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IoT : Internet of Things or Internet of Trash : A Survey

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ABSTRACT

The Internet of Things is an extension of Internet in which the large number of 'things' including sensors actuators and processors, in addition to human users, are connected and able to provide accurate data on their surroundings and also to exercise a degree of control over it. It is still in the stage of development, and many problems/research challenges must be solved before it is widely adopted. Many challenges are of from technical side which includes interoperability and scalability. In business world deciding on how to invest in the IoT is a challenge as billions of heterogeneous devices will be connected. Some of the challenges which must be resolved are also major social, legal and ethical challenges, including security and privacy of data collection. As the future IoT will be a multi-national, multi-industry, multi-technology infrastructure, the paper reviews the impact IoT have in the E-Waste. The main purpose of the paper is to give a broad survey, based on published literature, articles published on the Internet and some suggestions which may assist in dealing with the E-Waste. It is the time to address the problems that will lead to more E-waste due to IoT because IoT turns out to be the part of everyday life and the analysts are predicting 'IoT with AI' is the Future. So 'impact of IoT in E-waste' has its technical and non-technical research challenge.

Keywords : Looming,IT asset disposal (ITAD),Stopping the E-waste Problem (StEP),wireless sensor nodes (WSNs),Centre for Environment and Development for the Arab Region and Europe (CEDARE),International Telecommunication Union (ITU)

I. INTRODUCTION

Hundreds of papers have been written on the IoT and E-Waste mostly dealing with the technical and non-technical research challenges, but the increase in adoption of IoT in business also deals with the legal, social and ethical problems in a business ecosystem. Few single papers discuss both research challenges of the E-waste in IoT on an equal footing. Regarding the IoT as a whole package requires knowledge from many technical and non-technical disciplines and the fields like domestic, business and personal fields to which the IoT is or will be applied. But most of everybody ignores the cause and effect of IoT in the E-waste. Because more IoT means more waste, obviously. Thus writing about the IoT and E-waste from a holistic perspective is needed to be done. The aim of this paper is to identify the involvementof IoT in E-Waste. The research approach we take is, in part, a survey of existing papers and articles from Internet which apply to IoT and E-waste. The paper does not present any detailed "solutions" to the problems/research challenges, but does try to give some idea of what might be involved in the future to

apply for reducing E-waste from IoT. The website we referred and its URL are also included in this paper if somebody needs further clarification.

II. LITERATURE SURVEY

Most papers discuss about how IoT helps in managing many types of waste or making it smart. Along with that this paper tries to open up a little insight on the E-waste which is going to be cumulated by the revolution of IoT. It is a challenge to be addressed just like the other E-waste sources like computers or mobiles or other electronic equipment items. Revolution of IoT definitely did a good work on all the other areas of waste management but it also pile up in the e-waste section because the "connected things" are usually communicate by sensors and other electronic devices.

2.1 The world of the Internet of Things opens the world to more E-Waste.

"According to the forecasts of Ericsson's former CEO Hans Vestburg in 2010, more than 50 billion devices and machines would "talk" to each other by 2020. That is about six times the total population of the earth. According to the estimation of IBMmore than one trillion devices would be connected in the cloud by 2030.

By 2040, the present number of more than one billion cars is expected to be doubled and share of electric vehicles could be 20-50 percent more. Growth rates for (smart) household appliances in countries such as India and China are over 10 percent. And on other side, the horrendous amount of (IoT) E-waste that arises when new models and latest versions arrive and the existing equipment goes into retirement. The vast number of sensors and lithium batteries required in a rapidly growing market for electric vehicles, driverless cars, smart phones, energy storage devices – as well as rare earths for sensors and printed circuit boards for computers and CCTVs – require a rethink.

The CEO of SoftBank Group Corp, predicted that within in the next 25 years, there will be a trillion connected devices throughout the world and orbiting the planet**in 2016**. The investment in Arm Holdings, the chip-design company, which is profiting from increased demand for battery-sipping chips meant for low-compute jobs spurred. Arm's microcontrollers are now common insidewatches, rings etc and sensors on industrial equipment.As we are making the "Things" smart, we are also adding these "things" to the E-Waste which is not so smart. In 2016 the United Nations endowed that people generating about 44.7 million metric tons of e-waste globally and expects that to grow more than 52.2 million metric tons by 2021.

