

## **ELECTRONIC WASTE: CONCERNS OF MOBILES IN JHARKHAND**

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### **ABSTRACT**

Technological advancement leads to growth which leads to further expectations and this trend goes unabated till an optimal / sustainable growth pattern is thought off and achieved. Advancement is a two sided sword which leads to achievement and pushes to concerns also. Growth of communication and electronic industry is very suitable example for this. Rapid modernization has lead to environmental degradation which has given birth to multiple threats. As unique opportunity and threats perception can be visualized in case of mobiles also. It has eased the life but has posed problems also. Starting from e waste concerns, regulatory measures, depletion of precious & rare materials, increase in toxicity & hardness, socio economic to cultural evasion can be seen. The instrument hardly weighing 80 to 100 gm has multiple aspects. The constituent's recovery, reuse, recycling provisions and awareness regarding these are major areas which have to be highlighted and thought about. Strict adherence from user side for preservation of materials, modification, concerns regarding EPR, take back recycling, reuse and proper disposal mechanism development has to be adequately addressed by the producers. The role of regulatory agencies is very important, enactment and enforcement of available legislative and regulatory measures can result in better environment & sustained development.

In all one can say that recovery of around 90 % material can be achieved from extraction from the wastes resulting in lessening in use of virgin materials for production. Lessening of e waste generation is the best policy for reduction of e waste and this can be achieved by awareness. Best tool for effective and sustained e waste management is to create awareness, frame requisite policy, sustainable model development and proper implementation of this model. The creation of awareness may need to include topics in the curricula of professions courses.

**KEYWORDS:** Coverage, Extraction, Hazards, Mobiles, Residuals, Technology, Tele Density, Waste Generation

### **INTRODUCTION**

The recent past has witnessed revolutionary growth and upsurge in technology in the arena of Electrical Electronic Equipments (EEE) in general and computer and communication in particular. After the globalization effect in India, India has emerged as global leader in the Information Communication Technology (ICT). Growth of communication and players involved has been unprecedented to mark country as telecom leader in the world. Population, increase in purchasing power, reach to technology, technological advancement and requirement has lead to revolutionize the masses. Indian governmental approach, initiatives, policies, dedication, efforts to match and provide best to its natives has lead to the communication revolution. The fastest growing and least life of product with launch of everyday new features and provision has lead to situation where mobile has particularly become the fastest growing concerns of the contributors of the electronic wastes (e waste). "E-waste" is attributed to generic term which encompasses the diversified forms of EEE,

electronic appliances which has attained to a situation where these are no longer useful and have lost their value and are old attaining end-of life (EoL) to be classified to have ceased to be of any value to their owners (UNEP Report, 2007). The diverse composition of e waste attracting numerous products and more than 1000 hazardous and non hazardous substances (Wath et al 2010) makes it more vulnerable. The hazardous and non hazardous substances range from elemental to metals to manmade substances.

Collection and treatment i.e. proper disposal of e waste is really a problem and as a solution the extended producers responsibility where they themselves take back or get it collected by authorized agencies come in role. This approach awareness and availability has to be verified and its effectiveness has to be judged. The depletion of materials or constituents is another burning issue. Materials present on/in earth have limited volumes and its preservation in terms of reuse and extraction from disposable items is also a challenge.

In case of large number of mobiles which have very little amounts in individuals, amounts to large volumes and weight when we see it in terms of millions available in and around us. Thus the stock of situation and experimentally verifying the easy means of extraction of valuables from wastes is of utmost importance. Keeping these factors in mind the present work of extraction and field study becomes important and valuable.

## **E-WASTE IN INDIA**

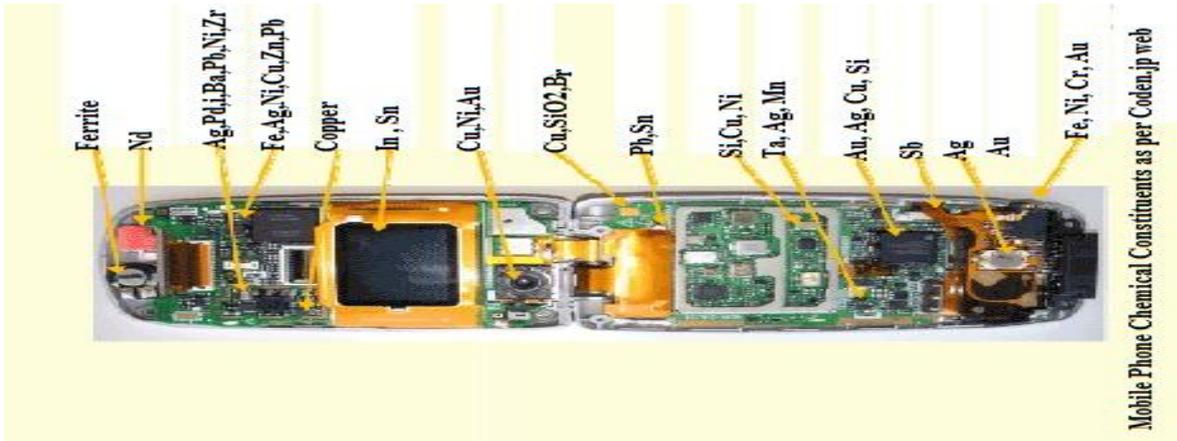
Global statistics of waste put by MAIT, UNEP, Greenpeace reports and other articles states that India produces 380000 tons of e waste 800000 tones by 2012. The UNEP 2010 report mentions that it will grow 500 % by 2020. E waste constitutes 1-2 % of total waste being generated. As per Govt. of India (GOI) "E-Waste (Management & Handling Rules), 2011, E waste means waste coming out of electrical and electronic equipment, whole or in part or rejects from their manufacturing and repair process, which are intended to be discarded. MAIT Executive Director in his report forecasted that in the same period e waste from mobile will grow 18 times in India because of availability, accessibility, demographic advantages and increased use.

