General Assessment of E-waste Problem In Egypt

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Abstract

The e-waste problem in Egypt is not very well assessed. Few efforts to collect specific e-waste components were not satisfactory. This paper tries to synthesize the quantity of e-wastes in Egypt and to project it to the year 2020. There is a common believe that the problem is not yet manifested as Egypt is not an authentic nor large producer of electronic devices rather it is a big consumer market for e-goods. With the remarkable reduction in the market price of new mobile phones and of new personal computers and with the rapid developments in their functions and capabilities, the use of e-goods has witnessed remarkable increase in Egypt during the past few years and expected to witness even further increase. Increase in the use of mobile phone monitored from 2000 until 2008. We found that in 2001, the total number of subscribers was 4.3 millions. In 2005 the number reached 8.2 millions. In 2007 the number increased to about 25,600,000 subscribers, while 2008 official reports report more than 37,600,000 subscribers, which is almost five times increase in three years with an increase of 12,000,000 in one year. On the other hand, estimated increase in the use of personnel computers follows a similar curve. In the late 1980s early 1990s, only main frame computer systems were used. Personnel computers were very limited in use, and were mainly used by researchers and university staff who had a chance to travel abroad and join academic or research institutes in the west, could afford purchasing a personal computer. At that time, Personal Computers (PCs) were very expensive in the local markets and less than 2% of the population had the possibility to buy them.

With the advent of local area networking routines and the increasing use of the internet in the mid 1990s, institutes like universities, banks, telecommunication, and travel agencies started to replace their costly maintained main frame systems with workstations and desktop computers, and with the remarkable increase in PC manufacturing and improvement of technology; prices of PCs started to decrease, and more become interested in having their own PC. It is merely estimated that the number of PCs increased from about 120,000 in 1992 to more than 400,000 in 1996, to about 2.0 million in 2002 and to about 4.5 millions in 2005. The current figures for those who own PC or a laptop estimated at 8.0 millions in addition to those used by institutes, banks and companies which estimated at another 3.2 millions. The e-waste problem started to attract the interest of several environmental institutes in Egypt since 2004. However, neither organized nor formal action has been taken to accurately assess the problem and propose solutions. The present article provides guidance as to possible policy actions to control the e-waste problem and to limit the disposal of e-wastes in municipal dumpsites and in landfills.

1- Introduction

The electrical and electronic equipment (EEE) sector is largely a globalized industry with production and assemblage occurring mainly in developed countries. EEE comprises electrical gadgets such as fridges, air conditioners, washing machines, microwave ovens, fluorescent light bulbs; and electronic products such as computers and accessories, mobile phones, television sets, modulators and stereo equipment. The growth in global electrical and electronic equipment (EEE) production and consumption has been exponential in the last two decades, fuelled by rapid changes in equipment features and capabilities, product obsolescence, decrease in prices, and the growth in internet use. This has created a large volume of waste stream of obsolete electrical and electronic devices (WEEE or e-waste) in developed and developing countries. With the globalization of trade in e-waste, there is high level of trans-boundary movement of electrical and electronic devices both new and secondhand or end –of-life from developed into developing countries in an attempt to bridge the 'digital divide', as a result an expected increase in e-wastes.

E-wastes contain several persistent, bio-accumulative and hazardous substances (PBT) including heavy metals such as lead, nickel, chromium, mercury and organic pollutants such as polychlorinated biphenyls (PCBs) in capacitors in the older models which are still available in the market or in use, and the brominated flame retardants (BFR). Thus globalization of e-waste has adverse environmental and health implications in the downstream end, especially in developing countries. Developing countries are economically challenged, lacking the infrastructure for sound hazardous waste management including recycling, or effective regulatory framework. Furthermore, there is pervading low public awareness of the hazardous nature of e-waste with the use of low-end or crude waste management techniques. Hence the profound concern for adverse socio-economic, public health and the environmental impact of toxics in e-waste in developing countries evolves.

The significant contributions of EEE to the rapid transformation of quality of life and the revolution of the information communication technology (ICT) are well recognized. Yet the fast growing volume of e-wastes generation in developed countries and their imports by developing countries whether in a form of post-consumer goods or end-of-life equipment imported or generated domestically therefore require both international and National actions to address the myriad of scientific, technological, policy, human and environmental health, as well as legal issues associated with e-waste management including toxics reduction in the upstream sector of EEE supply chain, through green design initiatives.

