



“WEEE Resource Recovery and Role of Informal Sector: Prospects of Circular Economy in Pakistan”

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ABSTRACT

Circular Economy through recovering resources from Waste of Electric and Electronic Equipment (WEEE) can play vital role in uplifting the socio-economic condition in developing countries. Global estimate shows that the worth of precious materials present in WEEE products are more than 55 billion euros. Average WEEE imported to Pakistan is 37746.92 tons/per/year and it is expected to increase in future. Estimates shows more than 9 billion dollars are involved in WEEE economic activity in Pakistan. In Pakistan, major activities for WEEE materials extraction used in circular economy are performed in informal sector. The size of the informal sector is highest among the developing economic countries; 62% of the businesses are operating in the informal economy. “Quotative” research approach was adopted for this research work. The research estimated the resources present in WEEE materials used for circular economy. The paper sketch comprehensive view on socio-economic conditions of the working class in informal sector. The research routes on the Management barriers of informal sector and suggests actions to overcomes these challenges. Presently, Pakistan do not have policies regarding Circular Economy. Based on data, the paper discusses prospects of Circular Economy through WEEE resource recovery to gain the concept of sustainability.

Introduction to Circular Economy and WEEE

The Circular Economy is based on the concept that waste can be used as an input material to create valuable products. Therefore, circular economy presents an alternative to traditional linear economy (make, use, dispose) in which resources are used for a longer possible time (EllenMac, 2013). Waste of Electric and Electronic Equipment (WEEE) is one of the fast growing waste streams in the world (Dodson et al., 2012). WEEE have multi-facet properties: it is perilous, due to toxic ingredients and at the same time it is valuable, due to treasurable metals which are equipped in the course of engineering process (Sauvé et al., 2016). Main aspects that contribute toward the abandon production of WEEE are the excess manufacturing of Electric and Electronic Equipment (EEE); that characterized with improved technology, reduction in goods lifecycle, reasonably priced and product-design that discourage upgrading and repairs (Shahkhan et al., 2017). WEEE provides materials and energy for different activities such as reuse, recovery and recycling that enables the use of WEEE waste materials for many time before discarded (Lee and Na, 2010; Bhaskar and Rama, 2017).

In manufacturing electronics devices significant amounts of treasurable metal such as platinum, gold, silver, etc. are equipped (Singh & Ordoñez, 2016). The approximated ratio of these precious elements present in personal computers are about 3% of gold, 4% silver, 13% Palladium and 15% Cobalt (Ghisellini et al., 2016).

Some modern electronic equipment's also contain up to 60 different precious and rare elements (Parajuly & Wenzel, 2017; Işıldar et al., 2017). It is said that mining of precious material in WEEE products are more beneficial than mining in natural earth because gold found in the electronic equipment's circuitry varies from 40 to 800 times greater as compared to gold ore found in earth mining (Shittu et al. 2021; Shahkhan et al. 2017). These precious elements are the main source of providing the resources materials for circular economy (Chen et al., 2019; Bigum et al., 2013). Due to the importance of circular economy in coming era, the paper focus the estimation of WEEE materials – how much treasurable materials are present in WEEE resources; and can be utilized in an efficient way. As all the major activities of materials extraction are performed in informal sector, the paper highlighted the management deficiencies of informal sector. Prospects of circular economy through WEEE resources recovery in Pakistan are discussed. At the end policy direction are sketched for the improvement of informal sector and implementation of circular economy. Therefore, to have secure access to resources, circular economy can bring societal welfare, environmental protection and economic growth in developing countries (Di Maio et al., 2017).

Circular Economy: Global Estimation of WEEE Materials

Table 1. Domestic 'WEEE production in 50 countries' (Kusch and Hills, 2017)

