

# TODAY'S ELECTRONIC GADGETS TOMORROW'S ELECTRONIC WASTE - E- WASTE MANAGEMENT FOR SMART CITIES THROUGH INTERNET OF THINGS

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## Abstract

Internet of Things (IoT) contributes for the efficient e-waste management system within smart cities across the globe. Efficient waste collection is considered as a fundamental service for smart cities. Internet of things can be applied in smart cities forming an advanced platform for novel applications. In India, at present 429 million people dump 62 million garbage per year, out of which 8.9 million are hazardous wastes. Approximately, 14% of hazardous waste is e-wastes. At present, the waste collection system aims to provide high quality of service to the citizens of a smart city, but focus to e-waste management is least. Proper awareness about e-waste as well as e-waste management is need of the hour. While the whole country is marching towards the successful vision of smart cities for better live hood of citizens in all aspects, it is a must for us to learn, evaluate and implement the best global practices in e-waste management. Keeping this as objective, authors of this paper try to throw light on the best e-waste management practices implemented and adopted using IoT across the globe.

**Key words:** E-waste management, smart city, internet of things, waste management, etc.

## 1. Introduction

E-waste or electronic waste is created when an electronic product is discarded after the end of its useful life. Electronic waste or e-waste may be defined as discarded computers, office electronic equipment or end of life entertainment device electronics, mobile phones, television sets, and refrigerators. This includes used electronics which are destined for reuse, resale, salvage, recycling, or disposal as well as re-usable. The term "waste" is reserved for a material which is dumped by the buyer rather than recycled, including residue from reuse and recycling operations, because loads of surplus electronics are frequently commingled. On the other hand, internet of things is a system of physical things embedded with sensors, software, electronics and connectivity to allow it to perform better by exchanging information with other connected devices, the operator or the manufacturer.

## 2. Smart cities

Information and communication technology are revolutionizing environmental services. The growing range of 'big data' available and increases in capacity have made it possible to create systems in which all stakeholders can interact in real-time to optimize network operations.

**Key challenges of smart cities:** Infrastructure, security and hackers, privacy concerns, educating and engaging the community, and being socially inclusive.

**Challenges of waste management:** Globally trades due to 60% recyclables; presence of toxic and valuable metals; high cost for repair and comparatively low cost of electronic items; recycling expensive; less space in landfill; and lack of proper regulation.

**Smart waste management:** Smart waste management companies have recently developed solutions based on the ultrasonic distance measurement. Some companies prefer to approach to the problem with an alternative solution using image processing and camera as a passive sensor. However, majority of these solutions use ultrasonic sensor for measurement of the distance.

**Robotic lampie:** Most robots are used to repetitive actions considered too dangerous for humans. Artificial humans are believed to bring that balance move beyond in the urban space. Robots have limited battery life and perform simple tasks like shifting from any side. Top 3 smart cities in working of robots are: Tokyo, Singapore and Dubai.

## 3. Recycling of waste

Recycling of trash is a complex task. Obstacles that may be encountered in implementation of this task are as follows: Recyclables are distributed throughout the city and collection of recyclables and other materials is complicated; the city trash and recyclable materials are generated not only in every home, building and production facilities, but also in public spaces; and each recyclable has a different strategy for the end of life. The good news is that you have plenty of options for properly recycling or donating used electronics.

**Use a certified e-waste recycler:** Find an e-waste recycler certified through the Basel Action Network (BAN). BAN is a non-profit organization devoted to certifying e-stewards, recyclers who are committed to safely and responsibly recycling electronics. Members take and demonstrate the pledge of responsible recycling, so working with a certified e-steward means you don't have to worry that your gadget will become another nation's pollution or a criminal's newest project. BAN's recycler locator will help you find the certified safety and comfort of e-stewards in your area.

**Visit civic institutions:** Check with your local government, schools, and universities for additional responsible recycling options. With e-waste becoming such a large problem, government offices and schools are assigning days when citizens can bring unwanted electronics to a designated drop-off location. Many communities post a calendar that will include recycling days, so check your local paper or visit their website. When you recycle your items locally, you can make the occasion a day trip and a community event. Encourage your neighbours to join you and spread the word about educated e-waste disposal.

**Explore retail options:** Best buy, for example, isn't certified through BAN's e-steward program, but they do have an effective recycling program in all of their stores. They claim to only use recyclers who adhere to the highest standards of e-waste processing.