The emerging policy issue of information needs on electronic waste is adequately recognized in the Strategic Approach for International Chemicals Management (SAICM), strategic objectives (SO) 13, 14, 15 and 18 respectively in the Overarching Policy Strategy (OPS) as well as the Global Plan of Action (GPA). Strategic objective (SO) 13 states the 2020 goals of SAICM on sound management of chemicals throughout their life-cycle; SO 14 emphasizes the need to minimize risks to human health and the environment as well as vulnerable groups subject to exposure to toxic chemicals throughout the life cycle of chemicals; SO 15 aims to ensure that: "information on chemicals throughout their life cycle including where appropriate, chemicals in products, is available, accessible, user friendly, adequate and appropriate to the needs of all stakeholders…." ; while SO 18 aims " to prevent illegal international traffic in toxic, hazardous, banned and severely restricted chemicals , including products incorporating these chemicals, mixtures and compounds and wastes-----" .

The present paper tries to through light and brings into focus the e-waste problem in Egypt, through synthesizing data for generation of the main e-waste streams PCs, TV sets and mobile phones, using development indicators and other published data.

2- E-waste Generation and Management

Worldwide about 500 million personal computers (PCs) reached the end of their life (EoL) in the decade between 1994 and 2003 and these contain approximately 2,870,000 ton of plastics, 718,000 ton of lead, 1,363 ton of cadmium and 287 ton of mercury . Most of these EoL will end up as waste in developing countries releasing their hazardous constituents, endangering the environment and human health. E-waste is growing at a rapid and uncontrollable rate and is the fastest growing portion of the municipal solid waste stream. Currently WEEE constitutes 1% of municipal waste in the US (Li et al., 2006) and 4% in the EU. As these PCs become obsolete, they are replaced and the old PCs are disposed.

Personal computers (PCs) constitute the second largest component next to Cathode Ray Tubes (CRTs) in the e-waste stream and are growing most rapidly. PCs also contain the largest amount of printed wiring board (PWB) among electronic products (Nnorom and Osibanjo 2008). The cathode ray tubes (CRTs) in computer monitors and televisions contain about 8% lead by weight; amounting to about 2–4 kg of lead each. Computer CRTs present a disposal problem because of their growing magnitude in the waste stream and their role as a major source of Pb in Municipal Solid Waste (MSW). Consumer electronics accounts for 27% of Pb discards in MSW in 1986 in the US and is projected to comprise 30% of lead discards by 2007. By 2000, CRTs were projected to contribute 29.8% of all Pb in MSW or approximately 98.7% of all Pb from electronics. Lead is included in CRTs for various reasons among which is providing shield necessary for x-rays.

In the case of mobile phones, for example, its use has grown exponentially from the first few users in the 1970s, to 1.76 billion in 2004, and more than 3 billion in April 2008[i]. Eventually these mobile phones will be discarded, whole or in parts.

Very soon, and with the adoption of TV digital transmission, old analog TV sets will be phased out and become obsolete. It is expected that in the USA, **i**n 2009, when the analog to digital switchover takes place, around 80 million televisions might not work without a special converter box, and presumably will be replaced with LCD sets and old sets will be disposed off.

Management of e-wastes in developed countries has been developed seriously during the past decades. Many executive regulations and principles have been promoted and adopted. Among which is the extended producer responsibility. Some States in the USA such as California have enacted regulations on the sound management of e-waste. The European Union has adopted common regulations on e-waste for all member states. Also, facilities for recycling e-wastes have been developed in few EU states, most of them receives e-wastes from neighbor countries according to the Basel Convention Procedures and in compliance with the EU relevant regulations. Nevertheless, much of the e-waste (used e-goods) from developed countries witnessed excessive transboundary movement to south east Asia and Africa ; Figure (1) depicts the e-waste known and suspected routes [ii] from developed to developing world around the world.

On the other hand, most developing countries have neither a well-established system for separation, storage, collection, transportation, and disposal of waste nor the effective enforcement of regulations relating to hazardous waste management (Mundada et al., 2004).

Figure (1) e-waste known and suspected routes from developed to developing world around the world (source: www.etoxics.org)

Formal recycling of e-waste using efficient technologies and state-of-the-art recycling facilities are rare. As a result electronic wastes are managed through various low-end management alternatives such as disposal and eventual burning in open dumps, backyard recycling and disposal into surface water bodies.

The crude recycling operations in these countries can seriously jeopardize the health of workers and severely pollute the environment. Furthermore waste management occurs in the informal sector of the economy involving thousands of poor people ignorant of the hazard of exposure to toxins in e-waste. The most vulnerable groups especially children and women are actively involved in e-waste scavenging and crude recycling activities.