WEEE Quantities in 1000 M-Tonnes			
Countries	Amount	Countries	Amount
Germany (DEU)	1769	Bulgaria (BGR)	77
The United Kingdom (GBR)	1511	Belarus (BLR)	72
France (FRA)	1419	Slovakia (SVK)	62
Russian Federation (RUS)	1231	Serbia	56
Italy (ITA)	1077	Azerbaijan (AZE)	48
Spain (ESP)	817	Croatia (HRV)	48
Turkey (TUR)	503	Uzbekistan (UZB)	45
Poland (POL)	397	Lithuania (LTU)	34
The Netherlands	394	Slovenia (SVN)	31
Ukraine (UKR)	258	Latvia (LVA)	22
Belgium (BEL)	242	Turkmenistan	22
Sweden (SWE)	215	Bosnia and Herzegovina	21
Switzerland (CHE)	213	Georgia (GEO)	21
Romania (ROU)	197	Albania	20
Austria (AUT)	188	Estonia (EST)	19
Portugal (PRT)	171	Armenia (ARM)	16
Greece (GRC)	171	Cyprus (CYP)	14
Czech Republic (CZE)	157	Macedonia	13
Norway (NOR)	146	Luxembourg (LUX)	12
Israel (ISR)	138	Iceland (ISL)	09
Denmark (DNK)	135	Kyrgyzstan (KGZ)	07
Kazakhstan	131	Tajikistan (TJK)	07
Hungary (HUN)	125	Malta (MLT)	06
Finland (FIN)	118	Republic of Moldova	06
Ireland (IRL)	92	Montenegro	04

At global scale, the WEEE present one of the topmost growth figures in solid waste category. Balde et al. (2017) showed that in 2016, 44.7 million (Mt) of WEEE were produced at global level and the limit of 46 million (Mt) was crossed in 2017, further the forecast for 2021 is about 52.2 (Mt) (Zeng et al., 2017). Out of 46 (Mt) generated WEEE in 2017; only 20% (9.2 Mt) are collected and recycled. Approximately 1.7 (Mt) are incinerated or land-filled or thrown into the residual waste while the remaining amount of WEEE

is transported to the developing economics nations (Balde et al., 2017). The notable results of increased production of WEEE are noted in European Union where 12.3 (Mt) of WEEE produced each year and lies within the range of 16% -28% (Khan et al., 2015). Further, in United States, number of outmoded, stored or discarded WEEE goods are growing at frightening ratio; it owns more than 11.3 (Mt) of WEEE products (Balde et al., 2017). In 2016, Asia produces by far the largest amount of WEEE (18.2 Mt), followed by Europe (12.3 Mt), Africa (2.2 Mt), and Oceania (0.7 Mt).

Table-1 shows the domestic 'WEEE production in 50 countries' (Kusch and Hills, 2017).

The report (Ellen Report, 2015) gave approximation benefits towards transition in circular economy that would "allow Europe to grow resource productivity by up to 3 percent annually". The primary reserve value is assessed to be about €0.6 trillion/per/year by 2030 to Europe's economies (Simone et al. 2019). Other benefits (non-resource and externality benefits) are projected to be €1.2 trillion which created total profits of €1.8 trillion yearly (United Nations COMTRADE database, 2017). Other estimates had revealed that the value of these materials being recovered was around 55 billion euros in 2016 (Balde et al., 2017) and £ 34.5 billion in 2017 (Kusch and Hills, 2017). As the collective goal of the nations are to boost resource recovery and promote efficient consumption, circular economy holds the key to a sustainable future especially in developing countries (Borthakur and Govind, 2017). Therefore, need of the time

is to utilize the WEEE resource materials for circular economy. The materials extracted through WEEE in different countries - China, India, Colombia and Kenya is presented in Table-2.

Table-2 Statistics from WEEE material extraction in Different Countries

Countries	Refrigerators (tonnes)	Television (tonnes)	Personal Computers (tonnes)	Printers (tonnes)	Mobile Phone (tonnes)
China	500,000	130,000	300,000	2500	1800
India	100,000	275,000	56,000	1300	1200
Colombia	9,000	18000	65000	1300	1200
Kenya	11,400	2800	2500	500	150

Table-2 Statistics from WEEE material extraction in Different Countries

3: Circular Economy: WEEE Statistics for Pakistan

Electric and Electronic Equipment (EEE) are major imports of Pakistan. In Pakistan no previous data is available that details the WEEE materials recovery in informal sector. Literature examination suggests that no summative study had been undertaken to evaluate the number of materials recover from WEEE. Therefore, management issues of circular economy through WEEE materials recovery is relatively newer in Pakistan and it remained unaddressed until recent. In this study Quantitative research approach was adopted. The facts and figures gathered for the preceding twelve years' i.e. January- 2007 to December-2018, were obtained from Pakistan customs. The imported WEEE products include - computer sets, non-workable computer sets, printers, laptops, refrigerators, television, audio / video

devices were considering for calculation because they create 90% of the entire volume of the WEEE import of Pakistan. Estimation of the WEEE materials present in WEEE were done by using the formula provided by UN 2009 and Abdul et al., 2014. The year wise statistics for the WEEE quantities imported (in tonnes), are presented manipulated in Table-3.