#### 4. Reusing waste

Instead of carefully discarding, we can recycle to make new products. This reuse involves using the item in another way, when their primary use is finished. It is useful and remains in circulation in garbage pile in a landfill. There are many ways to reuse: using durable coffee mugs; using cloth napkins or towels; refilling bottles; reusing boxes; and purchasing pens and incredible products. The environmental impact of the processing of different electronic waste components is as follows:

E-Waste Component	Process Used	Potential Environmental Hazard
Cathode ray tubes (Used in TVs, computer monitors, ATM, video cameras, and more)	Breaking and removal of yoke, then dumping	Lead, barium and other heavy metals leaching into the ground water and release of toxic phosphor
Printed circuit board (Image behind table – a thin plate on which chips and other electronic components are placed)	De-soldering and removal of computer chips; open burning and acid baths to remove metals after chips are removed.	Air emissions and discharge into rivers of glass dust, tin, lead, brominated dioxin, beryllium cadmium, and mercury
Chips and other gold plated components	Chemical stripping using nitric and hydrochloric acid and burning of chips	PAHs, heavy metals, brominated flame retardants discharged directly into rivers acidifying fish and flora. Tin and lead contamination of surface and groundwater. Air emissions of brominated dioxins, heavy metals, and PAHs
Plastics from printers, keyboards, monitors, etc.	Shredding and low temp melting to be reused	Emissions of brominated dioxins, heavy metals, and hydrocarbons

## 5. Ways to reuse electronic wastages

The latest Global E-Waste Monitor places India as one of the highest contributors to global e-waste, generating over 2 million metric tonnes in 2016. Posing serious health and environmental risks, growing e-waste represents the hidden cost of increasingly digital lives in an information society.

**Enjoy your very own cloud/digital storage space:** The older iPods that have exhausted its song list are ideal for getting more storage on the go. For Apple products, simply plug the device in and press 'enable disc use.' It turns into a fully functional portable drive. You can transfer songs, movies, files, and more. You can even turn it into a backup storage drive for all your files.

**Get eyes everywhere with recycled surveillance cameras:** Your old web camera can easily be re-purposed into a surveillance camera. Many of the latest devices come with built-in cameras, so many of the web cameras go to waste. Extracting the camera is an effective way to reuse these old devices and save some money.

**Add a screen to your work space:** Those of you in need of a second monitor can easily make use of an old unused laptop. Detach the screen part of the laptop and use some technical whiz to make this an additional monitor. This might require more technical knowledge, but it definitely pays off when you are working on a tight deadline and in a tight budget.

**Reuse and re-purpose to create everyday essentials:** There are many ways to refurbish old electronics into handy everyday household items. Gluing together old batteries are great anchors and platforms in a workshop, key pieces from an old keyboard make a simple stand for toothbrushes or paperclips. Make use of electronic chips to decorate a photo frame or even make one. Jewelry can be made from batteries, electronic chips, and much more, just put in a little bit of creativity and time into each re-purpose project.

**Rethink the way you display family memories:** Take the CDs and break them into small pieces; take extra caution while doing this. Now you can glue the pieces together in a shape or design you prefer and put in some photos. You can hang up the disk on the wall or prop up the disk on a counter. These also make a unique gift for your loved one too.

**Make modern and trendy coasters:** The easiest way to reuse any device which is flat and on the smaller side is turning it into a coaster. CDs, floppy disks, you name it...just a can of spray paint is enough to brighten it up. Now have a pile of coasters ready when guests come over. These make excellent party decorations. Serve up that ice tea this hot summer without fear of glass stains all over your coffee table.

**Save the world and plant something:** Try this out to freshen up your work space or kitchen counter. Take four floppy disks and make it into a container, use an empty yogurt jar to place the plants in it. Place the plant in the floppy disk container and you will have your floppy disk planter. Get creative and see what else you can reuse in this same way. That extra boost of oxygen will definitely go a long way!

**Create flashy key chains:** Make yourself unique key chains out of old electronic chips, keys from a keyboard etc. Get a ring from a local hardware shop and attach it to your item of choice. Ring your keys on this unique keychain and be sure to never lose them again.