3- International Initiatives for Supporting e-waste Sound Management

Many international organizations showed great interest for global action on e-wastes and initiated programs for dealing with this ever increasing problem; the most common are:

a) Initiatives under the Basel Convention: Basel Convention is the multilateral environmental agreement dealing with hazardous waste. E-wastes are characterized as hazardous wastes under the Convention when they contain components such as accumulators and other batteries, mercury-switches, glass from cathode-ray tubes and other activated glass, PCB-capacitors or when contaminated with cadmium, mercury, lead or PCBs. Also, precious ash from incineration of printed circuit boards and glass waste from cathode-ray-tubes and other activated glasses will be characterized as hazardous wastes. However, most often e-wastes are exported as second articles e-goods and thus constraints the implementation of the Basel Convention Illegal Traffic provisions. The Basel convention had two important partnership initiatives for e-wastes under which related guidance and co-ordination established, these are the Mobile Phone Partnership initiative (**MPPI**), and the Partnership for Action on Computing Equipment (**PACE**).

b) Solving the E waste Problem (**StEP**) of the United Nations University UNU and UNESCO

c) The Global e-Sustainability Initiative (**GeSI**) – E-waste Working Group established by UNEP DTIE, as well as the appropriate European Union directives, Waste Electric and Electric Equipment (**WEEE**), and Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (**RHOS**).

More details regarding those partnership initiatives can be obtained from their respective Web sites.

4- Synthesize E-waste generation in Egypt

Due to the lack of information regarding e-waste generation, e-waste recycling facilities, and common practices in Egypt, the present work tries to synthesize methodologies to estimate past, current and future e-wastes in Egypt. The whole process for inferring e-waste generation status in Egypt relied on statistical data appeared in periodic publications of the Egyptian Board of Ministers, Ministry of Trade and Industry, Central Agency for Public Mobilization and Statistics and those from Ministry of Environmental Affairs in Egypt. Other statistical data are taken from relevant publications of the World Bank and the UNDP. The main objective of the study is to through light on the problem, its current and future trends with and without proper actions.

4.1 Estimating e-waste generation and generation rate for TV sets waste

In order to estimate the e-waste generation and generation rate from TV sets, data on population and development indicators were used. In addition useful time of a TV set was determined based on a survey done on a sample of people and services centres. The following table presents the useful time for a TV set for household and for a service centre.

Table (1) The useful time for a TV set for household and for a service centre.

Source of TV set	Time Life (years)	Average Weight (Kgs)/unit
Household	10	18
Service centre	7	25

Data on population and on number of households from 1992-2007 were used to estimate the TV waste generation and generation rate utilizing the above mentioned lifetime of a TV set and average weight of unit.

The following sequence was used to calculate the cumulative number of waste TV sets from 1992-2008:

1- Assuming an initial number of waste TV sets irrespective of estimated number of TV sets in use.
2- Using annual increase in number of households and in percentage increase of households own TV sets to calculate annual increase in TV sets in use.
3- For households the following formula was used to calculate the cumulative waste TV sets at any Year:

$$y_{i+1} = y_i + 0.1x_{i+1} \quad \text{----------(1)}$$

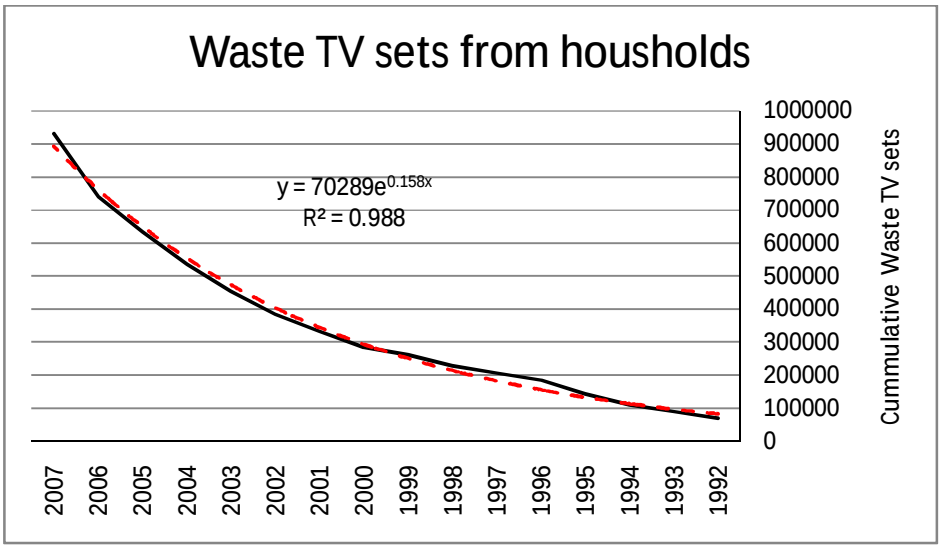
Where y_i is Waste TV sets at year *i* (initial waste TV sets)
y_{i+1} is the waste TV sets in at year *i+1*
$\times_{i+1}$ is the number of TV sets in use in the year *i+1*