For example, the sports equipment company Wilson, makes a Bluetooth connected basketball. The challenge of putting a replaceable battery inside without messing up the overall performance was too great, leading the engineers who built it to throw up their hands and say when the battery fails so does the connectivity also.

Another example, Spire makes an adhesive wearable that tracks activity levels, breathing etc, with a battery that dies after about 18 months. Cofounder and CEO Jonathan Palley hopes consumers will ship the device back to the company when that happens. The company has designed each of the components inside the device's flat, 5.3 by-3.2cm enclosure to be easily taken apart for recycling.

Palley says it was a challenge to find glues that would allow the wearable to be machine-washed. Making something to become waterproof and easy to disassemble takes a lot of engineering works. The most companies that developing IoT products aren't spending that kind of effort on original design, however, some are creating recycling programs, as the challenges associated with e-waste are better understood. For example, Dell uses approximately 3,000 kilograms of gold in its computers and servers

each year, and some of that is recycled from other Dell products.

Such programs make for good PR. But as we embed toxic and precious metals into more and more devices, the tech industry must start to design with sustainability and recyclability in mind. The process may start with the materials, but it should make that sure these goods have a long life.

2.2 The Internet of Trash: IoT Has a Looming E-Waste Problem

There are two issues. According to the consumer's requirement, producers are adding semiconductors to products that previously had none, and that leads to shortening the life of devices as we add more computing, turning products that might last more than 15 years into ones that must be replaced every five years. In fact, many small connected devices such as jewelry, trackers, or other wearables are designed to fail once the battery dies. At that point, the consumer tosses it out and prefer to buy another..

2.3 IoT Devices will Lead to More E-Waste in the Future

"Fitness armbands, Smart phones, smart watches, and other IoT devices have become more common in our everyday lives, and they will continue to play an important role in the future. An increase in internet of things (IoT) devices will also lead to more e-waste, however, the extent to which the e-waste will affect the environment will depend largely on how electronics recyclers innovate their services and processes.

In 2018 itself, the number ofinternet of things (IoT) connected devices is greater than the world population. This number will surpass over 10 billion by 2020 and may rise to 30 to 50 billion and more by 2030. That may seem alarming, but what's even more shocking is the potential environmental impact these devices could have.It's well known that most IoT devices have a lot of dangerous elements inside. This range from heavy metals such as lead, mercury, cadmium, and beryllium, to hazardous chemicals like brominates flame retardants. Improper disposal of these toxic substances not only causes damage to the environment, but they also affect the health of many communities.

Every consumers are often excited to explore all the cool things that they can do with their new devices, but rarely think about what happens after the device's disposal. Within 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, so that the need for electronics recycling will grow.

Electric cars may also chance of threat to the environment in the future. Currently, most electric cars use huge lithium-ion batteries. These batteries often have as much lithium as thousand smart phones, or even more, depending on the model. Eventually in future, these batteries will need to be replaced and that may create variety of challenges.UN estimates the value of precious metals from e-waste: gold, palladium and platinum, lithium, silver and similar – to be $60 billion. As the world becomes increasingly globalized and infrastructures improve, the demand for IoT devices in developing countries will also increase, leading to more demand for precious metals. "

This article is quoted from website securis.com. This is actually their page to promote their work than an article. Securis is an IT asset disposal (ITAD), data destruction and electronics recycling company located in Central Carolina, Central Maryland, Central New Jersey, Hampton Roads VA, Northern Virginia.

III. AS 'INTERNET OF THINGS' GROWS, SO DO E-WASTE CONCERNS

"The Internet of Things (IoT) will include some 30 billion connected devices by 2020, according to analyst firm Gartner. Although the IoT holds promise

for promoting global sustainability, there is a growing concern of what becomes of these devices when they reach end of life. Many end up in landfills because, when they are embedded in technologies and objects, it is almost impossible to recycle them.

