Capital, India 2016. Available from: https://www.britannica.com/place/New-Delhi.
13. Chandra N. India Today. Bio-medical waste raises health-care stink in New Delhi New

Delhi2015. Available from: http://indiatoday.intoday.in/story/bio-medical-waste-raises-health-care-stink-in-new-delhi/1/455503.html.

14. CPR Environmental Education Centre. Solid waste management 2002. Available from: http://www.cpreec.org/pubbook-solid.htm#1.

15. Department of Health Services. Presentation during the training of the Health Professional on Health Care Waste Management at Manang. 2013.

16. Directorate General of Health Services, Dhaka. Medical waste management training manual 2009. Available from: http://www.hsmdghs-bd.org/Documents/MWM/Doc_Training%20Manual.pdf.

17. DNA India. Shocking but true! Biomedical waste being recycled in the National Capital 2015. Available from: http://www.dnaindia.com/locality/north-west-delhi/shocking-true-biomedical-waste-being-recycled-national-capital-59408.

18. Encyclopedia Britannica. Delhi, India. Available from: https://www.britannica.com/place/Delhi.

19. English News. China to better medical waste disposal Beijing2014. Available from: http://news.xinhuanet.com/english/china/2014-01/08/c_133029451.htm.

20. Environment Guidance Document. Handling Household Medical Waste: Home, Nursing Home, Assissted Living. 2011:1-3.

21. European Project Report. Environment protection and sustainable development: building local capacities on solid waste management in Myanmar. 2012:1-73.

22. Fazlulhaq Nadia. Wijeya Newspaper. Cancer hospital clinical waste unattended Colombo2011. Available from: http://www.sundaytimes.lk/110814/News/nws_17.html.

23. Ferdowsi A, Ferdowsi M, Mehrani MJ. Incineration or autoclave? A comparative study in Isfahan hospitals waste management system (2010). Materia Socio Medica. 2013;25(1):48-51.

24. Gautam V, Thapar R, Sharma M. Biomedical waste management: Incineration vs. environmental safety. Indian Journal of Medical Microbiology. 2010;28(3):191-2.

25. Government of Pakistan, Ministry of Environment. Hospital waste management rules, 2005 2005. Available from: http://environment.gov.pk/act-rules/rHWMRules2005.PDF.

26. Gupta V, Gupta S, Pandey M. Bio-medical waste management: an insight approach. Veterinary Science Research Journal. 2014;5(1&2):38-46.

27. Haniffa R. Management of health care waste in Sri Lanka. Ceylon Medical Journal. 2004;49(3):93-5.

28. Health care without harm. HCWH and HECAF present on sustainability in health care in Nepal 2015. Available from: https://noharm-global.org/articles/news/global/hcwh-and-hecaf-present-sustainability-health-care-nepal.

29. Hussain A. Dhaka Tribune. Chittagong medical waste management in peril Chittagong2016. Available from: http://archive.dhakatribune.com/bangladesh/2016/jan/27/chittagong-medical-waste-management-peril.

30. INCLEN Program Evaluation Network (IPEN) study group - Bio-medical waste management: situational analysis & predictors of performances in 25 districts across 20 Indian States. Indian J Med Res. 2014;139:141-53.

31. Indian Chamber of Commerce. Health-care infrastructure and services financing in India: Operation and challenges 2012. Available from: https://www.pwc.in/assets/pdfs/publications-2012/health-care_financing_report_print.pdf.

32. International Institute of Health andHygiene. Waste Management 2016. Available from: http://sulabhenvis.nic.in/Database/WasteManagement_7081.aspx.

33. Jenkins N. How to reduce waste by increasing use of reusable medical textiles. Supply Chain Strategies & Solutions. 2008;6(2):6-8.

34. Karunasena G, Jayathilaka WMDM, Rathnayake RMNU. Comparison on disposal strategies for clinical waste: Hospitals in Sri Lanka. 6th International Conference on Structural Engineering and Construction Management 2015:13-21.

35. Kuchibanda K, Mayo AW. Public health risks from mismanagement of health-care wastes in Shinyanga municipality health facilities, Tanzania. The Scientific World Journal. 2015;2015:1-11.

36. Mathur P, Patan S, Shobhawat AS. Need of biomedical waste management system in hospitals - An emerging issue - A review. Current World Environment. 2012;7(1):117-24.

37. Ministry of Environment Forest and Climate Change. Bio-Medical Waste Management Rules 2016. Available from: http://envfor.nic.in/content/gsr-343e-28-03-2016-bio-medical-waste-management-rules2016?theme=moef_blue.

38. Ministry of Environment and Forests. Bio-Medical Waste (Management and Handling) Rules. 1998.

39. Ministry of Health and Population Government of Nepal. Health care waste management guideline. Department of Health Services, 2014.

40. Ministry of Environment and Forests. The Environment (Protection) Act, 1986 1986. Available from: http://envfor.nic.in/legis/env/env1.html.

41. Ministry of Health and Family Welfare. Environment assessment and action plan for the health, population and nutrition sector development program 2011. Available from: http://documents.worldbank.org/curated/pt/874871468198578021/Tribal-ethnic-health-population-and-nutrition-plan.

42. Ministry of Health. Health care waste management in Nepal 2003. Available from: http://www.mohp.gov.np/index.php/publication/211-health-care-waste-management-guideline.

43. Ministry of Health: The Republic of Union of Myanmar. Environment Management Plan 2014. Available from: http://documents.worldbank.org/curated/en/758731468060302941/Myanmar-Essential-Health-Services-Access-Project-environmental-management-plan.

44. Ministry of Health and Population. Study overview and baseline injection safety assessment in Nepal Preliminary main findings and Recommendations. 2012.

45. Ministry of Health. Environmental management framework for health-care waste & infrastructure development. 2012:1-11.

46. Modak S. The Indian Express. Bio-medical waste: Hospitals flaunting disposal norms face action Mumbai2016. Available from: http://indianexpress.com/article/mumbai/bio-medical-waste-hospitals-flouting-disposal-norms-face-action/.

47. Narayan D. Biomedical waste - types, disposal and outstanding work in its management. Biotech Articles. 2014:1.

48. NMN. Nepal Mountain News. Govt's alarm for hospitals for strict waste management Nepal2013. Available from: http://www.nepalmountainnews.com/cms/archives/72226.

49. Noor-Ul-Qamrain. Sunday Guardian Live. Bio-medical waste poses threat to health in valley Srinagar2016. Available from: http://www.sundayguardianlive.com/news/4470-bio-medical-waste-poses-threat-health-valley.

50. OPCW. Bamako Convention on the ban of the import into Africa and the control of transboundary movement and management of hazardous wastes within Africa 1994.

Available from: https://www.opcw.org/chemical-weapons-convention/related-international-agreements/toxic-chemicals-and-the-environment/bamako-convention/.

51. Pakistan Times. EPA issues showcase notices to hospitals, residential schemes Karachi2016. Available from: http://www.pakistantoday.com.pk/2016/06/24/city/karachi/epa-issues-showcase-notices-to-hospitals-residential-schemes/.

52. Pakistan Today. EPA concerned over improper disposal of medical waste by hospitals Islamabad2016. Available from: http://www.pakistantoday.com.pk/2016/06/01/city/islamabad/epa-concerned-over-improper-disposal-of-medical-waste-by-hospitals/.

53. Population Ministry of Health and, Nepal. Health Care Waste Management Guideline. Department of health Services. 2014.

54. Press Information Bureau. New bio-medical waste management rules will change the way country used to manage waste earlier; make a big difference to clean India Mission: Javadekar 2016. Available from: http://pib.nic.in/newsite/PrintRelease.aspx?relid=138353.

55. Press Information Bureau. New bio-medical waste management rules notified 2016. Available from: http://pib.nic.in/newsite/PrintRelease.aspx?relid=138353.

56. PRISM Bangladesh Foundation. Medical waste management program 2013. Available from: https://www.pbf.org.bd/?page_id=717

57. Rao MS, Wankhede WS. Management of hospital wastes with potential pathogenic microbes. In: Satyanarayana T JB, Prakash A, editor. Microorganisms in Environmental Management2011. p. 365-401.

58. Royal Government of Bhutan. Waste prevention and management regulation. 2012:1-181.

59. Sarojini E, Jayanthi S. Effect of solar radiation on disinfection of infectious biomedical wastes. Journal of Environmental Science and Engineering. 2010;52(2):93-6.

60. Song J. Epoch Times. The frightening ways China recycles used syringes and other medical waste China2016. Available from: http://www.theepochtimes.com/n3/2031242-the-frightening-ways-china-recycles-used-syringes-and-other-medical-waste/.

61. Sra A. The Nation. Be careful! Hospital waste can leave you in worse health Islamabad2016. Available from: http://nation.com.pk/E-Paper/islamabad/2016-06-24/page-13.

62. Sri Lanka College of Microbiologist National Guidelines. Waste Management. 2006:95-108.

63. Sri Lanka Internet Newspaper: Colombo Page. Australian assistance to establish clinical

waste management systems in Sri Lankan state hospitals Colombo2015. Available from: http://www.colombopage.com/archive_15B/Aug02_1438507346CH.php.

64. Statistics: Market Research Consulting. Medical waste management - Global market outlook (2015-2022) 2016. Available from: http://www.strategymrc.com/report/medical-waste-management-market.

65. Stringer R. Medical waste and human rights. Health Care Without Harm. 2011:1-58.

66. Swachha. Waste segregation chart 2016. Available from: www.swachha.org.

67. The Economic Times. 5 Delhi hospitals not strictly adhering to biomedical waste management rules: Jayanthi Natarajan 2013. Available from: http://economictimes.indiatimes.com/industry/health-care/biotech/health-care/5-delhi-hospitals-not-strictly-adhering-to-biomedical-waste-management-rules-jayanthi-natarajan/articleshow/22141571.cms.

68. The Times of India. 32 hospitals get notices on disposal of bio-medical waste 2013. Available from: http://timesofindia.indiatimes.com/city/chandigarh/32-hospitals-get-notices-on-disposal-of-bio-medical-waste/articleshow/26709799.cms.

69. The Pioneer. 17 hospitals get notice for improper biomedical waste handling 2014. Available from: http://www.dailypioneer.com/state-editions/raipur/17-hospitals-get-notice-for-improper-bio-medical-waste-handling.html.

70. The Indian Express. Delhi government plans steps to ensure proper disposal of biomedical waste 2016. Available from: http://indianexpress.com/article/cities/delhi/delhi-government-plans-steps-to-ensure-proper-disposal-of-bio-medical-waste/.

71. The Hindu. CB-CID to probe 'sale of' bio medical waste from hospitals Chennai2016. Available from: http://www.thehindu.com/news/cities/chennai/cbcid-to-probe-sale-of-bio-medical-waste-from-hospitals/article8582550.ece.

72. The Indian Express. Delhi government plans steps to ensure proper disposal of bio-medical waste Delhi2016. Available from: http://indianexpress.com/article/cities/delhi/delhi-government-plans-steps-to-ensure-proper-disposal-of-bio-medical-waste/.

73. The Tribune. Biomedical waste disposal a problem at military hospitals 2013. Available from: http://www.tribuneindia.com/2013/20130112/nation.htm#14.

74. The Times of India. 2 Jalandhar hospitals get Punjab Pollution Control Board notice over faulty waste management 2013. Available from:

http://timesofindia.indiatimes.com/city/chandigarh/2-Jalandhar-hospitals-get-Punjab-Pollution-Control-Board-notice-over-faulty-waste-management/articleshow/17880541.cms.

75. The Tribune. Disposal of biomedical waste a headache for civic bodies 2011. Available from: http://www.tribuneindia.com/2011/20110727/bathinda.htm#1.

76. The Times of India. Civil hospital dumps biomedical waste in own campus 2016. Available from: http://timesofindia.indiatimes.com/city/gurgaon/Civil-hospital-dumps-biomedical-waste-in-own-campus/articleshow/51591974.cms.

77. Uddin MN, Islam MR, Yesmin K. Knowledge on hospital waste management among senior staff nurses working in a selected medical college hospital of Bangladesh. Journal of Waste Management. 2014;2014:1-5.

78. UNESCO. United Nations educational, scientific and cultural organization educating for a sustainable future 1997. Available from: http://www.unesco.org/education/tlsf/mods/theme_a/popups/mod01t05s01.html.

79. UNECE. UN recommendations on the transport of dangerous goods - Model regulations 2011. Available from: http://www.unece.org/trans/danger/publi/unrec/rev17/17files_e.html.

80. United Nations Development Program. Lucknow hospital earns global recognition for sound bio-medical waste management systems 2013. Available from: http://www.in.undp.org/content/india/en/home/presscenter/pressreleases/2013/03/05/lucknow-hospital-earns-global-recognition-for-sound-bio-medical-waste-management-systems.html.

81. United Nations Environment Programme. Basel Convention on the control of transboundary movements of hazardous wastes and their disposal 2014. Available from: http://www.basel.int/portals/4/basel%20convention/docs/text/baselconventiontext-e.pdf.

82. United Nations Environment Programme. Rio declaration on environment and development 1972. Available from: http://www.unep.org/Documents.Multilingual/Default.asp?documentid=78&articleid=1163.

83. Veronesi P, Leonelli C, Moscato U, Cappi A, Figurelli O. Non-incineration microwave assisted sterilization of medical waste. The Journal of Microwave Power & Electromagnetic Energy. 2007;40(4):211-8.

84. WHO. Health-care waste 2015. Available from: http://www.who.int/mediacentre/factsheets/fs253/en/.

85. WHO. Ecosystems and human well-being Health synthesis 2005. Available from: http://www.millenniumassessment.org/documents/document.356.aspx.pdf.

86. WHO. Safe management of wastes from health-care activities 2014. Available from: http://www.who.int/water_sanitation_health/publications/wastemanag/en/.

87. Wikipedia. West Delhi 2016. Available from: https://en.wikipedia.org/wiki/West_Delhi.

88. World Population Review. Delhi population 2016 2016. Available from: http://worldpopulationreview.com/world-cities/delhi-population/.

89. Yi W. Ministry of Public Health of the People's Republic of China. Measures for medical wastes management of medical and health institutions China2003. Available from: http://www.asianlii.org/cn/legis/cen/laws/mfmwmomahi633/.

"LET THE WASTE OF **THE SICK** NOT CONTAMINATE THE LIVES OF **THE HEALTHY**"

Block 4

E-Waste Management

Swachhta Action Plan

Mahatma Gandhi National Council of Rural Education
Department of Higher Education
Ministry of Human Resource Development, Government of India
Hyderabad - 500004

Contents

Chapter1 Generation of e-waste and its comparison with other countries

1.1 Definition of E-waste
1.2 Classification of E-waste
1.3 E-waste generation across the world
1.4 E-waste generation in India including information technology
1.5 E-waste and its relation to sustainable development goals

Chapter**2 Hazardous substances in E- waste**

2.1 Hazardous substances
2.2 Illegal dumping and informal dismantling of Electronic items
2.3 Environment and Public health impacts of E-waste
2.4 Restriction of hazardous substances
2.5 Business Sustainable technologies

Chapter 3 E-waste management and the Regulatory framework

3.1 Common e-waste management scenarios
3.2 International regulations and laws-
3.3 E-waste Rules 2016
3.4 Collection centre
3.5 Extended producers Responsibility

Chapter4 Dismantling and recycling of E-waste

4.1 E-waste and the informal sector
4.2 Formal recyclers and dismantlers
4.3 Responsibilities of the dismantler and the recycler
4.4 Recycling of different types of waste
4.5 Business models

Chapter 5 Sustainable consumption and production

5.1 Sustainable consumption and production
5.2 Circular economy
5.3 Life styles of health and sustainability
5.4 Carbon footprint
5.5 Personal action plan

E-Waste Management – An Introduction

The burgeoning Information technology sector with an ever- increasing demand for the EEE pose an unprecedented challenge for the human health and environment. The EEE such as personal computers, Lap top, TV, AC,refrigerator, mobile phones, which facilitate our lives on a daily basis become E-waste once they reach their end of life. The e-waste because of its complex composition comprising of hazardous substances is non-biodegradable and therefore categorized as a red category waste which is threat to human health and environment, when disposed and managed by rudimentary methods in the informal sector. Some of the hazardous substances present in the EEEare lead, mercury, cadmium, Beryllium etc. In addition, this waste also contains precious metals such as gold, silver, palladium, platinum and copper in small amounts in the PCB 's, therefore it is also a thriving business opportunity.

E-waste is a global phenomenon with more than 40 million tonnes of waste generated annually. With an estimated 2 million tonnes of waste generated annually, India is among the top 5 countries that generate maximum waste in the world. The transboundary movement of E-waste from the developed countries in Europe and America to the developing countries in Asia and Africa add to this growing challenge. The trade is purely driven by economics as the cost of recycling the EEE items is 10 times cheaper in developing countries as compared to developed nations.

E-waste management is a big challenge. Some of the methods used for E-waste management in the country are dumping in the landfills, burning/incineration, dismantling and recycling. More than 95 % of the E-waste in the country is being managed in the informal economy by unskilled workers who are engaged in collection, segregation, dismantling and recycling of the waste manually, using rudimentary methods such as breaking, burning and extraction of precious metals using acid -baths that release emissions and toxic gases that harm the health of the workers engaged in these activities.

A multipronged approach comprising of awareness generation for different stakeholders, upgradation of the informal workers via training in appropriate technologies and development of innovative models for addressing the problem in the E-waste value chain are some of the measures that need to be taken to resolve this growing menace of E-waste in the country.

Chapter 1 Generation of e-Waste and its Comparison with Other Countries

Introduction

The decade of 1970-1980 started with the economic power houses of the world facing saturation in their domestic markets. These Developed economies with highly productive enterprises and machines required new emerging markets. The developing countries in turn, were happy to reciprocate and provide cheaper resources in form of man, materials and simplified goods to the developed countries.

The world was linking with each other – both ways.

Globalization kick-started all over the world in the Mid 1980's. The movement was spread across the continents of Europe, United States of America and Asia. The backbone of the globalization era was the revolution in the Information technology and Communication which made the world a small place.

The most critical element of this revolution was the IC (Integrated Circuits) and the PCB (Printed Circuit Board). The information technology and communications platform depended on the processing power of the IC, to enable additional bouquet of services to the end customer. Each year required an addition in the capacity of the basic IC to ensure newer value additions for the end customer. This led to the research and development over the next 30 years to make IC smaller with a high processing power.

All equipment being used in day to day affairs are embedded with the IC and PCB boards.

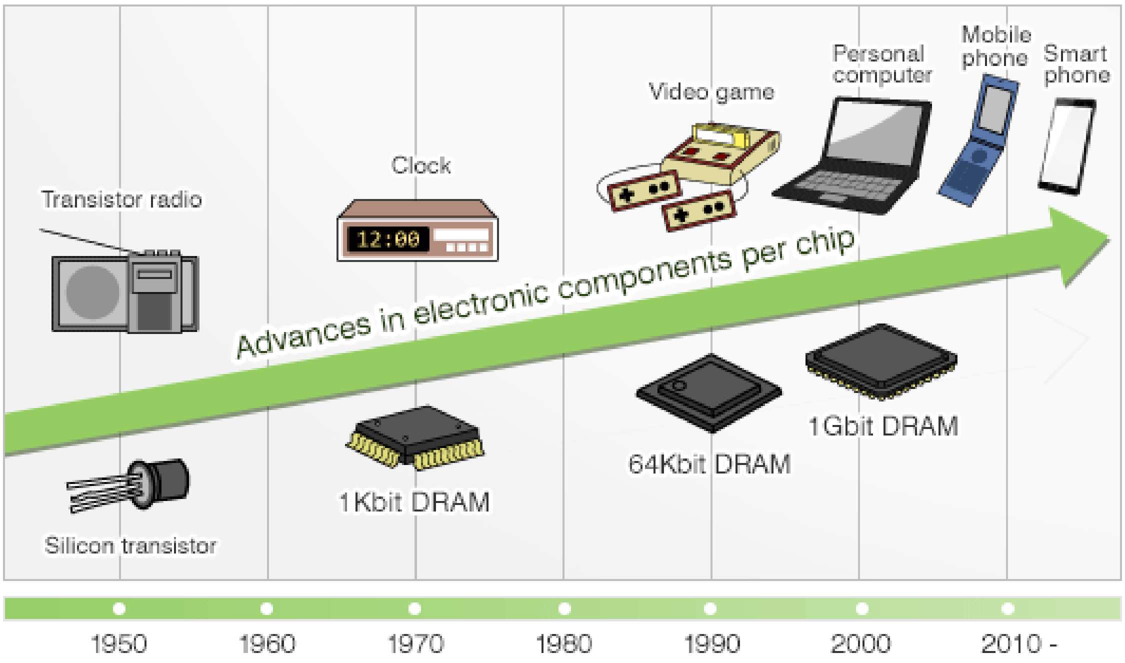


Fig1.1 Roadmap of Equipment's with development of higher processing power of IC

The quantum leap in the development of processing power has led to application of IC and Electronic components on a variety of products, all over the world. IC is now utilized in washing machines, cars, television, smartphones etc. etc.

As of date, in 2019 any launch of a new IC leads to launch of a newer model by different product manufacturer which fuels product obsolesces within a period of five years.

The equipment volumes have grown at an exponential rate in certain segments like the Smartphone segment shown below

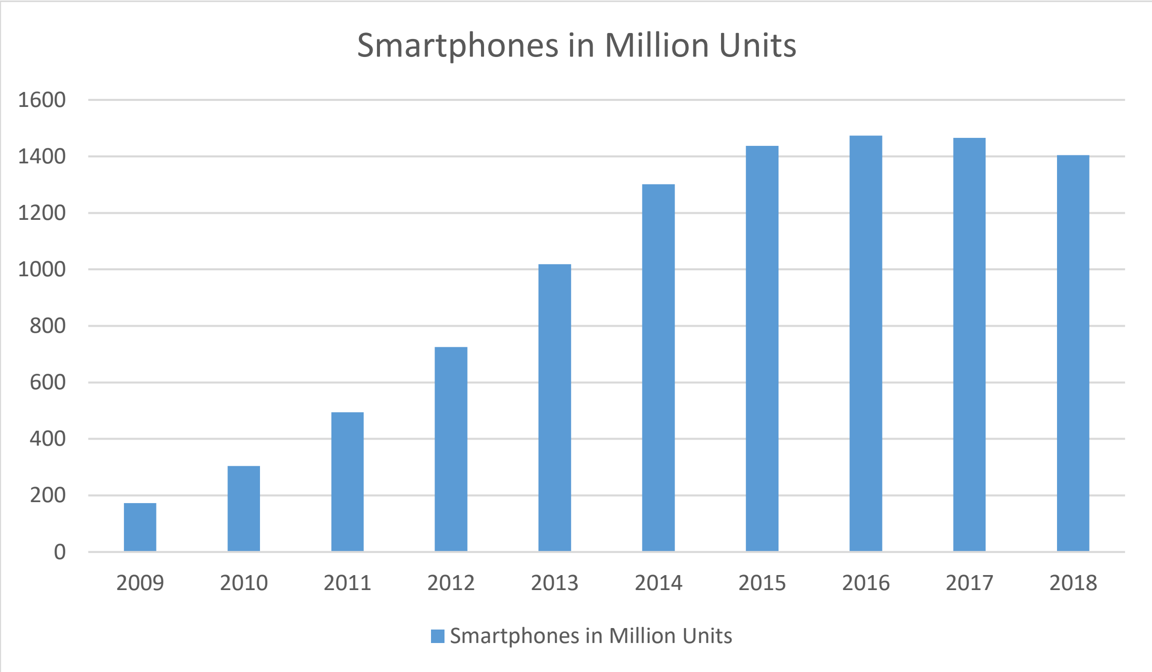


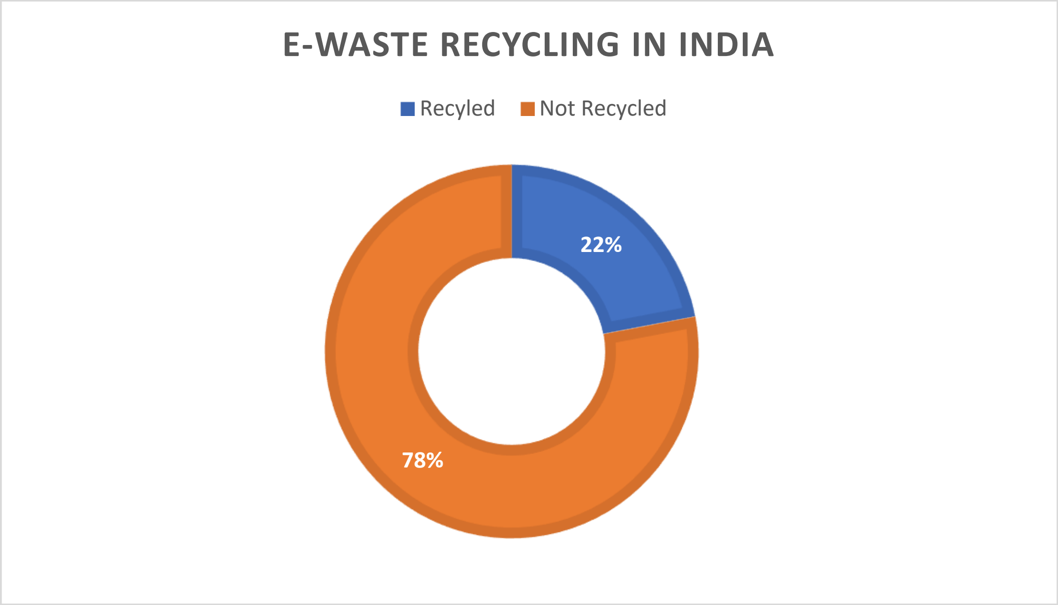
Fig1.2 Smart-Phone shipments over the world 2009-2018

The faster obsolesce and subsequent upgradation of the electronics product is forcing consumers to discard old products, in turn leading to generation of waste – E-waste. The current rate of obsolesce in e-waste is a period of 3-5 years. Implies that the entire commodity manufactured goes out of life and is a trash for global community after the stipulated time of 3-5 years.

This back-drop was never envisaged by Governments of the day, the citizens of the country and the conventional method of waste handling was difficult to control such high volumes of waste.

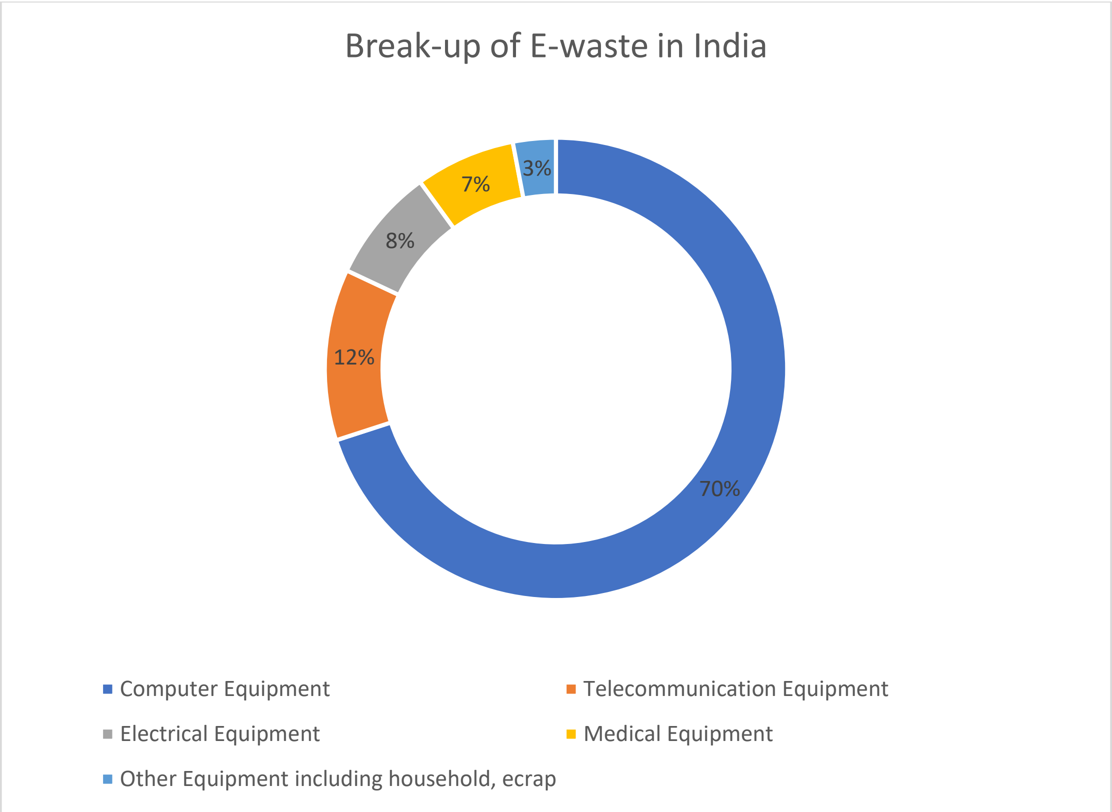
Electronic waste (e-waste) is one of the fastest growing waste streams in the country and has assumed gigantic proportions.

The discarded and end-of-life electronics products ranging from computers, equipment used in Information and Communication Technology (ICT), home appliances, audio and video products and all of their peripherals are popularly known as Electronic waste (E-waste).