4- For service centres (public halls, coffee shops, social clubs, restaurants, etc.) another equation utilizing the 7 years life time to calculate the waste generation rate;

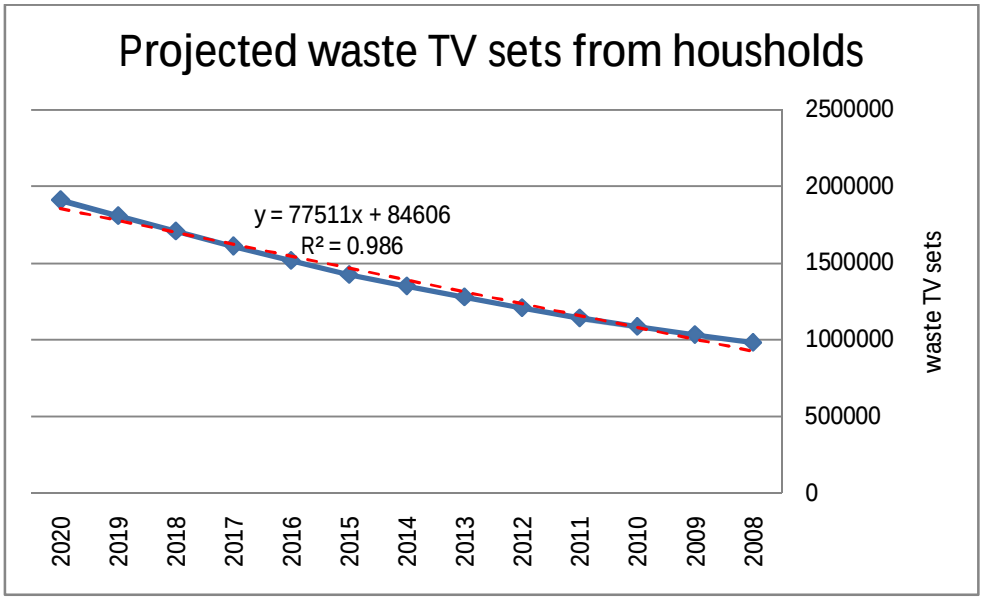
$$y_{i+1} = y_i + 0.142x_{i+1} \quad \text{----------(2)}$$

5- Adding results of equations (1) and (2) gives the total estimated waste TV sets.

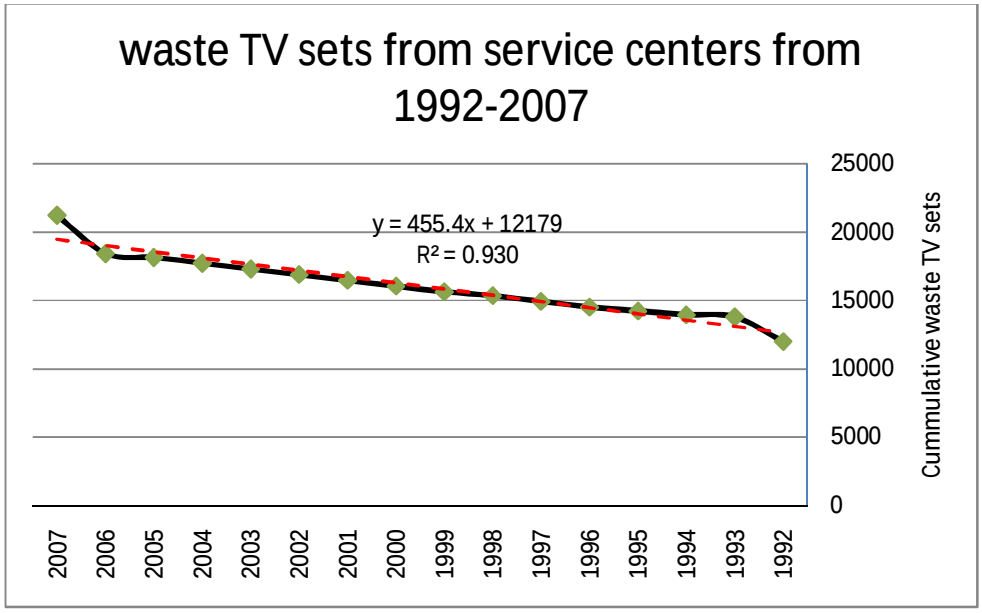
The equations were also used to project waste TV sets up to the year 2020 to reflect the escalation of the problem. Constants used for estimating the increase in population and in number of households were kept unchanged as the increase in turning over TV sets rate will be compensated by the decrease in population increase rate observed since the start of the current millennium. One important statistical analysis carried out over a small population sample, the assessment of the fate of end of life TV sets. Estimating the waste TV sets from households and from services centres since 1992 until 2020 are presented in figure (2). Results on the survey statistics are shown in figure (3).