In 2013, around 53 million tons of e-waste was disposed of worldwide, while around 67 million tons of new electrical and electronic equipment were put on the market, according to the United Nations University (UNU). The Stopping the E-waste Problem (StEP) initiative, a joint effort from UN organizations, grassroots groups and industry, predicts that by 2017 the total annual volume of e-waste will have risen by a third, to 65.4 million tons—nearly 11 times the weight of the Great Pyramid of Giza. Gartner says there is already a shift in manufacturing towards products and materials that are sustainably sourced, but there is still a need for industry to innovate around recent materials to produce sensors, that can be disposed of in a more environmentally friendly fashion.

IoT researchers from the Georgia Institute of Technology claim that a standardized GPS tracking capability and a universal identification system for devices, similar to the ISBN code used on books, could help to facilitate better end-of-life management. This could help to overcome the cost challenges of collection and recycling, and create new opportunities for the private sector, such as the recovery of rare-earth metals. It would also facilitate the enforcement of regulations restricting the use of certain hazardous substances. Untilmanufacturer's address this on their end, there will need to be a significant focus on the disposal process to prevent these devices and sensors from ending up in landfills.
Despite waste concerns, IoT (the internet of things) is still helping businesses reduce their carbon footprints. Global greenhouse gas emissions could be reduced by 9.1 billion metric tons by 2020, or 18.6 percent of all emissions in 2011, through the widespread adoption of machine-to-machine (M2M) technologies, according to a 2013 report by AT&T and the Carbon War Room. M2M (machine to machine) technologies can facilitate "smart grid" based implementations in the energy sector, optimize logistics and transportation, cut the energy footprint of buildings and slash greenhouse gas emissions in the agriculture sector.

The leading IT companies like Apple, Canon, HP etc are making major efforts to source sustainable, recycled materials for their products, it ultimately comes down to consumer purchasing choices.
Consumers or businesses should take into account the sustainable manufacture and design of the products when making a purchase choice. Considerations mainly includes, sustainable sourcing and recycling of materials, energy efficiency, sustainable supply chain and packaging, product design for environment and recycling.

In July, Dell, Intel and Samsung were among the six companies that came together to establish a new industry consortium focused on improving interoperability and defining the connectivity requirements for billions of devices that will make up IoT. The OIC(Open Interconnect Consortium) is focused on defining a common communications framework which is based on industry standard technologies to wirelessly connect and intelligently manage the flow of information among personal computing .

The above article is taken from www.nerc.org. It is the blog of NERC- North-East Recycling Council - is a non-profit organization that conducts research, hands-on projects, training, and outreach on issues associated with source reduction, recycling, composting, environmentally preferable purchasing, and decreasing the toxicity of the solid waste stream. Written by Mike Hower is Marketing Communications Manager at Carbon Lighthouse.

With a background on both sides of the communications podium — as a journalist and strategic communicator — he is committed to helping organizations address climate change through sustainability innovation.

3.1 E-waste and the Internet of Things

"The Internet of Things (IoT) was all the rage at the 2014 International CES, staged by the Consumer Electronics Association, in Las Vegas, United States, from 7 to 10 January. Essentially, IoT describes the integration of any object, whatever its size or nature, into the communications space.

Thanks to the timely convergence of many technologies, anything can now be reached and interfaced with, anytime, anywhere. This is fertile ground for application developers. But as electronics are increasingly embedded in the economic and personal fabric of society, we will need to manage these devices beyond their useful life, both to protect the environment and to maintain our supply of materials.

3.2 Internet of Things fuels E-Waste.

A report by the US (United States) Interagency Task Force on Electronics Stewardship, acknowledges that "these technologies have become critical to our growing economy and to our way of life". It clearly warns that "with these technologies, however, comes the increasing challenge of protecting human health and the environment from the harmful effects associated with the unsafe disposal and handling of these products." The Principal Legal Officer at the Communications Commission of Kenya, Mercy Wanjau, already noted that "e-waste is one of the fastest growing waste streams." .According to United Nations University estimates reported by ITU, 67 million metric tons of electronic and electrical equipment's were put on the market in 2013. In the same year, around 53 million metric tons of e-waste (include both waste electrical and electronic equipment) were disposed of worldwide.

