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Survey and Analysis of Literature in "E-waste Management"

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ABSTRACT—
Over the recent past, the requirement of electrical and electronic equipment (EEE) in colleges has grown exponentially, while the lifespan of these products has become shorter. The production of semiconductors, printed circuit boards, disk drives and monitors used in computer uses many hazardous chemicals. Printer inks and toners often contain toxic materials such as cadmium. Computer Central Processing Unit (CPU) contains heavy metals such as cadmium, lead and mercury. Printed Circuit Boards (PCB) contain heavy metals such as antimony, silver, chromium, zinc, lead, tin and copper. This report highlights the hazards of e-wastes, the existing strategies for its appropriate management and options that can be implemented. To learn about Electronic waste management system, a review process involving 3 stages approaches has been undertaken 42 research papers which were published in the period of year 1995 to year 2014.The reviewed papers covered the analysis of various countries in the world like, India, China, USA, Switzerland, Netherland, UK. After an exhaustive review process two main issues were found "Hazardous effect of electronic waste on human health" and "Environmental pollution". The review discusses the existing solutions of electronic waste like landfilling, incineration and recycling. Recycling, reuse,reduce and refurbish are the 4 strategies for successful management of ewaste. Primarily the research were based on development of reverse logistics model of supply chain and extended producer responsibility concept for electronic waste. Very few Researchers analyzed the treatment methods of recycling. Issue discussed in reverse logistics was not having enough electronic waste material for recycling. Very few researchers analyzed the impact on recycling by increasing awareness of electronic waste. Very few of the research papers reviewed were pertained to ewaste management in India which reflects on the lack of awareness as well effective ewaste management. In this report I have discussed the comparative study of different research papers, their findings and solution approaches

1. INTRODUCTION

E-waste is the term used to describe old, end-of-life or discarded appliances using electricity. It includes computers, consumer electronics, fridges etc which have been disposed of by their original users. Examples: Computers, LCD / CRT screens, cooling appliances, mobile phones, etc., contain precious metals, flame retarded plastics, and many other substances. The information technology has changed people's life style during last century. This leads into new problem contamination and pollution. The lifespan of the electronic products has become shorter. More of these products are ending up in rubbish dumps which creates a new challenge to policy makers. The production of semiconductors, printed circuit boards, disk drives and monitors used in computer manufacture uses many hazardous chemicals. Thus disposal of e-wastes is a particular problem faced in many regions across the globe .The incineration, land filling and recycling are the existing solutions for managing electronic waste. The hazardous effect of land filling and incineration on human health and environment are discussed above. Most E-Waste is trashed, not recycled. Most e-waste ends up in our landfills and incinerators. Currently about 70% of discarded electronics end up in the trash, even though the hazardous chemicals in them could leach out of landfills into groundwater

and streams.. The outline of this paper is structured as, Section II describing the review process adopted. In section III the categorical review is described followed by issue wise solution approach of the reviewed papers is discussed. Finally a conclusion is made followed by references.

2. REVIEW PROCESS ADOPTED

Stage 0: get a feel

This stage is the beginning of literature review process wherein one has to broadly select his / her area of interest and start searching the scientific research papers from valid sources. Almost all the research papers download have to be scanned for deciding whether it belongs to the area of interest or not.

Stage 2: Get the big Picture

In order to understand the paper broadly and get an idea whether the paper exactly belong to the research area / sub area selected or it deviates, if deviates how much, these concepts are made clear this stage, known as Get Big Picture. It helps in classifying the research papers according to key issues and narrowing down the survey. The papers are selected through the stage 0, are processed through this stage classified into different groups. The groups of papers are prepared according to common issues & application sub areas.

Stage 3: Get the details

Stage 2 deals with going in depth of each research paper and understand the details of methodology used to justify the problem, justification to significance & novelty of the solution approach, precise question addressed, major contribution, scope & limitations of the work presented.