## 6. IoT will be leading more e-waste in future

An increase in IoT devices will also lead to more e-waste. However, the extent to which this e-waste will impact the environment will depend largely on how electronic recyclers innovate their processes and services. In 2018, the number of IoT connected devices is greater than the world population. This number will surpass 10 billion by 2020 and may rise to 30 to 50 billion by 2030. That may seem alarming, but what's even more shocking is the potential environmental impact these devices could have. Consumers are often excited to explore all the cool things they can do with their new devices, but rarely think about what happens after the device's disposal. Just like the millions of devices that have been released in the past few years, "Smart" devices are subject to Moore's Law and become obsolete very quickly. As more people replace their old devices, the need for electronics recycling will grow. It is good idea for recycling and demanding IoT devices all over India. Moore's Law allows all manner of electronic devices to conduct real world tasks like computing your business taxes, piloting a spaceship, or changing the television station almost as fast as they did back in the 1970s, when operating systems were trillions of times. It is the failure law, it will be increasing and demand in high fast in 2030 year.

## 7. Innovations to reduce e-waste and landfills

**BMW's gas-to-energy project:** Methane gas produced as a result of decomposition represents one of the most harmful byproducts of landfills. Methane is a potent greenhouse gas, and it has a destructive effect on the ozone layer. Sensing an opportunity, the BMW Corporation partnered with both the Energy Department and the South Carolina Research Authority. Through this collaboration, researchers created innovative fuel cells powered by hydrogen converted from methane gas. Representatives at a Greer, SC manufacturing plant use the new fuel cells to power a large fleet of forklifts. BMW expects the new source of fuel to reduce labour costs related to refueling by 80%. Additionally, they anticipate requiring 75% less space for equipment compared to lead-acid based batteries.

**Dissolvable batteries:** At Iowa State University, researchers explore alternatives to the common battery. Batteries are one of the hardest electronics to responsibly dispose of. Over the years, research on decomposing batteries has stalled due to their low power density. As a result, research shifted to a "hybrid", a small lithium-ion battery that is capable of delivering 2.5 volts of power. This new hybrid will also dissolve in water within 30 minutes. Although dissolvable batteries have nano particles that do not degrade, they safely disperse into the environment. Though the project has not yet begun testing, it is a major breakthrough towards decreasing the amount of e-waste sent to landfills every year.

**Silicone circuit boards:** Aside from batteries, scientists also strive to make other common electronics soluble as well. After discovering that silicon is water soluble in 2012, researchers looked to use that new knowledge for good. One new innovation involves a common 1 mm thick circuit board that will dissolve in a landfill within 3 to 6 months. Professor John Rogers, a project lead at the University of Illinois, stated that around 12 research groups around the world are making "really substantial" efforts in the area. Bury trash, burn it or dump it in the ocean. For too long, this has been the popular approach to waste management. Trash can no longer be an "out-of-sight, out-of-mind" issue. Improved levels of recycling and composting, and innovations such as the ones above, are critical. Less trash in landfills means a more sustainable future.

## 8. IoT in 2019, platforms will proliferate

- In 2019, we will see the major players, such as utilities, insurance, and grocery and food companies, take a different approach with ongoing services enabled by smart devices.
- In 2019, the term 'IoT' will take a back seat in the marketing lexicon, with vendors of these solutions reverting to language that describes business solutions and outcomes, such as 'real-time asset performance monitoring and a combination of IoT, data, analytics, workflow, business process, and insight with recognizable and quantifiable value.
- We will see IoT platform vendors narrow their focus on specific use cases and tout their APIs and capabilities for integration with enterprise applications, analytics, and security management.
- In 2019, we expect to see more targeted ransom ware attacks against vulnerable components of successful smart city implementations. These hacks will cause disruptions to citizen services and will force cities to invest in cyber security defences to minimize the risk of further attacks.
- In 2019, we will see the emergence of an IoT 'run' market to help manage, monitor, and operate the fragmented array of IoT networks, devices, and assets.

## 9. Conclusion

E-waste is a relatively new segment in the global problem of waste removal. It is also the fastest growing segment worldwide in discarded waste. This growing problem in the world is largely ignored or misunderstood. Many people do not understand what it is or how it affects them, the world, or the environment. E-waste comes from the improper disposal of any number of electronic devices. These devices include computers, televisions, cell phones, or most other electronic equipment.

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