## **DETAILS OF MOBILES AND ITS CONTRIBUTION IN E WASTE**

It is clear that the mobile / cell phone is one of the major contributors for the changes EEE and as a victim of rapidly changing technology is the prime contributor of the most volatile product popularly getting its reach to and all in the countries, state, cities and rural areas.

The penetration is major but the penetration in rural areas is also no lesser. The teledensity in the overall, in rural and urban sector tells the story of the development. The states had their own pace of modernization and increase in teledensity.

The relatively backward states which showed low teledensity continued to remain so but the development is static and even by increasing at no less speed than the so called forward or so called developed states. The details of mobile as per its metallic constituents, which range over 50 metals, can be viewed as in figure 1. Percentage wise major materials used in mobiles has been depicted in figure 2 and the compositional difference between materials with considerations of toxicity of materials and its hazardness from the early mobile inception to current use of technology has been shown in figure 3.



**Figure 1: A Typical Nokia Model Sketch**

Figure shows a typical mobile set sketch. It displays possible substances constituents in it. The items can be put in various ranges i.e. some of the substances are valuable ones, some are of concern and some are highly toxic in nature and while disposal they need to be cared a lot. The valuables are to be extracted and preserved.



**Disassembled Mobile Phones**

**Figure 2**

Figure 2 shows typical views of disassembled mobile sets in different conditions. These are of commonly available mobile sets in market.

**Table 1**

Mobile Material Constituents	Mobile % of Materials
Plastic	45
Metals	35
glass & ceramics	10
Batteries & electrodes	9
precious metals	0.11
Others	0.9

Table 1 shows a composition wise breakup (Nokia 2011a) of general mobile sets. The use of plastic, glass, ceramics, batteries are of great concern when these become e waste. Metals are one which needs to be segregated or extracted when these are to be disposed off. Batteries are the major sources of hazardness and EPR is highly applicable area in his case

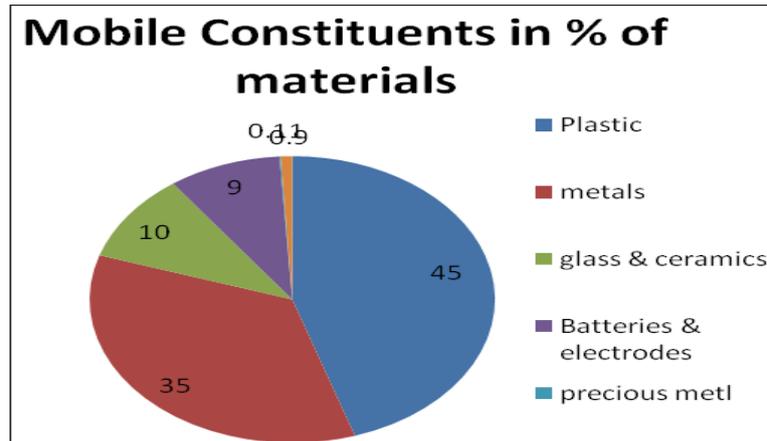


Figure 3

The above figure 3 shows a graphical representation of different materials used in a common mobiles

Table 2

Material	Difference in Composition from 1999 to 2003 (in %)	% of Total Material in Mobile
Glass	100	10.59
Plastic	113.8	59.6
Liquid crystal	133.3	0.2
Ag	40.9	0.24
Al	48.2	2.9
As	100	0.001
Au	74.3	0.038
Be	66.4	0.003
Bi	15.9	0.03
Br	100	0.94
Cd	200	
Cl	200.2	0.006
Cr	181.7	0.035
Cu	69	14.24
Fe	106.2	8.04
Ni	77.9	1.12
Pb	116	0.31
Pd	78	0.02
Pt/Ta	149.7	0.01
Sb	91.5	0.1
Sn	77.3	0.69

Table 2 shows details of different materials used pre 1999 to post 2003 (TUDelft, 2004) with advancement in technology and concerns about the disposals and toxicity vis-a-vis hazadness of the residues which is left out in the formal or informal disposal. The constituents in terms of substances used in manufacturing of mobile sets are also outlined here. Figure 4 and 5 shows the pie chart representation of these. One can clearly see that to the extent of 70 % plastic and glass are used where as the copper and iron as metals constitutes 22.28 % i.e. the major share in substances. The rare, hazardous and precious metals are present in very small amount and volume in the mobiles