Table 2.1 Stage 2 Questions Along With Probable Location of Answers in Papers

What you are looking for?	Where to find it?
What problem does the paper attempt to solve?	Introduction, Problem definition
What is related work? What are gaps?	Introduction, Literature Survey or Related Work
What contribution does the paper claim – idea, technique, proof, surprising result?	Introduction, Conclusion
How does the paper solve the problem?	Solution, Experiment, figures.
How do the authors defend the solution?	Methodology, Experiment, Results.
What is the precise research question addressed?	Introduction, Problem definition
Why is it believed that solution works, better than previous?	Solution approach, figures
What are assumptions, scope?	Problem definition, solution approach
What are details of proposed solution – argument, proof, implementation, experiment?	Solution, System details, Experiment, Methodology, figures
What evidence is provided?	Figures, Results
What is the take-away message from the paper?	Overall

Stage 3: Evaluate the details

After getting the details like key issue / problem, solution approach, hardware / software setup, experimental design, results obtained, advantages and limitations presented by the researchers, it is necessary to evaluate these details with some standard aspect to compare, correlate, and generalize the concepts & methods presented by the authors with reference to other similar works. This stage provides an insight how to deal with evaluation of the details presented by the researchers and generalize the concept.

Stage 3+: Synthesize the detail

This stage deals with synthesis of the data, concept & the results presented by the authors. This stage does not only require the understanding of other research papers but requires creative thinking and good knowledge in the area / sub area of research. Here imagination of situations different from those presented and expected results has to be predicted. In short it uses interpolation and extrapolation to find out the gaps in the published research.

3. CATEGORICAL REVIEW OF E-WASTE MANAGEMENT

The review process was adopted by surveying the research in last 16 years (1999-2014) for extraction of information about 6 sub issues. Review process was adopted in the area of different e-learning experiences and environments.

3.1 Environmental and health effect of Ewaste:

[1] [Ramachandra T.V, et-al, 2004] has discussed the hazards of e-wastes, the need for its appropriate management and options that can be implemented like waste minimization in industries involves adopting Inventory management, Production-process modification Volume reduction. While buying electronic products one can opt for those products which are made with fewer toxic constituents, use recycled content, are energy efficient, are designed for easy upgrading or disassembly, utilize minimal packaging. [2] [M. Khurrum S. Bhutta, et-al, 2011]discussed that how recycling is the key to reduce the e-Waste. [3] Shihab A. Hameed, et-al, 2012 Author has recommended following strategies to control the electronic waste:-Enriching all educational programs and curriculum with material to show e-waste status, its harmful impact on environment, human health and life. [4] [Siddharth Ghansela ,et-al, 2013] has provided techniques of green computing like energy saving mode in software and hardware devices, green design to be adopted in manufacturing electronic component, upgrade the video card, turndown the brightness etc. [5][Dr. B. J. Mohite, et-al, 2013] has discussed that the best option for dealing with E-Waste is to reduce its volume. Designers should ensure that the product is built for re-use, repair and/or upgradeability .[6][L. Nageswara Rao, et-al, 2014] gave a novel approach to problem by stating that e-waste is a good source of revenue generation for many people in India. [Shashi N. Kumar , et-al, 2014] proved that e-waste is more hazardous than many other municipal wastes because electronic gadgets can contain thousands of components made of potentially harmful chemicals.

3.2 Recycling of electronic waste material:

[Chris Hendrick-1994] [8] found out that use of nickel-cadmium and nickel-metal hydride batteries has high cycle life. Author has listed down the primary type of batteries like Lead Acid, Sealed Lead/Acid, Nickel etc.[9][John *C.* Bullock-1995] has concluded with policy implication like increase the effective life of machines, safe disposal of batteries . [10] [Bemardus M. J. C.Siioss-1999] has analyzed the type of plastic used and identification of these plastic after dismantling process.[11] [Hai-Yong Kang, 2004] studied that the major materials in electronic equipment are metals, plastics, and glass are present in the monitors and CRTs.[12][Matthew J. Realff,et-al, 2004] has discussed the resale value of recovered CRTs is very low in their original markets. This discourages the testing and refurbishment of CRTs and increases the need to recover the leaded glass, metals, and plastics.[13][Author Xuefeng Wen-2006] has introduced the current situations of E-waste and reviewed various technologies and different scale facilities of E-waste recycling existing in China. In China, Hydrometallurgical and pyro metallurgical methods are preferred for middle and large scale enterprises. CRT-to-CRT, Glass-to-Glass recycling, Glass-to-lead is also feasible from technological view, but there are not relevant reports in practice in China.[14] Author, Hyunmyung Yoon, 2006] has discussed generation rates, regulations, collection systems, and recycling practices of e-waste in Korea. Korean government has introduced EPR(Extended producer responsibility) in 2003. [16] [Ramzy Kahhat -2007] has proposed E-market for Electronic waste. He has mentioned the concept of Radio-Frequency Identification Device (RFID) placed on the product to track economic and material flows.[17][N. Othman, et-al, 2009] has mentioned the Catalytic de-polymerization Process technology able to use electronic plastic waste as a natural resource to generate synthetic diesel (energy) without contribute to any negative effects to the environment. The researcher states that the concept of thermal treatment of plastic waste does not release any air emission to the environment.[37][Kejing Zhan, et-al, -2010] has discussed the research on Innovative Information-Flow Management of Waste recycling network based on cloud computing.[18][Sang-Jae SONG -2010][18] has developed the java web based application for electronic waste material circulation.[19]Azadeh Dindarian,et-al,2011] has collected data for the microwave oven where people tends to change microwave oven either for technological upgrade or