Total e-waste generated in India 2 million tonnes per annum

Fig1.3 E-Waste recycling and Break-up of E-waste in India



The main sources of electronic waste in India are the government, public and private (industrial) sectors, which account for almost 70 per cent of total waste generation.

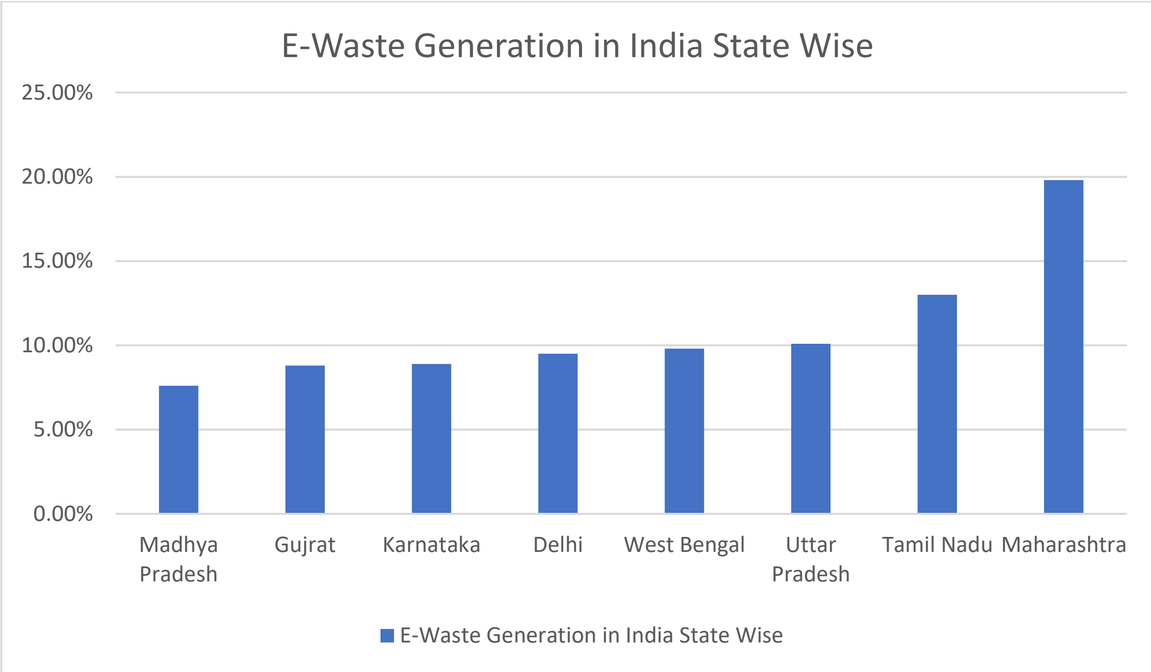
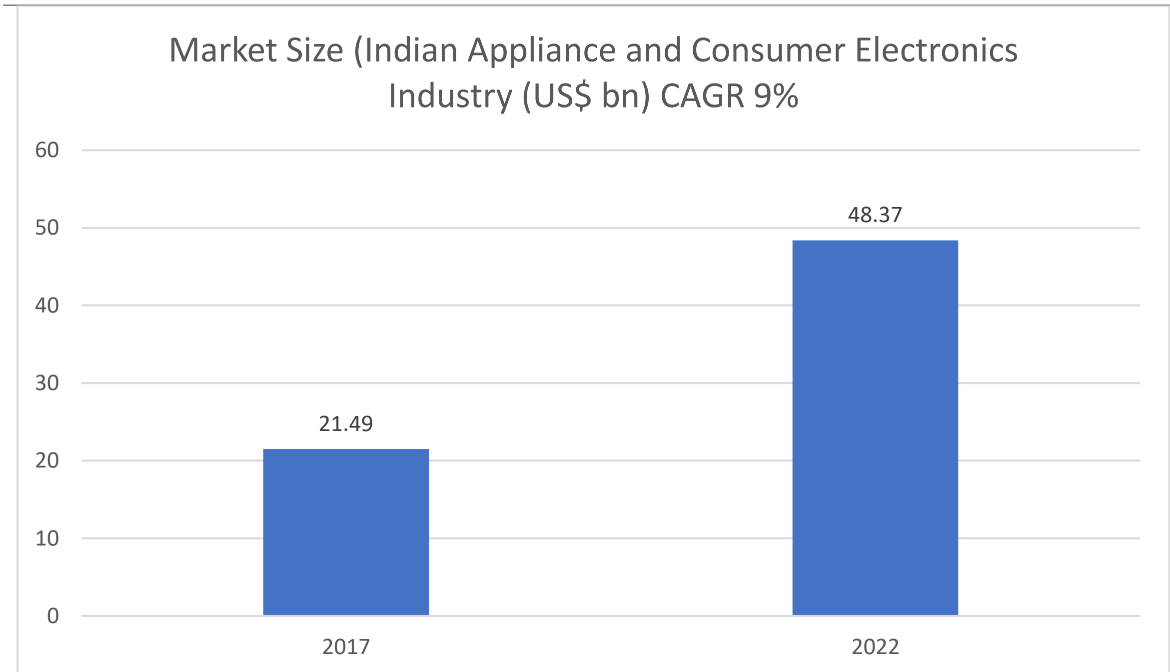
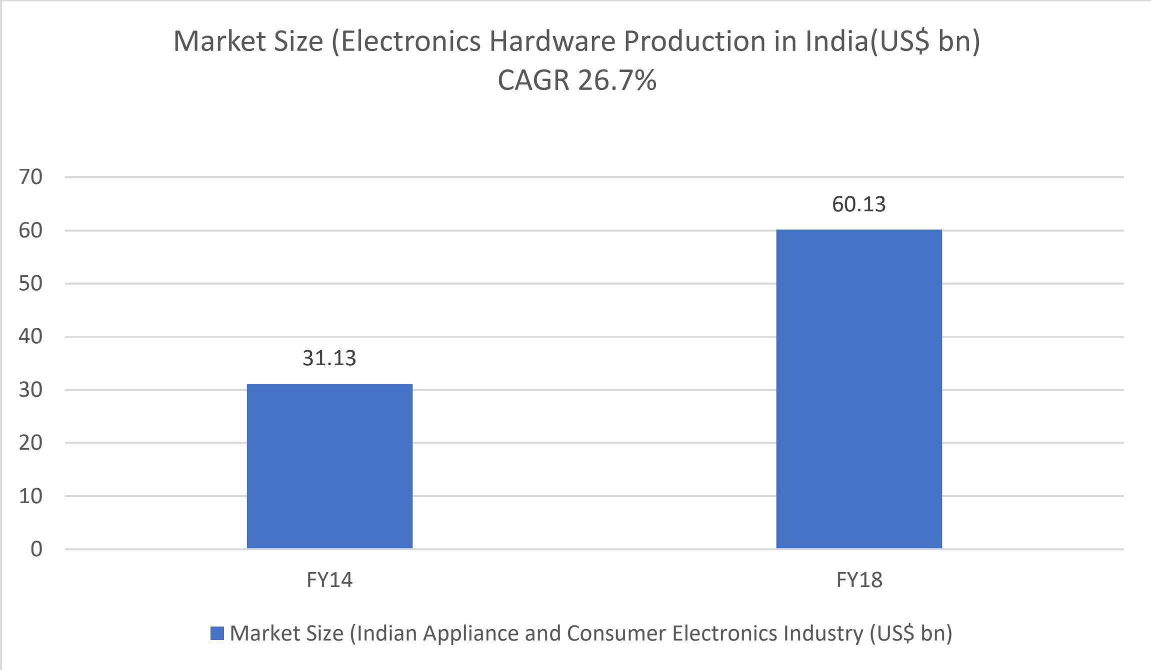


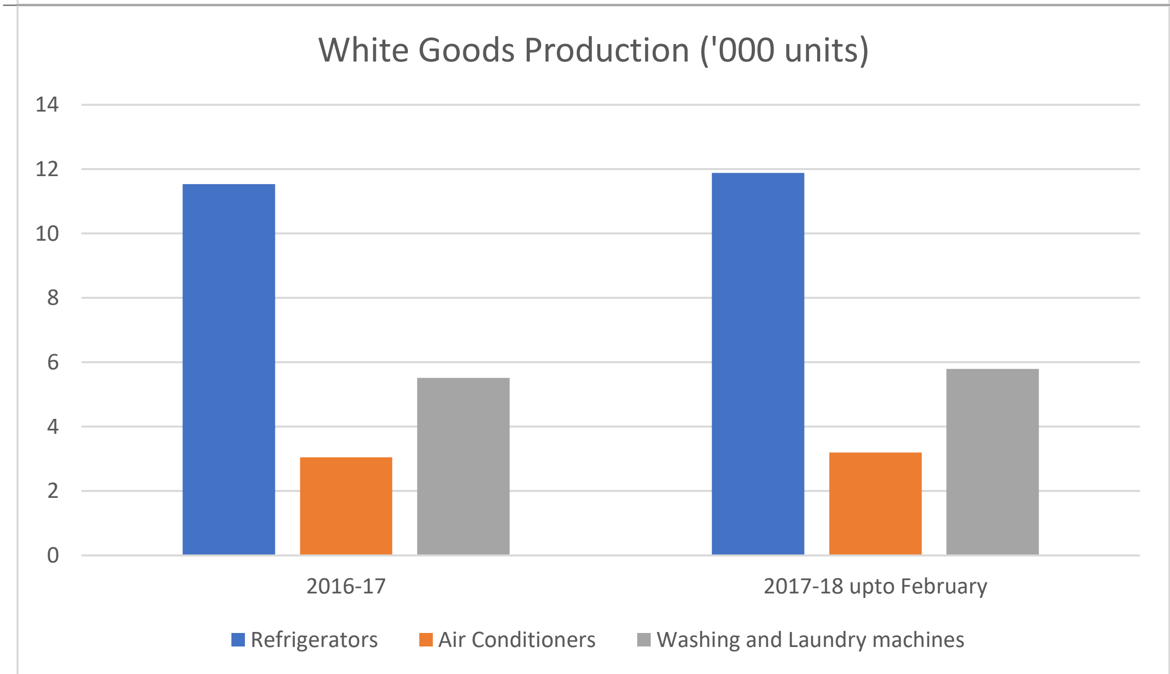
Fig 1.4 E-waste Generation India State Wise

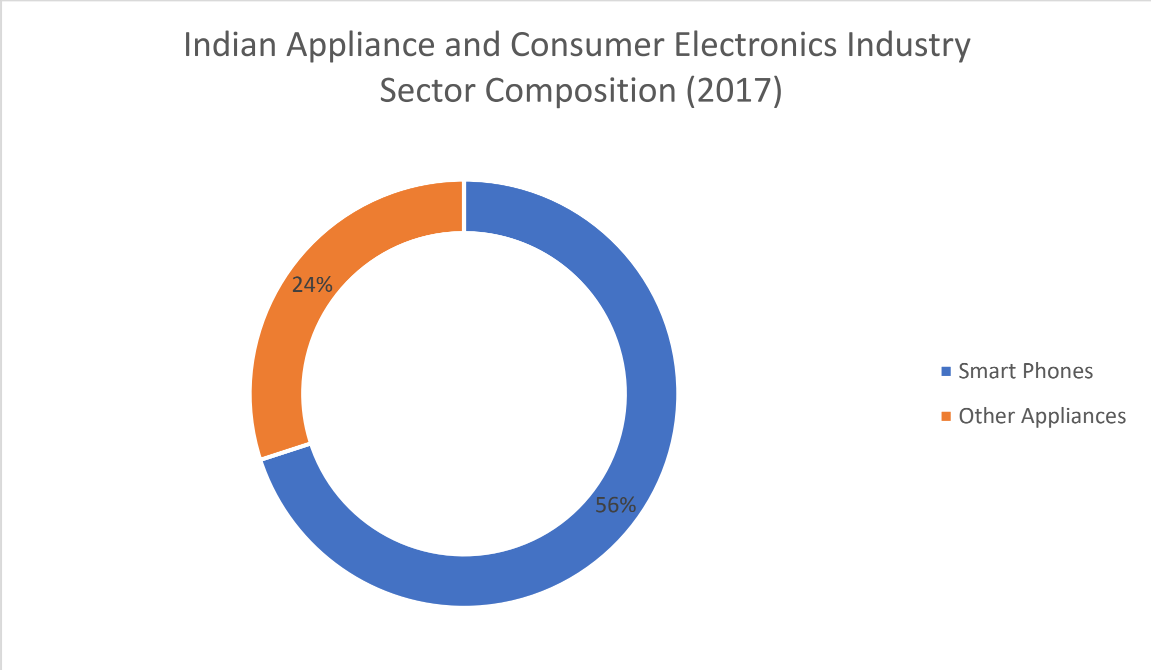
The contribution of individual households is relatively small at about 15 per cent; the rest being contributed by manufacturers. Though individual households are not large contributors to waste generated by computers, they consume large quantities of consumer durables and are, therefore, potential creators of waste.

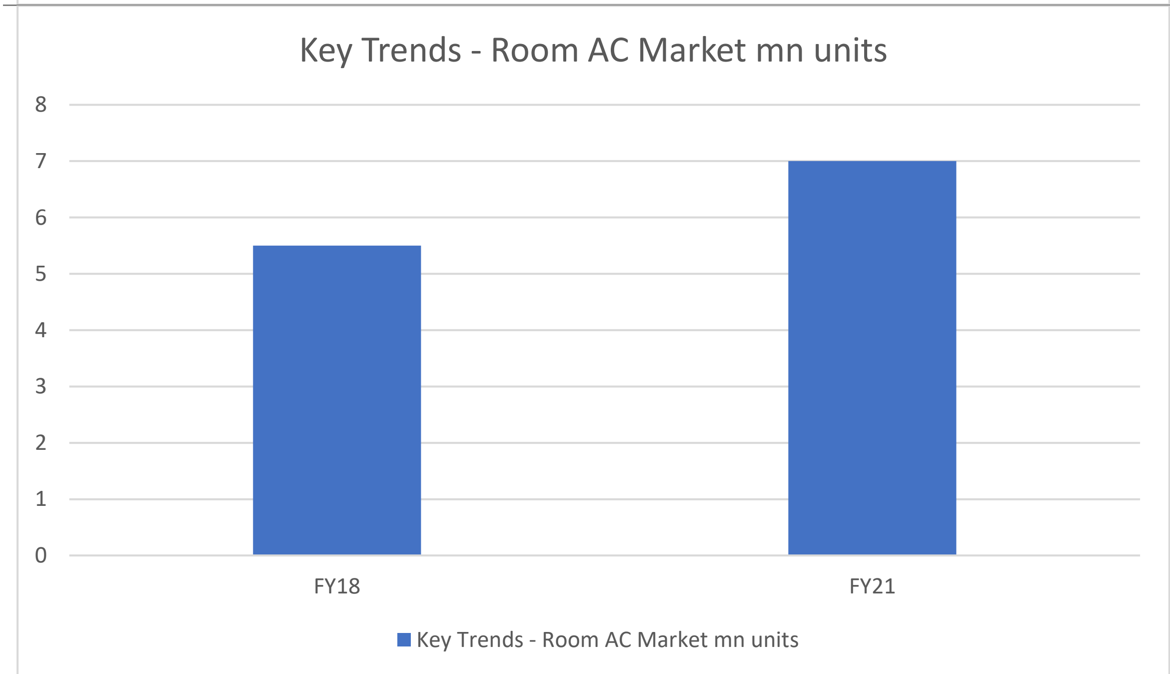
Consumer Durable

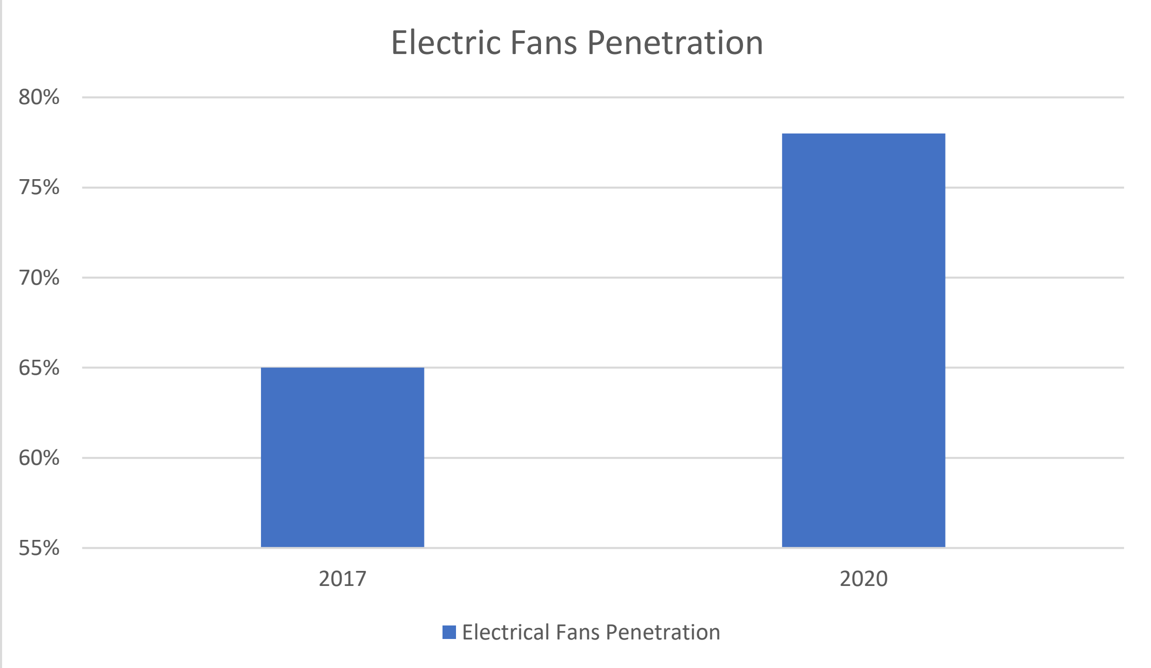



Market Size (Electronics Hardware Production in India(US$ bn)
CAGR 26.7%
70
60
50
40
30
20
10
0
31.13
60.13
FY14
FY18
Market Size (Indian Appliance and Consumer Electronics Industry (US$ bn)


White Goods Production ('000 units)
14
12
10
8
6
4
2
0
2016-17
2017-18 upto February
Refrigerators
Air Conditioners
Washing and Laundry machines


Indian Appliance and Consumer Electronics Industry
Sector Composition (2017)
24%
56%
Smart Phones
Other Appliances


Key Trends - Room AC Market mn units
8
7
6
5
4
3
2
1
0
FY18
FY21
Key Trends - Room AC Market mn units



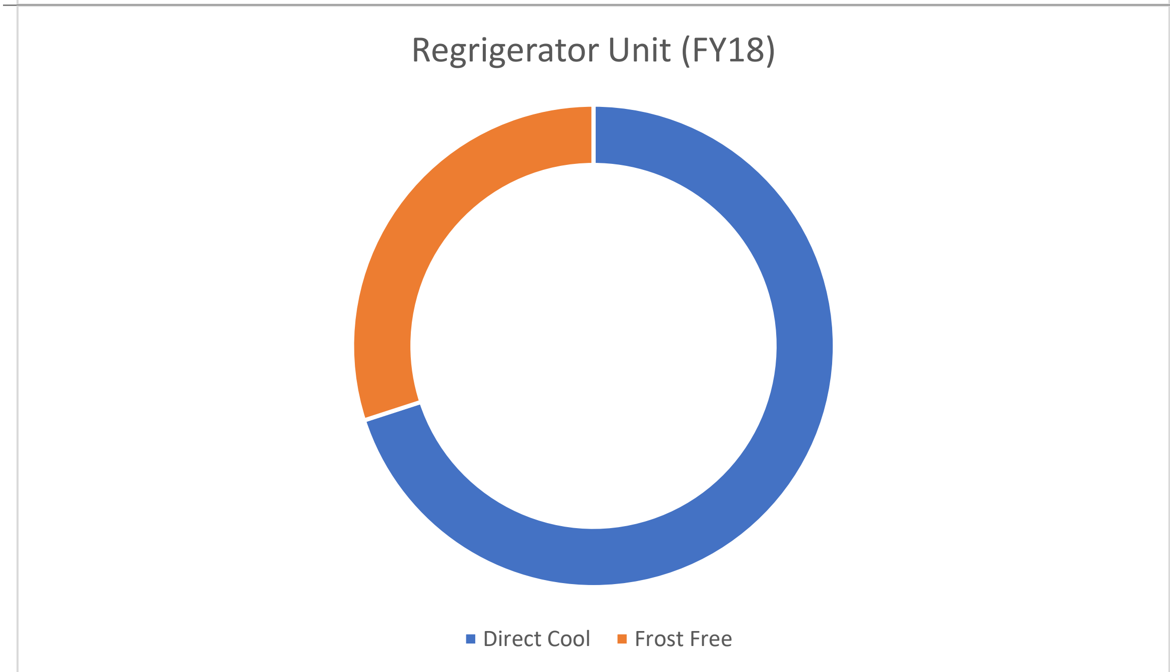


Fig 1.5 Quantum of Consumer Durables market in India

An Indian Market Research Bureau (IMRB) survey of 'E-waste generation at Source' in 2009 found that out of the total e-waste volume in India, televisions and desktops including servers comprised 68 per cent and 27 per cent respectively. This gives us an idea that better awareness of critical items will enable us to get a hold and control over the high dispersion of e-waste. Imports and mobile phones comprised of 2 per cent and 1 per cent respectively (Rajya Sabha Secretariat 2011).

Main contributors of e-waste include computer and its accessories, monitors, printers, keyboards, central processing units; typewriters, mobile phones and chargers, remotes, compact discs, headphones, batteries, LCD/Plasma TVs, air conditioners, refrigerators and other household appliances (Rajya Sabha Secretariat 2011).

Objectives

1. Explain what E-waste is composed of, where e-waste is produced and in what quantities
2. Identify the constituents and categories of E-waste
3. Identify the generation of E-waste across the globe include E-waste generation in India
4. Explain the connection between E-waste and sustainable development goals

1.1 Definition of E-waste

To do activity

Write a note on the current understanding.
Write a note on aspiration aspiration vis a vis this course
Discussion and finally the presentation of the various definitions by the instructor

The information technology has revolutionized the way we live, work and communicate bringing countless benefits to all its users. However, with these benefits it has also brought in a new stream of waste called the E-waste. E-waste consists of all waste from electronic and electrical appliances which have reached their end- of- life period or are no longer fit for their original intended use and are destined for recovery, recycling or disposal. It includes computer and its accessories monitors, printers, keyboards, central processing units; typewriters, mobile phones and chargers, remotes, compact discs, headphones, batteries, LCD/Plasma TVs, air conditioners, refrigerators and other household appliances.

Table 1.1 Definitions of E-waste

The European Union laid down a comprehensive policy on WEEE in 2003, along with a definition for it "Electrical or electronic equipment, which is waste including all components, sub-assemblies and consumables, which are part ofthe product at the time of discarding

The **Organization** for Economic Co-operation and Development (OECD) also made a definition in 2001, "electrical and electronic equipment, whole or in part discarded as waste by the consumer or bulk consumer as well as rejects from manufacturing, refurbishment and repair processes."

The Basel Action Network, a non-governmental **organization** campaigning for the safe handling of hazardous materials, defines e-waste as, "a broad and growing range of electronic devices ranging from large household devices such as refrigerators, air conditioners, cell phones, personal stereos, and consumer electronics to computers which have been discarded by their users."

E-waste contains over 1000 different substances, many of which are toxic, and creates serious pollution problems, upon disposal. The awareness will among consumers help identify the proper segregation and handling of hazardous elements in small proportions in E-Waste.

The composition of e-waste is diverse and falls under 'hazardous' and 'non-hazardous' categories. Non-hazardous also need to be handled with care although the timelines of action are not as difficult as the hazardous ones.

Broadly, it consists of ferrous and non-ferrous metals, plastics, glass, wood and plywood, printed circuit boards, concrete, ceramics, rubber and other items. This is a preferred way to understand the e-waste type and handling methodology.

Iron and steel constitute about 50% of the waste, followed by plastics (21%), non-ferrous metals (13%) and other constituents.

Non-ferrous metals consist of metals like copper, aluminum and precious metals like silver, gold, platinum, palladium and so on. The presence of elements like lead, mercury, arsenic, cadmium, selenium, hexavalent chromium, and flame retardants beyond threshold quantities make e-waste hazardous in nature.

Table 1.1 Composition of E-waste

Iron and steel	**50%**
Plastics	21%
Non-ferrous metals (copper, aluminum, silver, gold, platinum, palladium)	13%
Other constituents (lead, mercury, arsenic, cadmium, selenium, hexavalent chromium, and flame retardants)	16%

The composition of e-waste is very diverse and contains products across different categories.

To do Activity
Film Analysis and discussion
https://www.youtube.com/watch?v=aHaySL8EL6g

To Do Activity
Case study analysis and discussion
Write the problems being discussed in the case study.
Write 2-3 solutions being offered in the case study
Prepare a list oflearnings from the case study
http://greene.gov.in/wp-content/uploads/2018/01/CollegeStudents-1.pdf

1.2 of Electronic and Electrical Equipment and basic e-waste elements

There are two categories of EEE

1) Information technology and telecommunication equipment
2) Consumer Electricals and electronics

Table 1.2 Categories of electrical and electronic equipment

Categories of electrical and electronic equipment	
Information technology and telecommunication equipment: Centralised data processing: Mainframes, Minicomputers Personal Computing: Personal Computers (Central Processing Unit with input and output devices) Personal Computing: Laptop Computers (Central Processing Unit with input and output devices) Personal Computing: Notebook Computers Personal Computing: Notepad Computers Printers including cartridges Copying equipment Electrical and electronic typewriters User terminals and systems Facsimile Telex Telephones Pay telephones Cordless telephones Cellular telephones Answering systems	Consumer Electricals and electronics Consumer electrical and electronics: Television sets (including sets based on (Liquid Crystal Display and Light Emitting Diode technology) Refrigerator Washing Machine Air-conditioners excluding centralised air conditioning plants Fluorescent and other Mercury containing lamps

The basic elements as pollutants are present in all the daily items and the below mentioned tables provides the details of the items. The segregation methodology has to ensure that the category A dangerous metals are handled very carefully.

Table 1.3: Types of pollutants and their occurrence in E-waste

Pollutant/Element	Occurrence
Arsenic	Semi-conductors, diodes, microwaves, LED's (Light Emitting diodes), Solar cells
Barium	Electron tubes, filler for plastic and rubber, lubricant additives
Brominated flame-proofing agent	Casing, circuit boards(plastic), cables and PVC cables
Cadmium	Batteries, pigments solder, alloys, circuit boards, computer batteries, monitor cathode ray tubes (CRT's)
Chrome	Dyes/pigments, switches, solar
Cobalt	Insulators
Copper	Conducted in cables, copper ribbons, coils, circuitry pigment
Lead	Lead rechargeable batteries, solar, transistors, lithium batteries PVC (polyvinyl chloride), Stabilizers, lasers, LEDS, thermoelectric elements, circuit boards
Liquid crystal	Displays
Lithium	Mobile telephones, photographic equipment, video equipment (batteries)
Mercury	Components in copper machines and steam irons; batteries in clocks and pocket calculators, switches, LCD's
Nickel	Alloys, batteries, relays, semiconductors, pigments
PCBs (Polychlorinated biphenyls)	Transformers, capacitors, softening agent for pain, glue and plastic
Selenium	Photoelectric cells, pigments, photo-copiers, fax machines
Silver	Capacitors, switches (contacts), batteries, resistors
Zinc	Mixed with Steel, brass, alloys, disposable and rechargeable batteries, luminous substances

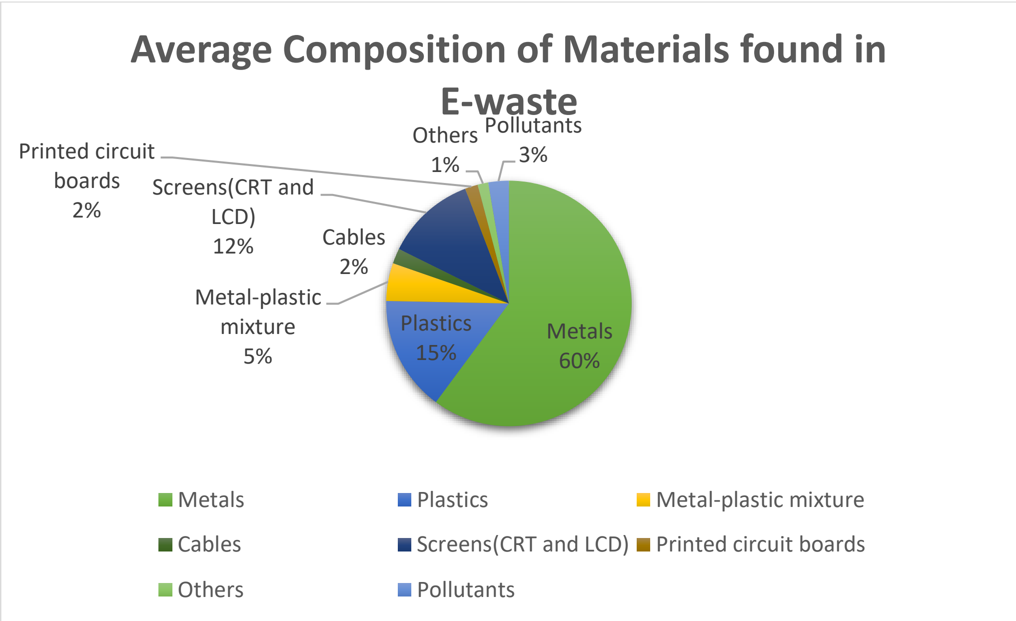


Fig1.6 Average composition of material found in E-waste

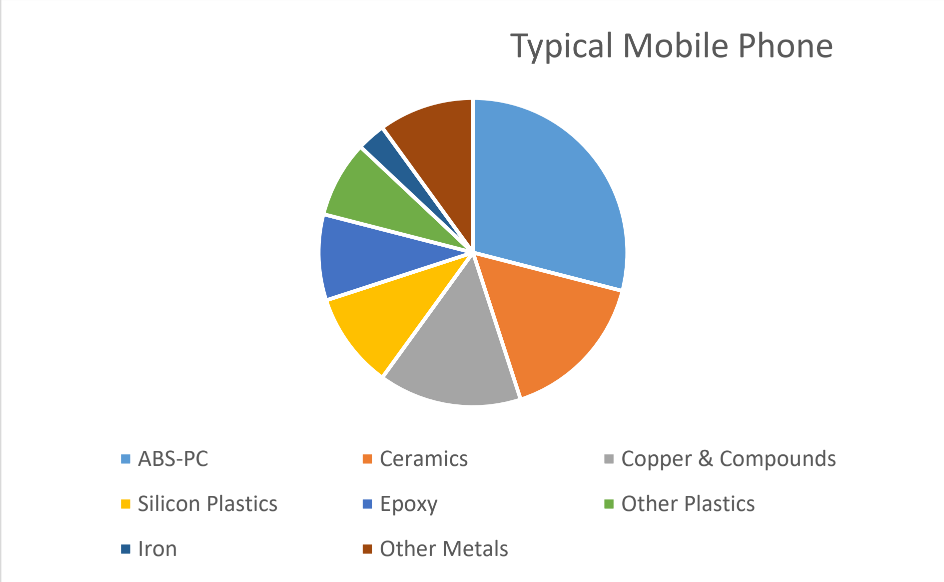


Fig 1.7 Metals extracted from a typical mobile Phone

1.3 E-waste Generation across the World

All over the world, the quantity of electrical and electronic waste generated each year, especially computers and televisions, has assumed alarming proportions.