As a result, e-waste is receiving a lot of attention not only at the national level but also at the international level. For instance, ITU is working with the Secretariat of the Basel Convention on controlling transboundary movements of hazardous wastes and their disposal, and with the United Nations University, in collaboration with the Centre for Environment and Development for the Arab Region and Europe (CEDARE) and Solving the E-waste Problem (StEP) took initiative to raise awareness about e-waste and to encourage and arise the inclusion of e-waste management in the design of national policies for information and communication technologies (ICT).

ITU maintaining a comprehensive reference site referencing on e-waste, and has published a toolkit on end-of-life management of ICT equipment. This toolkit was developed in partnership with environmental organizations and also more than 50 ICT companies and generated a new technical standards, such as Recommendation ITU–T L.1000 "the universal power adapter and charger solutions for various hand-held ICT devices and mobile terminals". This standard sets technical specifications for universal charger compatible with a variety of electronic devices, reducing waste and improving user convenience. When fully implemented around the world, the new standard will eliminate an estimated 82 000 tons of redundant chargers and at least 13.6 million tons of CO_2 emissions annually. While various governments around the globe are looking closely at the impact of IoT on current society, mainly on security and privacy, the consequences of IoT on environmental sustainability are not being treated with the same degree of urgency.

Electronic equipment's used throughout the IoT may eventually end up as e-waste. A TreeHugger article by Elizabeth Chamberlain and Kyle Wiens of iFixi, published on 9 January 2014, comments on a recent study by Huabo Dunn and colleagues at the Massachusetts Institute of Technology on "Quantitative characterization of domestic and transboundary flows of used electronics — Analysis of generation, collection, and export in the United States", released on 15 December 2013. That article mentioning the rise of computerized basic IoT elements as an emerging culprit in losing the war against e-waste, "and as more and more objects — toys, household appliances like fridges, and accessories, It's easy to make the connection between a giant CRT monitor and e-waste; it's less easy to make that connection with singing birthday cards. Nobody thinks twice about trashing them but they are e-wastes."

Researchers at University Catholique de Louvain in Belgium (June 2013) made the argument for this clearly: "The vision of the Internet-of-Things (IoT) calls for the deployment of trillions of wireless sensor nodes (WSNs) in our environment. The sustainable deployment of large number of electronic systems needs to be addressed with a Design-for-the-Environment approach. This requires minimizing 1) the embodied energy and carbon footprint of the WSN production, 2) the Eco toxicity of the WSN e-waste, and 3) the Internet traffic associated to the generated data."

IV. ENVIRONMENTAL MANAGEMENT THROUGH THE INTERNET OF THINGS

IoT technologies, such as machine-to-machine (M2M) communications are already being used to improve the environment, for example rubbish collection, light bulb recycling, oil recycling, control of noise pollution, and reduction of CO_2 emissions, wastewater management, and even removal of cooking grease in restaurants.

At an IoT Workshop in Beijing, China, in August 2013, Li Haihua, Senior Engineer of the China Academy of Telecommunication Research, Ministry of Industry and Information Technology, and Deputy Director of the Department of Internet of Things and Service & Resources, reported that in China "IoT has been applied in the automatic monitoring of more than 15 000 key pollution sources".

In a paper presented in April 2012 at the 2nd International Conference on Environment Science and Engineering, on "Adopting the Internet of Things(IOT) technologies in environmental management in South Africa", Nomusa Dlodlo, a Senior Researcher at the Council for Scientific and Industrial Research's Meraka Institute in Pretoria, shows the linkage between IoT and environmental management across many domains.

3.3 Internet of Things and e-waste management

Considering, the discarded electronics components inside IoTenabled objects are one of the significant source of e-waste, providers of IoT equipment must increasingly take account of dangers arising from the use of hazardous material in the production of devices. Products should be designed and manufactured to reduce their lifecycle environmental impact. Biological and Environmental concerns should also be an integral component of smart manufacturing procedure, which has a symbiotic relationship with the Internet of Things. As an example, the Georgia Institute of Technology's Manufacturing Institute, which is closely associated with the United States Advanced Manufacturing Partnership, considers the environment as a central concern of modern manufacturing.

