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Statistical Estimation of Copper, Silver, Gold and Palladium Requirements for the Manufacture of Mobile Phones Needed in Future

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Abstract :– **Todays electronic equipments such as Mobile phones, PCs and Laptops are tomorrow's E-waste. A Mobile phone contain more than forty elements including base metal Copper (Cu) and precious metals Silver (Ag), Gold (Au), and Palladium (Pd). Metals represent on average 23% of the weight of a phone, the majority being Copper. In one ton of Mobile phone handsets without battery there are 3.5 kg of Ag, 340 g Au, 140 g Pd and 130 kg Cu. For a single unit the metal content is 250 mg Ag, 24 mg Au, 9 mg Pd and 9 g Cu. Analysing global sales of Mobile phones using linear regression equation we can compute the sales of Mobile phones in future and estimate the amount of Cu, Ag, Au and Pd requirements.**

***Keywords*:- E – waste, Mobile phones, Copper, Silver, Gold, Palladium, Global sales, linear regression equation.**

I INTRODUCTION:

E-waste is one of the fastest growing waste streams in the world. E-waste comprises of wastes generated from used electronic devices and house hold appliances which are not fit for their original intended use and are destined for recovery or disposal. Treatment processes of E-waste includes art and craft works, recovery of the elements and uses as construction material. E-waste contains several types of substances and chemicals creating serious human health and environment problems. In India volume of E-waste is estimated to be 0.8 million tones in 2012. According to the Comptroller and Auditor General's (CAG) report

4 lakhs tones of E-waste are generated in the country annually. Clean Kerala Company Ltd.,

Thiruvananthapuram collected 1372.04 tones E-waste as on 31.05.2019. The growth of internet users has grown at a lightning pace and in India it is estimated that about 1.42 million PCs are getting obsolete every year. The total E – waste in India has been estimated to be 1,46,180 tones per year. E- waste has typical application in industry and society before dumping. The major areas of application are utilization of E-waste in metal industry, in construction industry and in charity works. Landfill has serious problems as the disposal at random places causes pollution.

II LITERATURE REVIEW:

Authors & Year	Title	Journal	Findings
Monika and Jugal Kishore (2010)	E-waste Management : As a Challenge to Public Health in India.	Indian Journal of Community Medicine, 2010	A large number of workers are involved in crude dismantling of these electronic items for their livelihood and their health is at risk, therefore, there is an urgent need to plan a preventive strategy in relation to health hazards of E-waste handling among these workers in India
Devin N. Perkins BS et al. (2014).	E-waste : A Global hazard.	Science Direct, Volume 80, Issue 4, 2014.	E-waste should be refurbished and reused as a complete product instead of dismantled. When refurbishment is not possible, E-waste should be dismantled by trained , protected and well-compensated workers

Table 1. Literature review of E-waste hazard and management

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Authors & Year	Title	Journal	Findings
Md. Sahadat et al. (2015)	E-waste : A Challenge for Sustainable Development	Journal of Health & Pollution , 2015	An urgent global multilateral agreement is needed addressing E-waste handling, storage, transportation, recycling and final disposal of any residual waste, whether by land fill or incineration
Ahmad Ashfaq, Amna Khatoon (2014)	Environmental Impacts and Assessment of E-waste Management	International Journal of Current Microbiology and Applied Sciences, 2014.	Uncontrolled fires may arise at landfills and this could be a frequent occurance in many countries.

Table 2. Literature Review of E-waste hazard and management.

III ENVIRONMENTAL IMPACT OF E-WASTE:

E-waste contains harmful elements such as lead, mercury, cadmium and many toxic substances which leach into soil and water polluting the water bodies. If this happens in a large scale the water body will become unsafe for consumption.

E- waste recycling is complex and expensive owing to the diversity of metallic and non metallic components as well as their difficulty in separation. Poisonous gases like dioxins and furans generated as a result of the material extraction process. High volume of acidic effluents generated owing to the hydrometallurgical recycling process lead to the environmental pollutions.