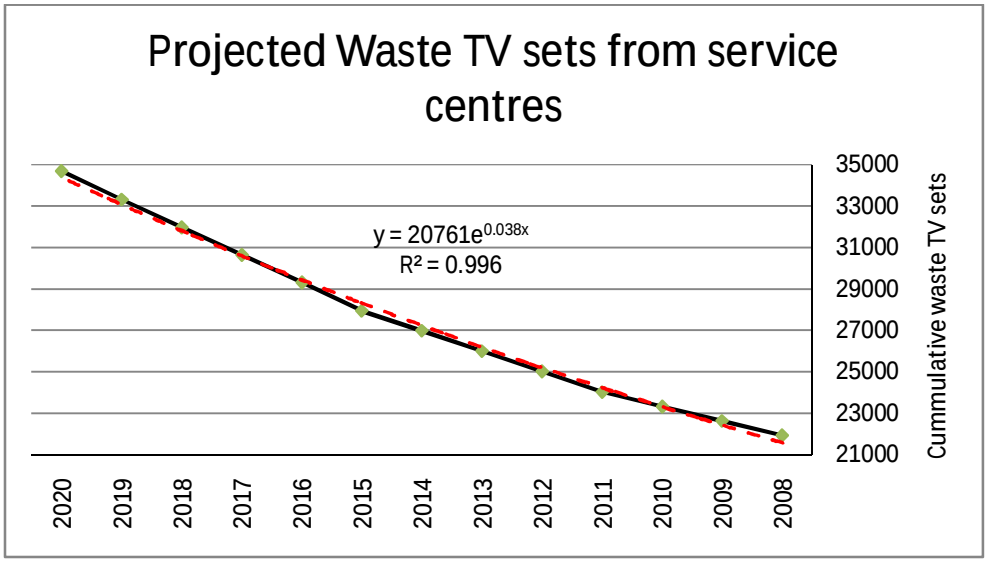
(a) Estimated waste TV sets from household for the period from1992 to 2007.



(b) Projected Waste TV sets from households until the year 2020

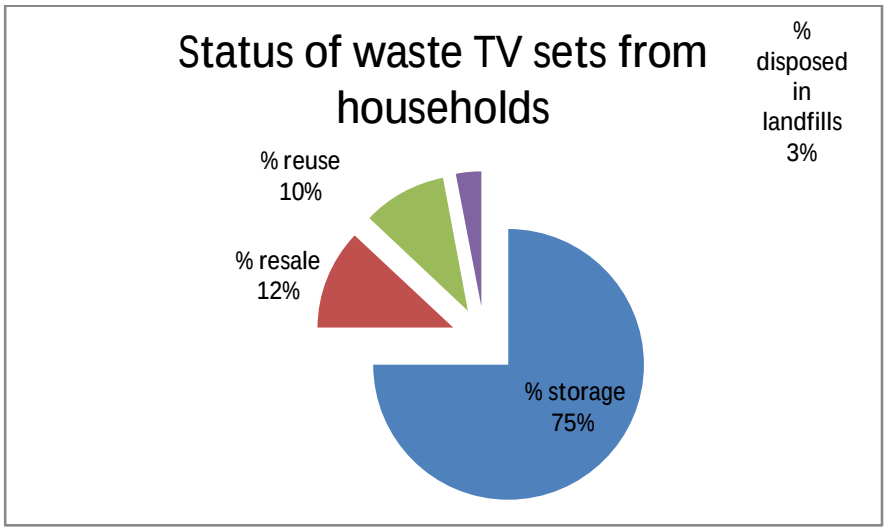


(c) Estimated waste TV sets from service centers for the period from1992 to 2007.