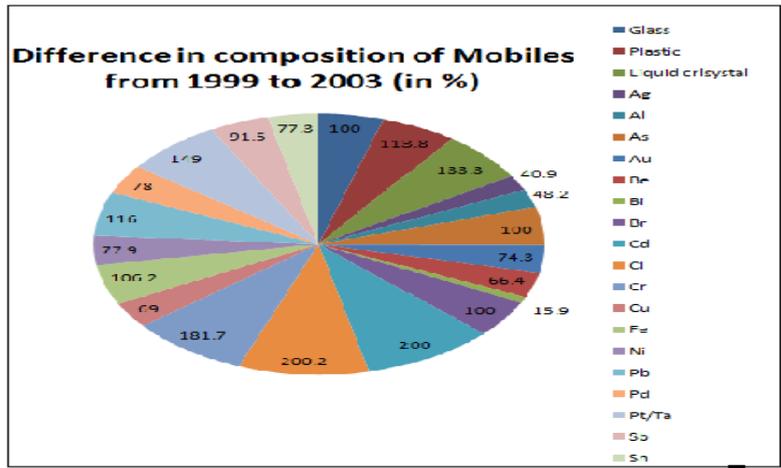


Figure 4

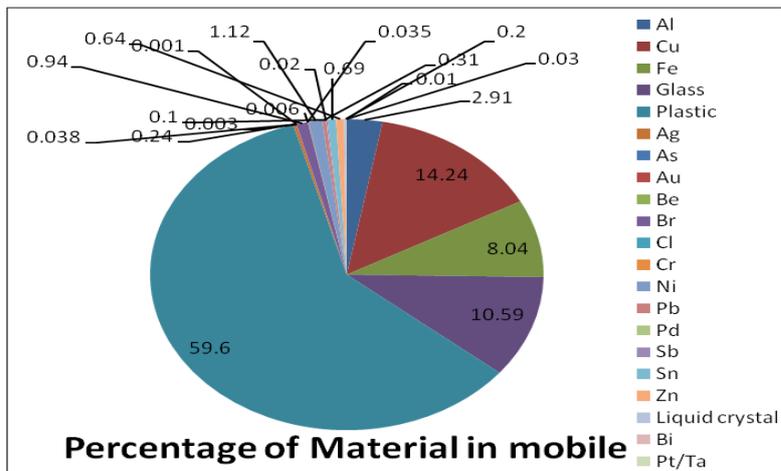


Figure 5

Table 3

Company	PSU & Private Service Provider in %
Tata	7.06
Telewings	3.8
Sistema	1.06
Vediocon	0.47
MTNL	0.39
Loop	0.33
Quadrant	0.23
Bharti	22.48
Vodaphone	18.16
Idea	14.56
Reliance	13.7
BSNL	10.6
Aircel	7.66

Table 3 shows the percentage representation of government and private major service providers in the wireless mobile services. Bharti followed by Vodaphone, Idea and Reliance etc are the major private sector service provider. Government sector representation is very limited. The details of the providers whose data are available has been put forth.

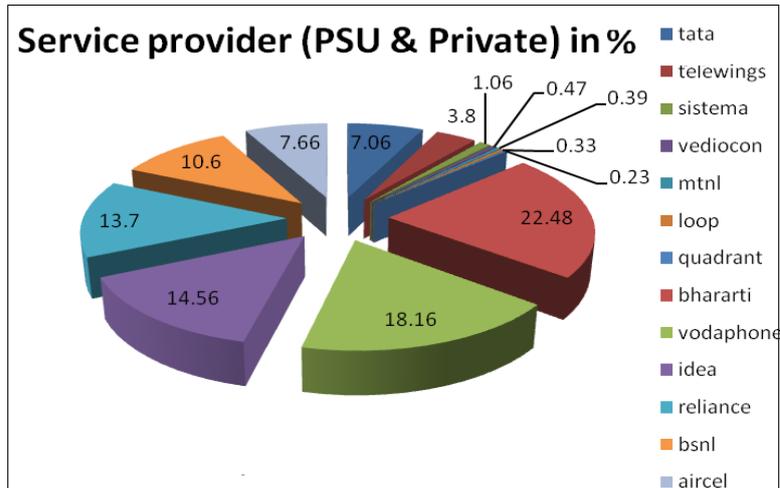


Figure 6

Figure 6 gives a graphical representation of service providers.

Table 4

Years	Mobile Subscribers in m
2004-05	98.41
2005-06	140.32
2006-07	206.83
2007-08	300.49
2008-09	429.72
2009-10	621.28
2010-11	811.59
2011-12	919.17
2012-13	921.0
2013-14	922.04

Table 4 shows the details of mobile subscribers as per TRAI reports from 2004 – Jan 2014. The Growth of the subscribers in the wireless sector can be seen growing. The major growth was seen till 2011-12 and from there after the growth has almost come to halt. The telecom policies and the market conditions are responsible for this.



Figure 7

Figure shows the growth of wireless (mobile) subscribers from 2004-05 till 2013-14 (till Jan 2014)

Table 5

Years	Teledensity	Teledensity Bihar & Jharkhand
2004-05	9.08	
2005-06	12.86	
2006-07	18.23	
2007-08	26.22	
2008-09	36.98	
2009-10	52.74	
2010-11	70.89	
2011-12	78.66	46.53
2012-13	76	
2013-14	74.5	45.06

As per TRAI (Telecom Regulatory Authority of India) Growth of overall (i.e. wireless and wired) telecom services and availability can be well shown in terms of teledensity. The steady increase in teledensity can be witnessed till 2011-12. The figures from 2011-12 till 2013-14 till Jan 2014 can be seen as decreasing. This is mainly because of surrendering/returning of landlines due to dissatisfaction and saturation of subscriber’s mood in wireless sector. The subscribers which had multiple connections became causes and surrendered the sets. The tariffs are saw some rise and users decreased.