As the fastest growing component of municipal waste across the world, it is estimated that more than 50 MT of e-waste is generated globally every year.

Table 1.4: Annual Per capita e-waste generated world –wide 2016

Country	Region	Population (in 000)	Per capita e-waste (Kgs)	National regulation exits	Country	Region	Population (in 000)	Per capita e-waste (Kgs)	National regulation exits
Afghanistan	Asia	32739	0.6	No	USA	America	323978	19.4	Yes
Bahrain	Asia	1319	15.5	No	Mexico	America	122273	8.2	Yes
Bangladesh	Asia	161513	0.9	No	Canada	America	36209	20	Yes
Bhutan	Asia	791	2.5	Yes	Brazil	America	206090	7.4	No
China	Asia	1386341	5.2	Yes	Colombia	America	48750	5.6	Yes
Hongkong	Asia	658	16.6	Yes	Belgium	Europe	11332	21.2	Yes
India	Asia	1309713	1.5	Yes	Finland	Europe	5500	21.1	Yes
Indonesia	Asia	22.8258802	4.9	No	France	Europe	64569	21.3	Yes

Iran	Asia	80460	7.8	No	Germany	Europe	82571	22.8	Yes
Iraq	Asia	36067	6.1	No	Italy	Europe	61151	18.9	Yes
Israel	Asia	8528	14.1	Yes	Netherlands	Europe	17030	23.9	Yes
Japan	Asia	126804	16.9	Yes	Norway	Europe	5263	28.5	Yes
Kuwait	Asia	4225	15.8	No	Switzerland	Europe	8325	22.2	Yes
Myanmar	Asia	52254	1.0	No	UK	Europe	65572	24.9	Yes
Nepal	Asia	28834	0.8	No	Russia	Europe	143440	9.7	Yes
Oman	Asia	3957	14.9	No	Egypt	Africa	91047	5.5	No
Pakistan	Asia	192996	1.6	No	Ethiopia	Africa	91196	0.5	No
Philippines	Asia	104195	2.8	No	Ghana	Africa	27573	1.4	No
Qatar	Asia	2578	11.3	No	South Africa	Africa	55870	5.7	No
South Korea	Asia	50823	13.1	Yes	Tanzania	Africa	48633	0.8	No
Saudi Arabia	Asia	32013	15.9	No	Uganda	Africa	41087	0.6	Yes
Singapore	Asia	5591	17.9	No	Kenya	Africa	45451	0.8	Yes
Sri Lanka	Asia	21252	4.5	No	Madagascar	Africa	24916	0.5	Yes
Thailand	Asia	68981	7.4	No	Australia	Oceania	24357	23.6	Yes
UAE	Asia	9856	13.6	No	New Zealand	Oceania	4712	20.1	No

The EU and the U.S. would account for maximum e-waste generation during this current decade. As per the Inventory Assessment Manual of the UNEP, 2007, it is estimated that the total e-waste generated in the EU is about 14-15 kg per capita or 5MT to 7MT per annum.

In countries like India and China, annual generation per capita is less than 1kg. In Europe, e-waste contributes up to 6 million tonnes of solid waste per annum.

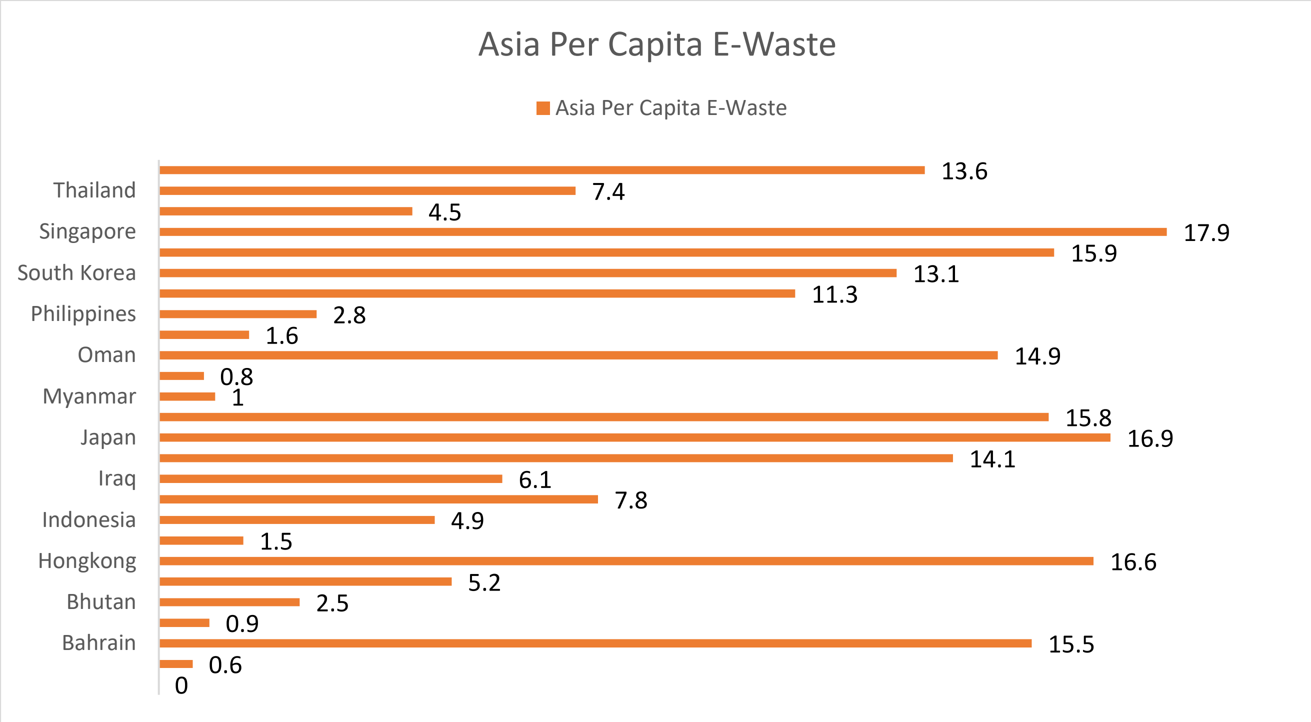


Fig1.8 Asia per capita E-waste

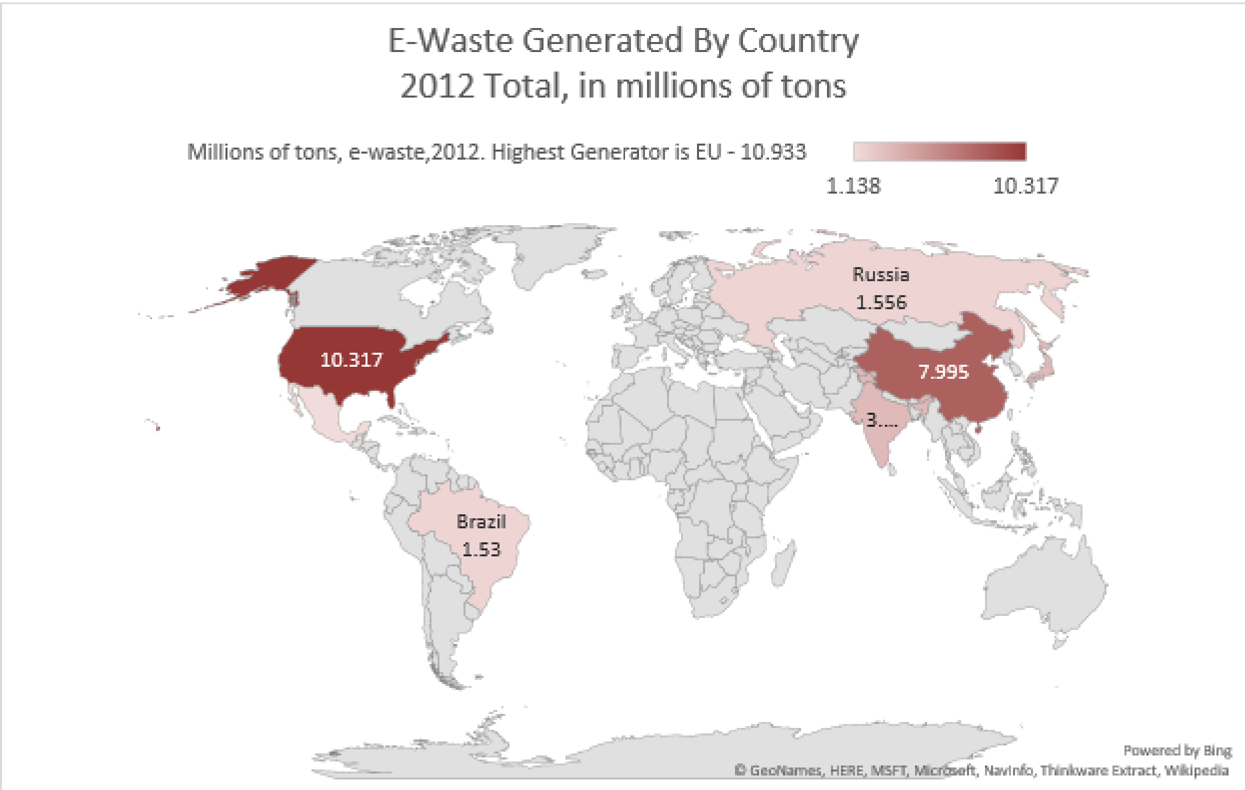


Fig1.9 Tracking the world's E-waste

To do Activity

Write the name of the country which generates the largest amount of E-waste in the World.

List down the names of to 5 countries in Asia that generate the maximum amount of e-waste.

List down the names of to 5 countries in the world that generate the maximum amount of e-waste.

1.4 E-Waste Generation in India Including Information Technology Boom and Growth of E-Waste in India

According to the Comptroller and Auditor- General's (CAG) report, over 7.2 MT of industrial hazardous waste, 4 lakh tonnes of electronic waste, 1.5 MT of plastic waste, 1.7 MT of medical waste, 48 MT of municipal Central Pollution Control Board (CPCB) estimated India's e-waste at 1.47 lakh tonnes or 0.573 MT per day.

A study released by the Electronics Industry Association of India (ELCINA) at the electronics industry expo – "ComponexNepcon 2009" had estimated the total e-waste generation in India at a whopping 4.34 lakh tonnes by end 2009. The CPCB has estimated that it will exceed the 8 lakh tonnes or 0.8 MT mark by 2012.

There are 10 States that contribute to 70 per cent of the total e-waste generated in the country, while 65 cities generate more than 60 per cent of the total e-waste in India.

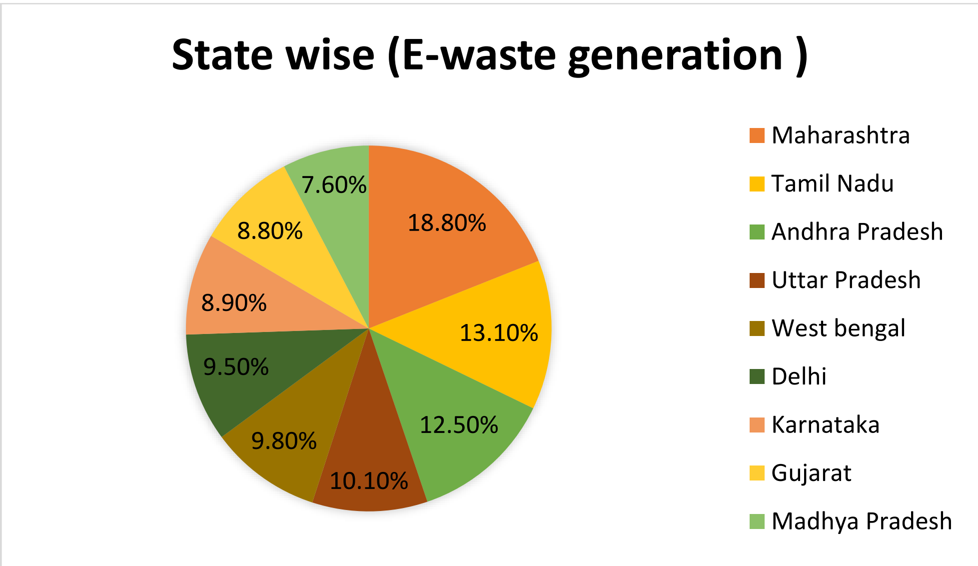


Fig1.2: State wise E-waste Generation in India (Tonnes /Year)

Among the 10 largest e-waste generating States, Maharashtra ranks first followed by Tamil Nadu, Andhra Pradesh, Uttar Pradesh, West Bengal, Delhi, Karnataka, Gujarat, Madhya Pradesh and Punjab.

Among the top ten cities generating e-waste, Mumbai ranks first followed by Delhi, Bengaluru, Chennai, Kolkata, Ahmedabad, Hyderabad, Pune, Surat and Nagpur.

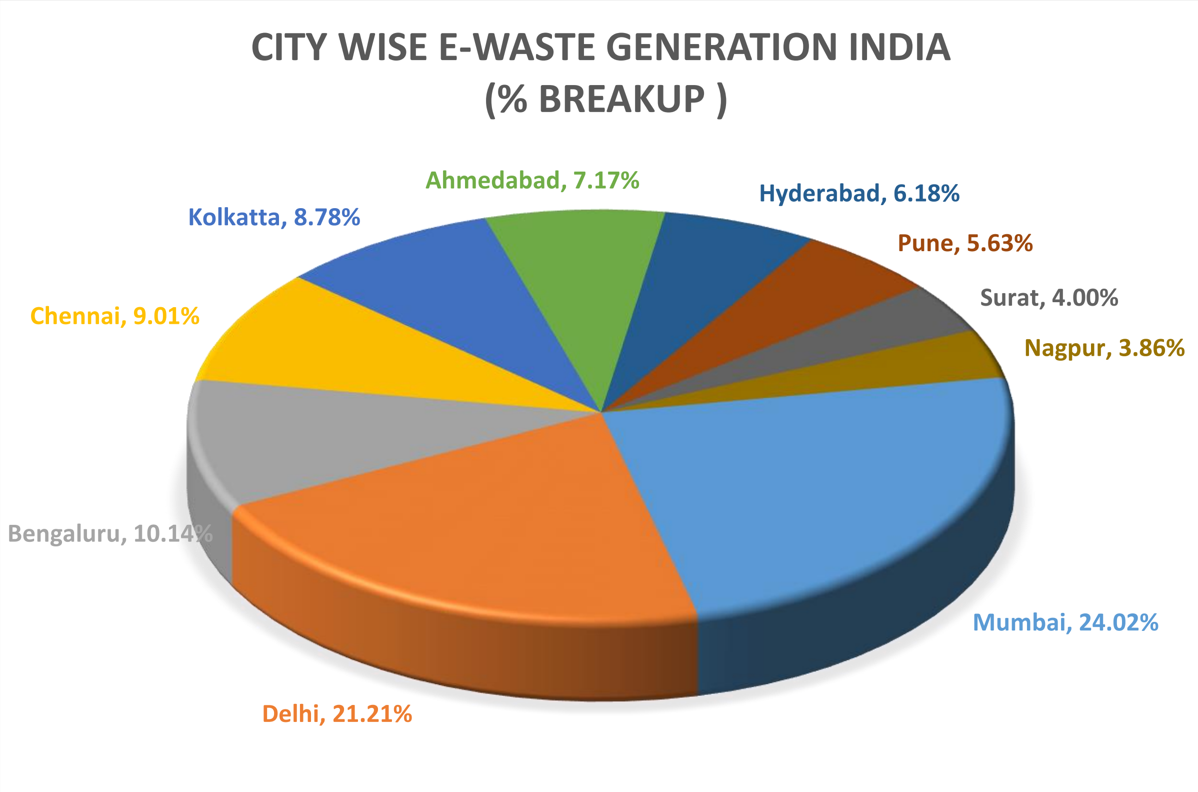


Fig 1.11 City -wise generation of E-waste in India

The main sources of electronic waste in India are the government, public and private (industrial) sectors, which account for almost 70 per cent of total waste generation. The contribution of individual households is relatively small at about 15 per cent; the rest being contributed by manufacturers. Though individual households are not large contributors to waste generated by computers, they consume large quantities of consumer durables and are, therefore, potential creators of waste. An Indian market Research Bureau (IMRB) survey of 'E-waste generation at Source' in 2009 found that out of the total e-waste volume in India, televisions and desktops including servers comprised 68 per cent and 27 per cent respectively. Imports and mobile phones comprised of 2 per cent and 1 per cent respectively.

To Do Activity
Write the name of the state in India which generates the highest amount of E-waste

List down the names of 5 states that generate the maximum E-waste in India. What are the reasons for these 5 states generating the maximum E-waste in India?
To Do Activity Which city in India is the biggest generator of E-waste? What are the top 5 cities that generate the maximum E-waste? What are the reasons for these 5 cities generating the maximum E-waste?

Table 1.6 Top ten states and top ten Cities generating E-waste in India

S. No	States	e-Waste (MT)	Metros/Cities	e-waste (MT)
01	Maharashtra	2,90,271.59	Mumbai	11,017.1
02	Tamil Nadu	13,486.24	Delhi	9,729.15
03	Andhra Pradesh	12,780.33	Bengaluru	4,648.4
04	Uttar Pradesh	10,381.11	Chennai	4,132.2
05	West Bengal	10,059.36	Kolkata	4,025.3
06	Delhi	9,729.15	Ahmedabad	3,287.5
07	Karnataka	9,118.74	Hyderabad	2,833.5
08	Gujarat	8,884.33	Pune	2,584.2
09	Madhya Pradesh	7,800.62	Surat	1,836.5
10	Punjab	6,958.46	Nagpur	1,768.9

India, in the last couple of decades, has also been vastly influenced by the culture of consumerism.

The application of electronics related technology has been very wide spread in all sectors. Coupled with the rapid pace of industrialization, Personal Computers (PCs) — desktops and notebooks, televisions and mobile phones and other manufacturing items like refrigerators have experienced high growth and even faster replacement cycle.

The electronics manufacturing industry has emerged as one of the most innovative industries in the world over. It is constantly engaged in creating and utilizing new technologies. This has also partly contributed to what is called inbuilt product obsolescence.

This has resulted into an ever-increasing quantity of electronics and electrical appliances being discarded, as it is often cheaper to buy new product than to repair or upgrade a broken or obsolete one. The electronics industry is driven mainly by the computer and computer component sectors with as much as a fifth of its revenues coming from sales of Personal Computers. The huge scale of demand in the market can be observed from the sale of the P.Cs.

The growth in the market started in the period of 2005-2007, catalyzing the e-waste problem as shown in the below mentioned growth data.

Personal computers sales have seen a major jump in the last few years from around units of 3.1 million in 2003-04 to 7.3 million in 2007-08 approximately. It dropped to 6.7 million units in 2008-09 during the recession but the industry once again picked up in 2009-10. The total sales of personal computers for the quarter October - December 2009 were 2 million (20 lakh) units, registering a growth of 42 per cent over the same period in the previous fiscal year.

In the same quarter, the sales of desktops stood at 1.35 million (13.5 lakh) units, while netbooks and notebooks taken together recorded a consumption of 0.66 million (6.6 lakh) units growing 27 per cent and 90 per cent respectively, on a year-on-year basis.

Moreover, increasing disposable income and the price decline influenced by robust demand has been factoring the growth in this segment. A phenomenal rise in the sale volume of the flat panel color television by 70.9 per cent in 2007 as against just over 33 per cent of the CRT color television demonstrates this new trend.

According to a report on Indian Consumer Durables Industry by the Corporate Catalyst India, the sales trend of television indicated that sales would go up from 8,867,000 units in 2005 to 11,795,000 units in 2010. According to Display Search, a leading global provider of consumer and retail market research, globally, overall TV shipments were expected to rise from 205 million units in 2008 to 218 million units by 2010.

The telecom industry in India has also witnessed an unprecedented growth in recent times owing to the subscription and developmental potential of its large population. The total telephone (landline and wireless) subscriber base had reached 653.92 million by the end of May 2010. Currently, there are an estimated 617.53 million mobile phone users compared to 36.39 million fixed line subscribers inIndia.

In April 2010 alone, 16.90 million subscribers were added in the wireless (cell phone) segment. It is estimated that India would overtake China to become the world’s largest mobile telecommunications market by the year 2013. It is predicted that by then, the teledensity would shoot up from 55.38 per cent in May 2010 to 75 per cent and the total mobile subscriber base would be a staggering 1.159 billion! The cell phone or mobile users have increased in number very rapidly in India and this momentum will be maintained in the coming years. However, the waste generated by this product is physically less in volume due to the nature of the product. In the telecommunications segment, due to the increasing use of fiber optic technology to replace copper for faster transmission of data and for expanding the bandwidth of service networks, the optical components markets are also expected to rise from a market worth at $3.8 billion in 2008 to $11.3 billion by 2015.

1.3 E-waste and its relation to sustainable development goals

To Activity

- Write a note on Sustainable Development Goals.
- List down all the 17 Sustainable development goals and their main objectives
- Write the year of inception and year of completion of the SDGs

In September 2015, the United Nations and all Member States including India adopted the ambitious 2030 Agenda for Sustainable Development. This new agenda identified 17 Sustainable Development Goals (SDGs) to address Environmental, social and economic concerns of our planet. E-waste, when treated informally, poses serious health issues since it contains hazardous components, including contaminating air, water, and soil, and putting people's health at risk. Dismantling processes that do not utilize adequate means, facilities, and trained people pose additional threats to people and the planet. Therefore, goals are directly impacted by generation and informal disposal of e-waste- Goal 6 (Clean water and Sanitation), Goal 11 (Sustainable Cities and Communities), Goal 12 (Responsible Consumption and Production), Goal 14 (Life Below Water), and Goal 8 (Decent Work and Economic Growth).

Table 1.7 SDG Goals and E-waste

SDG Goal	
Clean water and sanitation	Goal 6
Sustainable cities and s communities	Goal 11
Responsible consumption and production	Goal 12
Life Below water	Goal 14
Decent work and Economic Growth	Goal 8

Table 1.8 SDG Targets ad E-waste Mitigation

Target 3.9	**The reduction of the number of deaths and illnesses caused by hazardous chemicals and air, water, and soil pollution and contamination**
Target 6.1	Seeks to achieve universal and equitable access to safe and affordable drinking water for all
Target 6.3	Aims to reduce pollution, eliminate dumping, and minimize release of hazardous chemicals and materials
Target 14.1 and 14.2	Refers to the marine pollution and the protection of the marine ecosystem
Target 11. 6	Aims reduce the adverse per capita environmental impact of cities, by paying special attention to air quality and to municipal and other waste management
Target 12.4	Aims to achieve the environmentally sound management of chemicals and all waste throughout the life cycle, in accordance with agreed international frameworks, and to significantly reduce their release into air, water, and soil in order to minimize their adverse impacts on human health and the environment
Target 12.5	Aims to substantially reduce waste generation through prevention, reduction, repair, recycling, and reuse
Target 8.3	Aims to promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity, and innovation, and to encourage the formalization and growth of micro-, small-, and medium-sized enterprises
Target 8.8	Calls for the protection of labour rights and promotes safe and secure working environments for all workers, including migrant workers, particularly women migrants, and those in precarious employment. The sound management of e-waste can create new employment and contribute to economic growth in the recycling and refurbishing sector.

Summary

Technological advancement has led to the creation of electrical and electronic equipment's that has upgraded our quality of life. However, it has also posed serious challenges to environmental and human health impacts. The problem of E-waste is growing with each passing day and we need to take urgent steps nationally as well as globally to address this problem.

Model Questions

1. Technology is a necessary evil. Analyze the statement in the context of national E-waste situation.
2. What are some of the major strategies that can be adopted to spread awareness amongst common public on the issue of E-waste?
3. Do you think there is an impact of E-waste on sustainable development? Illustrate with examples from the Indian context.
4. How is the E-waste currently being managed in your city/town village? What are the challenges in the current system? Develop a case study to highlight the problems and suggest possible solutions to address the problems.

References

- Baldé, C.P., Wang, F., Kuehr, R., Huisman, J. (2015), The global e-waste monitor – 2014, UnitedNations University, IAS – SCYCLE, Bonn, Germany, http://i.unu.edu/media/ias.unu.eduen/news/7916/Global-E-waste-Monitor-2014-small.pdf

- Chaturvedi, Saha ,Bhatt (2018) Recycle Bin Managing E-waste in India , Ministry of environment, Forests and Climate Change

- Chatterjee , Dr. S. 2011: Electronic Waste and India , New delhi : Department of Information technology

- Cucchiella, Federica, D'Adamo, Idiano, Koh, S.C. Lenny, Rosa, Paolo, (2015), Recycling of WEEEs:An economic assessment of present and future e-waste streams, Renewable and Sustainable Energy

- Ellen Macarthur Foundation, (2015), Concept of circular economy http://www.ellenmacarthurfoundation.org/circular-economy/overview/concept

- Indian Ministry of Environment and Forests & Climate Change 2015. E-waste (Management) Rules,2015.http://www.indiaenvironmentportal.org.in/files/file/notified%20ewaste%20rule%202015.pdf

- Lines, Garside , Sinha , Fedorenko Clean and inclusive? Recycling e-waste in China and India

- Natural Marketing Institute, (2007), Understand the LOHAS Consumer. http://www.lohas.se/wpcontentuploads/2015/07/Understanding-the-LOHAS-Consumer-11_LOHAS_Whole_Foods_Version.pdf

- Rajya Sabha Secretariat 2011: E-waste in India. New Delhi http://rajyasabha.nic.in/rsnew/publication_electronic/E-Waste_in_india.pdf

- WEEE Recycle & CSE. E-Waste Training Course for Policymakers and Regulators – Facilitator'sManual,http://www.igep.in/live/hrdpmp/hrdpmaster/igep/content/e54413/e54441/e62968/WEEERecycleCSEmanual.pdf

Chapter 2 Hazardous Substances in E-waste

Introduction

The e-waste because of its complex composition comprising of hazardous substances is non-biodegradable and therefore categorized as a red category waste which is threat to human health and environment, when disposed and managed by rudimentary methods in the informal sector. Some of the hazardous substances present in the EEE are lead, mercury, cadmium, Beryllium etc.

In India more than 95 percent of E- waste is being managed in the informal sector by unskilled workers who are working in dangerous conditions without any safety measures that result in environmental and health hazards. The people working in the informal economy are from the bottom of the pyramid and have no access to education and livelihood opportunity and they work in difficult circumstances for survival.

Objectives

- Explain the hazardous substances found in e-waste
- Describe the risks associated with hazardous substances
- Understand the E-waste management in the informal sector
- Explain the actions that producers can undertake to prevent the hazards resulting from these substances

2.1 Hazardous substances

Table 2.1 The periodic table with the elements hazardous to living beings marked in red and orange.

Group	1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Period																			
1	1 H																		2 He
2	3 Li	4 Be												5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg												13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca		21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr		39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	*	71 Lu	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	**	103 Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Uub	113 Uut	114 Uuq	115 Uup	116 Uuh	117 Uus	118 Uuo
*Lanthanoids			*	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb		
**Actinoids			**	89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No		

The hazardous elements of highest order are Lead (Pb), Titanium, Mercury, Cadmium, Chromium, Beryllium and Arsenic.