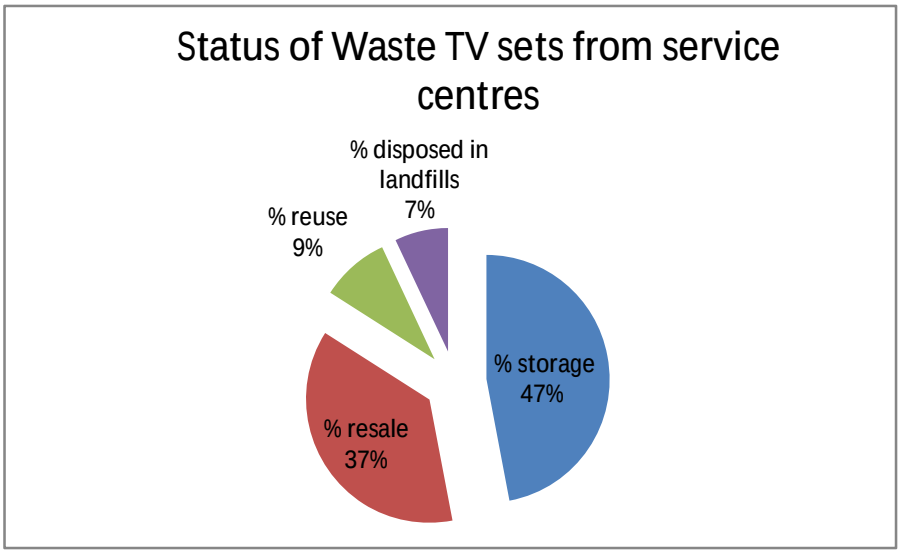


(d) Projected waste TV sets from service centers until the year 2020

Figure (2) Estimated waste TV sets from households and from services centers since 1992 until 2020



(a) For household waste TV sets



(b) For waste TV sets from service centers

Figure (**3**) Waste TV sets management status for both households and service centers

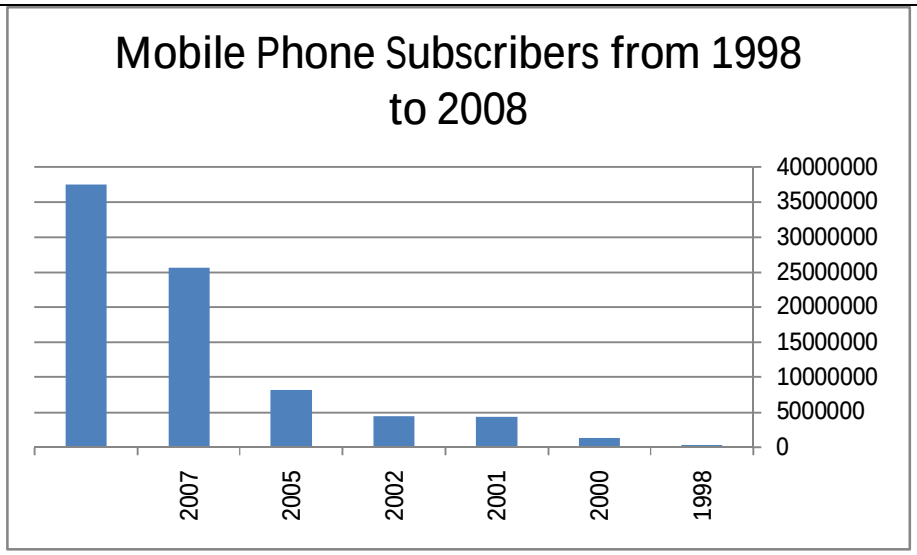
The total estimated cumulative waste TV sets from 1992 until end of 2007 from households and from service centers amounts to at least 2000,000 units which contain more than 4000 tones of lead.

It is fortunate until now that most of these generated waste TV sets remain in storage with the owners and minimum were disposed off with municipal wastes. It is to be noted that the reuse in the present context means use as spare parts or refurbish and resale. While resale means to sell as a post-consumer products for direct re-use.

4.2 Estimating e-waste generation for mobile phones

For mobile phones, data published periodically by the government and those declared by the mobile phone operating companies were used along with suggesting a 4 years time life for mobile sets in Egypt to estimate the current and projected waste mobile phones in Egypt.

Figure (**4**) represents both the increase in mobile phone subscribers over the last 10 year, along with the projected increase in subscriber's number which was calculated by extrapolation of the current trend. These data on subscribers are used to estimate waste (end of life) mobile phone handsets in Egypt.