functionality upgrade. In order to increase the amount of reuse, household waste recycling centre, charities and social enterprise organizations should work closely, to create viable business environment.[22]Atsushi Terazono, et-al, 2012 found that surface dust from e-waste recycling sites have higher levels of metal contaminated than surface soil.[13]Ashish. Chaturvedi -2012 analyzed the carbon footprint of eight metals i.e. Steel, aluminum, lead, nickel ,copper, gold, silver and palladium. The emissions of CO2 from extracting metals vary depending on location and processes used. Author included pyro metallurgical treatment of recycling. The option of hydrometallurgical/wet treatment is not considered since it is environmentally harmful[22]Maik Bergamos, et-al, -2012 has mentioned that LEDs consist of critical and scarce materials like indium, gallium, and rare earth elements.[23][Somayaji Siva Rama Krishnan,2013] has designed novel technique of virtualization to reduce the electronic waste. Information and communication technology (ICT like smart grid saving, data center et. [24] [Author Tsai C. Kuo-2014] has proposed petri net analysis to deal with recycling problems of electronic waste

3.3 Spreading awareness about Electronic waste though education :

[25][Gülfem Dilek Yurtta,et-al, 2010] has revealed that according to the students air pollution and one of its consequences, global warming, were found to be considered as the most serious environmental problems. It is reported that sensitivity towards air, water and soil pollution is very high. [26]Author Lim Fung Chen.2011] believed that education is the root of solving the e-waste management problem. Students need to be educated with e-waste management knowledge and they should be given chances to carry out their research and industrial training in the e-waste management industry.[2][William C. Bullock-2011]has discussed the electronic waste project introduced by author at the University of Illinon

3.4 Reverse Logistic and supply chain management

[28] [Auhtor Nidhi Tyagi-2013]states that the corporate sector should establish a reverse logistic system to take the equipment back from the customers. [14] IgIbretBittencourt et-al. 2009proposed a computational model for developing Semantic Web-based Educational System focusing on the problem of developing a richer and robust e-learning environment useful for developers and authors. The author aimed at incorporating semantic web resources to design of artificial intelligence in education (AIED) systems for updating their architecture to provide more adaptability, robustness and richness to the e-learning environments. [26] Paul Pocatilu et-al. 2009 attempted to measure the positive impact of cloud computing architecture for e-learning solution development and enhancing e-learning implementation process control. The author also attempts to evaluate the efficiency of cloud computing usage in the field of e-learning. [40] Yang Song et-al. 2013, examine Storage Mining capabilities for effective IT Management using techniques of Big Data Analytics. The paper attempts to leverage Big Data Analytics framework to design storage management solution. [25] P. Michalik et-al. 2014 identify the Big data sources from university's environment and also propose an architectural design to process this Big Data from a technical perspective. The paper defines different dimensions of Big Data like the Volume, Variety, Velocity, Veracity and Complexity and further describes the technology like Map Reduce, Hadoop, HDFS, Apache Hive and NoSQL used for processing this Big Data. [03] A. Fernandez et-al. 2014 provides a detail overview of the current state of the structure of Cloud Computing for applications on e-learning. The author provides details of the most common infrastructures that have been developed for such a system supporting the same with examples of e-learning approaches for cloud computing that can be found in specialized literature.

3.5 Business models for various stakeholders

[35] [Amit Jain- 2010] has proposed that e-waste business model that evolves from recycling industry

operation. In Indian context, the implementation of EPR system will require a complete shift in "consumer behavior". PPP model can serve as a viable transition mechanism to an EPR based regime for E-waste management in Maharashtra and India.[36][Kejing Zhang 2010] has developed STOF model for Ewaste recycling service system.[Hua ZHONG ,et-al, 2011] has proposed framework for deposit refund system .