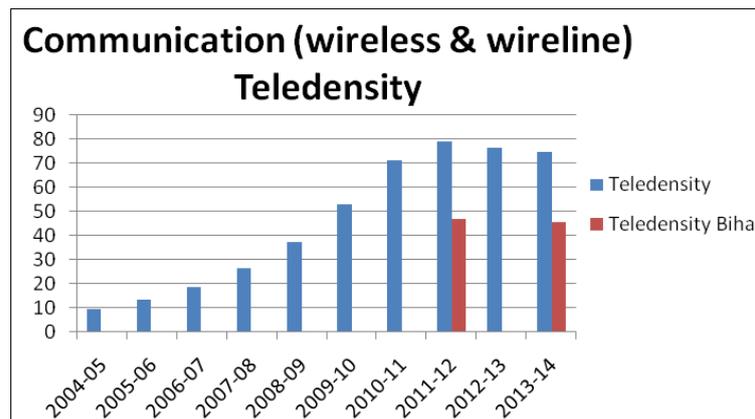


Figure 8

Figure 8 shows the representation of over all teledensity in India as per TRAI reports

Table 6

Year	GSM Million Subscriber	CDMA Million Subscriber	Total Million Subscriber
2004-05	41.07	11.15	62.22
2005-06	69.19	20.95	90.14
2006-07	120.47	44.64	165.11
2007-08	192.7	88.37	261.07
2008-09	297.26	94.5	391.76
2009-10	498.68	106.64	584.32

The wireless communication mainly comprises of the GSM or CDMA technologies. The popularity of GSM over CDMA is well evident from the figures available from the data of TRAI reports. The growth rate of subscribers are almost same for the two despite of the fact that the CDMA is bit costlier compared to GSM. The steady growth and details for all facts have been graphically represented in figure 9.

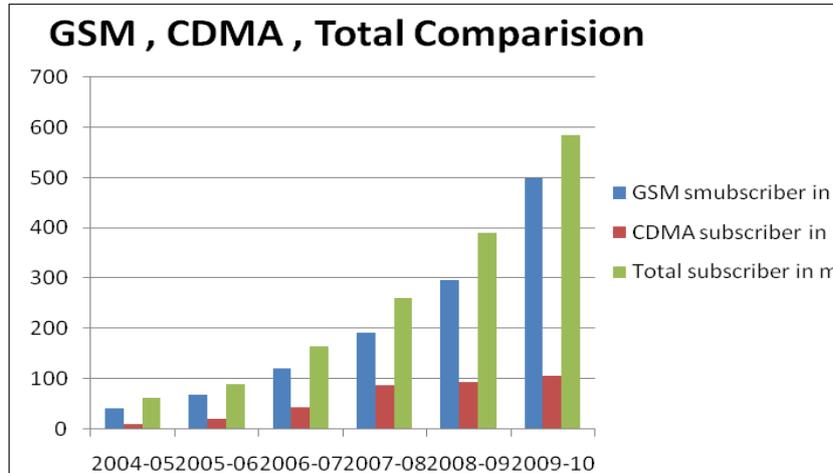


Figure 9

Table 7

Year	Urban Teledensity	Rural Teledensity	Total Teledensity
2006-07	48.1	5.89	18.22
2007-08	66.39	16.22	26.22
2008-09	88.84	48.11	36.98
2009-10	119.45	24.31	33.83
2010-11	39.22	39.79	70.89
2011-12	169.55	39.22	78.66
2012-13	149.55	39.9	73.34

Growth of communication efforts both in of urban and rural teledensity also need to be looked at. Table 7 shows that the technology adaptability prone urban population is seen increasing till 2011-12 but the local variants impact can be seen on growth after this. The rural sector despite of recession grew. The overall trends in the teledensity are seen to follow the urban sector as the subscribers strength is highly populated in this sector only.

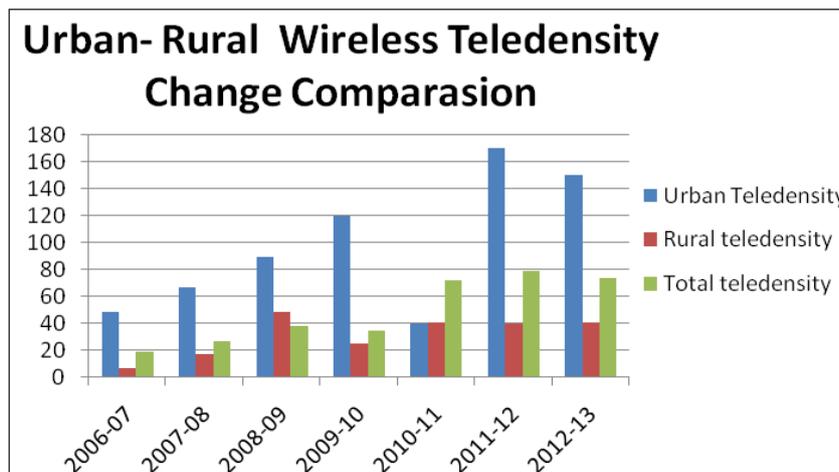


Figure 10

Figure 10 shows the details of teledensity in the graphical way. The spikes of urban teledensity can be seen as noticeable developments with the other explanation as cited above. The rising trends till 2011-12 i.e. evident thereafter we see decline in urban well as total teledensity. The teledensity of more than 100 can be noticed from mid 2009-10 and is continuing which can be well noticed in the graphical.

### STUDY OF MOBILE SCENARIO

The TRAI reports does not have exclusive authentic report on Jharkhand state. In addition with Bihar it is reported to have relatively low teledensity. The state of Bihar and Jharkhand are well known for their backwardness and poverty which results in ill remaining communicated i.e. having lesser teledensity. With time variation it has grown and with the rate declining trend of decrease in this case also can be witnessed. Thus we see that the survey for mobile services in all aspects are to be determined. Other major concern is the extraction of metals and materials also. To meet both ends we have gone for detailed study of both types.

- These are once the mobiles are to be disposed these need to be dismantled and after dis mantling of mobiles the recovery of metals is evaluated.
- Field survey cum door to door approach for collection of data regarding various aspects on the developed questioners were taken up.