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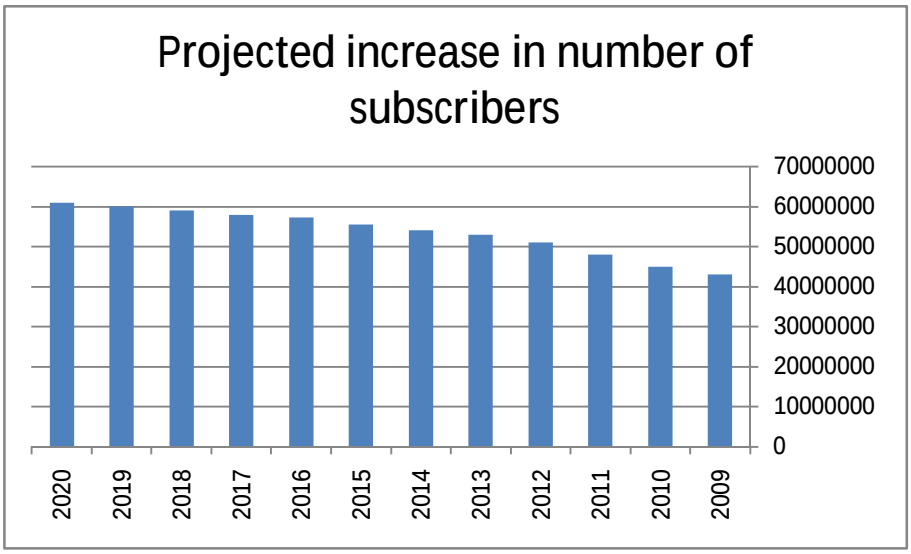
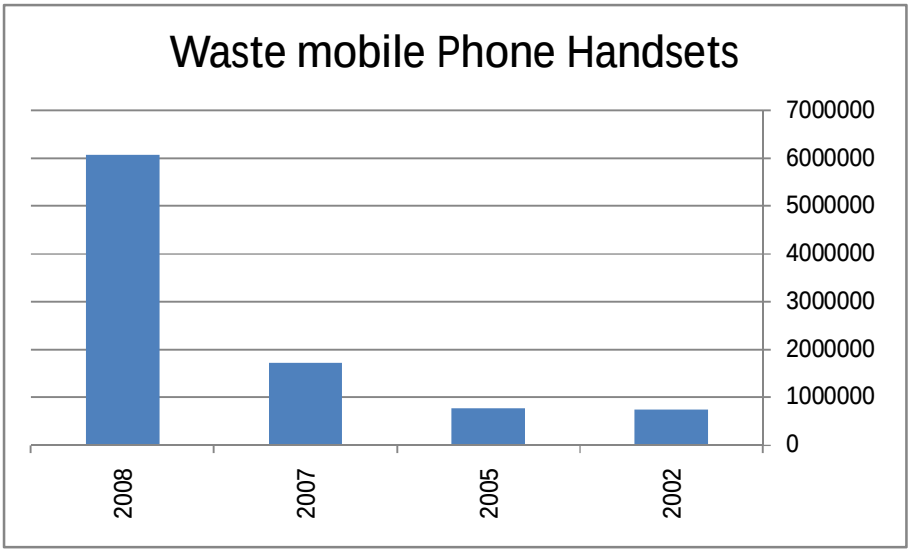


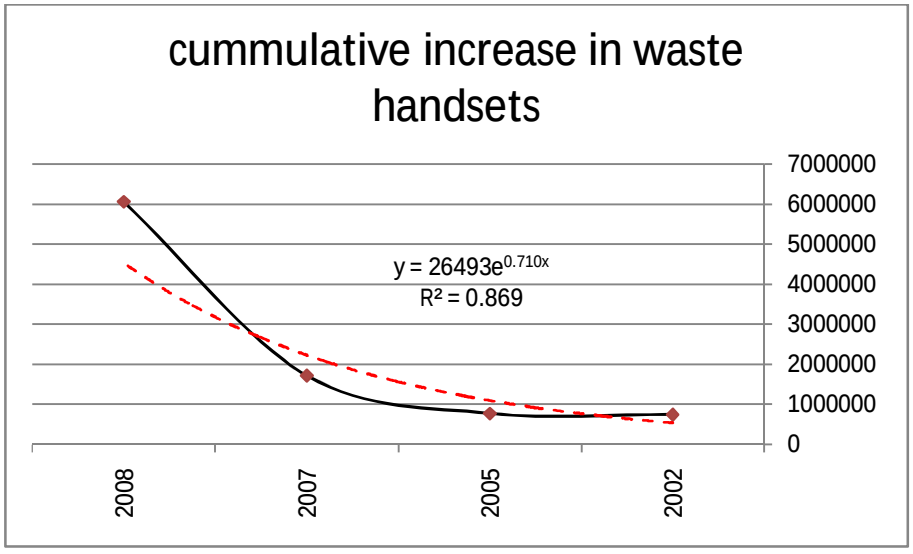
(b)

Figure (4) a-Increase in mobile phone subscribers in Egypt since 1998 until 2008, b- Projected increase in number of subscribers until 2020.

A tremendous jump in the number of subscribers is observed in two years from 2005 to 2007. Another anomalous increase is observed in the number of subscribers from 2007 to 2008. The number of subscribers increased steadily from 2001 until 2005. One then can describe the in crease in mobile Phone subscribers as exponential from 2000 until 2008, and that this exponential increase will change into linear increase during the next decade.

The waste[iii] mobile phone handsets accumulation corresponding to the period 1998-2008 is depicted in figure (5). The estimated number of waste mobile phone handsets based on an assumed a life time of 4 years for the handset and that each subscriber had only one handset at a time.





(c) Exponential increase in waste handsets, estimated

Figure (5) The cumulative waste mobile phone handsets over the period 2002-2008.

The exponential increase in the number of end of use handsets or waste mobile phone handsets is clearly shown in the figures.