3.6 Future Prediction of Electronic Waste

[41][Yang Yang, et-al, 2010] has designed a time series model on electronic waste resources which will be available for recycling.[11]Hai-Yong Kang ,et-al, 2012] has estimated future quantities of electronic waste. To generate estimates, he used a time-series materials flow analysis model (MFAM).

4. ISSUE WISE SOLUTION APPROACH

4.1 Solution approach for Environmental and health effects of E- waste:

Researchers have done descriptive study under this issue. Several pilot projects have been initiated in Africa, China to show that recycling can provide employment opportunities. Waste in industries can be minimized through proper inventory management, production process modification and by reducing volume of product. Researchers has recommended use of solar computers. Recycling industry can use web applications to share knowledge of a variety of product data and its electronic waste data and its material flow status.

.4.2 Solution approach to recycle electronic waste:

Small and middle scale enterprises, use physical processes such as "wet shredding and water table separation", "dry shredding and electrostatic/air table separation", for recycling of waste printed circuit board. Hydrometallurgical and pyro metallurgical methods are preferred for middle and large scale enterprises. CRT-to-CRT, Glass-to-Glass recycling, Glass-to-lead is also feasible from technological view. Researchers have done survey of dismantling and recycling processes of e-waste. They have collected environmental and human blood samples at the formal and informal recycling sites from China, Indonesia, Philippines and Vietnam from 2009-2011.

Recyclers can use petri net analysis method to determine better disassembly processes based on economic value. An example of ADSL router and its components are discussed.

4.3Solution approach for Reverse Logistic and supply chain management:

Research was carried out for assessing the effectiveness of e-waste collection center. Analytical Hierarchy Processing is done to provide rating for collection center. Researcher has discussed the case study of recycling of telephone equipment frames and ADSL routers and feedback methodology was established for disassembly operations.The researchers have suggested bidding as one of the solution approach for selling the recycled materials manufacturers and should be regulated by government.Researcher has done exploratory research. They proposes a solution with a radio frequency tag (RFID) to assist in the recovery process of electronic devices.

4.4 Solution approach for business models for various stakeholders:

Researchers has studied the current existing three business models are- public private partnership, extended producer responsibility and conventional model.

One of the researcher has mentioned Service, technology, organization and finance (S.T.O.F.) model where service domain is the interaction of service provider and customer

Researchers have discussed option analysis of smelting and hydrometallurgical based technology for precious metal recovery. Researchers has proposed to create e-waste recycling fund. The capital for this fund should be created through funds from producer, consumer and government.

4.5 Solution approach for Prediction model of Electronic Waste

Researcher has done exploratory research where they have proposed a new time series equation for prediction of electronic waste. To generate estimates, they used a time-series materials flow analysis model (MFAM).They used linear regression

technique to predict the number of units and the tons of e-Waste for the targeted years.

4.6 Solution approach for spreading awareness about Electronic waste though education:

Researchers has done the survey in the countries like Malaysia, Turkey, China and U.S.A to assess the awareness of electronic waste among the students, and housewives

The data collected through questionnaire is studied using SPSS 16.0. Pearson Chi-square, t test and One way ANOVA test was used

CONCLUSION

The reviewed papers discuss the e-waste management current strategies like landfilling, incineration and recycling.

Recycling is the only key to reduce the electronic waste.

Researchers believe that education is the root of solving the e-waste management problem. Some research has been carried out on cloud computing, web server application for real-time collection of e-waste data, real-time monitoring of material flow. The data security issue in cloud computing is the major obstacle to push forward the SaaS platform. There is no accurate estimates of the quantity of e-waste generated and recycled available in India. Challenge for e-waste collection is related to a lack of awareness of potential hazards as a result of improper disposal of e-waste among consumers and local governments. Without effective take-back systems, necessary policy backup and finance subsidy, it's The limitation of EPR model is that it does not specify how much manufactures should pay and how to collect and use the fund, how to determine the amount of the deposit fee, when should recycling companies get subsidy and how to control recycling flow and manage fund. Government, manufacturer and consumer together should develop a well establishment system for separation, storage, collection, transportation and disposal of ewaste. Research is lacking on comprehensive use of IT systems and newer technologies such as mobility, big data, cloud etc. to manage e-waste