#### Study on Extraction of Materials

In order to get the preposition of major valuable metals in mobiles of different types were collected and batteries were removed. Disassembly and seperation of movable parts were done followed by dismantling, crushing of the Printed Circuit Board (PCB). The flow chart in the figure 11 shows the total process carried out for extraction of metals. The processing carried out mainly consisted of acid leaching followed by purification of leached solution for removal of impurities. By electro refining process and chemical reduction the metals were extracted from the solution. The findings were obtained and results thus obtained were compared to the reported results. It was observed that the extraction confirmed to the reported results with slight variation.

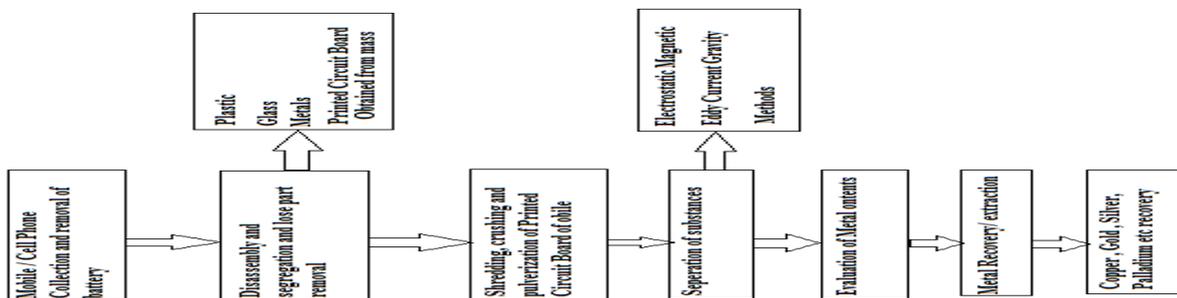


Figure 11: Flow Chart for Extraction of Metals from PCBs of Mobile Phones

#### Door to Door Survey Study

In order to get the details of survey for the EPR and conditionality of the Mobiles questioner was prepared and circulated in the major cities namely Ranchi, Jamshedpur, Dhanbad, Dumka, Bokaro, Daltongang, Hazaribagh and Chaibasa of Jharkhand state. The questioners were mailed to certain known persons also for collection of data. Total of 100 questioners equally making four groups distributing among demographical and economical background were distributed in the eight cities and 200 questioners were dispatched by post and e mail. The total sample size thus was 800+200 making total of 1000. The various statistical methods were employed to get the desired observations which have been summarized in the following sections.

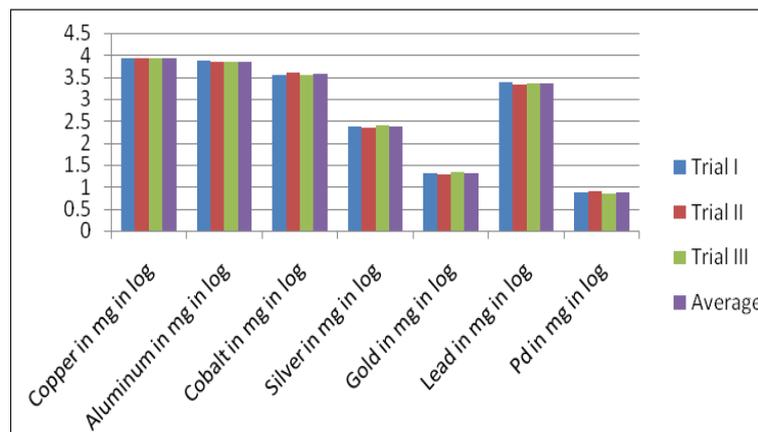
**DATA AND ANALYSIS**

**Extraction of Materials**

From the determination of extraction of metals three trials were done and the results obtained were as follows:

**Table 8**

Sl	Metals Recovered in	Trial I	Trial II	Trial III	Average
1	Copper in mg	8492	8476	8412	8460
2	Aluminum in mg	7316	7125	6971	7137.33
3	Cobalt in mg	3623	3912	3487	3674
4	Silver in mg	238	219	248	235
5	Gold in mg	21	19	22	20.67
6	Lead in mg	2374	2164	2271	2269.67
7	Pd in mg	7.4	7.8	6.9	7.367



**Figure 12**

Results show the high content of copper, aluminum, cobalt, lead, silver gold and Pd are in conformity of the results obtained by the other research papers published in this area which mentions in the per 1000 kg of PCB of the mobiles which when converted comes to the figures nearer. Log scale has been preferred to get a better view of variation. Absolute values would not show results of silver, gold and Pd in linear scales as the amounts is very small.

**Field Survey**

Data for the survey of the various aspects regarding mobiles are placed in table 9 and table 10 which are as follows

**Table 9**

Cities	Information Sought	Responses	Procurement			Recycling Info	Disposal Trend				Mobile Awareness			Mobile Change		
			Purchase	Gift	Other		1	2	3	4	EPR Back	Aware Waste	Toxicity Aware	A	B	C
Ranchi	100	76	58	16	2	56	34	26	10	6	19	28	3	25	32	12
Jamshedpur	100	85	65	11	6	45	45	21	5	3	23	56	7	21	19	29
Dhanbad	100	71	56	12	4	34	45	9	4	6	16	45	11	45	11	16
Bokaro	100	67	45	9	6	43	34	21	6	2	18	47	8	45	6	12
Hazaribagh	100	48	24	15	6	23	34	6	2	4	8	11	10	19	12	16
Dunka	100	36	26	7	5	29	21	9	1	4	4	11	2	15	11	17
Daltonganj	100	39	28	5	5	12	25	12	1	5	3	21	11	21	5	12
Chaibasa	100	28	17	6	5	11	21	4	1	2	4	12	16	14	8	6
Post / mail	200	87	65	11	9	67	34	23	11	7	45	41	47	43	16	23