The other hazardous elements are Cobalt, Nickel and Copper.

- The hazardous and toxic substances found in e-waste include lead (Pb) and cadmium (Cd) in printed circuit boards (PCBs).
- Lead is primarily found in all electronic products/ assembly, cathode ray tubes (CRT) etc.
- Cadmium is found in monitor/ CRTs while there may be mercury in switches and flat screen monitors. Besides the cadmium in computer batteries, cadmium is also used for plating metal enclosures/ metal parts in sub-assemblies.
- Mercury is also found in CFL, relays and some other specific products.

Polychlorinated biphenyls are found in capacitors and transformers and as brominated flame retardant on printed circuit boards, plastic casings, cable and polyvinyl chloride (PVC) cable sheathing for insulation and PBD/PBDE in plastic parts of electronics. Many of these substances are toxic and carcinogenic.

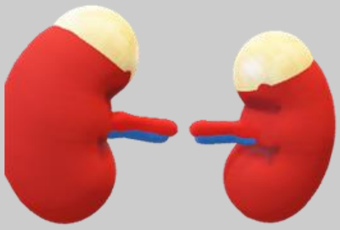
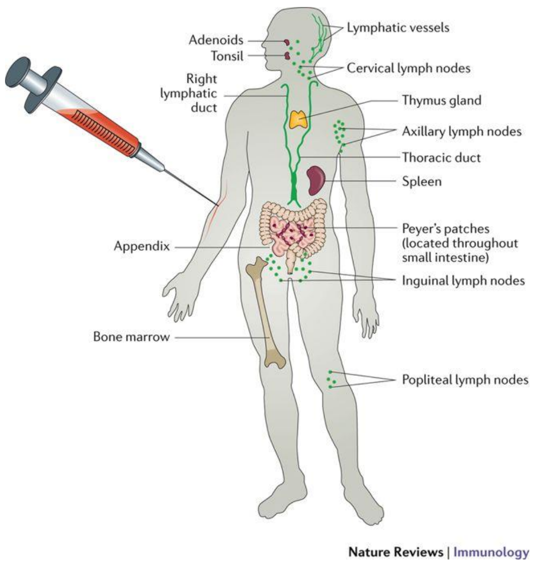
The materials are complex and have been found to be difficult to recycle in an environmentally sustainable manner even in developed countries.

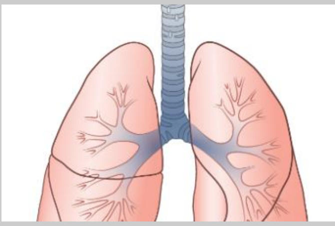
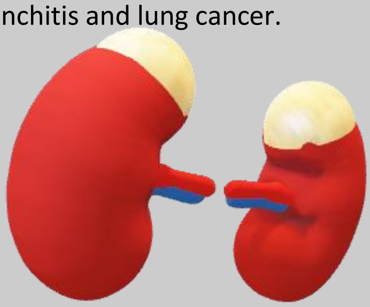
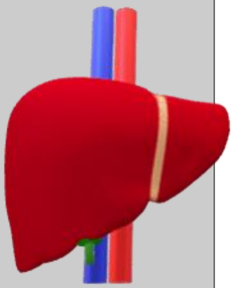
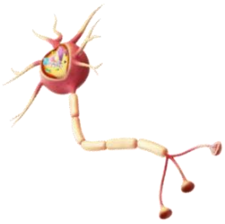
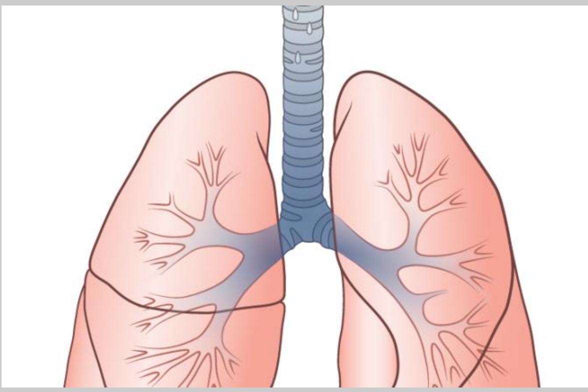
To do Activity
Write the names of 5 hazardous substances in E-waste and their hazards

Listed in the table below are the harmful elements in the compositions of electrical and electronic appliances that can be hazardous to health and environment:

Table 2.2 Hazardous substances and their impact on human health

Hazardous Substance	**Danger**
Lead	A neurotoxin that affects the kidneys and the reproductive system, high quantities can be fatal.

	 It affects mental development in children. Mechanical breaking of CRTs (cathode ray tubes) and removing solder form microchips release lead as powder and fumes.
Plastic	Found in circuit boards, cabinets and cables, they contain carcinogens. BFRs or Brominated flame retardants give out carcinogenic Brominated dioxins and furans Dioxins can harm reproductive and immune systems.  Burning PVC, a component of plastics, also produces dioxins BFR can leach into landfills Even the dust on computer cabinets contains BFR.

Chromium	Used to protect metal housings and plates in a computer from corrosion, inhaling Hexavalent chromium or chromium 6 can damage liver, and kidney and cause bronchial maladies including asthmatic bronchitis and lung cancer.   
Mercury	Affect the central nervous system, kidneys and immune system.  It impairs foetus growth and harms infants through mother's milk. It is released while breaking and burning of circuit boards and switches mercury in water bodies can form methylated mercury through microbial activity. Methylated mercury is toxic and can enter the human body through aquatic food chain.
Beryllium	Found in switch boards and printed circuit boards. It is carcinogenic and causes lung diseases. 

Cadmium	A carcinogen. Long-term exposure causes Itai-Itai disease, which causes severe pain in the joints and spine. It affects the kidneys and softens bones. Cadmium is released into the environment as powder while crushing and milling of plastics, CRTs and circuit boards. Cadmium may be released with dust, entering surface water and groundwater.
Acid	Sulphuric and hydrochloric acids are used to separate metals from circuit board's fumes contain chlorine and Sulphur dioxide, which cause respiratory problems. They are corrosive to the eye and skin.
PBB	Polyhalogenated derivatives which can cause pre and post-natal complications and can lead girls to menarche at an early age. They can also cause acne.
PBDE	Leads to restriction in development of kids between the age of 1 and 6 years.

to do Activity

List don the hazardous substances in a personal computer.

List down the recyclable materials in a PC

List down the hazardous substances in a laptop

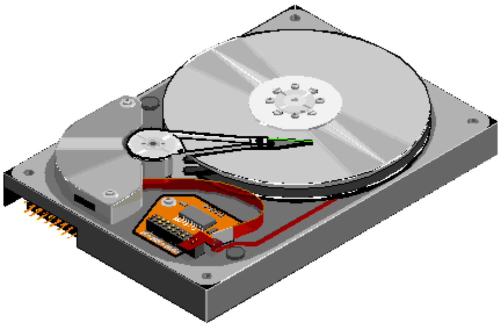
List down the recyclable materials in Laptop.

Desktop Computer & Components

Laptop Computers & Components

Re-Cyclable	Containing Hazardous substances

Fans 	Capacitors 
Body, Front Panel,frame parts 	Real-Time Clocks
External power supply 	Circuit Boards 

Drives 	Liquid Crystal Display 
Cable Wiring, Loudspeaker	Power Cable

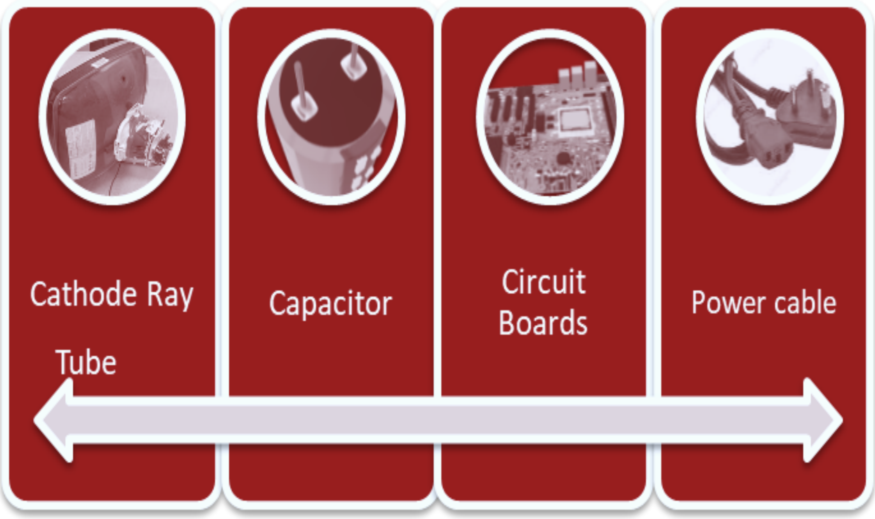
Additional Laptop Computer & Components	
	
Re-Cyclable	Containing Hazardous substances
Plug-in cards	Re-chargeable Battery, Back-up battey
Keyboard	Fluroscent Lamps
Clear plastic layers	Liquid Crystal screen

Fig1.1 Recyclable material and hazardous substances in a PC and a Laptop

To Do Activity
List down the recyclable materials in TV
List down the hazardous substances in a refrigerator

List down the recyclable materials in TV
List down the hazardous substances in a refrigerator?
List down the hazardous substances in a monitor
List down the recyclable materials in monitor
List down the hazardous substances in a laser printer
List down the recyclable materials .

Monitors

Re-cyclable	Hazardous
De-gaussing inductor Cable Wiring and Earth Strip Frame Parts Coverings and cooling modules Deflexion coil Casing Back-up battey	

Laser Printer

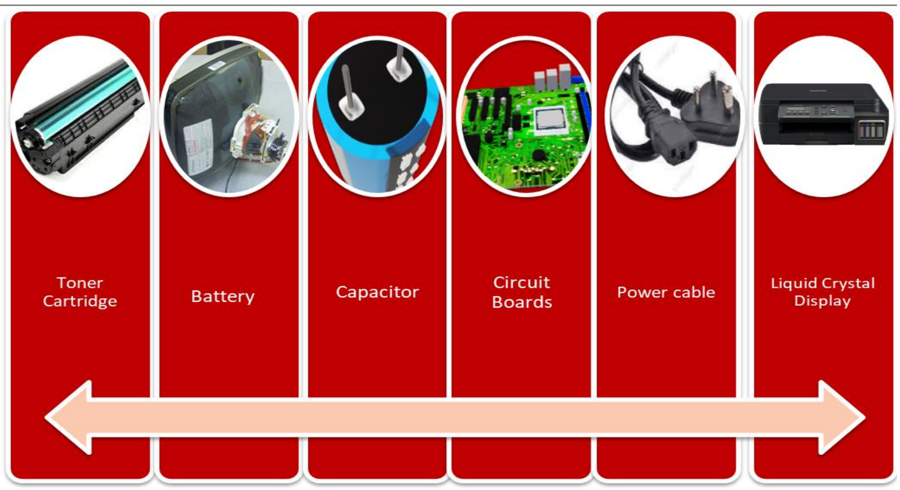
Re-cyclable	Hazardous
Electric Motor Internal Power supply unit Frame Parts Casing Rolls Fan Gear Mechanism Back-up battey	

Fig2.1 Recyclable material and hazardous substances in a monitor and aprinter

TO DO Activity

What are the hazardous substances in a TV?

What are the recyclable materials in TV?

What are the hazardous substances in a refrigerator?

What are the recyclable materials in refrigerator?

Fig2.3 Recyclable material and hazardous substances in a TV and refrigerator

To do Activity

What are the hazardous substances in washing machine?

What are the recyclable materials in washing machine?

What are the hazardous substances in a portable stereo?

What are the recyclable materials in portable stereo?

Fig2.4 Recyclable material and hazardous substances in a washing machine and a CD player

2.2 Illegal dumping and informal dismantling of Electronic items

India is the second largest e-waste generator in Asia. More than 90 per cent of the e-waste generated in the country ends up in the unorganized market for recycling and disposal and more than 2 million people work in the informal sector.

To do Activity
Film screening analysis and discussion GIZ comprehensive

Fig2.5: Glimpses of Un-organized sector

https://counterview.org/2018/12/28/lack-of-planning-indias-95-of-e-waste-is-managed-by-unorganized-sector-mainly-kabadiwalas/

The unorganized sector mainly consists of the urban slums of the metros and mini-metros, where recycling operations are carried out by the unskilled workers using the most basic methods to reduce cost.

Fig 2.6: Dangerous exposure to e-waste in urban slums for processing e-waste

https://thewire.in/economy/photo-story-the-e-waste-workers-of-delhi

Workers face dangerous working conditions as they may be without protection. Many workers function from homes to reprocess waste, further exposing themselves, their families and the environment to dangerous toxins. For instance, to extract metals from circuit boards, gas torches are used to heat a board just enough to melt the solder, which separates the metal parts from the boards.

Metals are also extracted by soaking the circuit boards in open acid bath followed by manual scrapping to extract copper and precious materials next to open drains. However, since e-waste also contains significant concentration of substances that are hazardous to human health and the environment, even a small amount of e-waste entering the residual waste will introduce relatively high amount of heavy metals and halogenated substances. Such harmful substances leach into the surrounding soil, water and air during waste treatment or when they are dumped in landfills or left to lie around near it. Sooner or later they adversely affect human health and ecology.

Fig2.7 Workers dismantling a picture tube in unorganized sector

https://thewire.in/economy/photo-story-the-e-waste-workers-of-delhi

Unless suitable safety measures are taken, these toxic substances can critically affect the health of workers and others in the vicinity – who manually sort and treat the waste – by entering their body through respiratory tracts, through the skin, or through the mucous membrane of the mouth and the digestive tract. It has been linked to the growing incidence of several lethal or severely debilitating health conditions, including cancer, neurological and respiratory disorders, and birth defects. Many workers engaged in these recycling operations are the urban poor and unaware of the hazards associated with them. For instance, such recycling activities lead to the deterioration of local drinking water which can result in serious illnesses.

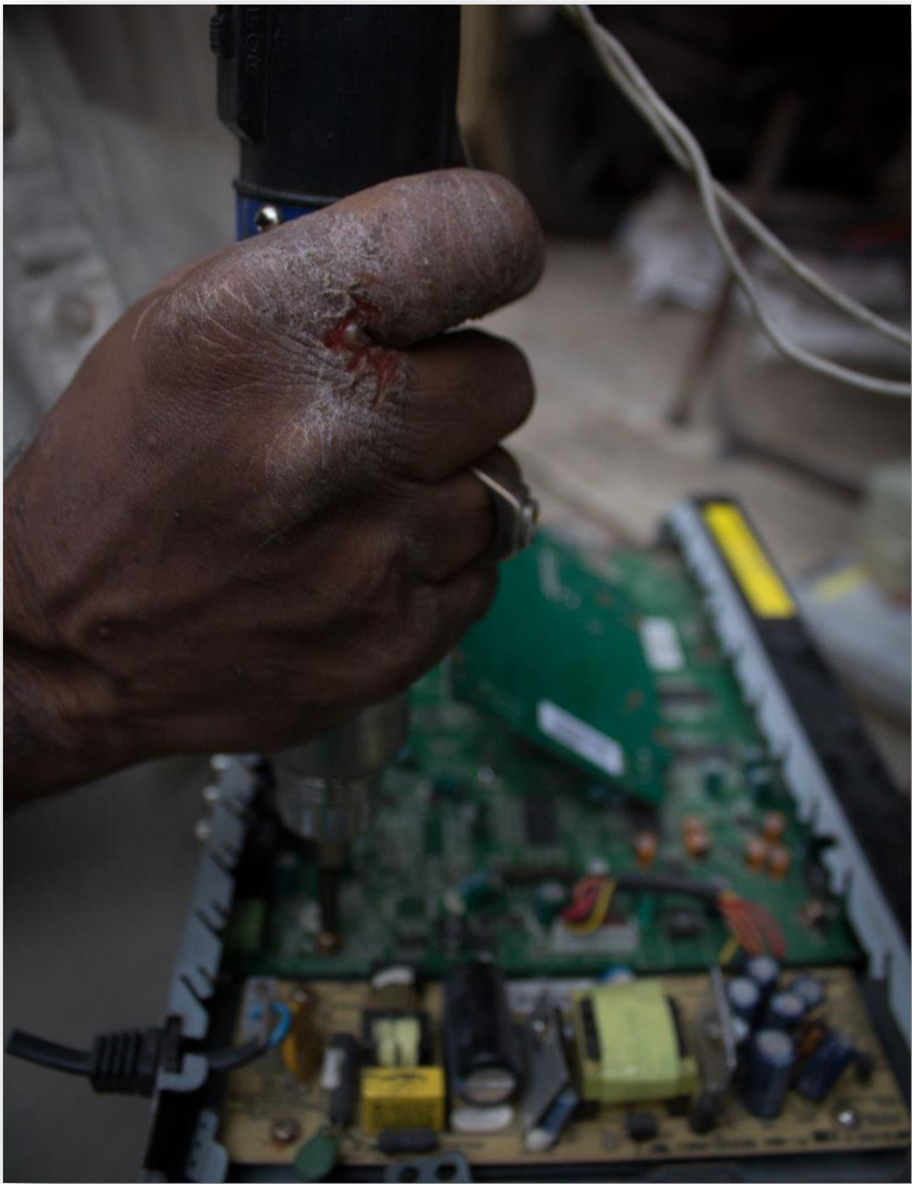


Fig2.8: Sick workers working with medication and exposing themselves to hazard risk

https://thewire.in/economy/photo-story-the-e-waste-workers-of-delhi

To DO Activity

Reading and Brainstorming session

Radiation incident , 2010 in Mayapuri, New Delhi

A scrap dealer purchased an irradiator and was dismantled by him in his shop at Mayapuri, New Delhi. Within a week, he observed skin hyper-pigmentation of the hands and forearm, loss of scalp hair, nausea and fatigue. He came to emergency Department of AIIMS, New Delhi for treatment. The article was identified as a Gamma irradiator & the radioactive material as Cobalt-60. Seven other persons working in that shop during that period were also traced, who had already developed similar skin manifestations and fatigue. They were initially treated in a private hospital, out of which five were shifted to AIIMS hospital. All five were diagnosed and treated for Acute Radiation Syndrome out of which one died, during the course of treatment. This incident attracted huge media attention in India.

Very often child labour is employed to separate the parts from the circuit boards, utilizing wire cutters and pliers. The items that are not worthy of re-use go directly to the open fires to reduce them to metals. Released gases, acid solutions, toxic smoke It is estimated that about half the circuit boards used in the appliances in India end up in Moradabad (Uttar Pradesh) also called PeetalNagrior the brass city.

Fig2.9: Children burning wires to extract copper at garbage dumping site

Currently, around the world, the volume of obsolete computers and other e-wastes temporarily stored for recycling or disposal is growing at an alarming rate. The generation of huge quantity of electronic waste presents an enormous environmental and health hazard to any community. This is best indicated by the table below which shows the amount of waste that 500 million computers can create.

Table 2.2 How much waste is in 500 million computers?

Hazardous substance	Waste
Plastic	6.32 billion pounds
Lead	1.58 billion pounds
Cadmium	3 Million pounds
Chromium	1.9 million pounds
Mercury	632000 pounds

2.3 Environment and Public health impacts of E-waste

The ill effects of e-waste could be on soil through leaching of hazardous contents from landfills; flowing in water due to contamination of rivers, wells and other water sources; mixing in air due to emission of gases and burning of e-waste. The recycling process, if not carried out properly, can cause damage to human being through inhalation of gases during recycling, contact of the skin of the workers with hazardous substances and contact during acid treatment used in recovery process.

Table 2.4: E-waste components and their impacts on environment and health

E-Waste Source	E-Waste Component	Environmental Hazard	Effects on Human
CRTs (used in TVs, Monitors, ATM, Video Camera, etc.), Batteries, PVC cables, Paints	Lead, barium & other heavy metals	These metals leaching g into the ground water and release of toxic phosphor	Anemia, Renal Toxicity, Insomnia
Batteries, Housing & Medical equipment	Mercury	Air emissions as well as discharge into rivers of glass dust	Renal Toxicity, Muscle Tumors, Mental retardation cerebral palsy

Plastics from printers, keyboards, monitors etc.	Plasticizer bisphenol-A (or BPA) as well DEHP and DBP Plastic compound known as phthalates	Chlorinated plastic release harmful chemicals into the surrounding soil, which seep into ground water or other surrounding water sources which cause serious harm to the species that drink this water.	Risk in developing heart problems, obesity reproductive disease
PVC & Polymer, Paints, Printing inks, electrical transformers & Capacitors	Polychlorinated Biphenyls (PCBs)	Include extreme pollution from production, toxic chemical exposure during use, hazards form fires	Suppression of immune system damage to the liver nervous and reproductive systems

2.4 Restriction of Hazardous Substances

As a legislative initiative to solve the problem of huge amounts of toxic e-waste, a Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment, namely 2002/95/EC, commonly referred to as the Restriction of Hazardous Substances Directive or RoHS was adopted in February 2003 by the European Union. The RoHS Directive came into force with effect from 1 July 2006 and is required to be enforced and become law in each member state. The Directive restricts the use of six hazardous materials in the manufacture of various types of electronic and electrical equipment.the RoHS Directive requires the substitution of various heavy metals, namely lead, mercury, cadmium, hexavalent chromium and brominated flame retardants like polybrominated biphenyls (PBB) or poly-brominated diphenyl ethers (PBDE) in new electrical and electronic equipment’s put on the market since 1 July 2006.

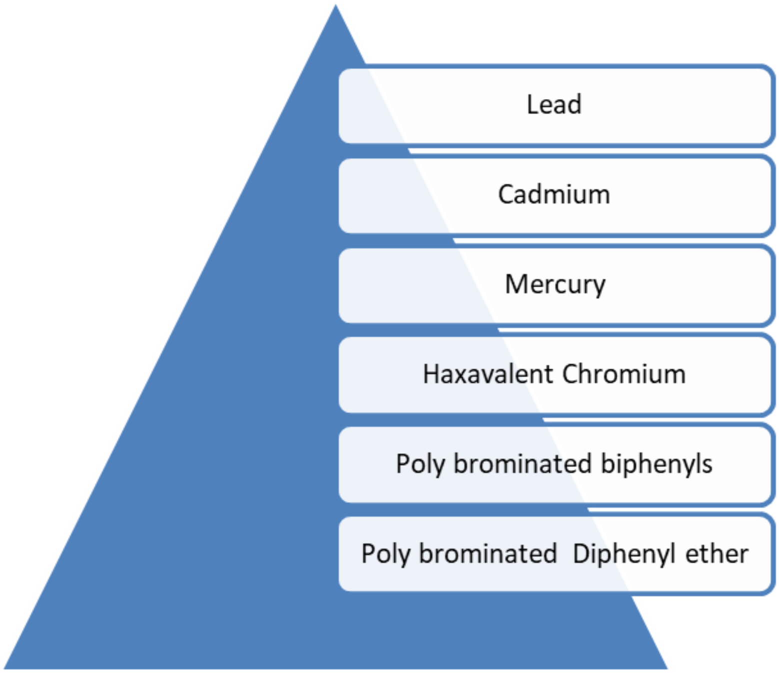


Fig1.5: Restricted hazardous substances

2.5 Sustainable Technologies for Producers

The Ministry of Electronics and Information Technology (MeitY) has developed indigenous technology at C-MET and Central Institute of Plastics Engineering & Technology (CIPET) for recovery of precious metals and plastics from e-waste respectively. After laboratory scale experiments, these technologies have now been upscaled to industry level use. The C-MET technology for recycling of Printed Circuit Boards from electronic items like mobile phone, laptops, computers and television can recycle at the rate of 100 kg per day (~1,200 tonnes per annum of e-waste) and the CIPET technology for plastics from e-waste can recycle at the rate of 1 metric tonne per hour (3,600 metrics tonnes per annum).

These indigenously developed technologies provide solutions for recycling of complex materials which otherwise had to be exported to countries where state of the art technologies have been developed and large-scale investments made to source and recycle materials from different parts of the world. One such facility which recycles precious metals from e-waste is Umicore in Belgium which is one of the largest such facilities in the world today.

In India, the informal sector plays a key role as far as resource recovery is concerned. However, the resources are extracted using technology which is hazardous to the environment as well as to human health. Fostering adoption of such technologies as stated above can create a disruption in the way e-waste is managed in India today and can create co-benefits to many different stakeholders concerned.

It is, however, important that access to such technology is made available to the informal sector at prices where a potential demand can be created. This will lead to formalization and cause materials to flow back into the formal chain. Furthermore, enhanced resource efficiency through a technologically proven process will create resource security for the country leading to greater accomplishments across different missions instituted by the Government of India.

Aggregation of demand for such technologies is likely to bring down the price of the same as well, which will benefit the institution who has developed the technology as well as the buyer of the technology. This can create the platform for large scale proliferation which will enable access to material in the formal value chain. A disruption of this scale can alter the way e-waste is recycled in the country and can provide fillip to Make in India and Swachh Bharat Missions.

It is, however, important to be able to benchmark these technologies to already existing ones including those in the informal sector. This will not only provide a scope to visualize the benefits but also provide an estimate on the economies which are provided by each of these technologies.

Table 2.5 Comparative analysis of the technologies

Parameters	**Indigenous technologies developed by MeitY**	**Umicore**	**Informal Sector**
Materials recovered from e-waste	Gold, Silver, Platinum and Palladium, Plastics of different varieties	17 metals including Gold, Silver, Platinum and Palladium	Gold, Silver, Platinum, Palladium and Lead
Efficiency of recovery of materials	Between 80% to 97%	Above 95%	20%-30%
Input costs involved	Rs 25,000 per 100 kg	Includes Ore which increase input costs as higher amount of energy is required	Rs 7,000 for a 100 kg batch
Logistics cost	Depends on where the facility comes up	Export costs include shipping from India	Delhi to Moradabad in a truck is about Rs 10 per kg
Capital costs involved[1]	Rs 25 crores to start the facility for precious metals	More than Euro 2 billion invested already	In-house facility

[1]The basic input for the cost of the material and other essential utility required were provided by MeitY and arrived at by GIZ, which is tentative.

	and plastics recycling		
Operational costs	Rs 7-10 lakhs per month	Not Available	Rs 15,000 to Rs 25,000 per month
Profit margins	~50% to 80%	Not Available	~15% to 25%

Benchmarking of the technologies which are in use in the informal sector as well as the best available technologies show the huge gap which exist when it comes to recycling complex materials embedded in e-waste. Furthermore, when it comes to recycling of precious metals the efficiency of recycling and extraction of metals in the informal sector lags behind from the other 2 options that are available.

A look at the comparative parameters achievable under indigenous technologies and Umicore shows that considering the costs involved, the difference in extraction rates of materials can be more than offset by using indigenous technologies. Proliferation of this technology can lead to more material being recycled in the country. There are several direct and indirect impacts of the same as well which are listed below:

- Fostering use of the technology in India will lead to opportunities in the recycling sector and its development. This will allow for creation of livelihoods in the country
- Technology availability with the informal sector will allow them to retain their livelihoods as well as bring in knowledge and rich experience, especially in the domain of dismantling
- Formalisation of the informal sector will lead to mitigation of health and environmental hazards of improper e-waste recycling
- Resource security of materials will allow for proliferation of the manufacturing sector of electronics in the country, thus providing a fillip to the Make in India mission
- Development of skilled jobs in the recycling industry will provide a fillip to the Skill India Mission
- Safe e-waste disposal in an environmentally friendly manner will provide a fillip to the Swachh Bharat Mission

This will also leave a positive impact on the Sustainable Development Goals and help India meet its targets for reducing emissions under the Paris Agreement.

Presently, India has a policy whereby, material fractions for which technology is not available in the country are exported. Many recyclers who have been operating under the ambit of the e-waste management rules, 2016, have not developed such technologies, either due to lack of resources or due to lack of materials because of the intense competition with the informal sector. Now, with the availability of indigenous technology as well as a strong EPR regime, both of these issues have been countered by the Government.

Summary

E-waste if not managed well can impact the environment and health adversely. However, 95 percent of the waste electrical and electronic equipment are managed in the informal sector. The workers employed in the informal sector adopt rudimentary methods to dismantle and extract the precious metals under dangerous conditions without any safeguards and get exposed to the toxic gases and emissions released during the process of recovery and extraction. Therefore, there is an urgent need to bring the informal sector under the purview of the legal framework such that these harmful practices are stopped.

Model Questions

1. What are the top 5 hazardous substances in E-waste and what are their impacts on human health and environment?
2. What are the impacts of illegal recycling of E-waste on air, water and soil?
3. Informal recycling of E-waste is a livelihood for many families, who have been in the business for over generations. What can be done to rehabilitate these families? What are some of the alternative livelihood opportunities for them?