There are benefits in tracking e-waste. The Massachusetts Institute of Technology's in 2011

clarified the "convoluted path of e-waste", highlighting glaring economic inefficiencies. Proper remote tracking would improve the accuracy of e-waste data.For example, the United States Environment Protection Agency has recognized the need for a scientific based approach to getting better information on e-waste flows from the United States.
The current work emphasis on defining protocols, standards and specifications in the IoT space is on interoperability, because there is no common language for machines and objects across a wide range of markets. Currently, No specific consideration has been given to integrating environmental concerns into IoT standards.

What now?

If IoT-enabled objects were to have not only a standardized Global Positioning System (GPS) tracking capability but also some sort of universal e-identification, it would facilitate recycling, reuse and end-of-life management. It may help to overcome the cost challenges of recycling and open up a new opportunities for the private sector such as the recovery of rare earth metals. It would also facilitate the enforcement of regulations restricting the use of certain hazardous substances. Identification systems such as the Universal Product Code (UPC) and the International Standard Book Number (ISBN) are widely used; a similar system could surely be developed for electronics products.
Some tools are already available. An environmental procurement tool known as EPEAT helps buyers identify, compare and select environmentally preferable products, and provides manufacturers with environmental criteria for the design and development of products.

Also, e-Stewards Certification for electronics recyclers, the Stewards Initiative has created an integrating the requirements of the ISO 14001 standard on environmental management and there are a lot of services that supports the effective electronics use and management.
We are on the cusp of widespread deployment of IoT technologies. The attractive possibilities are masking unintended consequences, including e-waste. Policy-makers need to consider the environmental component. The time to act is now. "

V. RECYCLING OF E-WASTE

The Internet of Things is one of the key trends of the future. Already today, 15 billion things are digitally connected with one another and experts predict an increase to 50 billion devices in the IoT (Internet of Things) by the year 2020. These things include not only computers, tablets and smart phones, but also wearable, consumer electronics and the vehicles we use. However, a fact that was clearly underlined at this year's International Electronics Recycling Congress (IERC) 2017 in Salzburg that it can cause recycling companies with a wide range of difficulties.
But there are some other materials that are causing headaches for recyclers. "Apart from the increasingly complex materials, composites of mixed materials, the known legacy heavy metals and halogenated flame retardants, new additives are also beginning to emerge, such as nano particles, presenting recycling enterprises with new challenges," emphasized Dr Mike Biddle, Managing Director of cleantech fund Evok Innovations and Founder and Director of recycler MBA Polymers. Little research has been done on some newest materials with respect to how they behave in traditional recycling processes, he said. It is possible that some of these new materials and additives may also present new environmental problems with respect to environmental protection and industrial health and safety if not handled with care, particularly during the process of shredding or other size reduction processing. Moreover, it is often not very easy or even possible for the recycler to know which products have additives that might need

special handling as these additives are sometimes kept secret as proprietary.

From a commercial standpoint, too, the years to come are also likely to remain challenging. As Dr Biddle explained, there are three trends that are actually good for the planet. Firstly, there are downsizing that is, making electronic devices smaller and smaller. Secondly, life-extension, which means the turnover cycles of many devices are beginning to lengthen. And thirdly, there is certain general trend towards a sharing economy.

“Particularly in major cities, the idea of sharing is becoming more and more popular,” said Biddle. Every home doesn’t needs all of the power tools and appliances that they perhaps use only a few times a year. Although, the sharing economy is a good initiative idea, it definitely also has a downside for e-waste recyclers, as it reduces the number of new devices that need to be manufactured and therefore the volume of end-of-life devices that need to be disposed of.

Hence, recyclers again needed to be position themselves to remain competitive going forward. They need to make strategic choices in terms of innovation, cost savings, specialization and internationalization, stated Norbert Zonneveld, Executive Secretary of the European Electronics Recyclers Association (EERA). “The solution for each type of e-waste treatment operations varies, some recyclers are already working on future proof business models, but there is still a great deal of uncertainty. “The uncertainty is caused mainly by the differences in implementation of WEEE regulations across Europe and the difficulties with enforcement, said Zonneveld. “This limits the scope of future-proof business models.”