**Disposal Trend:** 1. Throw, 2. Leave in house, 3. to collection centre, 4. Gift to some one

**Mobile Change:** A in year, B when becomes non working, C Frequent

Table 10

Cities	Inform-ation Sought	Respo-nses	Mobile Choice				Multiple Mobiles Uses		Regulations / Legislation Awareness				Mobile as Danger	Mobile as Tool
			Price	Feat-ures	Trend	Brand	Single	Multi	All Availab-ile	Maj- or	Conc-ern	Least		
Ranchi	100	76	36	12	14	45	22	43	9	45	54	7	34	48
Jamshedpur	100	85	32	38	8	52	28	53	4	39	23	10	12	58
Dhanbad	100	71	33	12	9	57	12	58	4	34	36	11	9	46
Bokaro	100	67	25	22	9	10	13	45	6	24	23	5	12	42
Hazaribagh	100	48	12	21	6	11	15	33	4	21	12	7	11	34
Dumka	100	36	15	12	3	9	11	25	3	12	9	9	9	22
Daltonganj	100	39	14	11	7	7	14	25	8	6	16	9	7	32
Chaibasa	100	28	6	7	6	10	11	15	6	11	6	3	6	22
Post / mail	200	87	16	14	24	51	24	53	45	19	11	6	34	51

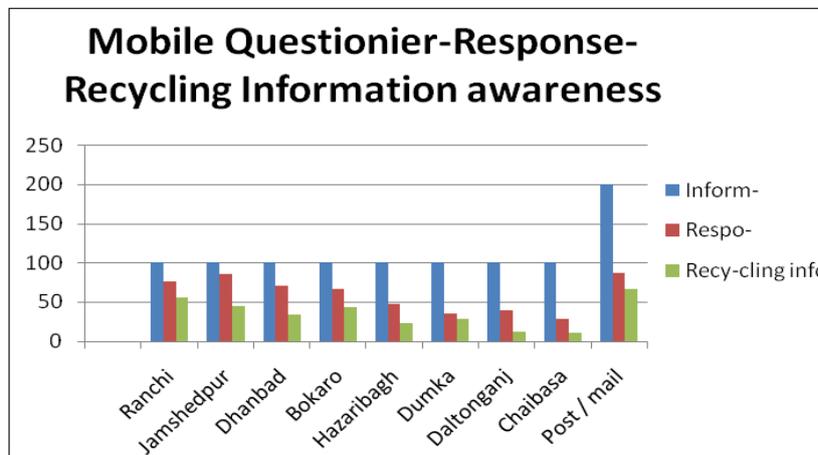


Figure 13

Out of all 1000 informations required responses city wise responses are available and has been projected in figure 13. The maximum response was available from Jamshedpur wher as the least from Chaibasa. The senario of Postal and email service was also poor. The information regarding recycling information awarenness is discouraging marking that population is lesser intersted in awareness of degradation around us.

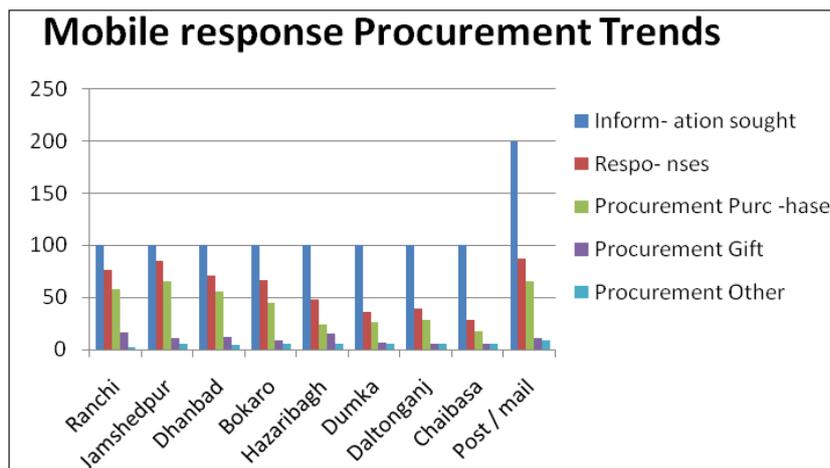


Figure 14

Data for mobile procurement figure 14 puts the purchase on top as expected. The option of other may include legitimate or illegimate procurement and has also taken few percentage in study.

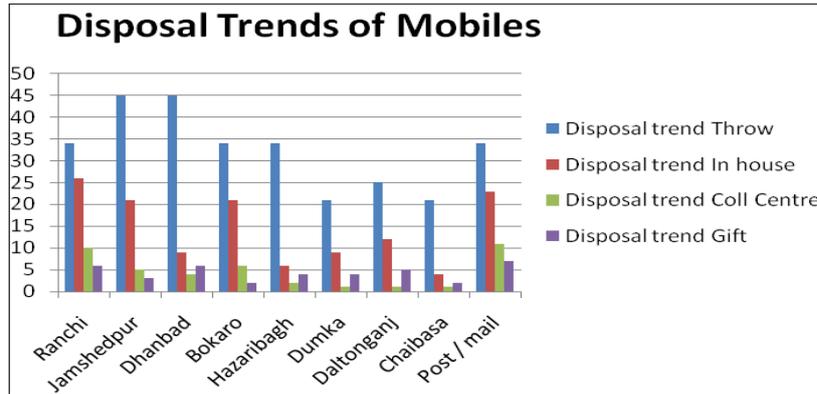


Figure 15

Figure 15 shows the disposal trend after EOL of mobile set or otherwise. Population is not aware of collection centres hence a larger section is left with no other option than to discard the mobile in house itself. Some persons are smart to pass on it to others as gift also.