References

- Baldé, C.P., Wang, F., Kuehr, R., Huisman, J. (2015), The global e-waste monitor – 2014, UnitedNations University, IAS – SCYCLE, Bonn, Germany, http://i.unu.edu/media/ias.unu.eduen/news/7916/Global-E-waste-Monitor-2014-small.pdf
- Chaturvedi, Saha ,Bhatt (2018) Recycle Bin Managing E-waste in India , Ministry of environment, Forests and Climate Change
- Chatterjee , Dr. S. 2011: Electronic Waste and India , New delhi : Department of Information technology
- Cucchiella, Federica, D'Adamo, Idiano, Koh, S.C. Lenny, Rosa, Paolo, (2015), Recycling of WEEEs:An economic assessment of present and future e-waste streams, Renewable and Sustainable Energy
- Ellen Macarthur Foundation, (2015), Concept of circular economy http://www.ellenmacarthurfoundation.org/circular-economy/overview/concept
- Indian Ministry of Environment and Forests & Climate Change 2015. E-waste (Management) Rules,2015.http://www.indiaenvironmentportal.org.in/files/file/notified%20ewaste%20rule%202015.pdf
- Lines, Garside , Sinha , Fedorenko Clean and inclusive? Recycling e-waste in China and India
- Natural Marketing Institute, (2007), Understand the LOHAS Consumer. http://www.lohas.se/wpcontentuploads/2015/07/Understanding-the-LOHAS-Consumer-

11_LOHAS_Whole_Foods_Version.pdf

- Rajya Sabha Secretariat 2011: E-waste in India. New Delhi http://rajyasabha.nic.in/rsnew/publication_electronic/E-Waste_in_india.pdf
- WEEE Recycle & CSE. E-Waste Training Course for Policymakers and Regulators – Facilitator'sManual,http://www.igep.in/live/hrdpmp/hrdpmaster/igep/content/e54413/e54441/e62968/WEEERecycleCSEmanual.pdf

Chapter 3 E-waste Management and the Regulatory Framework

Introduction

Since E-waste constitutes various hazardous substances its management is a big challenge. In the Indian context more than 90 percent of the E-waste is being managed by the informal sector and therefore there is a critical need for laws to regulate such illegal activities that harm our health and environment. The sector employs people from the marginalized sections of the society, who do not have opportunities of education and livelihood and therefore for survival purposes they are forced to work under such hazardous conditions without any safety equipment. In addition, the sector also employs large number of child labour that is available at a cheap cost. Given this context the E-waste Rules 2016 came into force to hold the various stakeholders accountable and responsible for the management of E-waste in the country.

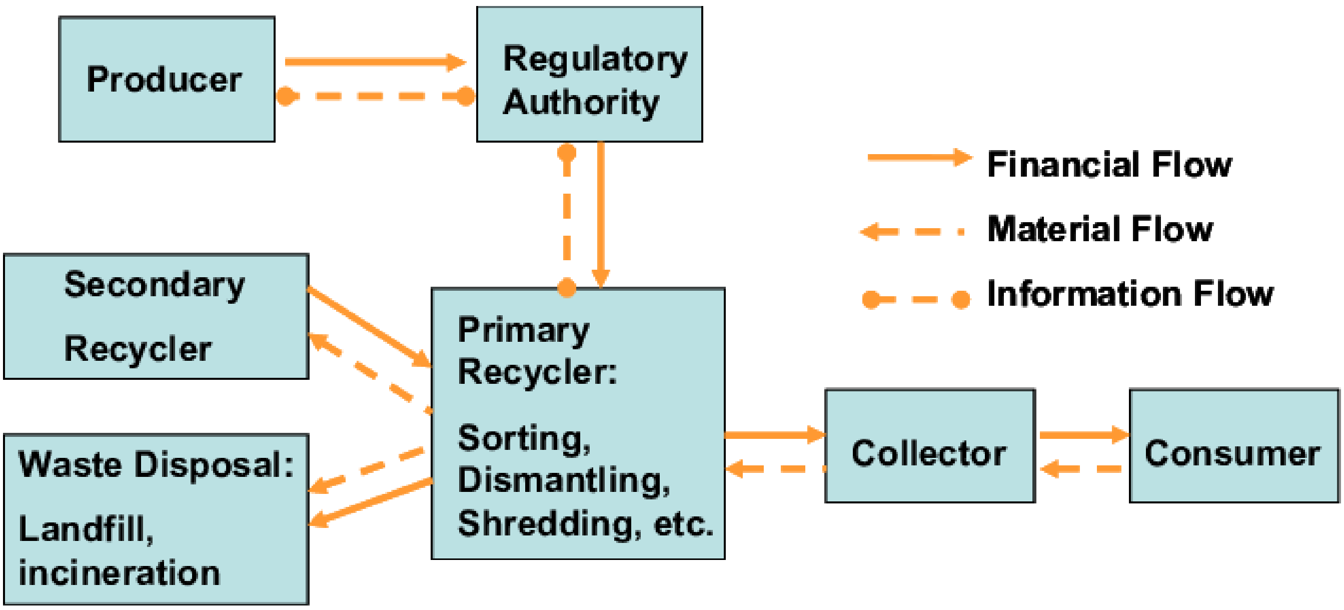


Fig 3.1 E-waste management

Objectives

- Explain the E-waste management scenarios
- Understand international regulatory framework
- Explain the tenets of the E-waste rules 2016
- Identify the challenges in implementing the Rules

To Do Activity

Film screening analysis and Discussion

https://www.youtube.com/watch?time_continue=83&v=3qDF_mMkUDc(Understanding E-waste Management)

3.1 Common E-waste Management Scenarios

E-waste exists all around us be it homes, academic institutions, government bodies , private companies This waste is increasing at an alarming rate and we have not been able to keep pace with the growing waste to develop methods and processes to manage it in a satisfactory manner .The world over the E-waste is managed via 4 methods:

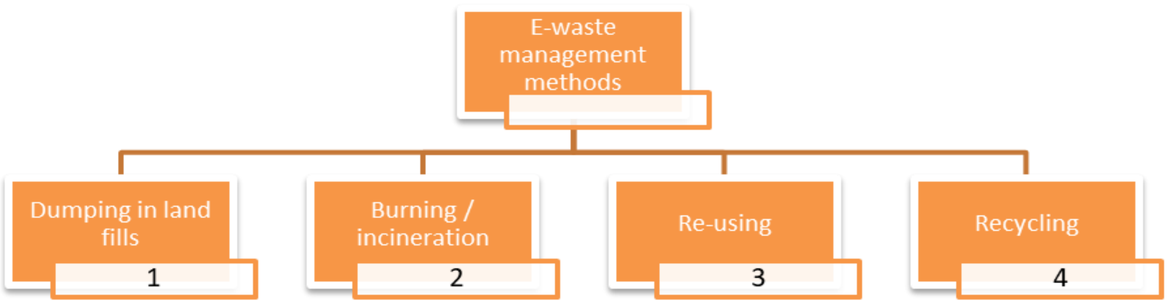


Fig 3.2 Methods of E-waste management

1) Dumping in the landfills: Landfill is where the trash is cleaned out of metals, asphalt, tyre rubber and covered at the end of day to reduce odours and prevent it from flying away.

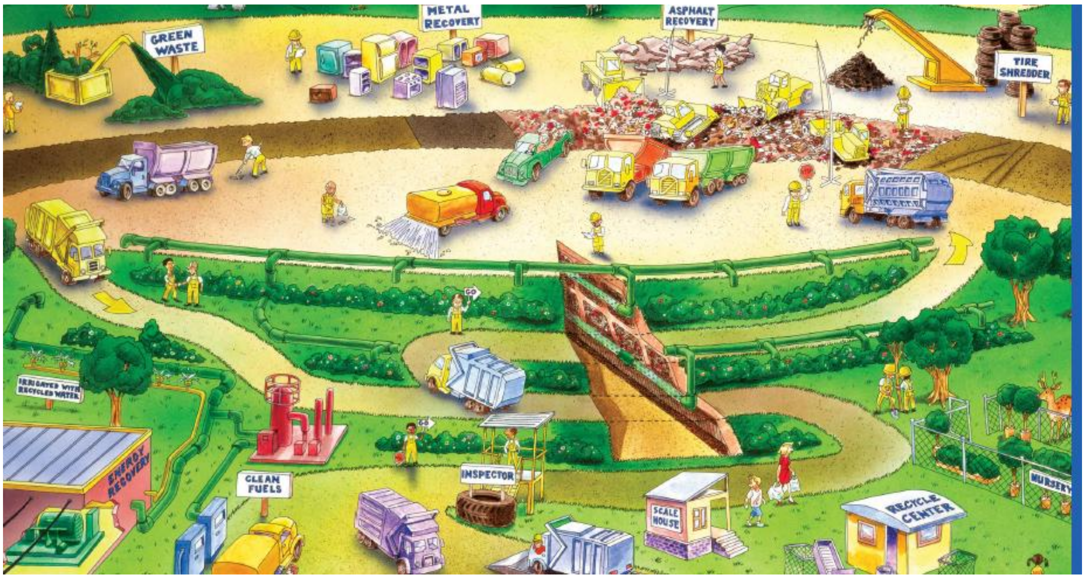


Fig 3.3 Segregation of E-waste

Dumping of e-waste is not recommended in a landfill. It results in the contamination of the soil that further contaminates the water table and the soil resulting in plethora of diseases. However, in absence of clear-cut policies the e-wastes have found ways to the landfills of the cities of India.

Fig 3.4 Landfill dumping site in Delhi, Ghazipur area

https://www.livemint.com/Politics/A5RPFpntA18vkzcxkPS4XJ/Ghazipur-landfill-collapse-NGT-panel-rejects-EDMCs-alterna.html

2) Incineration or burning of the electronic or electric items:

incineration or burning of the waste electrical and electronic items, releases toxic substances such as lead, cadmium and mercury in the atmosphere impacting the health of the people who work in these hazardous conditions.

The methods 1) and 2) require the e-waste to be segregated, collected and collated for steps 3) and 4)

3) Re-using of the electronic items:

Re-use of the electronic items is also one of the strategies widely used in some countries such as India that tend to extend the life of the electronic items . In India for example there are dedicated second hand markets of electronic and electric items, where the products are available at a cheaper cost.

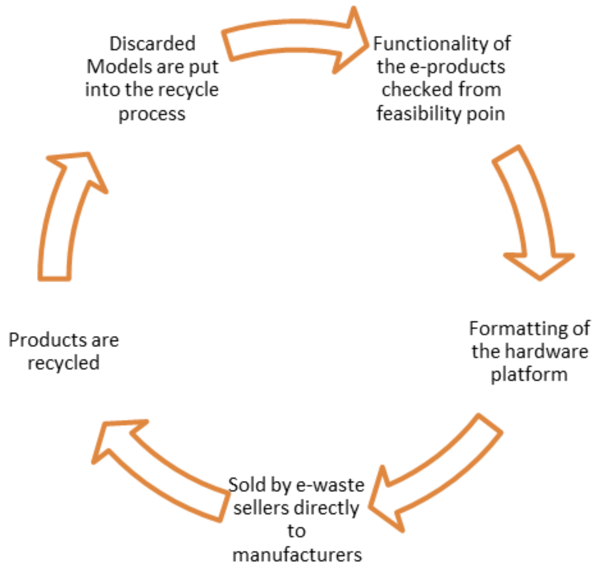


Fig 3.5 Re-use of Electronic items

However, the lack of manufacturers of electronic manufacturers in India for smart phones, laptops and desktop computers is a hurdle for the above process

4) Recycling of the waste electronic items; Recycling of the E-waste items in legal way can be an excellent way to produce wealth from waste. The product created is new in look and appealing to the end customer without any biases.

Fig3.6 Recycling of e-waste

Activity To do
Film screening , analysis
https://www.youtube.com/watch?v=mv5GATREkjE

Table 3.1 what happens with E-waste?

Methods of E-waste Management	**What happens with the E-waste ?**
Landfills	More than 4.6 million tonnes of WEEE ended up in landfills in 2009, according to the US Environment Protection Agency (EPA). The chemicals from these products seeps into the soil and is also released into the atmosphere, adversely impacting the health of communities living nearby.
Burning	Burning e-waste releases heavy metals such as lead, cadmium, and mercury into the atmosphere. These can accumulate in the food chain, particularly in fish, a major source of exposure for the general public.
Re-used	A substantial amount of end of life electronics are sent to developing nations. While, these products are reused for a short time they are irresponsible dumped. In most cases, into areas that have no hazardous waste management facilities.
Recycle	While the benefits of recycling are globally accepted the methods differ. In developing countries recycling happens in unregulated hazardous environments. This results in severe harm to workers in the recycling yards.

3.2 International regulations and laws

India is a signatory to the international conventions and is obliged to follow the commitments. These are:

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal become effective on 5 May 1992. It is an international treaty that was designed to reduce the movements of hazardous waste between nations, and specifically to prevent transfer of hazardous waste from developed to less developed countries.

It obliges India to reduce e-waste, to create adequate disposal facilities, and to minimize the environmental impact of hazardous waste and its management, among other things.

Rotterdam convention became effective in 2004, promotes forthright exchange of information on hazardous chemicals; it calls on exporters to use proper labelling, includes directions on safe handling, and inform purchasers of any known restrictions or bans.

Stockholm Convention 2004, an international treaty to reduce chemicals called persistent organic pollutants that accumulate in the food web, posing a risk to human health and environment.

Table 3.2 International Regulatory Framework

Year	International Conventions/ treaty
1992	Basel convention
2004	Rotterdam Convention
2004	Stockholm convention

Country Experiences

The EU implemented, in 2006, the WEEE Directive which aimed to set-up a system for product take back which would increase efficiency and move towards Circular Economy[2].

The RoHS directives also allowed for the reducing the use of hazardous substances which would make recycling safer for many of the end of life equipment.

E-waste management frameworks have evolved in regions like the EU where WEEE directives like

[2]http://closeweee.eu/weee-management-and-circular-economy/

2012/19/EU introduce schemes and targets for collection, recycling and recovery of all types of electrical goods and appliances and 2002/95/EC which restricts the use of substances in electrical and electronic equipment because of their hazardous properties. Furthermore, the Close WEEE project looks at aligning these directives in a manner which will help recover valuable materials which can be then fed into the production process thus trying to establish the principles of resource efficiency and circular economy.

In the US, in 2004, the state of California introduced a waste recycling fee to cover the cost of recycling of monitors and televisions. The amount was adjusted to match the real cost of recycling later. Till date 18 such states have drafted rules for e-waste management. Most of these elements[3] form part of the framework which is the basis for e-waste management principles in a country.

In Asia, many countries have drafted e-waste rules. In India, targets have been given to producers, which keep increasing over a period, to collect end of life electronic and electrical products. The e-waste management rules, 2016, are a step in that direction in India which has led to PROs being set-up to manage targets for producers.

Transboundary Movement of e-waste

India is among the fastest growing generators of e-waste in the world. Yet it has little or no system to deal with the problem. More than 95% of e-waste in India is processed by a thriving informal sector, which lies outside the ambit of law and regulation.

The primary reason for this is the economics of recycling e-waste. Scientific and environmentally sound e-waste management is technologically and financially intensive. Which is why developed countries export their e-waste to countries such as India and China, where it can be processed at a cheaper cost— though in an unsound manner. It is a vicious cycle, because, in the absence of an effective regulatory system, India is a target for developed countries looking to export their produce and industrial waste.

[3]https://www.researchgate.net/publication/271564472_Electronic_and_electrical_waste_management_in_Sri_Lanka_Suggestions_for_national_policy_enhancements/figures?lo=1

Fig 3.7 Export of E-Waste Lewis (2011)

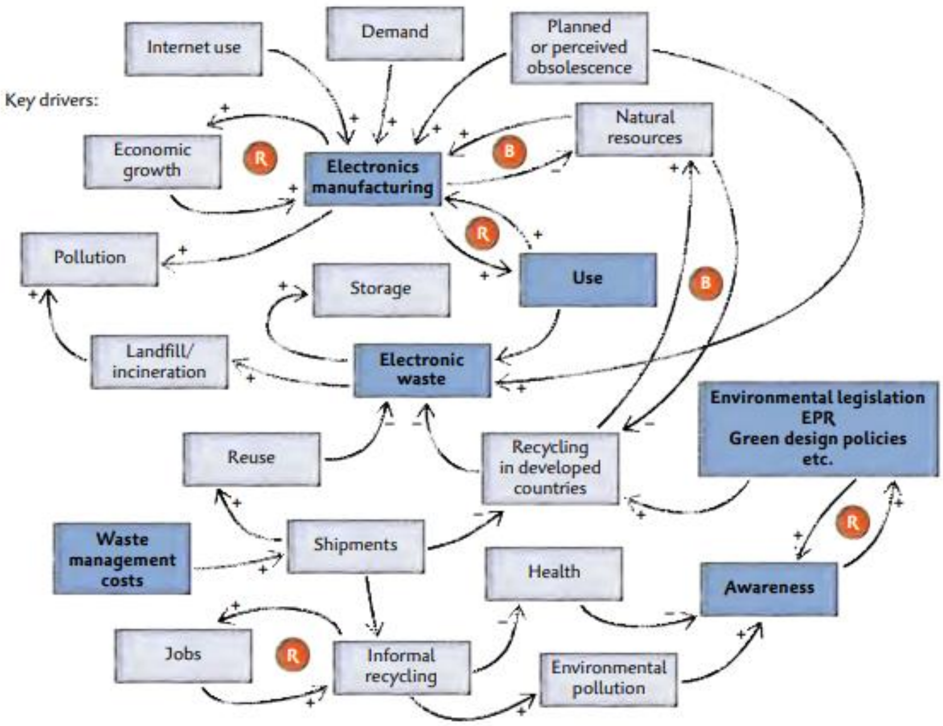


Fig 3.8: E-Waste Trade problem worldwide

The main destination of e-waste is countries in Asia and Africa. Smaller devices are exported to West African nations, while bigger equipment ends up in Southeast Asia. Hotspots in Asia include China, India, Pakistan, Malaysia, Singapore, Sri Lanka, Vietnam and Thailand.

It is estimated that China receives nearly 70% e-waste generated globally. Traders avoid detection by first importing the cargo to bigger ports such as Dubai, Singapore and Philippines and then shipping them to smaller ports in developing nations.

Fig 3.9 Global E-waste Management Market

India too is experiencing an e-waste trade problem. The UN estimates that by 2020, e-waste imports in India will grow 500% from the 2007 level. In India, e-waste is processed in the cities of Delhi, Meerut, Moradabad, Firozabad, Delhi, Chennai, Bengaluru and Mumbai.

Fig 3.10 E-Waste Flow within India (Skinner, Lloyd,Dinter& Stronthmann,2010)

As countries in south Asia begin to legislate and enforce rules against e-waste, Africa is expected to see an exponential increase in the import of e-waste. The profit motive drives this global trade. A

2011 investigation by the Environmental Investigation Agency, an NGO in the UK, revealed criminal groups involved in the trade and money laundering Once e-waste reaches developing countries, it goes through a network of formal and informal traders and recyclers. It begins from the formal sector where obsolete electronic items are traded on the organized market and passed from one level of traders and refurbishes to another of informal recyclers.

In India, 95% of all recycling takes place in the informal sector and is highly profitable with each player in the value chain making at least 10% profit. The highest profits go to the traders who import this waste into the country. The sector involves unorganised labour who work for more than 12 hours a day in unsafe conditions. e-waste contains a wide range of hazardous compounds that may be released during improper handling thereby becoming a threat to humans and the environment. In addition, in some processes used, new hazardous compounds, such as dioxins, may be formed as the original e-waste components are degraded. Most risks arise during the uncontrolled e-waste recycling activities using rudimentary methods. These include manual disassembly and sorting; heating and acid leaching of printed circuit boards (PC-boards); shredding, melting and extrusion of plastics; open burning of plastic coated wires and other components; and sweeping and collection of toners from toner cartridges. These activities are mostly carried out directly on the ground in open air or in poorly ventilated workshops, and involve minimal emission control systems and personal protection for the workers.

The environment is mainly contaminated from the open burning processes and through leakage from dumped residue of various recycling activities, e.g. stripped cathode ray tubes (CRTs) and PC-boards, spent acids from the digestion processes and residual ashes. On the whole, lead seems to be particularly problematic among the metals, and dioxins (chlorinated and brominated) and polybrominated diphenyl ethers (PBDEs) among the organic compounds. These compounds are all very toxic and may potentially be emitted in large amounts during rudimentary e-waste recycling activities. Lead and PBDEs because they both are highly abundant in e-waste, and dioxins because the formation conditions many times are ideal in the processes used. As a consequence, extremely high levels (in some cases the highest ever measured) of these compounds have been measured in environmental as well as human samples collected in areas where uncontrolled e-waste recycling is taking place. Risks also arise when e-waste is treated as general municipal solid waste.

Humans and the environment in the areas where these activities are carried out may therefore be highly exposed to the emissions generated. The recycling workers and the local residents are particularly exposed via dust generated during dismantling and shredding processes, and fumes and smoke generated during acid digestion processes and various high temperature processes, such as open burning and heating, melting, and extrusion processes Delhi is the capital of e-waste in India. It is estimated that 70% e-waste processed in India’s capital city is imported.

3.3 E-waste Regulatory framework in India including the E-waste Rules 2016

Municipal bodies are primarily responsible for managing waste, including e-waste. Three laws regulate e-waste: One, the Environment Protection Act, 1986; two, the Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016; and three, the E-waste Management Rules, 2016.

. The E-waste (Management) Rules, 2016, enacted on October 1, 2017, is a comprehensive set of guidelines that strengthened its predecessors. The E-waste rules 2016 provides a comprehensive regulatory framework to segregate, collect, manage e-waste. The key stakeholders in the E-waste management are:

- Refurbishers, Collectors, Dismantlers & Recyclers of E-waste
- Bulk Consumer/Consumer
- MoEF/CPCB/SPCBs/PCCs. ULBs
- Producers and manufacturers

Fig 3.11 Stakeholder’s in the E-waste management

Table 3.3: Progressive account of the e-waste rules in India

Year of Notification	Title of the Rule	Definition of E Waste	Applicability
2003	The Hazardous Wastes (Management and Handling) Amendment Rules	The 2003 definition provided here is similar to that of Basel Convention. E-waste only briefly included in the rules with no detail description.	Not defined
2008	Guidelinesfor Environmentally Sound Management of E Waste	It classified the E-waste according to its various components and compositions and mainly emphasizes on the management and treatment practices of E-waste. The guideline incorporated concepts such as "Extended Producer Responsibility".	Producer and End of line player in the supply chain
2011	The e-waste (Management and Handling) Rules	According to this regulation, 'electrical and electronic equipment' means equipment which is dependent on electric currents or electro-magnetic fields to be fully functional and 'e-waste' means waste electrical and electronic equipment, whole or in part or rejects from their manufacturing and repair process, which are intended to be discarded. These rules are meant to be applied to everyone in the supply chain as depicted in the next column.	Producer, consumer or bulk consumer, collection centre, dismantler and recycler
2016	E E-Waste (Management) Rules, 2016	Same as above	Expanded to manufacturer, dealer, refurbisher and Producer Responsibility Organization (PRO)

- Some key observations with respect to the framework for e-waste management rules in India could be summarized as

  The producer's role has been clearly articulated under the Extended Producers Responsibility whereas a target has been fixed for each year for collection of the quantum of e-waste produced in the country

The bulk consumers of e-waste have been mandated to ensure that they dispose the e-waste in an environmentally sound manner to a recycler and maintain records of the same to be produced as and when requested by the respective SPCB or PCC

The refurbishers have to register themselves with the SPCB or PCC in order to carry on with their livelihood of repair of electronic and electrical items so that any waste generated is disposed of in an environmentally sound manner to the recycler of dismantler of e-waste

Producers can set-up Producers Responsibility Organization (PRO) which can manage collection and safe disposal of e-waste as per the targets stated in the e-waste management rules, 2016

Provisions of legislations were not sacrosanct and hence the same has been revised a few times to make it more robust and fool-proof.

Addressing these challenges can lead to integration of stakeholders in implementation of the rules. This will need to happen not only for stakeholder which have been mentioned in the rules but also at an inter-ministerial level at the Government in order to ensure that there is enough knowledge which is created and tested at the ground level which can ensure technical implementation of the rules. As per the E-Waste (Management) Rules 2016 all e-waste should be recycled by authorized recyclers and dismantlers.

3.4 Collection Centre

As per the e-waste management rules, 2016 to set up a collection center there is a need to apply for authorization from the State Pollution Control Board or Pollution Control Committee as per FORM – 1(a). There is a need to have agreements with producers who are willing to get the e-waste covered under their EPR collected at your center as well as with dismantlers and recyclers who will be taking the e-waste from the collection center for further processing. It should be ensured that systems for record keeping and training for safe handling and storage of e-waste is provided to the people who will be managing the collection center.

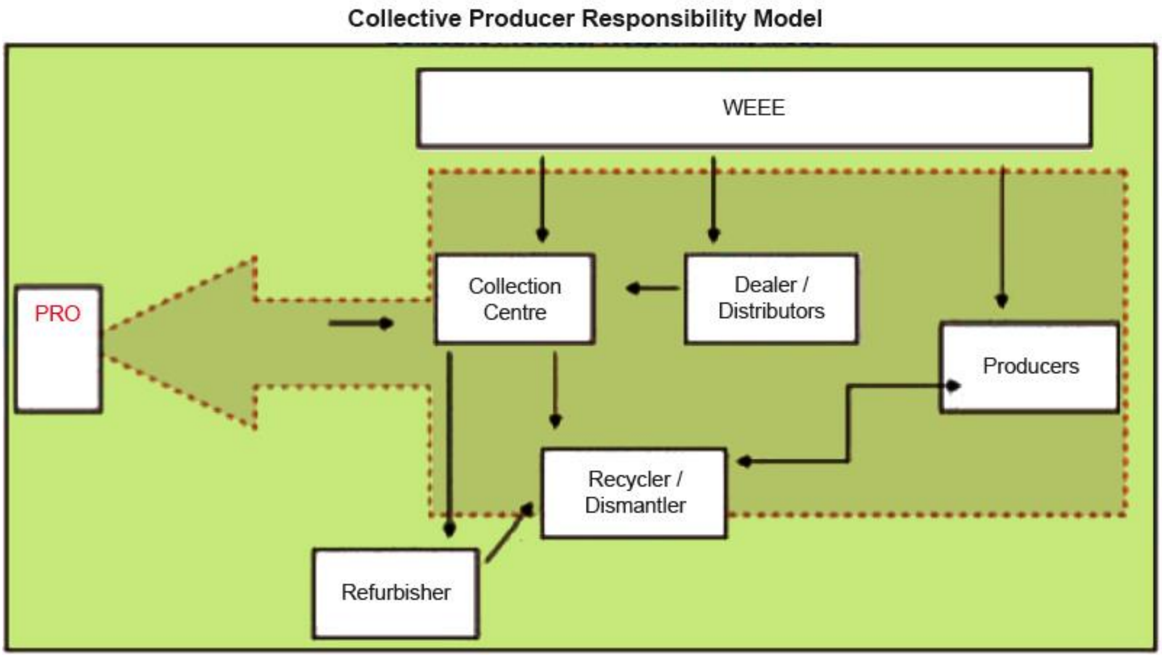


Fig 3.12 E-Waste drop box at Bengaluru

http://bengaluru.citizenmatters.in/bangalore-one-centres-e-waste-20541

Responsibilities of Collection Centers include:

(1) Ensure that the facilities are in accordance with the standards or guidelines prescribed by the Central Pollution Control Board from time to time;

(2) The e-waste collected by them is stored in a secured manner till it is sent to registered dismantler or recycler as the case may be;

(3) Ensure that no damage is caused to the environment during storage and transportation of e-waste;

(4) Maintain records of the e-waste handled in Form 2 and make such records available for scrutiny by the State Pollution Control Board or the Pollution Control Committee concerned.

How to set up a Collection Center for e-waste: All manufacturers, producers and dealers should provide information about locally availablecollection, dismantling and recycling services through their web platforms, outlets. The information should also be available at the SPCB web platforms. Regular awareness campaigns and advertisements should be organized for providing information about locally available collection, dismantling and recycling services.

As per the e-waste management rules, 2016 to set up a collection center there is a need to apply for authorization to the State Pollution Control Board or Pollution Control Committee as per the Draft FORM – 1(a). There is a need to have agreements with producers who are willing to get the e-waste covered under their EPR collected at your center as well as with dismantlers and recyclers who will be taking the waste from the collection center for further processing. It should be ensured that systems for record keeping and training for safe handling and storage of e-waste is provided to the people who will be managing the collection center.