Year	Computer Sets	Computer Accessories	Computer Printers	Laptop	Fridge	Television	Audio Video Device	Total in tonnes
2007	25121	2683	14045	155	2803	2149	11074	58,030
2008	17229	1915	3988	518	2804	1645	5161	33,260
2009	13814	2402	8673	698	3129	4179	3092	35,987
2010	15096	3735	5640	288	1645	2933	2758	32,095
2011	16209	3572	6766	529	1903	3322	3312	35,613
2012	16685	1879	11793	515	2336	2156	2714	38,078
2013	16485	1902	9897	399	2670	2802	5316	39,471
2014	15609	2019	10734	310	1602	2558	2907	35,739
2015	15033	1837	10259	433	1784	2697	2746	34,789
2016	17230	2098	11890	578	1657	2987	2234	38,674
2017	16970	1978	9763	356	2678	1876	2167	35,788
2018	15890	2498	9346	540	2167	2897	2098	35,436
Total	201371	28518	112794	5319	27178	32201	45579	452960
Grand Total	452960 tonnes							

Table-3 WEEE Assessment for the years 2007-2018 in tonnes Source: compiled

The data investigation pinpoints that computers with computer related equipment have the loin share in WEEE imports. Available data indicates that out of 452960 tons of imported WEEE, the weight of computer related equipment were 348002 tonnes. The average quantity of WEEE imports were presented in Table-4

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Table-4 Average per year import of WEEE: Source compiled

Per/Year	Computer Sets	Computer Accessories	Computer Printers	Laptop	Fridge	Television	Audio Video Device	Total in tonnes
Total	16781	2376.5	9399.5	443.25	2265	2683.42	3798.25	37746.92

Table-4 Average per year import of WEEE: Source compiled

Estimations of materials resources that can be potentially extracted from WEEE which can possibly be extracted for circular economy are given in Table-5.

Table-5 Estimation of WEEE resources recovered for Circular Economy. Source compiled

Metal	Percentage of Material Contained in WEEE	Computer Sets	Computer Accessories	Computer Printers	Laptop	Fridge	Television	Audio Video Device	Total Materials in WEEE
Ferrous	36 %	6041.16	855.54	3383.82	159.57	815.4	1781.43	1367.37	14404.29
Aluminum	5 %	839.05	118.82	469.97	22.16	113.25	247.42	189.91	2000.58
Copper	4 %	671.24	95.06	375.98	17.73	90.6	197.94	151.93	1600.48
Lead	0.29 %	48.67	6.89	27.26	1.29	6.57	14.55	11.01	116.04
Gold	0.0024 %	0.67	0.06	0.26	0.012	0.054	0.12	0.091	1.267
Silver	0.0012 %	0.21	0.028	0.12	0.0053	0.027	0.059	0.046	0.49
Mercury	0.00007 %	0.012	1.66	0.0066	0.0003	0.0016	0.0034	0.0026	1.69
Total Materials in WEEE		7601.02	1078.06	4247.42	200.76	1025.90	2241.32	1730.36	18114.84

Table-5 Estimation of WEEE resources recovered for Circular Economy. Source compiled

Panoramic View of Informal WEEE Recycling Sector

At global level, Pakistan has emerged as one of the largest importers of WEEE. The electronic gadgetry is imported under the rule of “second hand equipment”. The country imports new electronics goods, secondhand electronic items, as well as recyclables for further processing. Average legal import of WEEE in Pakistan is 37746.92 tons/year. It receives bulks

consignments of WEEE from Taiwan (15,476.23 tons- about 41% of overall imports), Japan (12833.96 tons- about 34% of overall import), Hong Kong and Singapore and other European countries (Imran et al., 2017).

In Pakistan; WEEE economic activities revolves around materials recovery, sorting and reusing waste. Most of WEEE materials extraction junkyards in informal sector are based in Karachi and Lahore. The electronic goods pass through various vendors, both in formal and informal sectors. The WEEE journey in informal sector is complex and somewhat cyclic in nature, with computers and electronic devices changing ownership from manufacturers to retailers’ numerous times before finding its path at a material recovery stage. Proper utilization of these WEEE materials in Circular Economy can provide ample prospects for consumers, industry and the economy in Pakistan.