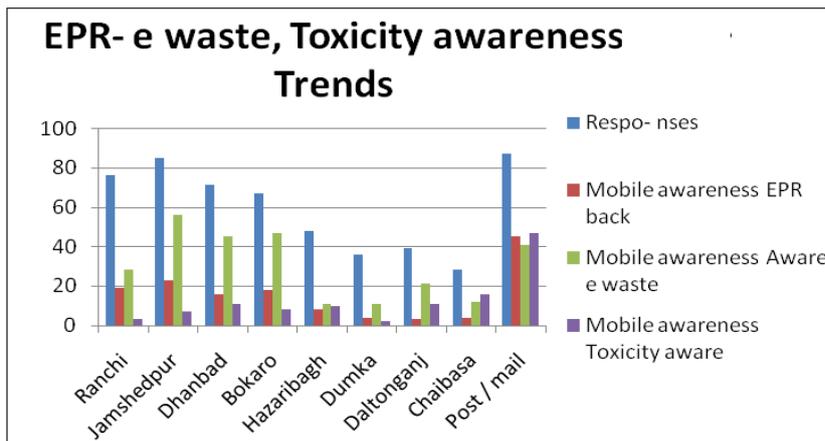


Figure 16

Figure 16 shows the mindset of users regarding EPR, e waste generation and threats. Awareness regarding waste is high but in relatively high industrial cities less knowledge about hazards is noticeable. The elite class of email is understandably alert and aware of all the options. Awareness regarding EPR and buy back options is required for proper disposal and handling ill effects of hazards arising out of this.

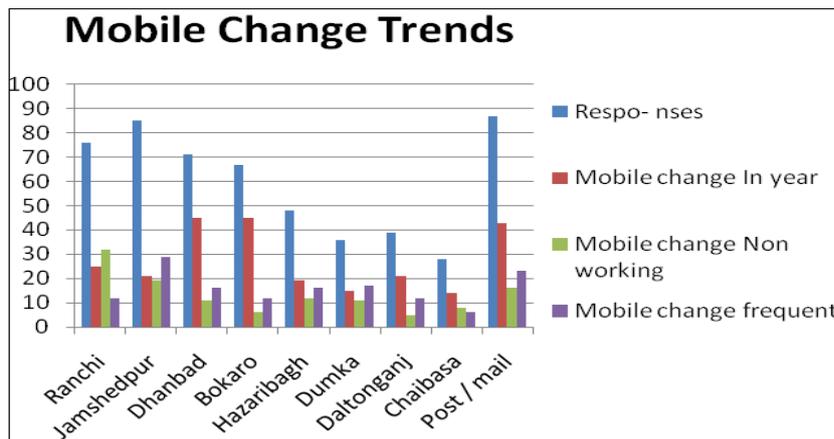


Figure 17

Purchasing capacity, industrial mind set of use and throw is well observed in a noticeable section. Maintaining mobiles for year of more is evident in relatively less industrial developed cities. The industrial growth reflects in the changes of gadgets also. These facts are observed from the depictions in the figure 17 which relates the mobile change trend. It testifies and justifies the industrial psychology and management theories.

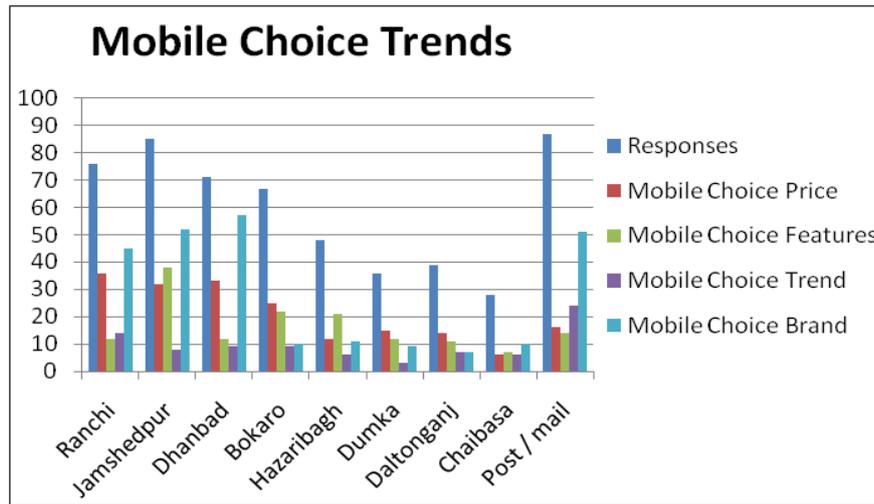


Figure 18

Throughout as per figure 18 it is evident that brand plays important role in purchase of any item. It is the goodwill which creates market. Features and prices are secondary to this. Observed data shows that the importance to some regarding money, to some regarding getting maximum in features can be witnessed.