3.5 Extended Producers' Responsibility

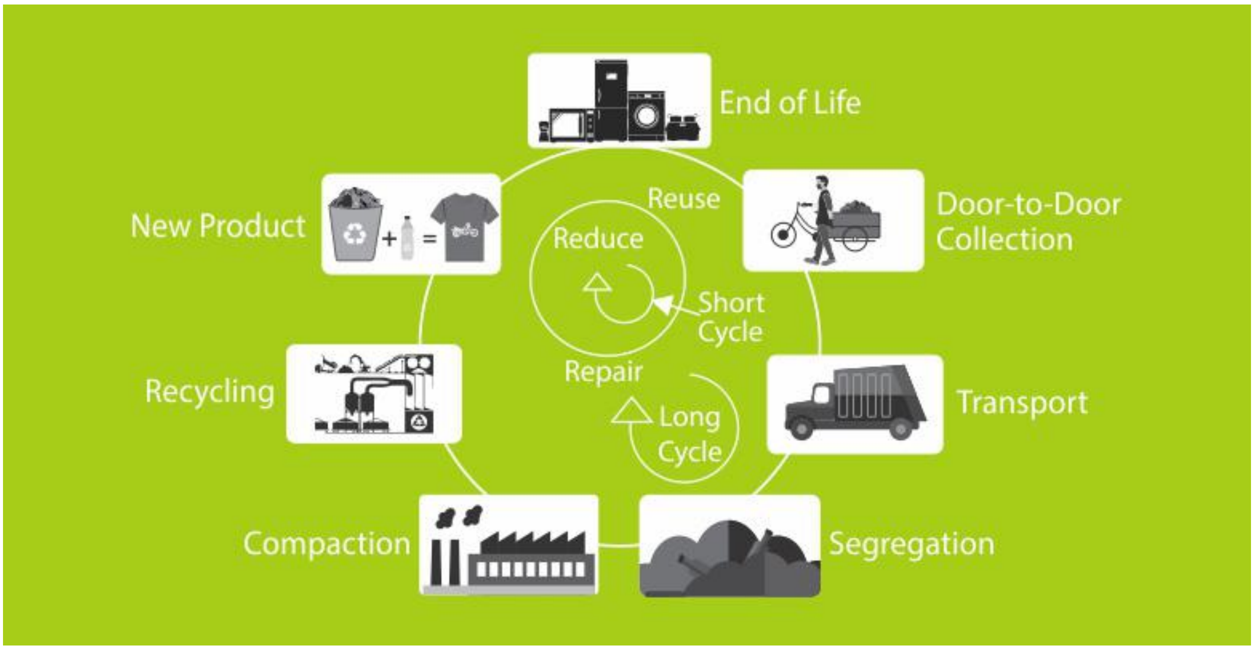
In order to ensure that the framework could be made more robust in light of the increasing challenge of this fast-growing waste stream, the E-waste rules were revised to the present-day e-waste management rules, 2016. The current rules emphasize on the need for Extended Producer Responsibility (EPR), a global best practice of e-waste management.

EPR ensures that after an electronic item is discarded, it is recycled by the manufacturer. To implement these rules, 'Producer Responsibility Organization' (PRO) have been established which are professional organizations authorized and financed by producers of electronic items. The aim is to share the responsibility for collection and channelization of e-waste generated from the 'end-of-life' or simply discarded products.

This ensures the scientific recycling of electronic products. An important upgrade in the new rules is the provision of a takeback target for the producers, which was missing in the first version of the Rule in 2012. Now, manufacturers are mandated to take back their sold products with recommended mechanisms. With the target pre-defined, producers are encouraged to invest in e-waste management infrastructure.

There are other innovative ways that the new rules have introduced to managee-waste.

One is a Deposit Refund Scheme (DRS). Under this scheme consumers putsome money upfront while purchasing an EEE and are refunded once they choose todiscard that EEE. Implementing this scheme however has proven to be a challenge.



Source MOEF

Fig 3.13 Steps in e-waste management

E-waste exchange- is an independent platform which provides sale-purchase services to big companies for the e-waste generated by them. Individual consumers and micro and medium scale enterprises are excluded from this platform. The exchange platform if extended to small players and consumers might be successful as it handles large amounts of e-waste.

The new rules also focus on sustainable design of Electrical and Electronic Equipment (EEE). It says, "Every producer of EEE and their components or consumables or parts or spares shall ensure that new EEE and their components or consumables or parts or spares do not contain pollutants such as lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls and polybrominated diphenyl ethers beyond a maximum concentration value. Every producer shall provide detailed information on the constituents of the equipment and their components or consumables or parts or spares, along with a declaration of conformance to the RoHS (Restriction of Hazardous Substances) provisions in the product user documentation".

The rules allocate the duty of random sampling of EEE placed on the market to the Central Pollution Control Board (CPCB). This involves monitoring and testing products to verify the compliance of RoHS provisions. The costs involved in testing is borne by the producer. If the product does not comply with RoHS provisions, the producers shall take corrective measures to bring the product into compliance, and withdraw or recall the product from the market, within a reasonable period as per the guidelines of the CPCB.

Source MOEF

Summary

India is bound the international regulations for E-waste including Basel, Rotterdam and Stockholm. In addition to this the Government has set its own e-waste management Rules that holds the various stakeholders in the value chain responsible for the scientific disposal of e-waste. Extended producer Responsibility is clause that has been added in the newly formulated E-waste Rules. This holds the producer responsible for the entire life cycle of the electric or electronic item.

Model Questions

1. What are the international laws with regard to the regulation of E-waste?
2. Who are the key stakeholders in the e-waste Rules 2016?
3. What are the challenges in the enforcement of the Rules ?

References

- Baldé, C.P., Wang, F., Kuehr, R., Huisman, J. (2015), The global e-waste monitor – 2014, UnitedNations University, IAS – SCYCLE, Bonn, Germany, http://i.unu.edu/media/ias.unu.eduen/news/7916/Global-E-waste-Monitor-2014-small.pdf
- Chaturvedi, Saha ,Bhatt (2018) Recycle Bin Managing E-waste in India , Ministry of environment, Forests and Climate Change
- Chatterjee , Dr. S. 2011: Electronic Waste and India , New delhi : Department of Information technology
- Cucchiella, Federica, D'Adamo, Idiano, Koh, S.C. Lenny, Rosa, Paolo, (2015), Recycling of WEEEs:An economic assessment of present and future e-waste streams, Renewable and Sustainable Energy
- Ellen Macarthur Foundation, (2015), Concept of circular economy http://www.ellenmacarthurfoundation.org/circular-economy/overview/concept
- Indian Ministry of Environment and Forests & Climate Change 2015. E-waste (Management) Rules,2015.http://www.indiaenvironmentportal.org.in/files/file/notified%20ewaste%20rule%202015.pdf
- Lines, Garside , Sinha , Fedorenko Clean and inclusive? Recycling e-waste in China and India
- Natural Marketing Institute, (2007), Understand the LOHAS Consumer. http://www.lohas.se/wpcontentuploads/2015/07/Understanding-the-LOHAS-Consumer-11_LOHAS_Whole_Foods_Version.pdf
- Rajya Sabha Secretariat 2011: E-waste in India. New Delhi http://rajyasabha.nic.in/rsnew/publication_electronic/E-Waste_in_india.pdf
- WEEE Recycle & CSE. E-Waste Training Course for Policymakers and Regulators – Facilitator'sManual,http://www.igep.in/live/hrdpmp/hrdpmaster/igep/content/e54413/e54441/e62968/WEEERecycleCSEmanual.pdf

Chapter 4 Dismantling and Recycling of E-waste

Introduction

The alarming rate of the of e-waste generation has become a major concern. However, the good news is that, this new waste stream can be a potential wealth creator and can provide livelihoods opportunities to thousands of unemployed youth. The rate at which we are generating waste is significantly high compared to the way we are managing it. First, challenge is the lack of appropriate technology; another significant challenge is the lack of people resources , who have the vision and drive to address the issue in a comprehensive manner . For this, the demographic dividend can be leveraged and youth can be mobilized , trained and skilled to set up their own businesses and enterprises , which will not only upgrade them professionally as well as socially but also provide employment to other youth and address the problem of E-waste management in the country.

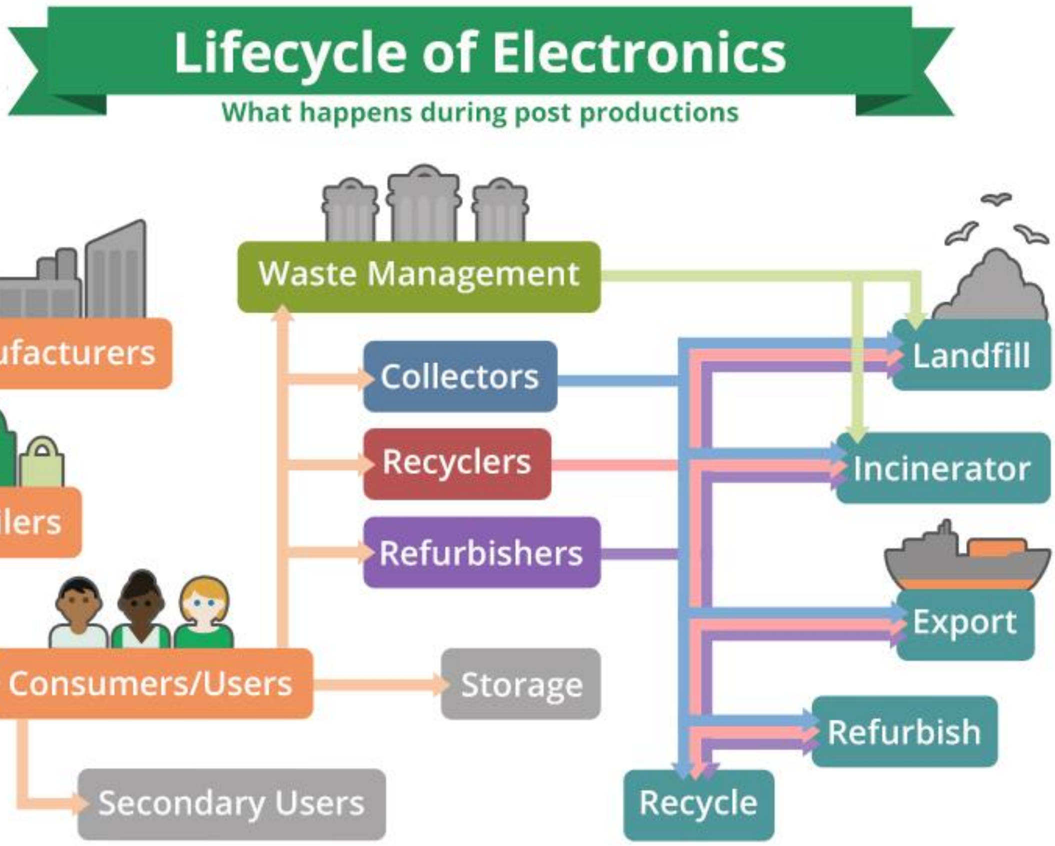
Objectives

- Explain how e-waste is managed in the informal sector
- Understand the working of the formal recyclers and dismantlers
- Identify the responsibilities of the dismantlers and the recycler
- Learn about the best practices for e-waste management

4.1 E-waste and the Informal Sector

It is a well-known fact that e-waste contains hazardous constituents that are potentially harmful to the environment and human health if they are not handled properly. The presence of valuable resources such as copper, silver, gold and platinum make it attractive to recycle e-waste. Recycling activities have invariably been associated with small backyard operators involving a large work force and located mostly in the developing nations. The major activity in e-waste recycling is dismantling which is labour intensive and requires manual operations which are available in abundance in poor nations.

The informal sector has a historic role in waste management and recycling in India and it is well known that e-waste recycling is no exception to this with an estimated 95 percent of e-waste being recycled through the informal sector (GTZ-MAIT study, 2007). The informal e-waste recycling sector provides jobs to thousands of people in urban and peri-urban areas, and supports the formal waste management agencies like municipalities.



(Source: http://greatforest.com/sustainability101/uncategorized/e-waste-recycled-video/)

Fig 4.1 Life Cycle of Electronics

To Do Activity

Quiz

Write down the average life of a Laptop.

Write down the average life of a mobile phone?

Write down the average life of a TV

Write down the average life of a Refrigerator

Write down the average life of AC

Table 4.1 Average Life of the EEE

S. No	Categories of EEE	EEE Code	Average Life
I	Information technology and telecommunication Equipment		
	Centralized data processing:	ITEW1	
	Mainframe		10 years
	Minicomputer		5 Years
	Personal Computing : Personal computers (central processing unit with input and output devices	ITEW2	6 Years
	Personal computing : laptop computers (central processing unit with input and output devices)	ITEW3	5 years
	Personal computing : Notebook Computers	ITEW4	5 years
	Personal computing Notepad computers	ITEW5	5 years
	Printers including Cartridges	ITEW6	10 years
	Copying equipment	ITEW7	8 years
	Electrical and electronic typewriters	ITEW8	5 Years
	User terminals and systems	ITEW9	6 Years
	Facsimile	ITEW10	10 Years
	Telex	ITEW11	5 years
	Telephones	ITEW12	9 years
	Pay telephones	ITEW13	9 years
	Cordless telephones	ITEW14	9 years
	Cellular telephones	ITEW15	
	Feature phones		7 years
	Smart phones		5 years
	Answering systems	ITEW16	5 years
II	**Consumer Electrical and electroni**cs		
	Television sets (Including sets based on (Liquid Crystal	CEEW1	9 years
	Refrigerator	CEEW2	10 Years
	Washing machine	CEEW3	9 years
	Air- Conditioners excluding centralized air conditioning plants	CEEW4	10 years
	Fluorescent and other Mercury containing lamps	CEEW5	2 years

A widespread and active network and considerable manual skills enable the existence of an informal but entrepreneurial SME based infrastructure that permits a profitable e-waste management business. Most of these informal SMEs concentrate on one or two recycling stages with well established relationships to other informal e-waste recycling SMEs up or down the recycling chain.

Value is added at each stage creating employment at different levels, thereby sustaining the system. The e-waste recycling in the informal sector essentially involves collection, segregation, dismantling. There are extensive repair and refurbishment activities resulting in an extended life of the products and a large second hand market, in particular for IT products.

To a large extend the informal sector in India is also involved in extraction of precious metals. These generally small units exercise little or no control over their activities and use highly-polluting process - in many cases without being aware of the risks of these. Environmental concerns regarding the operations in the informal sector occur at different stages of the e-waste recycling chain. Most severely the illegal extraction of precious metals is causing highly dangerous and toxic emissions such as dioxins, heavy metals, lead, cadmium, mercury etc. Additionally, the discharges and the smudges from e-waste processing leads to contamination of water bodies and soil due to residues e.g. acids, spent fluids/chemicals, traces of polychlorinated biphenyl (PCB), brominated flame retardants (BFRs), etc. This leads to considerable occupational health and safety concerns and environmental hazards. The contact with the chemicals used during the operations, improper ventilation and working without use of personal protection equipment lead to direct exposure to hazardous chemicals. Apart from this, workers are also exposed to other hazards leading to physical injuries and chronic ailments such as asthma, malnutrition, skin diseases, eye irritations etc. and in some cases even to long term and incurable diseases. However, the economics of recycling and the prevailing scales of operations are some of the factors that keep the informal sector going.

Source MoEF

Fig 4.2 Comparative view of the present and Future E-waste management

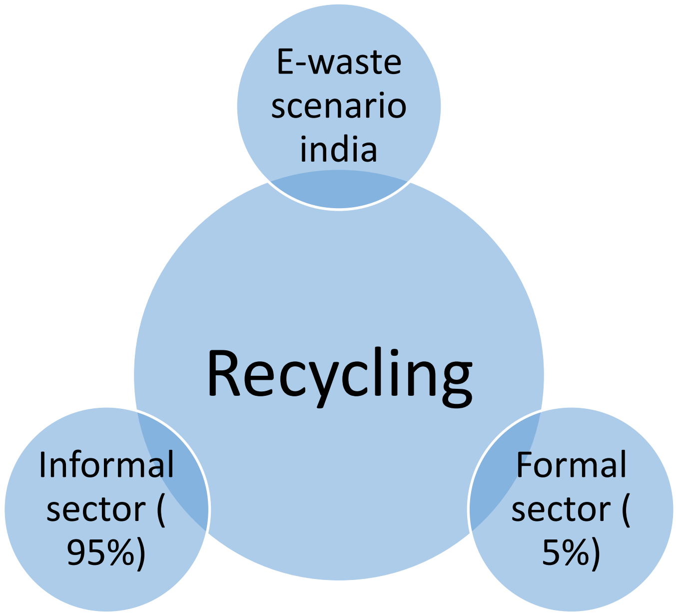


Fig 4.3 E-waste recycling in India

Prerequisites for Informal Sector to Move into the Formal Economy

- Access to land where they are able to engage in their livelihood which will not lead to any damage to nature
- Access to infrastructure which will allow them to engage in their livelihood in ways and means which will comply with the law
- Access to finance so that they are able to invest in infrastructure and work within the legal framework

The above can be fulfilled by integrating the informal sector through capacity building. For example, the Ministry of Electronics and Information Technology has initiated an awareness programme on the environmental hazards of electronic waste. As part of the programme, workshops have been conducted in the informal sector including Moradabad, which is the hub of informal PCB recycling in India. Benefits of formalization have been discussed and interaction channels have been opened with experts in the area. This has allowed to disseminate information on formalization, and stakeholders have come forth with their requests and actions agenda as a first step. Hand-holding these stakeholders through a formal process will allow to build confidence which will help the move towards formalisation.

The informal sector recycles material at an efficiency rate of between 20 to 30 percent. Provision of technology to these informal actors who are willing to formalise will allow benefits in the socio-economic and environmental space. Social benefits to the informal sector can accrue from formalised livelihoods in e-waste recycling by use of technology. Proper registration of their units allows them to reach out to disposers of e-waste both individuals and bulk consumers. The recognition also helps in the upliftment of social status from being at the lowest rung in the value chain for e-waste to authorised and formal recyclers pursuing their livelihoods to add value to materials and being resource efficient.

Capacity building of the informal sector on the use of technology can allow them to upgrade themselves to the formal chain. This has direct benefits of resource efficiency and circular economy allowing for more materials to flow back into the production chain. Furthermore, formalisation allows for materials to remain in the value chain which can be used for manufacturing and thus create resource security. Overall it is a win-win situation for the informal sector as well as the country as a whole.

4.2 Formal Recyclers and Dismantlers

To do Activity

Film screening Analysis and discussion Recycle
karo.comhttps://www.youtube.com/watch?v=FQnJFaH_Quo

With now rising e-waste quantities on one hand, and with new regulatory requirement entering into force soon on the other hand, formal recyclers increasingly enter the e-waste recycling sector. There is a widespread expectation that these formal sector recyclers would be able to manage e-waste in an environmentally sound manner by using Best Available Technologies (BAT) leading to better environmental management and enhanced resource recovery. However, it is not clear whether the advent of formal recycling would come at the expense of informal sector recyclers or would complement their activities. Additionally, investment in machinery and increased working standards are more cost-intensive and competition with informal sector recyclers is tough.

List of Authorized recyclers

http://cpcb.nic.in/cpcbold/List_of_E-waste_Recycler_as_on_29.12.2016.pdf

4.3 Responsibilities of the Dismantler and the Recycler

The E-waste Rules 2016 has set comprehensive rules for any person interested in starting a dismantling or a recycling unit. They are required to obtain authorizations and compliances to set up their business: The details of the authorization process are listed below.

- To obtain authorisation from the concerned State Pollution Control Board in accordance with the procedure under sub-rule (3) of rule 13;
- To ensure that no damage is caused to the environment during storage and transportation of e-waste
- To ensure that the dismantling/recycling processes do not have any adverse effect on the health and the environment
- To ensure that the facilities and dismantling & recycling processes are in accordance with the standards or guidelines published by the CPCB from time to time
- To maintain the record in form-2 and to ensure that dismantled e-waste is segregated and sent to the registered recycling facilities for recovery of materials
- Dismantlers shall not process any e-waste for recovery and/or refining of materials, unless registered as recycler for refining and recovery of materials.
- To make available all records to the CPCB or SPCB/PCC for inspection
- To ensure that residue generated after recycling is disposed of in a hazardous waste Treatment Storage Disposal Facility (TSDF)
- operation without Authorisation by any dismantler, as defined in this rule, shall be considered as causing damage to the environment.
- To file annual returns in Form 3

Source : E-waste Rules 2016

4.4 Recycling of Different Types of Materials in E-waste

The increased use of electrical and electronic equipment (EEE) and their high rate of obsolescence is leading to around 41.8 million tons of e-waste generation globally that is growing at an annual growth rate of 4 to 5 per cent per year (Baldé, (2015):24-25). From the developed countries around 75% to 80% of e-waste is shipped to countries in Asia and Africa for “recycling” and disposal where majority of imported e-waste is managed through informal unsafe recycling channels (Perkins et al., (2014): 287).

Around 1.7 million tonnes of e-waste is generated in India (Baldé, (2015):42)). According to Central Pollution Control Board (CPCB) (2015) list of registered e-waste dismantler/recycler in the country as on 27-11-2014 the total recycling capacity is 349154.6 MTA, this is only 20% of the estimated e-waste generation in India and therefore non-compliance to the rules is expected. The e-waste recycling sector revenue in 2015 was estimated at Euro 2.5 billion and is expected to grow to 3.5 billion by 2020 (Cucchiella et al., (2015)). For example, around 170,000 tons of electronic waste is generated from scrapped television alone in India every year. If each ton has a value of INR 10,000 then the recycling industry turnover would be INR 170 Crores. The total market is worth INR 1700 Crores despite considering a conservative value of e-waste.

As per the E-Waste (Management) Rules 2016 all e-waste should be recycled by authorized recyclers and dismantlers. In line with the principle of 'Extended Producer Responsibility' (EPR) the producers have to set up a scheme for collection of used/waste Electrical and Electronic Equipment from the Electrical and Electronic Equipment placed on the market earlier through dealers.

Environmentally sound E-waste treatment technologies are used at three levels as described below:

- 1st level treatment
- 2nd level treatment
- 3rd level treatment

All the three levels of e-waste treatment are based on material flow. Each level treatment consists of unit operations, where e-waste is treated and output of 1st level treatment serves as input to 2nd level treatment. After the third level treatment, the residues are disposed of either in TSDF (Treatment, Storage, and Disposal Facility) or incinerated. The efficiency of operations at first and second level determines the quantity of residues going to TSDF or incineration. The simplified version of all the three treatments is shown below.

For non-CRT E-waste, the major e-waste treatment facilities in India use the following technologies.

1. Dismantling
2. Pulverization/ Hammering
3. Shredding
4. Density separation using water

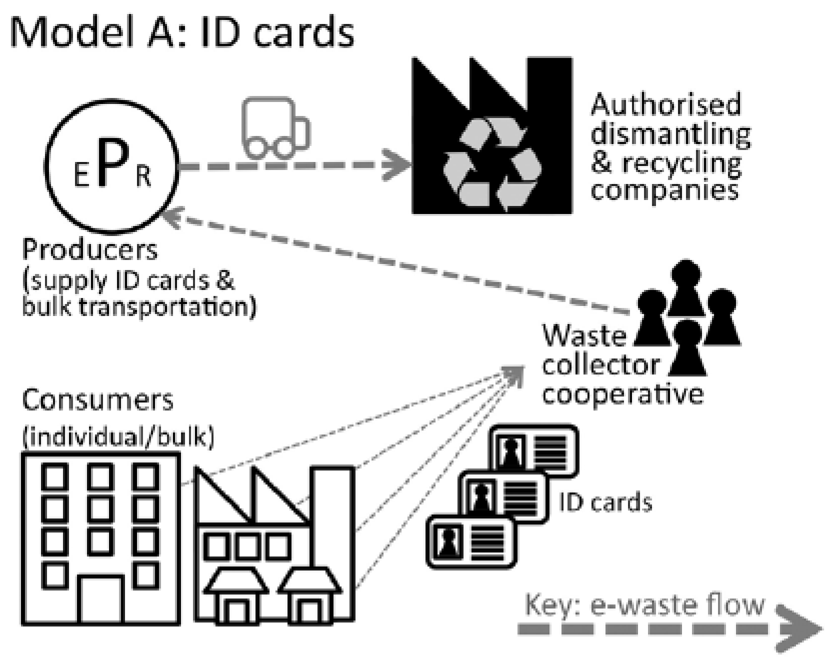
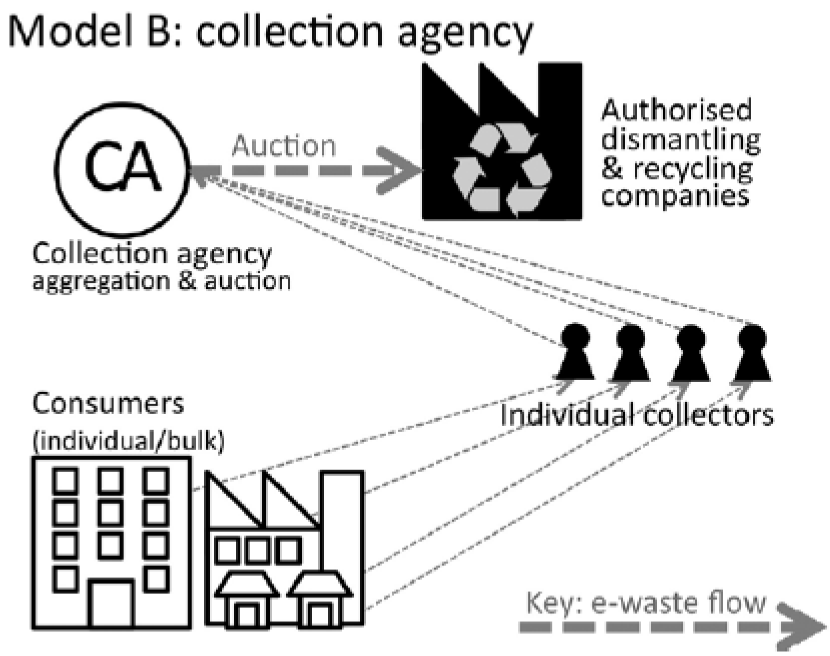
Fig 4.2 Treatment of E-waste

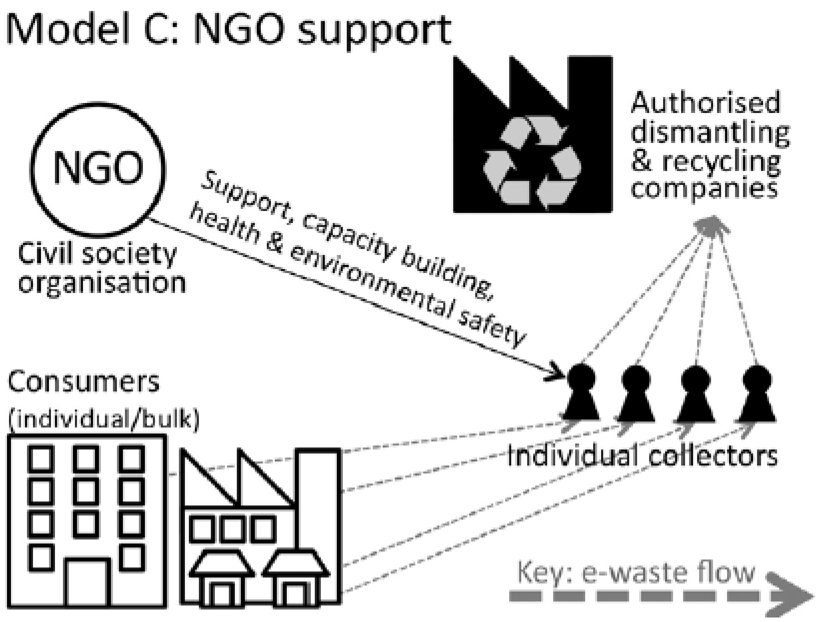
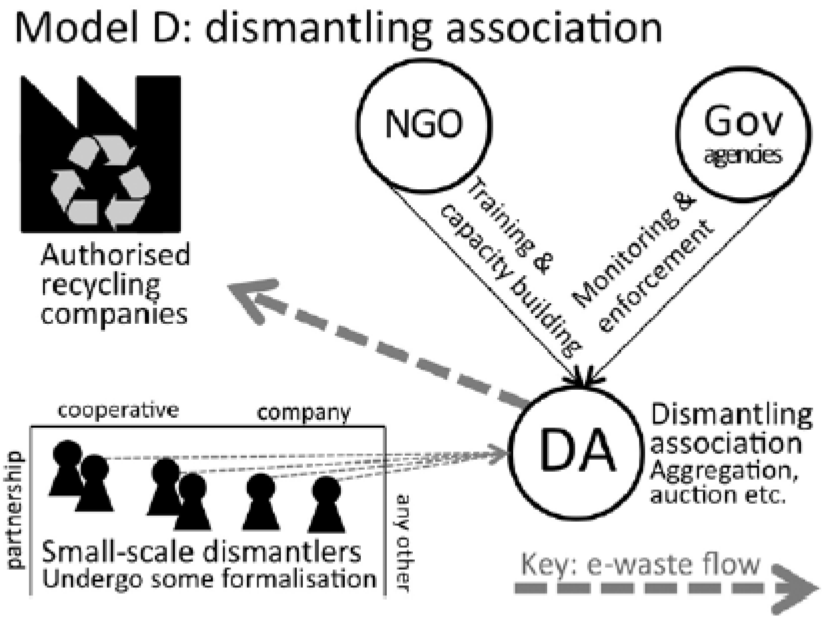
To Do Activity

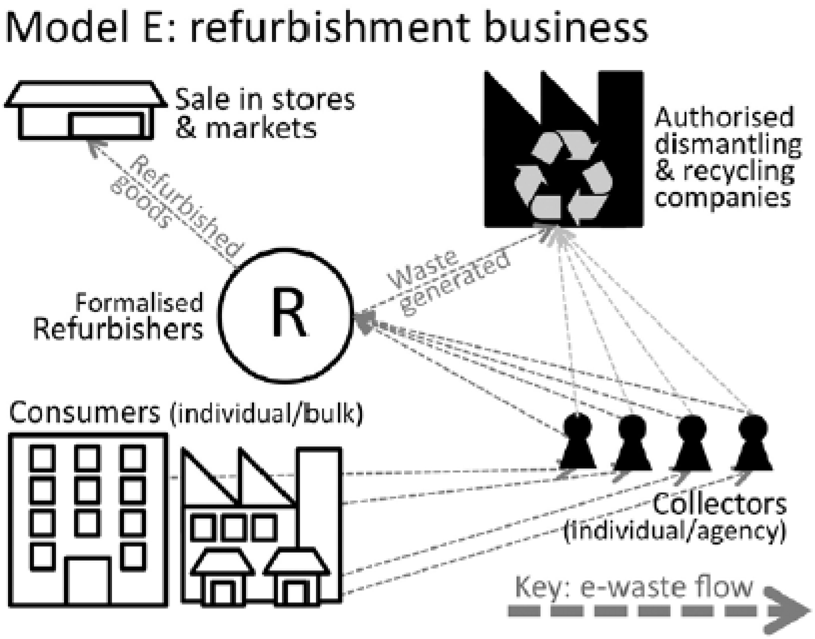
Exposure visit to a recycling facility and Discussion

4.5 Business Models

Based on the experience of solid waste management; hybrid models complementing the strengths of the formal and the informal sector has been developed by Toxic Link and NGO working on the issue of Waste management for more than a decade. This will also protect the jobs of thousands of workers employed in the informal sector.