IV E – WASTE REDUCTION POLICIES:

(i) Green Protocol
(ii) Zero Waste
(iii) Execution of Govt. Orders in Offices and Institutions.
(iv) Implementation of EPR and RoHS (v) Designers should ensure the product is built for Re-use, Repair or Upgradability.
(vi) Enabling Legal framework penalties for Violation of E-waste rules.

V ROLE OF E-WASTE IN METAL INDUSTRY:

As an example global sales of Mobile phones in 2018 are considered. Its content of Cu, Ag, Au and Pd estimated. Also estimated the metal requirements for the manufacture of Mobile phones in 2025 using linear regression equation.

Year	Sales in million units
2007	122.32
2008	139.29
2009	172.38
2010	296.65
2011	472.00
2012	680.11
2013	969.72
2014	1244.74
2015	1423.90
2016	1495.96
2017	1536.54
2018	1556.27
2019	1524.84

Table 3. Global sales of Mobile phones from 2007 to 2019

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Global sales of Mobile phones in 2018 : 1556.27 million units					
1556.27million	x	250 mg Ag	=	389.1	ton Ag
" "	x	24 mg Au	=	37.4	ton Au
" "	x	9 mg Pd	=	14	ton Pd
" "	x	9 g Cu	:=	14006	ton Cu

Table 4. Global sales of Mobile phones in 2018 and its metal content.

Total sales of Mobile phones in 2018

= 1556.2 million units.

Estimated base metal content , Copper = 14006 ton

Precious metals content, Silver = 389.1 ton

Gold = 37.4 ton

Palladium = 14 ton

Formulation of Regression Model for Estimation of Future Sales:

Year(x)	X=x-2013	Sales(Y)	XY	x^2
2007	-6	122.32	-733.92	36
2008	-5	139.29	-696.45	25
2009	-4	172.38	-689.52	16
2010	-3	296.65	-889.95	9
2011	-2	472.00	-944.00	4
2012	-1	680.11	-680.11	1
2013	0	969.72	0	0
2014	1	1244.74	1244.74	1
2015	2	1423.90	2847.80	4
2016	3	1495.96	4487.88	9
2017	4	1536.54	6146.16	16
2018	5	1556.27	7781.35	25
2019	6	1524.84	9149.04	36
Total	0	11634.72	27023.02	182

Table 5. Data for formulation of Regression model.

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$$\bar{X} = 0,\ \bar{Y} = 11634.72/13 = 894.98$$

$$b = \frac{\sum XY - n\,\bar{X}\,\bar{Y}}{\sum X^2 - n\,\bar{X}^2} = \frac{27023.02 - 0}{182 - 0} = 148.478$$

$$a = \bar{Y} - b\,\bar{X} = 894.98 - 0$$

The regression model is $Y = a + bX$

= 894.98 + 148.478 (x – 2013) Estimated sales of the mobile phones for example for the year 2025
= 894.98 + 148.478 (2025 - 2013)

= 2676.72 million units

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Global sales of Mobile phones in 2025 : 2676.72million units			
2676.72 million x	**250 mg Ag =**	**669.2**	**ton Ag**
‘’ ‘’	**x 24 mg Au =**	**64.24 ton**	**Au**
‘’ ‘’	**x 9 mg Pd =**	**24.1**	**ton Pd**
‘’ ‘’	**x 9 g Cu :=**	**24090 ton Cu**	

Table 6 . Estimated global sales of Mobile phones in 2025 and metal requirements for its manufacture.

VI RESULT :

Computed global sales of Mobile phones in 2025 = 2676.72 million units and for that sales of Mobile phones

Copper requirement = 24090 ton

Silver requirement = 669.2 ton

Gold requirement = 64.24 ton

Palladium requirement = 24.1 ton

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VII CONCLUSION:

Maximum amount of base metal and precious metals extracted from a given unit of Mobile phones are tabulated. Metal requirements for the production of Mobile phones needed for the sales in 2025 are also computed using linear regression equation.

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