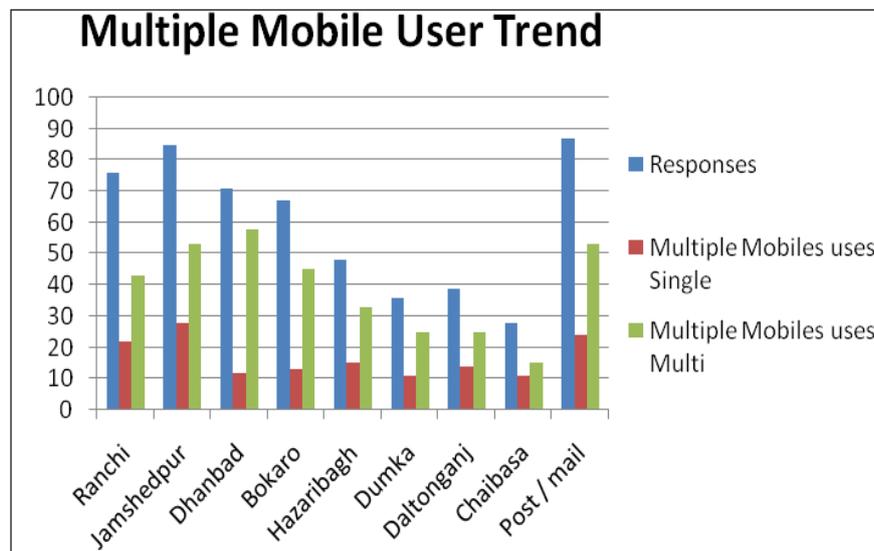


Figure 19

Newer trend of having multiple SIM or mobile as evident in figure 19 is popular these days. Affordability and trust breach are the two opposing factors mainly play role in this. The increase in per capita income is mainly responsible for this.

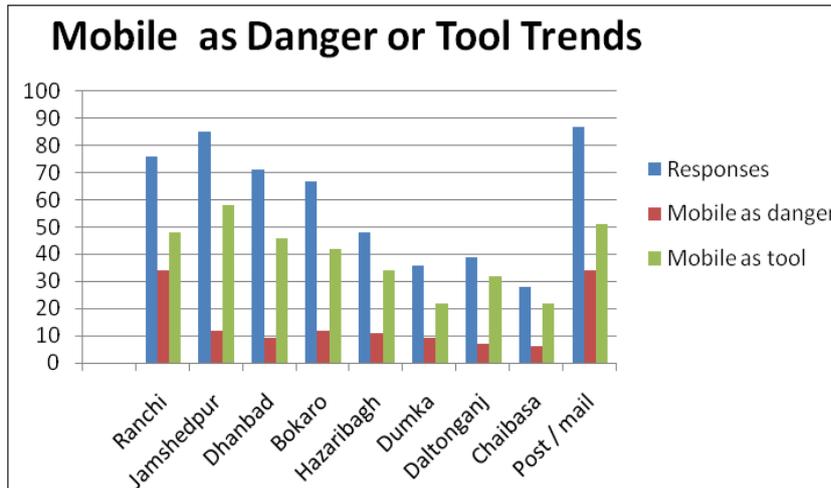


Figure 20

Users perception regarding mobile as a danger or tool was also surveyed. Anger here is of becoming victim and tool is for relief from situation. General mind set is for the tool option. However a section, though smaller maintains that it is a danger also. The trend is well seen in figure 20.

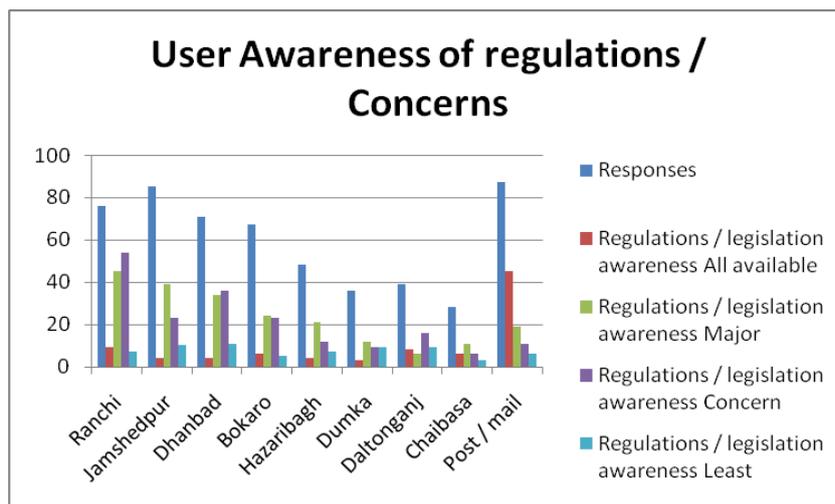


Figure 21

Figure 21 give brief of how users are aware of the regulatory and legislative measures. Majority has less to do with these. Use and throw is the general tendency. Sizable users in elite cities only are aware of these leaving rest ignorant of these. The major EPR or buy back initiative batteries act is known to users.

**CONCLUSIONS**

The paper gives a stock of impact of communication leader of world i.e. India, its growing and expanding impacts. The increasing size and growth of population of mobiles and tendency of frequently changing and doing away with the existing mobiles gives rise to waste mobiles. The tiny set has full valuable resource at one end and hazardness and toxicity at other end. The content and valuation of the extractable materials when amounted for the millions and billions of sets comes to several thousand tones in case of gold, silver etc valuable materials. The disposable waste if properly collected and recycled, reused and dismantled and segregation / extraction of valuable substances will lead to resource preservation and resource generation. In all one can say that recovery of around 90 % material can be achieved from

extraction from the wastes resulting in lessening in use of virgin materials for production. The properly technological disposal will ease out the alarming situation of hazardness and toxicity which otherwise will pollute the environment. Lessening of e waste generation is the best policy for reduction of e waste and this can be achieved by awareness. The situation of creation of awareness and knowhow of the regulations and legislative measures can further make human kind friendlier to environment. Opening of collection centre and making these known to commoners with provision of take-back and EPR aims will help in combating the menace. Best tool for effective and sustained e waste management is to create awareness, frame requisite policy, sustainable model development and proper implementation of this model. The tendency of having multiple mobiles may increase teledensity on papers but reach to connecting population will be left behind. Strictness to managing population to retain mobiles for longer with the existing mobiles can also lead to lessening of waste contribution from this end.

Last but not least creation of awareness and effective e waste management in general may need to include topics in the curricula of professions courses for saving mankind and provide the coming generation a sustained place to live in with resources and dignity in safer world.

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