In Pakistan, 62 percent of the businesses are operating in the informal economy and noteworthy portion of the trading is done around the movement of WEEE. The total employed labour force in informal sector, 40.6 percent or 21.8 million depend on directly or indirectly on the WEEE informal economy for their sustenance. Further 50% of the age group working in the WEEE informal sector lies between the age- brackets of 25 to 35 years (Shehryar, 2014). The ratio of informal women workers is 70% or 8.52 million. For the last three decades the informal sector had grown in Pakistan faster than the formal sector and accounts for at least one-third of the country’s GDP (Hanafiah and Ismail,

2019). Estimates shows more than 9 billion dollars are involve in WEEE informal sector to the total economic activity of Pakistan. It is estimated that a worker's income through different trading actives around WEEE ranges from 07\$ to 58\$ per day; this is more than a white color job's earning in Pakistan (Khan et al., 2014). Therefore, by using the WEEE's treasurable materials in circular economy will generate revenue for many stakeholders in Pakistan. Some of the issues of Circular Economy through WEEE management in informal sector are discussed below:

Management & Governance Issues of Informal Sector

In Pakistan; the WEEE recycling in informal sector is very far from hybrid governance; which is based on close and balanced interaction between the state, market and community. The informal WEEE materials extraction sector is presently functioning as a market-driven entity with no regulations or authorities controlling it. The market is working in unique way and operated by brokers/importers/ exporters and the labors. All the functions of the markets are performed without the involvement of the government. The lack of involvement of government contributes poor accountability. Further the working class involved in the circular economy processes are mostly illiterate. The whole system has lacks transparency and that hinders the process of better governance.

The main causes for the mounting informal sector are the barriers such as lengthy registration processes, heavy

registration fees, biasness in business dealing, lengthy licensing processes and problematical taxation policy. These barriers are supported by greedy persons within the state apparatus. The working conditions in informal sector are miserable, their salaries are low and jobs in informal sector are unstable. The sector is marked by low levels of capital, skill and technology with loose access to organized markets. In such a business environment, businesses that may wish to enter the formal economy would dither. What is needed is a policy that rewards, not punishes, informal sector enterprises and individuals for disclosing themselves. In fact, no body prefers to remain in informal sector for long that deprive the benefits of formal sector.

History of Policy and legislative on environmental context in Pakistan took root in 1980s. In Pakistan Solid Waste Management come under the context of Municipal waste and WEEE does not deal separately. Further; there does not exists any policy dealing Circular Economy through WEEE materials extraction in Pakistan.

Prospects of Circular Economy through WEEE Materials Extraction in Pakistan

Circular economy through WEEE materials extraction will works as backbone stream as they contain critical raw materials for industrial interest. The import figures of precious and rear elements in Pakistan for the period 2017 and 2018 are summarized in table-6

Table-6 Import of precious elements in Pakistan for the period 2017 and 2018 source compiled

Materials	Worth in US Dollars
Gold,	\$ 514 million
Copper,	\$ 3.6 million
Silver	\$ 4.6 million
Iron	\$ 3.42 billion
Lead metal	300 MT/month
Plastic Scrape	\$ 2.3 billion

The import figures of precious and rear elements in Pakistan for the period 2017 and 2018 for Gold, Copper, Silver and iron were equal to 6 % of the GDP. Further in 2018; the import of Lead metal was 300 metric tons per month and plastic scrape was 46,992 tons worth of \$ 2.3 billion which is equal to 4% of the GDP. The estimated raw materials present in WEEE products are of 9 billion dollars which is dumped each year through legally and illegally trading of the WEEE materials. Therefore, by applying the concept of circular economy Pakistan will save up to 15-20% of foreign exchange by utilizing WEEE materials instead of import of new raw materials.

The prospects of circular economy in Pakistan will be very bright and optimistic. It establishes bridge between economic growth, societal welfare, and environmental protection. The concept will work as a vision and strategy for sustainable development. As in the modern technosphere world WEEE is also the fastest on the rise waste stream in solid waste sector and Pakistan is the major importer of WEEE therefore WEEE provides economic input to Circular Economy— whether through material or energy recovery. The other benefits of circular economy through WEEE materials usage can reduced reliance on natural resources, reduced used of fossil

fuels that will results in reduction of carbon emission and waste. On the other hand, it will also generate new employment sector and provides millions of jobs in formal and informal sectors. Further the dependency on other countries for purchasing of precious materials become less reliant. All of these factors will save lot of foreign exchange, increase taxation and improve GDP. Therefore, the concept of Circular Economy in Pakistan offers a compelling economic structure for effective WEEE resource utilization and a strong economic rationale for a country.