Another area of concern is the emergence of two parallel worlds. One of the policy makers that aim for sustainable society with new ideas and the other operators who experience not enough support for improving the obligations of existing legislation and makes it difficult to make the best efforts for necessary change.The example of Christian Müller-Guttenbrunn shows that e-waste recycling enterprises can still be successful on the market, despite these adverse factors.

VI. SOLUTIONS SUGGESTED

The automation of sorting of recycling materials is coming along nicely, it's already well beyond the wildest dreams of a decade ago and getting even better. Trash sorting, before it hits the landfill, will probably be next, and possibly sequestration by type with compostable going to one sector for bio-gas generation, plastic to another, etc.

According to the International Telecommunication Union (ITU), the total amount of electronic waste summed up to around 41,8 million tonnes in 2014 worldwide and the estimate for 2018-19 goes up to roughly 50 million tonnes. Recycling is more important than ever. The potential management of e-waste can create new employment opportunities and boost entrepreneurship is one of the glad news on e-waste. The recycling of precious metals contained in e-waste such as gold, platinum, silver, lithium and palladium – as well as other raw materials such as iron, copper and aluminum – offers growing opportunities and areas of business. It just needs to be done.

Even though choosing the right electronics recycler matters. Just because a consumer gave their old gadgets to a recycler, it doesn’t mean it will be recycled. Some dishonest companies export e-waste to landfills in Africa and Asia and These landfills use cheap laborers who manually harvest reusable materials.

When laborers finish harvesting, huge piles of scrap remain behind. Once the storage space runs out, the excess waste is dumped into the ocean. Don't be surprised if the old gadgets washed up on the shores one day.

The good news is that getting rid of electronics devices is a relatively easy process if there is a reputable e-waste recycler like Securis in India also. Not just in India all over the world. They are an R2 certified electronics recycler since 2013 and joined the GSA Schedule 36 of approved contractors to provide data destruction services to the United States Government in 2007. They claim that their industry experience, combined with their unique expertise in e-waste recycling makes an ideal partner for any consumer to dispose IoT electronics waste needs.

But then again we cannot say recycling solves all the problems. Some of those little batteries are explosive hazards when crushed and industrial scale processing involves lots of crushing and shredding. But manufacturers are adding batteries by the bazillions, using adhesives instead of fasteners, and then failing to share even a basic schematic of the location of the hazard for recyclers. While it's not a complete solution - making sure that consumers, repair techs, and recyclers can replace and remove batteries is a big step in the right direction.

Perhaps the market can help a bit. If consumer reports and product reviews take into account the life of a product and call out those with irreplaceable batteries, it would provide some incentive for the manufacturers to improve on these aspects. That is, if the consumers care at all. Another way is for the Government to impose a waste tax on each battery sold, to partially compensate for the externality.

Since India is getting high on IoT, the government also needs to think about the adding E-waste before it leads to land filling which later cause severe land pollution. The Telangana government aims to attract ₹ 10,000 crore investments in the field of Internet of Things (IoT) and generate direct employment for 50,000 people in the next five years. The policy on IoT and another on e-waste management were launched at a programorganized by the industry body FICCI in association with the State government. IT Minister K.T. Rama Rao, IT Secretary Jayesh Ranjan, Intel India Country Head Nivurti Rai, Hewlett Packward president-India R&D Naresh Shah besides a host of industry leaders participated in the program. The same should be copied to other states when successful.

VII. CONCLUSION

Even all these discussions, E-waste from IoT and other areas are still a looming threat that needed to be taken care of as early as possible. Governments, producers and consumers- we all have to actively contribute whatever we can to find an effective solution.

From the above references, all we can conclude that E-waste is already an existing issue and by having IoT, which is the need of current circumstances, are adding more fuel to it. And we sincerely hope that these discussions will not be remained in the internet articles or research papers like so many current issues.

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