REFERENCES

1. Ramachandra T.V. Saira Varghese K , "Environmentally Sound Options For E-Wastes Management",Envis Journal of Human Settlements,India, page no. 1-8,2004 .
2. M. Khurrum S. Bhutta,1 Adnan Omar,2 and Xiaozhe Yang3, "Electronic Waste: A Growing Concern in Today's Environment", Economics Research International, Hindawi Publish ing Corporation, China, page no.1-6, 2011 .
3. Shihab A. Hameed ," Controlling Computers and Electronics Waste:
4. Toward Solving Environmental Problems", International Conference on Computer and Communication Engineering ,page 980-986, Kuala Lumpur, Malaysia,2012.
5. Siddharth Ghansela, "Green strategy for reducing ewate", International Journal of Advanced Research in Computer Science and Software Engineering,volume 3,page 476-480,2013
6. Dr. B. J. Mohite1, " Issues and Strategies in Managing E-Waste in India", Indian Journal of Research in Management, Business and Social Sciences (IJRMBSS),page1-5,2013.
7. Shashi N. Kumar / Arun Kumar Jain ,"Health Impacts in Developing Countries",EHS Journal,page 11-15,2014.
8. L. Nageswara Rao, "Environmental Impact of Uncontrolled Disposal of E-Wastes", International Journal of ChemTech Research, Volume 6, pp 1343-1353,2014.
9. Chris Hendrickson,' Lester Lave, Francis Michae , " Product Disposal and Re-Use Issues for Portable Computer Design", IEEE International Symposium IEEE International Symposium , San Francisco, CA ,pages 109 – 114, 1994 .Andreas Manhart," Recycling of critical metals from end-of-life electronics", Electronics Goes Green, IEEE, Germany, Page-1-6,2012.
10. John C. Bullock , "Environmentally Sound Management of Electronic Scrap And the

Basel Convention on Control of Transboundary Movements of Hazardous Wastes and Their Disposal", Electronics and the Environment IEEE International Symposium on, Orlando, page 1-5,1995

11. Bemardus M. J. C.Siioss , "Durable goods labelling and plastic recycling strategy for the electronic industry",ISBN 0-7803-5495-8,page 157 – 159, 1999.
12. Hai-Yong Kang and Julie M. Schoenung," Used Consumer Electronics: A Comparative Analysis of Materials Recycling Technologies", Electronics and the Environment, IEEE International Symposium,, California,page 226-233,2004.
13. Matthew J. Realff, Michele Raymond,"E-Waste an opportunity", materials today,ISSN 1369, page 40-46,Atlanta,2004.
14. Ashish. Chaturvedi," The Carbon Footprint of E-Waste Recycling - Indian Scenarios", Gesellschaft fUr Internationale Zusammenarbeit, Germany, page 1-6 2004.
15. Hyunmyung Yoon ," The Practice and Challenges of Electronic Waste
16. Recycling in Korea with Emphasis on Extended Producer Responsibility (EPR)", IEEE International Symposium on Electronics and the Environment
17. ,page 1-5, Scottsdale, AZ,2006.
18. Jinhui Li ; Liu Hao ; Fengfii Yin , "An Agenda to Move Forward E-waste Recycling and Challenges in China ", Electronics and the Environment, IEEE International Symposium, Scottsdale, page no. 315 – 320,2006
19. Ramzy Kahhat and Junbeum Kim, "Electronics and the Environment", Environmental research and education foundation Journal,page 181-185,2007.
20. N. Othman, L. Mohd Sidek and N. E. Ahmad Basri, "Electronic Plastic Waste Management in of Waste To Energy Conversion", 3rd International Conference on Energy and Environment,page 1-Malaysia:The Potential 6, Malaysia,2009.
21. Sang-Jae Song, "Second International Symposium on Environmentally Conscious Design and Inverse Manufacturing", IEEE,Tokyo,page 268 – 274,2010.
22. Azadeh Dindarian*, Andrew A.P. Gibson, "Reuse of EEE/WEEE in UK: Review on Functionality of EEE/WEEE at the Point of Disposal", International Symposium on Sustainable Systems and Technology (ISSST),IEEE, page 1-5, Chicago, IL,2011.
23. Andreas Manhart," Recycling of critical metals from end-of-life electronics", Electronics Goes Green,IEEE, Germany, Page-1-6,2012.
24. Recycling options for LEDs and LED products -2012 Maik Bergamos', Rolf Holtig,published in Published in: Electronics Goes Green 2012+ (EGG), 2012, 1 – 5, Berlin, ISBN no.978-1-4673-4512-5,2012.
25. Atsushi Terazono* Masahiro Oguchi , "E-waste recycling in Asia: process classification", :- Electronics Goes Green 2012+ (EGG),IEEE, Page-1-6, Berlin,2012 .
26. Somayaji Siva Rama Krishnan 1, Karthik Balasubramanian 2, Shruthi Reddy Mudireddy ," Design/Implementation of a Novel Technique in Virtualization to Reduce E-Waste", International Journal of Advanced Research in Computer and Communication Engineering Vol. 2, Issue 12, December 2013.
27. Tsai C. Kuo , "Waste electronics and electrical equipment disassembly and recycling using Petri net analysis", Computers and Industrial Engineering (CIE) 40th International Conference , 978-1-4244-7295-6, Awaji ,page 1-6,2010.
28. Gülfem Dilek Yurtta *, Yusuf Sülüna," What are the most important environmental problems according to the second grade primary school students?", Science direct Procedia Social and Behavioral Sciences, page 1605-1609,2010.
29. Lim Fung Chen and Haw Wai Yee, "E-waste Management:Are we ready for it?",