In coming era Circular Economy through WEEE materials extraction will represents a multi-billion-dollar industry for the country and industrial economy relied basically on the products manufactured from flows of material recovery of WEEE. By effective exploitation of the inherent value of WEEE, significant economic, environmental and social benefits can be derived, whilst limiting detrimental impacts resulting from its hazardous nature. Now a day, developing countries are facing economic deterioration due to heavy imports of raw materials. By utilization the concept of circular economy through utilization of WEEE materials will lessen the economic burden in developing countries. As the collective goal of the nation is to enhance resource recovery and promote efficient consumption, end-to-end Circular Economy projects hold the key to a sustainable future. Circular economy is also beneficial due to less resource consumption, less environmental deterioration and give

synchronisation between economy, environment, and society.

Policy Directions for Implementation of Circular Economy

In circular economy the materials recovery from WEEE is one the vital issue at global scale. By effective exploitation of the inherent value of WEEE; significant economic, environmental and social benefits can be derived. The study proposes policy directions that will be useful in designing the future policies for circular economy in a country.

- a. As Circular Economy is big concept and future for sustainable businesses lies on circular economy in a country. Therefore, Govt should give priority to this issue and draft policies for circular economy. Policies are designed in such a way that maximum participation and involvement of public - private sectors and major key stake holders for the solving the reuse of WEEE materials.
- b. Success of any system depend on the Data. As Pakistan don't have any data regarding WEEE materials extraction for Circular Economy. Further limited information is available for the activities that are performed in informal sector. As policies to achieve the target in Circular Economy system depends on reliable, consistent and harmonized data for better monitoring. In this respect a "Data Center" should be established. The

Data Center proactively provide services, notifications, and information to policy makers. Policies based on such Data will integrate and collaborate all sectors i.e. government, all stakeholders involve in Circular economy.

- c. Based on the data "Special Economic Zone" for WEEE Materials Extraction should be established in different parts of the country.
- d. As Circular Economy present multi-billion industry concept in near future, therefore new management model is needed to formulate the concept of Circular Economy. At present economic activities for WEEE materials extraction in Pakistan revolves around sorting and reusing of waste only in informal sector. Higher-value, employment-generating opportunities in the field of circular economy are yet to be captured.
- e. In Circular Economy the basic operations for materials extraction through WEEE are done in Informal Sector and income for millions of families are dependent on informal sector. In order to formalize the WEEE informal sector step by step incentive based programs will be lounded by the government. Firstly; the government should assign status of WEEE material extraction as home industry. Give remedies in taxes such as no tax at first five years, and gradually impose taxes on the industry, banks should give loan on soft terms, give strategies to ease

the unmanageable social costs associated with increasing stockpiles of discarded electronic goods, and gave subsidies for the import of new and advance machineries for WEEE material extraction.

- f. In designing the strategies for circular economy through WEEE materials extraction, starring role of municipalities can be apportioned. Municipalities should deal with all the procedure for circular economy through WEEE management that include sorting, collection, recycling, recovery, dumping etc. and give training to the informal labor force for safe abstraction of treasurable materials found in WEEE products.
- g. Circular Economy through extraction of WEEE materials usage will save lot of foreign exchange. Therefore, Pakistan needs new trade policies that could incorporate the concept of circular economy. Circular Economy through extraction of WEEE materials knowingly reduces the dependence on rising commodity prices and imports, but also reduces significantly the environmental impact of production.
- h. Lack of education and skill of the WEEE worker in informal sector have been found hurdle for the maximum extraction of WEEE materials. Non trained and non-skilled workers with low level of education, found themselves handicapped to fit in the progress of circular economy. To overcome this problem government should have

developed skill development centers. The centers will develop programs for capacity building of the stakeholders in planning business and WEEE management. As women are also involved in great number in the field of circular economy therefore the policies dealing with materials extraction of WEEE in Circular Economy also contain knowledge and awareness programs for women also.

Conclusion

The problem of WEEE dumping is gaining momentum in Pakistan. At present there is no law or regulation imposed in Pakistan or policy measures to control this situation. Therefore, necessitates expedites prompt measures. And in this situation circular economy present a good choice to handle this situation. Through this concept, a country can handle the waste in good manner, improve its economy, improve job status, lessen minerals import's burden, improve taxation system etc. and most important improve the livelihood of the working class engage in the informal sector. Therefore, by empowering the concept of circular economy by utilization of WEEE materials is probably the best investment that a country can make.

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