Description	Different Business Models
Waste pickers as collection agents using ID cards to legitimize collection from households and businesses on condition that collected materials go to clean channels. As part of their EPR requirements, EEE producers take responsibility for issuing ID cards and arranging bulk transportation of materials collected to registered recyclers and dismantlers. A variation of this model is being tested in a trial in Kolkata.	
Waste collectors as a collection agency. A group of informal waste collectors formalize as a cooperative or profit-making company. Where in Model A they act as agents for EEE companies, here they are responsible for selling collected material. There are similarities here with the HRA E-waste and Sheikh Tiwari Electronics case studies, where many of the challenges associated with this model are evident – including the formalization process, access to finance	

and credit, compliance, profit sharing and competition with other formal sector companies.	
Waste collectors form an alliance with an NG O. Waste collectors are linked to a community-based organization, which gives them credibility when approaching households, companies and offices for waste. The NGO can facilitate access to small grants for collection equipment such as carts, and to education and capacity building around health and environmental issues, ensuring materials collected go to clean channels.	
Dismantling associations, which involves formalizing informal dismantling operations, through registering a business entity and complying with environmental and human health and safety requirements, since e-waste dismantling exposes workers to hazardous substances. Attention by policymakers and formal recyclers to the dismantling sector is important, since the activity is mainly manual and contains good potential for job creation.	

<table>
<tr><td>Informal actors can pool human and financial resources,
and approach bulk generators for larger quantities
of materials.</td><td></td></tr>
<tr><td>Refurbishment business.
Refurbishment activities – can generate large profits, meet demand from poorer rural areas, and cut down on energy required for new products by extending the life of appliances.
Refurbishment needs to be recognized to secure informal sector engagement with clean systems of
e-waste management. A formalized refurbishment organization could also be an opportunity for dismantling workers or others with the necessary skills to operate at a larger scale.</td><td>


</td></tr>
</table>

Fig 4.4 Types of Model for e-waste management

With the aim of reducing the accumulation of electronic waste and the safe recycling of it, E-Parisaraa was started in 2005. It is India's first government authorized electronic waste recycling organization.

Best Practices

It's heartening to know that in the last decade there have been many success stories in the space of E-waste management in India. The best practices are from different sectors, one each from the 4 key stakeholders: Government, informal sector, NGO and the Producer. The case studies highlight the best practices being done in the field of E-waste management in India. The case studies are listed below:

E-Parisaraa is in the business of converting electronic waste products into smaller simpler elements that have a high recycling potential like; plastic, precious metals and glass. They do this through a simple process of segregation followed by manual dismantling, shredding and density separation. E-Parisaraa strives to recycle e-waste to about 90% and 1% hazardous materials which cannot be further recycled. What remains goes to scientific and secure Treatment and Disposal Facilities. Having developed their own techniques and technologies for recycling, they specialize in toner cartridge dismantling, gold recovery from Printed Circuit Board strips, silver recovery from silver coated components and circuit for reusing fused CFLs. Being aware of the health hazards that come with recycling these toxic appliances the organization conducts regular health check-ups, mock safety drills and first aid trainings for all its employees. With the goal of becoming a world-class recycling facility, E-Parisaraa considers e-waste to be a resource for recovery. They believe that this should be done in an environment friendly manner. They have also taken steps for conservation of natural resource like Energy, water etc. They have also been using solar power for charging of batteries used in dismantling tools. Rainwater is used for gardening. Through these interventions, E-Parisaraa has shown the way for formal, safe and environmentally friendly e-waste recycling.

Mohammad Sabir is a formal e-waste recycler who set up a shop in north-east Delhi, in 2011. Prior to this Sabir was part of the informal e-waste recycling industry. As he describes it, his time as a recycler was a nightmare, he recalls working in toxic conditions with small rooms filled with people dismantling and recycling e-waste. The decision to join the formal sector, therefore, was clear. Sabir approached theGerman Development Agency, GIZ, and went to Germany where he was trained on dismantling procedures. Upon his return, he founded the Green E-Waste Recyclers. He was now licensed to collect and sell e-waste to formal recyclers. Eventually, n 2017 Sabir also applied to register as a dismantler, he is still finishing up the necessary paperwork.

Urjasvibegan with the simple idea of utilizing electricity in efficient and sustainable ways, from creating LED reading lamps for school children in Uttarakhand it expanded into assembling and repairing LEDs, training individuals and institutions and adopting villages that were not only maximizing the use of electricity but, were saving power. Started in 2014, by the Society of Pollution and Environment Conservation Scientists (SPECS), 'Urjasvi' followed the motto; nothing is a waste. Everything is a resource waiting to be utilized.

The aim of the campaign was to promote the repair, recycling, reuse and safe scavenging of LED bulbs, tube lights and solar powered devices. Over the last five years they have built a strong community of over one lakh individuals who are now independently equipped to recycle LEDs. Working with large organizations, school and individuals they created a platform that encouraged skill building through trainings and workshops. The training program is open to all individuals with varied backgrounds and empowers them with the skills required to recycle LEDs either independently or as part of an organization. It is designed to encouraged trainees to become micro-entrepreneurs and open their own LED – repairing centers in their local areas. More than 500 entrepreneurs are already making their living through this business which has four models. First, the assembly of bulbs using locally sources materials which are sold at a much lower cost and come with a two-year warranty. Secondly, LED bulbs can be repaired which, sets them apart from other conventional lamps. Thirdly, repair centersalsobuy malfunctioning LED bulbs from the public, repair and refurbish them and sell them back to the bulk buyers. The advantage is reuse of the resources and bulk buyers effectively save 50% in purchase price as compared to the new bulbs. These bulbs also come with a replacement warranty of 1 year. Lastly, SPECS has developed an innovative "fuse" device which can be retrofitted in any LED bulb. This device protects the lamp components against voltage fluctuations and such.

In 2016 the government of India notified the revised E-Waste (Management) Rules. A central focus of these rules was the Extended Producer Responsibility (EPR). It was at this time that Karo Sambhav was founded with the intention to help producers fulfil these new ERP mandates. Karo Sambhav, started by Pranshu Singhal, believes in closing the loop when it comes to e-waste recycling and creating a sustainable value chain that works with individual consumers, bulk consumers, waste pickers and aggregators. The aim of the organization is to bring long-term behavioral change with regard to our relationship with e-waste. Starting out as a Gurgaon based organization, Karo Sambhav, has worked with large producers like Apple, Dell, Lenovo and the like. Over time they diversified to awareness building programmes, engaging students and teachers alike. They have worked with schools to create a curriculum that focusses on e-waste handling and recycling. As of last year, they had already trained 3000 teachers across 1500 schools in 60 cities. They aim to amplify this number to 2200 schools by the end of 2018. With a focus on the future, Karo Sambhav has already made inroads into working with Resident Welfare Organization's and plans to launch a mass media programme that focuses on individuals. Via these programmes, they intend on working with smaller consumers to not only decentralize the system of e-waste collection and recycling but also to start sensitizing them about the mounting problem of e-waste in the country and present a solution.

Summary

Dismantling and recycling is happening both in the informal and the formal sector. However, the need of the hour is to integrate the two streams of waste.

The integration can protect the livelihoods of thousands of men and women engaged in the informal sector. This would also require educating the informal sector and sharing with the harmful effects of the E-waste on their health and environment. At the same time, it is important that more youth join the e-waste value –chain to bring in fresh ideas and perspectives to create entrepreneurial initiatives that address the problem of E-waste management in the country.

Model Questions

What are the challenges of recycling in the informal sector ?

Document best practices from India and the world of e-waste management.

References

- Baldé, C.P., Wang, F., Kuehr, R., Huisman, J. (2015), The global e-waste monitor – 2014, UnitedNations University, IAS – SCYCLE, Bonn, Germany, http://i.unu.edu/media/ias.unu.eduen/news/7916/Global-E-waste-Monitor-2014-small.pdf

- Chaturvedi, Saha ,Bhatt (2018) Recycle Bin Managing E-waste in India , Ministry of environment, Forests and Climate Change

- Chatterjee , Dr. S. 2011: Electronic Waste and India , New delhi : Department of Information technology

- Cucchiella, Federica, D'Adamo, Idiano, Koh, S.C. Lenny, Rosa, Paolo, (2015), Recycling of WEEEs:An economic assessment of present and future e-waste streams, Renewable and Sustainable Energy

- Ellen Macarthur Foundation, (2015), Concept of circular economy http://www.ellenmacarthurfoundation.org/circular-economy/overview/concept

- Indian Ministry of Environment and Forests & Climate Change 2015. E-waste (Management) Rules,2015.http://www.indiaenvironmentportal.org.in/files/file/notified%20ewaste%20rule%202015.pdf

- Lines, Garside , Sinha , Fedorenko Clean and inclusive? Recycling e-waste in China and India

- Natural Marketing Institute, (2007), Understand the LOHAS Consumer.

  http://www.lohas.se/wpcontentuploads/2015/07/Understanding-the-LOHAS-Consumer-11_LOHAS_Whole_Foods_Version.pdf

- Rajya Sabha Secretariat 2011: E-waste in India. New Delhi http://rajyasabha.nic.in/rsnew/publication_electronic/E-Waste_in_india.pdf

- WEEE Recycle & CSE. E-Waste Training Course for Policymakers and Regulators – Facilitator'sManual,http://www.igep.in/live/hrdpmp/hrdpmaster/igep/content/e54413/e54441/e62968/WEEERecycleCSEmanual.pdf

Chapter 5 Sustainable Consumption and Production

Introduction

The generation of E-waste is directly related to our consumption patterns .The more we consume the more e-waste we generate. In order to address the problem at the nip of the bud it is pertinent to adopt practices and concepts that address the entire e-waste value chain. One such concept that is gaining prominence in the present times is the principle of circular economy -which focuseson reducing consumption, re-using the EEE by increasing the longevity of the products and finally recycle the products for material extraction and creation of new resources. In order to implement the principle of circular economy, manufacturers across sectors need to adopt this principle which can inform their product design and development by adopting green technologies that will contribute towards sustainable development. Related to the principle of circular economy is the concept of LOHAS (Life styles of Health and sustainability, that promotes the idea of sustainable lifestyles amongst consumers that can lead to health and sustainability .

Objectives

- Explain sustainable consumption and Lifestyles of Health and Sustainability
- Explain the concept of circular economy and the principles of 3Rs
- To apply strategies to mitigate E-waste in personal life

5.1 Sustainable Consumption and Production

Resource consumption is a term used for the many different ways in which humans consume the products of the natural world. In our planet, some resources are finite, meaning that once they are used there are none left, such as fossil fuels and land. Other resources are renewable, such as wind and solar energy.

Resource can be categorized into renewable and non-renewable, Renewable materials are not finite in availability as they can be replenished in a short duration for example agricultural products, livestock etc. While non-renewable resources are those that cannot be replenished or made again in short duration and may take billions of years to be made again for example fossil fuels that provide energy, metal ores used in the manufacture of cars and computers etc (FOE, 2005).

Resource can be categorized into renewable and non-renewable, Renewable materials are not finite in availability as they can be replenished in a short duration for example agricultural products, livestock etc. While non-renewable resources are those that cannot be replenished or made again in short duration and may take billions of years to be made again for example fossil fuels that provide energy, metal ores used in the manufacture of cars and computers etc (FOE, 2005).

Due to the finite nature of fossil fuels and metals it is likely that we will run out of these resources in future as highlighted in the chart below:

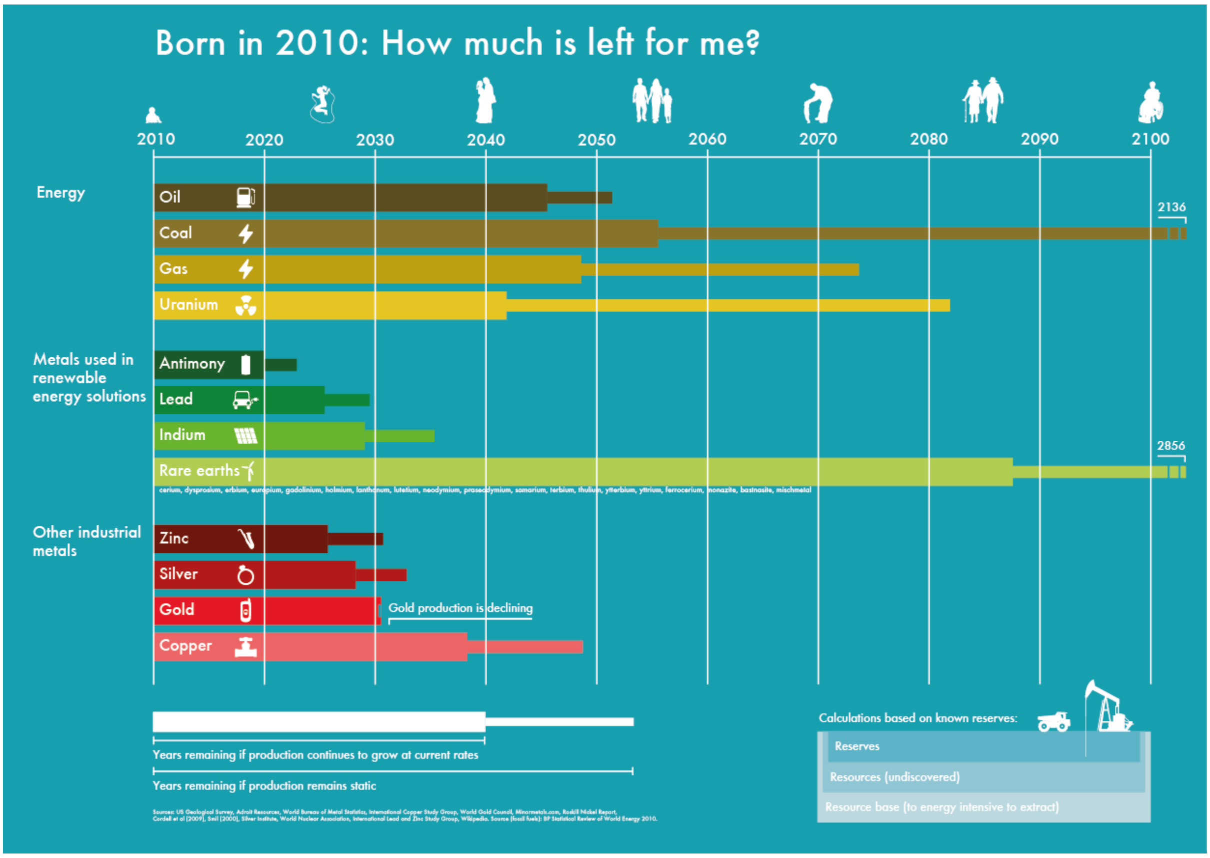


Fig 5.1 Resource Consumption over the years

Overconsumption due to lifestyle changes, higher income levels and increased rate of obsolesce of electrical and electronics goods is leading to overconsumption of resources. Therefore it is necessary to reduce overconsumption and recycle so that we don't run out of resources.

Fig 5.2 Resource consumption across the ages

Sustainable consumption and production is GOAL 12 of the sustainable development goals adopted by all the nations across the world including India . The targets of the goal have to be achieved by 2030. SCP offers an integrated approach to consumption and production by addressing the entire supply chain. Sustainable consumption and production is about promoting resource and energy efficiency, sustainable infrastructure, and providing access to basic services, green and decent jobs and a better quality of life for all. Its implementation helps to achieve overall development plans, reduce future economic, environmental and social costs, strengthen economic competitiveness and reduce poverty.Sustainable Consumption and Production (SCP) is a pre-requisite for the world's development to remain within the safe limits of growth and planetary boundaries. It is fundamental in order to achieve sustainable development.

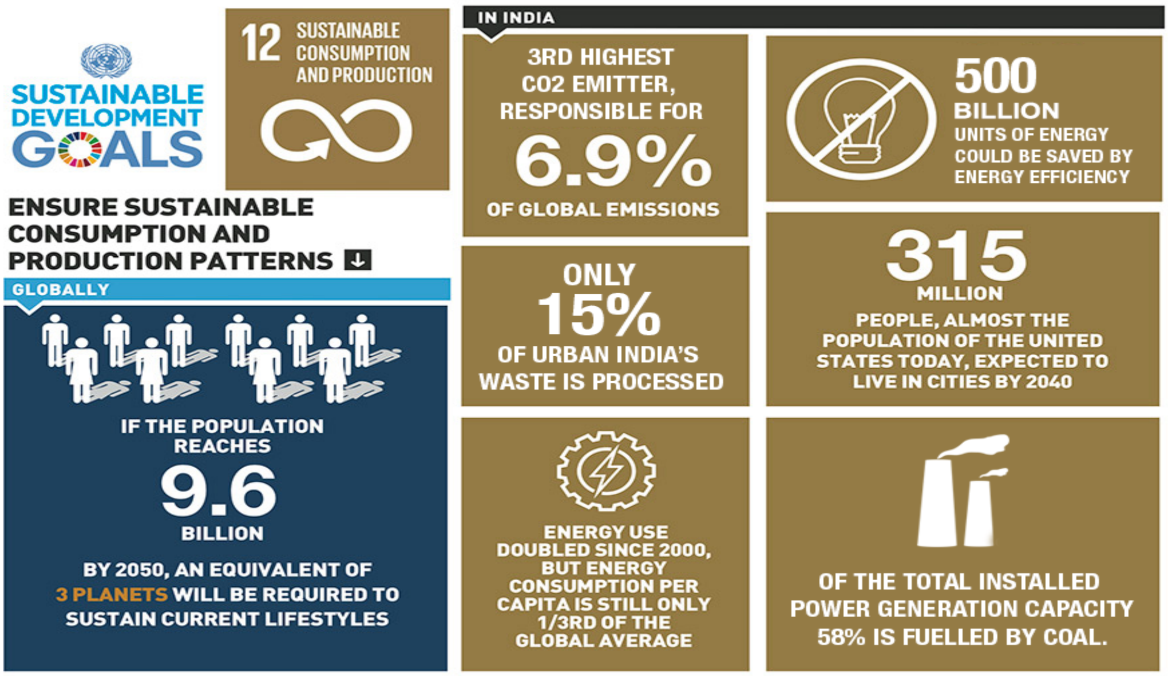


Fig 5.3Sustainable Consumption and Production Global and national data

At the one end of the spectrum of the SCP is the consumer, who has to be educated and made aware to make sustainable life style choices encompassing all aspects of his / her life such as energy consumption, water usage, clothes , choice of food and dietary habits etc. And on the other side of the spectrum is the producer or the companies who have to follow sustainable business practices to protect the social , economic and the environmental needs of the people and communities . In this way we can produce resource efficiency , green and decent jobs and a better quality of life for all of us.

India's per capita consumption is still fairly low as compared with the developed economies. India sees sustainable consumption as an instrument for social and environmental gain. On one hand it will prevent the excessive burden on natural and environmental resources, while on the other it will also be a step towards a more equitable society.

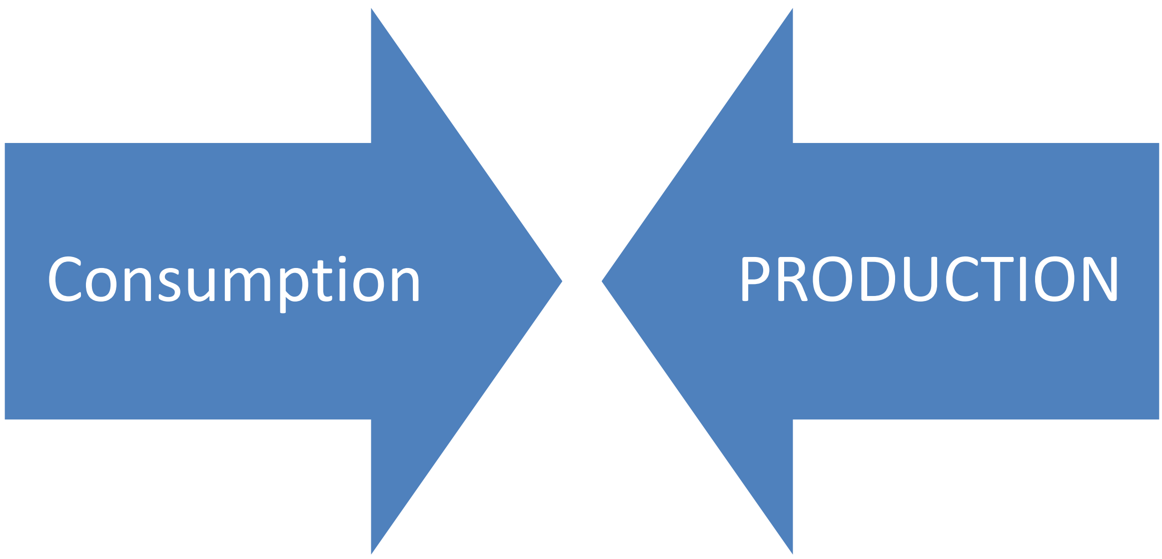


Fig5.4 Sustainable consumption and Production – An integrated approach

TO do Activity: Quiz on Lifestyle Choices

Instructor gives choices that make to the students

For each choice there are will two options: Option A and Option B. For each of these options, you need to choose one option and explain why you have chosen that particular option

Set 1

Option A: Local Apple.

Option B: Washington Apple.

Set 2:

Option A: Disposing garbage to the kachrawalla

Option B: Segregating and composting wet waste

Set 3:

Option A: Washing hair with shikakai (local plant for better hair)

Option B: Washing hair with an imported branded shampoo

Set 4:

Option A: Buying a seasonal local vegetable that you may not find too tasty

Option B: Buying an exotic vegetable (like broccoli or avocado) that is yummy but expensive and important

Set 5:

Option A: Taking a walk to your friend's home and spending time with him or her

Option B: Sending whatsapp messages or chatting with the friend from home

To do Activity

Film screening, analysis and discussion – Sustainable consumption and production

5.2 Circular economy

The linear economy of take, make and dispose is putting an immense amount of pressure on the natural resources. Clearly this model is unsustainable. Circular economy focuses on reducing consumption, re-using the EEE by increasing the longevity of the products and finally recycle the products for material extraction and creation of new resources. In order to implement the principle of circular economy, manufacturers across sectors need to adopt this principle which can inform their product design and development by adopting green technologies that will contribute towards sustainable development. A secondary resource is something created by the process or consumer of products at their end-of-life for further processing, obviously if it is economically viable to do so. It really is the economic value of secondary resources that drives the recycling system, and the basis of the circular economy. Thus treating secondary resources is principally a matter of considering the economic value that it contains and also the form in which this value is present i.e. the mineralogy, the combinations of materials, linkages etc. The Figbelow gives a succinct overview of a circular economy (Source: EC Brussels, 2.7.2014 COM(2014))

According to the Ellen Macarthur Foundation, today's linear ‘take, make, dispose’ economic model is reaching its physical limits or is unsustainable. Therefore there is a need to adopt a circular economy that is an attractive and viable alternative as it is restorative and regenerative by design, and aims to keep products, components, and materials at their highest utility and value at all times. As envisioned by the originators, a circular economy is a continuous positive development cycle that preserves and enhances natural capital, optimises resource yields, and minimises system risks by managing finite stocks and renewable flows. It works effectively at every scale.

The principle of circular economy preserves and enhances natural capital, optimises resource yields, and minimises system risks by managing finite stocks and renewable flows.

To Do Activity

Film Screening, Analysis and Discussion

https://www.ellenmacarthurfoundation.org/circular-economy/concept

Fig5.5 Principles of Circular economy

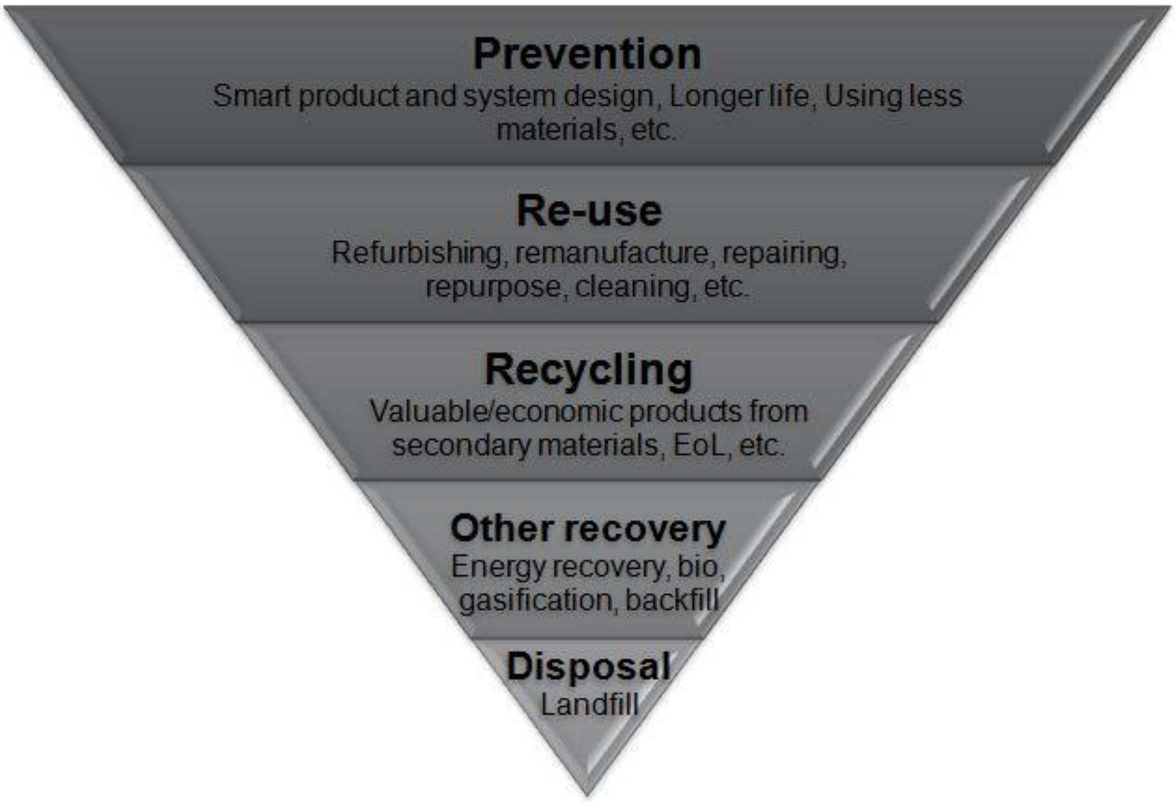


Fig 5.6 Steps in Circular economy

The Figvery clearly highlights through the “Raw Materials” and “Recycling” sections that process metallurgy is a key aspect in the realization of a closed-loop society. It really is the economic value of secondary resources that drives the recycling system, and the basis of the circular economy.

On the other hand primary resources are mostly extracted through mining operations leading to high economic, social and environmental costs. Use of secondary resources that use waste as a source of materials for building useful products leads to reduction in mining and prevents harmful environmental and social impacts.

Companies have already begun to transform themselves as participants of circular economy by design products that can more readily be recycled and reused. For example, Dell has introduced first computer made with plastics from recycled old electronics.