Proceedings of the 5th International Conference on IT & Multimedia at UNITEN (ICIMU 2011), IEEE ,page 1-5, Malaysia,2011

30. William C. Bullock," A pilot program for e-waste education and research", International Symposium on Sustainable Systems and Technology (ISSST),IEEE,page 1-4, Chicago, 2011.
31. Nidhi Tyagi , " A Study of Public Awareness about E – Waste", The international Research Journal on Social Science and management, Volume: 03,page 1-8,2013.
32. Viraja Bhat, Yogesh Patil," E-waste consciousness and disposal practices among residents of Pune city", Procedia - Social and Behavioral Sciences 133,page 491 – 498, 2014.
33. C. J. Boswell, "A FEEDBACK STRATEGY FOR A CLOSED LOOP
34. END-OF-LIFE CYCLE PROCESS" ,Edinburgh-U.S.A,page 142-147, 1995.
35. Matthew Deaves, "Taking the WEEE [EU waste electrical and electronic equipment directive", Manufacturing Engineer ,IEEE,Volume 82 , Issue: 6 ,page 38-41,2003.
36. Hilmi Yiiksel , " An Analytical Hierarchy Process Decision Model for
37. E-Waste Collection Center Location Selection",Electronics and the Environment-IEEE International Symposium, San Francisco ,pages 109 – 114, 2009.
38. Orhan Ercan, "A Research on Electronic Waste Awareness and Environmental Attitudes of Primary School Students", page 13-22,2014
39. Ma Hui, "Recycled Supply Chain Network of Waste Electrical and Electronic Equipment", Management and Service Science International Conference -978-1-4244-4638-4, Wuhan ,pages 1 – 4,2009.
40. Amit Jain, "Application of WEEE / E-waste inventorization methodology
41. using tracer tracking along material flow in EEE lifecycle in developing country", IEEE International Symposium on Electronics and the Environment, San Francisco, CA,page 1-4,2008.
42. Amit Jain,"E-waste Business Model, Policies and Regulations in India ", Sustainable Systems and Technology ,IEEE, Arlington, VA,page 1-4,2010 .
43. Kejing Zhang ,Ping Cang, Jutta Geldermann, "Research on Innovative Information-Flow Management of E-Waste Recycling ", Control and Decision Conference (CCDC),IEEe, Xuzhou,page 1049-1053,2010 .
44. Soulla Louca and Angelika Kokkinaki , "Closed-Loop Supply Chains in ICT: Best Practices and Challenges in Cyprus", Journal of Green Engineering, River Publishers, page 165–177 ,2011.
45. Kejing Zhang, Ping Cang, Fugen Song," Research on STOF-Model-Based Innovation of E-Waste Recycling Service System", Management and Service Science (MASS), IEEE, Wuhan,page no.1-5,2010 .
46. Schiller, S.,"Design of the expense allocation mechanism in e-waste recycling deposit system under EPR framework", Service Systems and Service Management (ICSSSM),IEEE, Tianjin,page 1-6,2011.
47. Yang Yang, Jian Zhan ," A Prediction on Electronic Waste Resource with Time Series Model ", International Conference on Computer Application and System Modeling (ICCASM 2010), IEEE,volume 2,page 551-557,Taiyuan,2010 .
48. Julie M. Schoenung, Hai-Yong Kang, "Estimation of future outflows and infrastructure needed to recycle personal computer systems", Journal of Hazardous Materials- Elsevier, Volume 137, Issue 2, Pages 1165–1174,2006