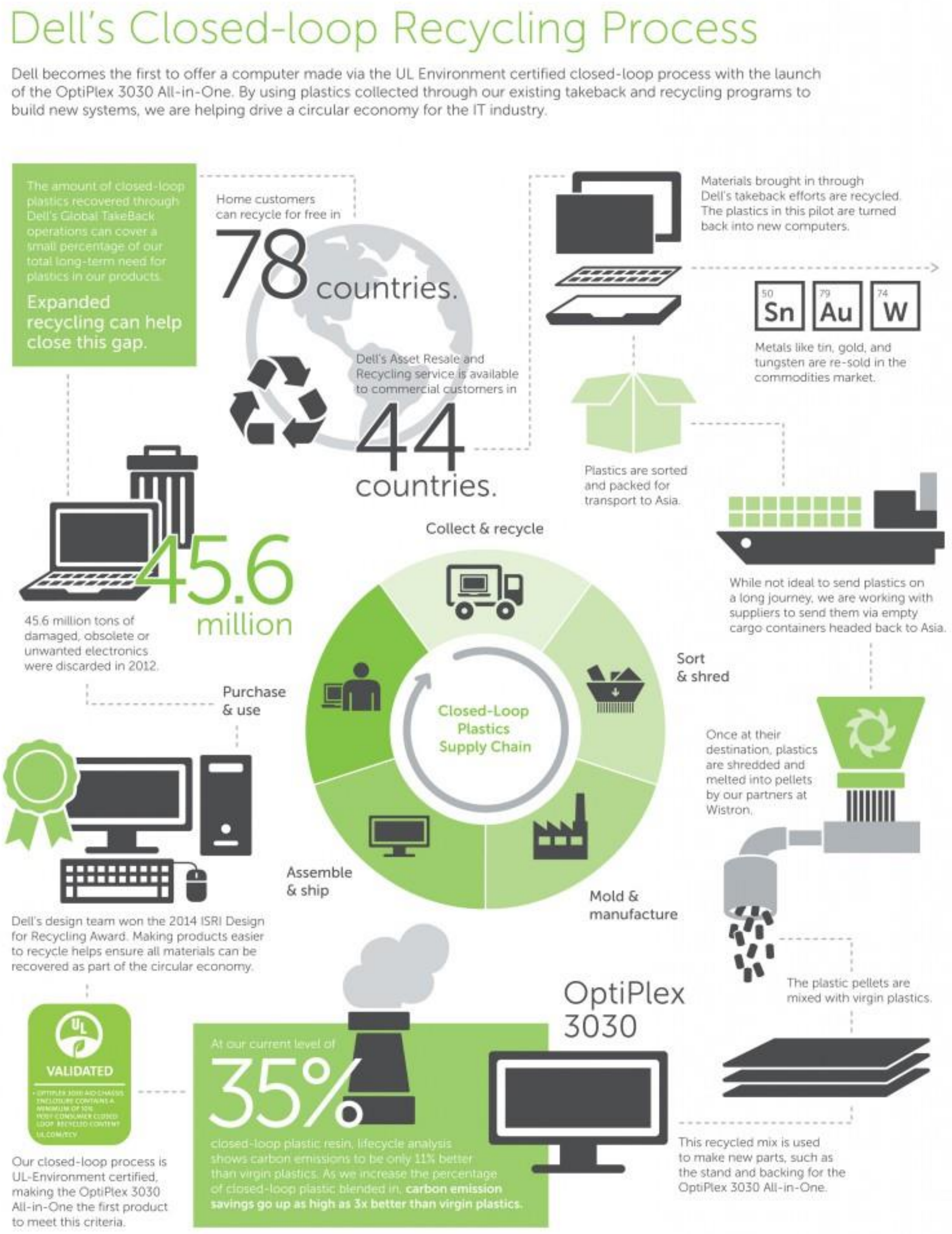


Fig 5.7 Dell's Closed loop recycling process

Fig 5.8 Reduce, Reuse and Recycle

To Do Activity
Please make a note of things you can do to reduce waste. Please make a list of items that you can reuse and another list of items that can be donated to other.s Enlist products you should buy that can be recycled easily

To do Activity
Film Screening , Analysis and discussion

5.3 Lifestyles of health and Sustainability (LOHAS)

The concept is based on the work of US sociologist Paul H. Ray. LOHAS consumers' lifestyle and purchasing decisions are informed by their values regarding personal, family and community health, environmental sustainability and social justice. These values and attitudes are driving the markets for products as diverse as renewable energy, solar hot water, organic foods, recycled and sustainable homewares, domestic rainwater tanks, sustainable timbers, natural cleaning products, alternative medicine, yoga and eco-tourism.

LOHAS contributes to the concept of circular economy by ensuring that products are used keeping in mind the aim of reducing the adverse environmental and social impacts. LOHAS aims at moving consumers from being purchasers to participants for making a difference in terms of environmental and social impact of the product. Personal action plan should start with finding and knowing more about the environmental and social impact of the product during manufacturing, use and end of life. For example, if we use a television we can find what all metals, minerals and other substances were used to manufacture it and what was the environmental and social impact of the product.

LOHAS contributes to the concept of circular economy by ensuring that products are used keeping in mind the aim of reducing the adverse environmental and social impacts.LOHAS aims at moving consumers from being purchasers to participants for making a difference in terms of environmental and social impact of the product.

Personal action plan should start with finding and knowing more about the environmental and social impact of the product during manufacturing, use and end of life. For example if we use a television we can find what all metals, minerals and other substances were used to manufacture it and what was the environmental and social impact of the product.LOHAS consumers actively seek green and sustainable products, support the principle of reduce, reuse and recycle in their day to day life and purchase decisions. Therefore, after the product's impact is know the person should compare the impact of this product with that of similar products available in the market. He or she should actively ask questions about the environmental management system and recycling program of the company. After comparison the consumer adopting LOHAS should opt for the most eco-friendly and recyclable product even if it costs slightly higher. For example, given a choice that you can buy a computer with 50% less harmful materials and made out of recycled plastic, you should buy it even if it is costing more than the computer with high percentage of harmful material and on use of recycled plastics. For tackling e-waste challenge LOHAS consumers should demand from manufacturers that products should be made with minimum amount of harmful substances and they should ensure that e-waste is collected and managed in an environmentally and socially responsible manner. This will motivate the companies to change their manufacturing process to more sustainable options and implement recycling programs.

To do Activity :

Illustrate with examples what changes you will make in your lifestyle

Write about your current life styles choices

Write about your future lifestyle choices

5.4 Carbon footprint

The total amount of greenhouse gases produced to directly and indirectly support human activities, usually expressed in equivalent tons of carbon dioxide (CO_2). **Global warming**, also referred to as **climate change**, is the observed century-scale rise in the average temperature of the Earth's climate system and its related effects. Multiple lines of scientific evidence show that the climate system is warming.In other words: When you drive a car, the engine burns fuel which creates a certain amount of CO_2, depending on its fuel consumption and the driving distance. (CO_2 is the chemical symbol for carbon dioxide). When you heat your house with oil, gas or coal, then you also generate CO_2. Even if you heat your house with electricity, the generation of the electrical power may also have emitted a certain amount of CO_2. When you buy food and goods, the production of the food and goods also emitted some quantities of CO_2 (TFC (2016)).

India is the third highest emitter of CO_2 in the world. India is, however, conscious of its global responsibility, and in December 2009, it announced that it would reduce the emissions intensity of its GDP by 20 to 25 per cent, from the 2005 levels, by the year 2020. This voluntary commitment, which India has made to the international community, shows India's resolve to ensure that its growth process is sustainable and based on low carbon principles.

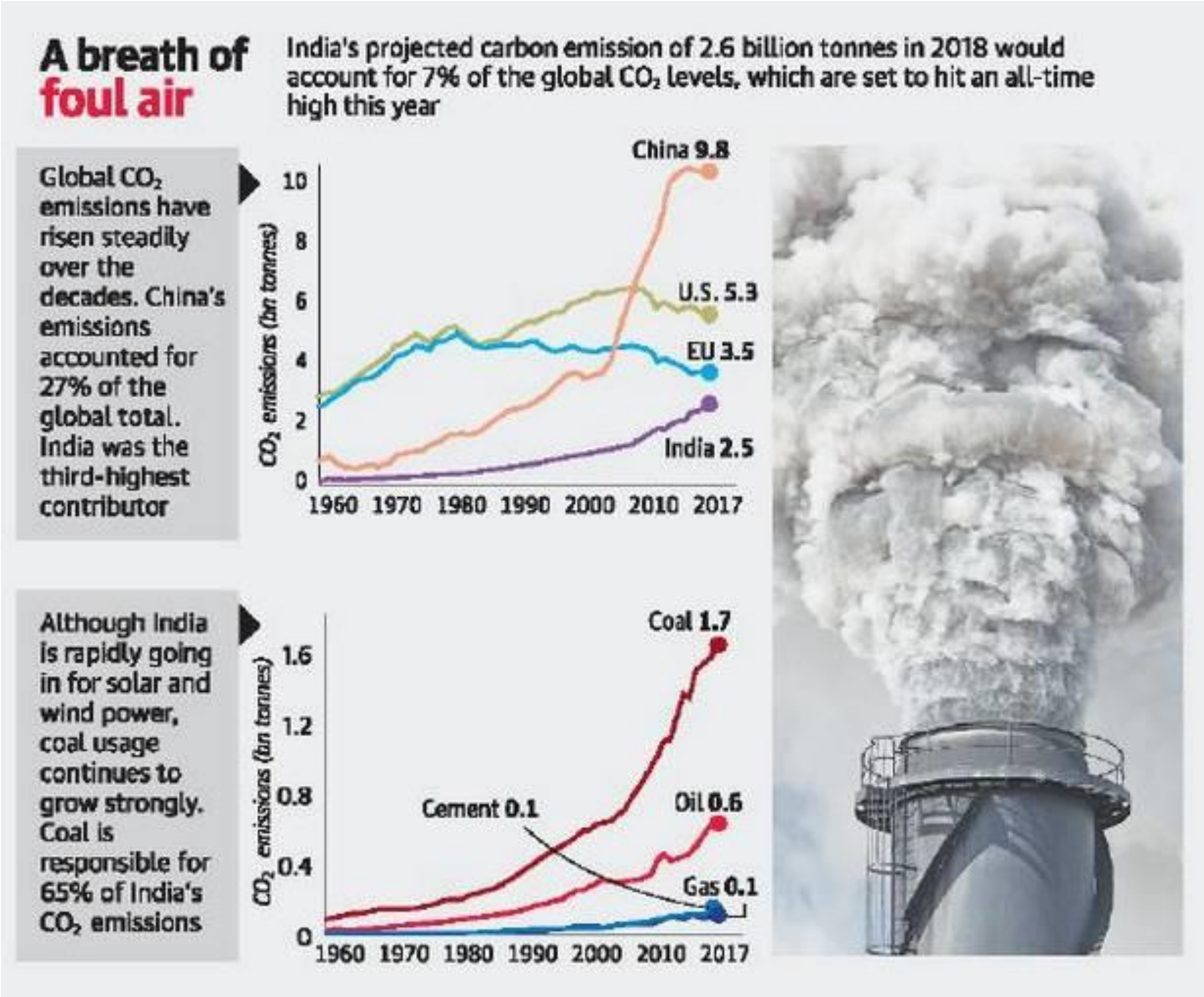


Fig 5.9 Global Co2 emissions

The 10 biggest emitters in 2018 are China , US , India , Russia , Japan, Germany , Iran, Saudi Arabia , south Korea and Canada.

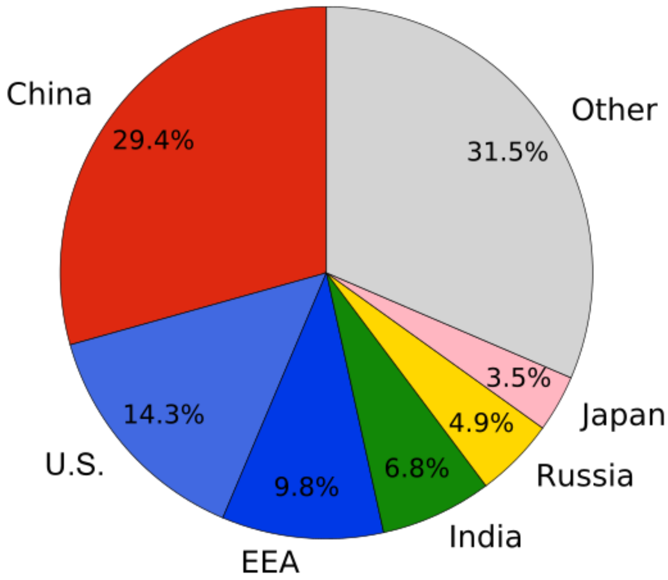


Fig 5.10 Percentage of carbon footprint across countries

https://byjus.com/free-ias-prep/upsc-syllabus-topic-carbon-footprint

To Do Activity
Film Screening, Analysis and Discussion on the Carbon Footprint film

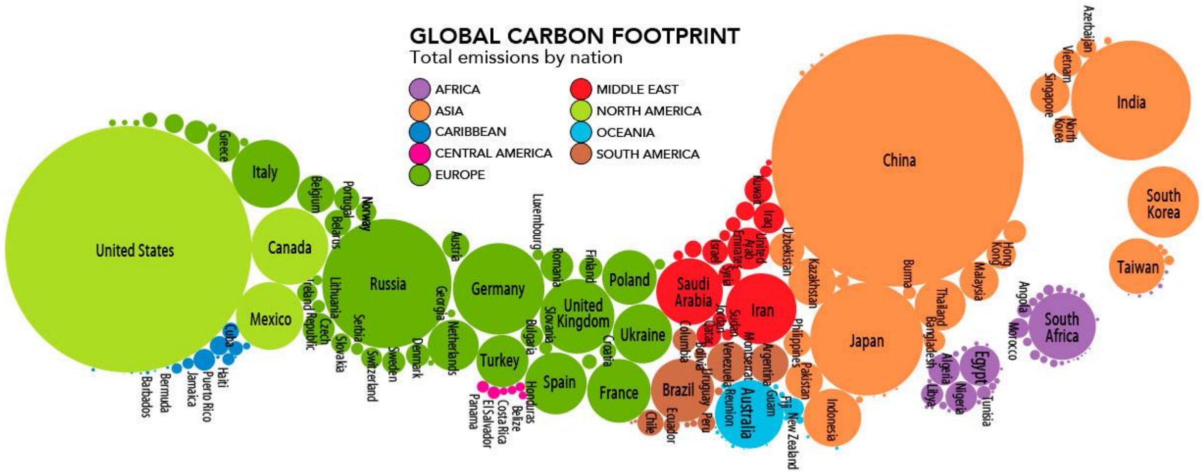


Fig 5.11 Global carbon footprint

India is amongst the 10 countries with the highest number of deaths due to pollution

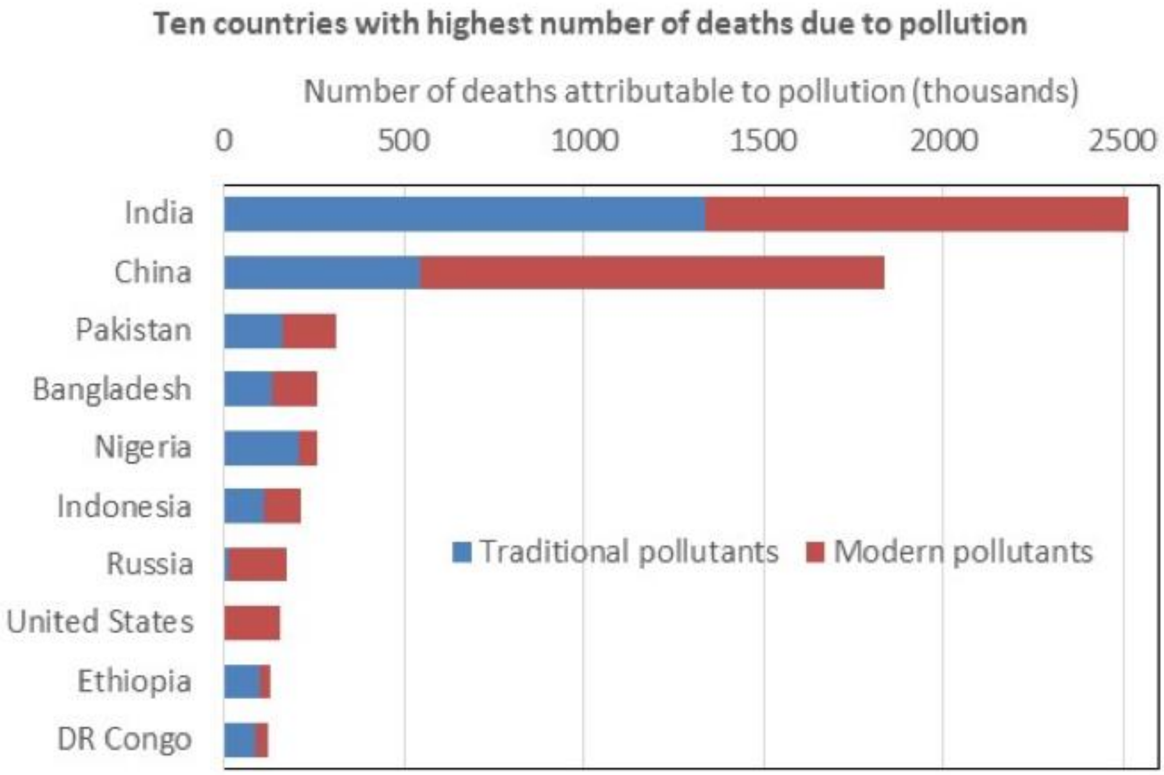


Fig 5.12 Ten countries with highest number of deaths due to pollution

Fig 5.13 Tips of reducing carbon footprint

To Do Activity
Prepare a list of things you will do to reduce your personal con footprint

5.5 Personal action plan- Issue opportunity that E-waste can provide to the youth?

India's youth population and the demographic dividend has been getting attention for several years now mainly because it is seen as one of the key sources of future economic growth in India. The youth segment of the population (15-34 age group) is projected to peak at 484.86 million in 2030. This has important implications for the labour market. According to official data, India's labour force, is expected to be around 653 million in 2031, and as per the Indian Labour Report, 300 million youth would enter the labour force by 2025, and 25 per cent of the world's workers in the next three years would be Indians. This has important implications for the labour market. According to official data, India's labour force, is expected to be around 653 million in

2031, and as per the Indian Labour Report, 300 million youth would enter the labour force by 2025, and 25 per cent of the world's workers in the next three years would be Indians.

Fig 5.14 Business idea in e-waste Management

To Do Activity

Develop an Action Plan for your e-waste Action project

- State in which fields of e-waste management you want to take action
- Formulate targets you want to
- For each target, specify indicators which you can use to measure whether the target has been achieved
- For each measure, specify other stakeholders need to be involved
- Also specify for each measure, which resources will be required
- Finally, think about a timeline for implementing the action plan.
- Prioritize the measures, think about dependencies between them and be realistic.

To do Activity

Develop a business plan for your idea

Sample Business Plan Format

1. Business Overview

a. Name of the firm, project, location

b. Description of the business - Aim, Objectives, Expected Results & Business Model

c. Social and business problems addressed by business idea

d. Major Demographic, Economic, Social and Cultural factors influencing business

2. Market Analysis

a. Describe Products/Services to sell in detail

b. Describe overall market

c. Describe target market

d. Describe competition and other players – Present demand and supply of product/service

3. Marketing & Sales Plan

a. Pricing and distribution channels

b. Advertising & Promotion Plan – Describe USP (Unique Selling Point/Differentiator)

c. Customer service policy

4. Business Operations

a. Describe Production Process/Service Process step by step (Raw Material – Finished Good) + Process Flow Chart

b. Technical know-how availability

c. Describe the following (Details + Amount/Value)

i. Land & Building

ii. Machineries/Equipment

iii. Misc. fixed assets

iv. Preliminary & Pre-operative expenses

v. Working Capital

d. Total Cost of Project = Fixed Assets + Working Capital + Preliminary Expenses

e. Means of Financing: Own Investment/Term Loan/Working Capital Loan/Any Other

5. Team Description

a. Entrepreneur’s Name, Age and Educational Qualifications

b. Special Training (if any) and work experience

c. Entrepreneur’s annual Income + value of assets owned (Movable + Immovable)

d. Story of entrepreneur + Inspiration for the business

e. Key advisors

f. Description of other team members

6. Financial Projections

a. 12-month (up to 3 years) Sales Forecast

b. Monthly Operating Budget

i. Raw Materials, Utilities, Wages

ii. Repairs & Maintenance

iii. Selling & Distribution Expenses

iv. Administrative Expenses + Interest & Depreciation

c. Monthly Gross Profit/Net Profit

d. Calculation of Break Even Point (BEP)

Summary

The rate at which the E-waste is being generated requires us to re-imagine the entire e-waste value chain., adopt principles and practices of circular economy that is base on the principles of reduce, reuse and recycles so that less hazardous substances enter the ecosystem. In order to implement the principle of circular economy, manufacturers across sectors need to adopt this principle which can inform their product design and development by adopting green technologies that will contribute towards sustainable development. The principle of circular economy preserves and enhances natural capital, optimises resource yields, and minimises system risks by managing finite stocks and renewable flows.

Model Questions

1. What is the difference between circular economy and linear economy?
2. Explain the principle of 3Rs.
3. Illustrate with examples the life style choices that promote sustainable development
4. What are the 3 actions you will undertake to reduce your carbon footprint?

References

- Baldé, C.P., Wang, F., Kuehr, R., Huisman, J. (2015), The global e-waste monitor – 2014, UnitedNations University, IAS – SCYCLE, Bonn, Germany, http://i.unu.edu/media/ias.unu.eduen/news/7916/Global-E-waste-Monitor-2014-small.pdf

- Chaturvedi, Saha ,Bhatt (2018) Recycle Bin Managing E-waste in India , Ministry of environment, Forests and Climate Change

- Chatterjee , Dr. S. 2011: Electronic Waste and India , New delhi : Department of Information technology

- Cucchiella, Federica, D'Adamo, Idiano, Koh, S.C. Lenny, Rosa, Paolo, (2015), Recycling of WEEEs:An economic assessment of present and future e-waste streams, Renewable and Sustainable Energy

- Ellen Macarthur Foundation, (2015), Concept of circular economy http://www.ellenmacarthurfoundation.org/circular-economy/overview/concept

- Indian Ministry of Environment and Forests & Climate Change 2015. E-waste (Management) Rules,2015.http://www.indiaenvironmentportal.org.in/files/file/notified%20ewaste%20rule%202015.pdf

- Lines, Garside , Sinha , Fedorenko Clean and inclusive? Recycling e-waste in China and India

- Natural Marketing Institute, (2007), Understand the LOHAS Consumer. http://www.lohas.se/wpcontentuploads/2015/07/Understanding-the-LOHAS-Consumer-11_LOHAS_Whole_Foods_Version.pdf

- Rajya Sabha Secretariat 2011: E-waste in India. New Delhi http://rajyasabha.nic.in/rsnew/publication_electronic/E-Waste_in_india.pdf

- WEEE Recycle & CSE. E-Waste Training Course for Policymakers and Regulators – Facilitator'sManual,http://www.igep.in/live/hrdpmp/hrdpmaster/igep/content/e54413/e54441/e62968/WEEERecycleCSEmanual.pdf

Editors' Profile

Dr W G Prasanna Kumar

Dr. W. G. Prasanna Kumar, PhD in Education with basic degree in Social Work and Master's Degrees in Sociology, Public Administration and Political Science has professional education in Environmental Economics, Public Relations, Communication and Training and Development. Presently Chairman, Mahatma Gandhi National Council of Rural Education (MGNCRE) under the Ministry of Human Resource Development, in Government of India strives to promote resilient rural India through Higher Education interventions. The national initiative of reviving Mahatma Gandhi's ideas of Nai Talim, spearheaded by Dr. W G Prasanna Kumar, has met unprecedented success at both national and state levels. The primary objective of this initiative is to promote Gandhiji's ideas on Experiential Learning, NaiTalim, Work Education and Community Engagement, and mainstreaming them in School Education and Teacher Education Curriculum & Pedagogy. As Professor and Head Centre for Climate Education and Disaster Management in Dr MCR HRD Institute, conducted several capacity building and action research programmes in climate education, disaster management and crowd management. He has handled many regional, national and international environmental education programmes and events including UN CoP11 to Convention on Biological Diversity and Media Information Management on Environmental Issues.

He was Director in National Green Corps in the State Government for over 11 years and Senior Social Scientist in State Pollution Control Board for 6 years. Conducted various curriculum and non- curriculum related training programmes in environmental education. He was a Resource Person for AP Judicial Academy, AP Police Academy, AP Forest Academy, EPTRI, Commissonerate of Higher Education and Intermediate Education, State Council for Educational Research and Training and National Council for Educational Research and Training New Delhi, CCRT, Bharathiya Vidyapeet University Pune, CPR Environmental Education Centre Chennai and Centre for Environment Education Ahmedabad. Dr W G Prasanna Kumar was trained in Community Consultation for Developmental Projects in EPA Victoria Australia in 1997 trained as State Chief Information Officer by IIM Ahmedabad and MCRHRDI Government of Andhra Pradesh in 2004 and trained in Environmental Education and Waste Management Technique by JICA, Japan in 2011.

He was awarded Best State Nodal Officer of National Green Corps Award from Centre for Science and Environment, New Delhi, 2008, Jal Mithra Award from Earthwatch Institute of India and Water Aid New Delhi, 2014 and Certificate of Commendation for the services in UN Conference of Parties to Convention for Biodiversity conducted at Hyderabad from 1-20 October 2012 by the Government of Andhra Pradesh 2012.

Dr K N Rekha

Dr K N Rekha, is a PhD Graduate from IIT Madras. She has 13 years of experience in training and education Industry. She works at Mahatma Gandhi National Council of Rural Education (MGNCRE), Hdyerabad as Academic Consutlant. She is involved in curriculum development on Rural Management and Waste Management. Prior to this, she worked as a researcher at Indian School of Business, Hyderaba, a short stint at Centre for Organization Development (COD), Hyderabad. She has Co-authored a book on "Introduction to Mentoring", book chapters, Peer reviewed research papers, book reviews, Casestudy, and caselets in the area of HR/OB. She also presented papers in various national and international conferences. Her research areas include Mentoring, Leadership, Change Management, Coaching, 360 Degree Feedback appraisal, etc. She was also invited as a guest speaker at proiminent institutions like IIT Hyderabad.

Author's Profile

Dr R Balamurali Krishna

Dr. R Balamurali Krishna is a Socio technologist at My Prof, Center for Development of Block chain Technology (CDBT). Having Doctorate in Social Work (Digital Humanities), he has published various research articles in e-governance, social work and research pedagogy. His research article on GIS and e-Governance was selected twice as best at the national conference on e-governance, Ministry of DARPG, Govt. of India. His focus areas of research include rural community development, rural social work, e-governance and 4th industrial revolution arenas. He has worked as Consultant in Tamil Nadu e-Governance, Dept. of Information Technology, Govt. of Tamil Nadu.

Dr Anupma Harshal Wadavlikar

Dr Anupma Harshal Wadavlikar is an educator with a teaching expertise of 17 years and a certified trainer for STEM for training teachers on Research Based Pedagogy. She is a UGC-CSIR Scholar and has accomplished her Doctoral thesis from Hindustan Lever Research Centre in collaboration with Topiwala National Medical College &B. Y. L. Nair Hospital, Mumbai. She has tutored, mentored and been a research guide to UG, PG students at Kishinchand Chellaram College, Mumbai University. She adds to her credit 11 research projects with her Undergraduate students with varied research interests that have received funding from the Mumbai University, UGC and other private labs.During her tenure at the college she was an articulate member of the grant applications for STAR DBT Funding, NAAC and others. She has been the co-ordinator of the Science Honors Program an Innovative UG Research initiative at the College. She served as the convenor of the Inter Collegiate Research Scholars Meet for several years. She has contributed to several regional RBPT workshops (funded by DBT / DST and CoESME, IISER Pune) across the country under this initiative, as a subject expert /observer.She was also associated as a resource person and for content development in pedagogyworkshops in regional language Marathi for science teachers from government schools of Maharashtra, conducted by CoESME, IISER Pune. She is a reviewer for several International Journals and has also reviewed a few books on Pedagogy. She is presently working on the Project funded by the Ministry of Science and Technology under the Indo-US Fold scope Grant.

Dr Anamika Gulati

Dr Anamika Gulati completed her B. Pharm. and M. Pharm. from Panjab University, Chandigarh. After completing post-graduation in 2007, she joined Heron Health Pvt. Ltd. to pursue a career in Health Economics and Outcomes Research. In August 2013, she joined Novartis Health-care Pvt. Ltd. as Senior Scientific Writer, responsible for transferring the clinical trial data from labs and hospitals to manuscripts, conference abstracts, and posters. Along with her professional career, she followed her dream to attain the Doctorate degree. She completed her PhD in 2018 in Biomedical Waste Management. During the educational and professional journey, she have 12 conference presentations (5 International and 7 National) along with 7 publications in National and International Journals.

Ms Sonal Chaturvedi

Ms Sonal Chaturvedi has developed multiple curricula using experiential learning principles and design concepts such as Donna E-walkers learning cycle, the ADDIE model and Kolb's model etc. She has a decade of experience across sectors in the area of content development and delivery. She has been associated with the Ministry of Electronics and Information Technology (MeitY) initiated project titled "Awareness program on environmental Hazards of Electronic waste" for more than 3 years. She was a part of the content development team, where she has co-authored 7 manuals to create awareness on environmental hazards of electronic waste for multi-stakeholders like Schools, Colleges , RWAs, Informal sector, NGOs, Bulk consumers and Dealers. All the manuals are available on the ministry website www.greene.go.in . As part of the implementation team she conducted one Master Trainer Development Workshop in Delhi and seven Trainer Development Workshops in 7 Cities across India for building the capacities of more than 350 trainers to create awareness amongst multi-stakeholders.

ISBN 978-81-940618-2-3

9 788194 061823

₹ 750

Mahatma Gandhi National Council of Rural Education (MGNCRE)

Department of Higher Education

Ministry of Human Resource Development, Government of India

सत्यमेव जयते

Where there is Rural Wellbeing there is Universal Prosperity

040 - 2321 2120

admin@mgncre.in
www.mgncre.in

#5-10-174, Shakkar Bhavan, Fateh Maidan Lane,
Band Colony, Basheer Bagh,
Hyderabad-500004