In order to check the current management status of end of life or waste mobile phone handset, a field survey was carried out over a heterogeneous sample of people. The survey indicated that there is a good potential trading in used mobile phone handset and that more than 30% of the subscriber's population makes use of the used mobile phone handset market either by selling or buying their needs. Unfortunately, more than 60% 0f the population of the sample tend to keep their old mobile phone handsets. Figure (6) reflect the current status of end of use mobile phone handsets in Egypt

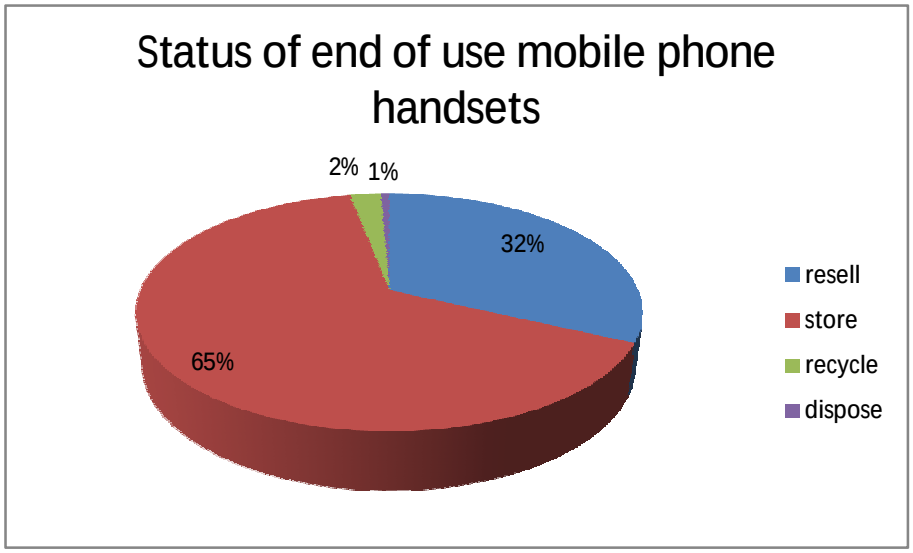
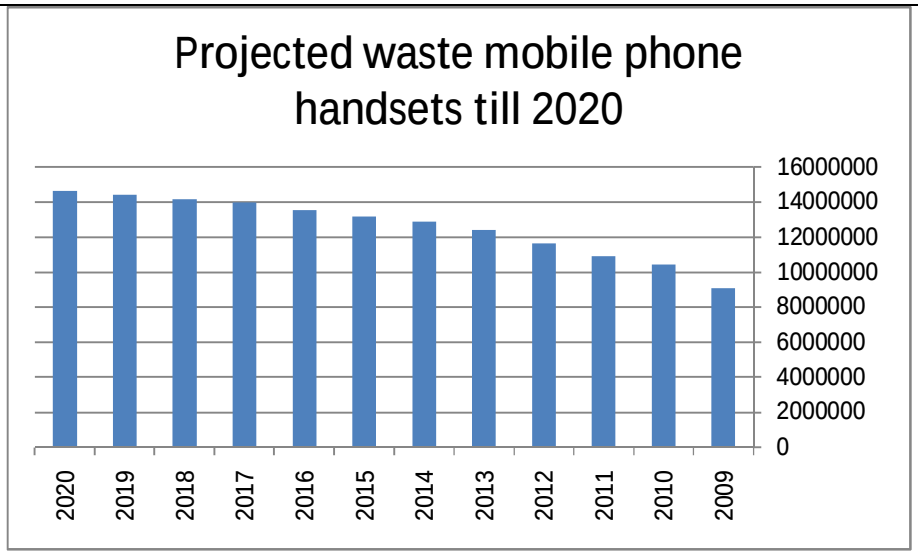


Figure (6) Current Status of end of use mobile phone handsets in Egypt

Some of them refused the term waste mobile phone. The term end of use instead of waste or end of life is then used. Many of those who participated in the survey indicated the working but unsatisfactory conditions of their old mobile phones, which they still keep. They also indicated that they keep their old phone because:

- Old handsets as second item become very cheap compared to original cost.
- They keep as a substitute in case the new handset fail or broken
- They keep for their kids to use in the future
- Those who their old handsets were broken and could not be repaired keep as spare or for possible future better repair opportunities.

The projected end of use mobile phone handsets were calculated utilizing projected increase in number of subscribers. The projected end of use mobile phone handsets increase is showing a steady state or a straight line type increase (figure 7) rather than the more or less exponential increase experienced during the first 8 years. However, it is expected that by 2013 the number will exceed 12 millions and action is needed to plan for their management as early as possible to avoid possible consequences and impact.



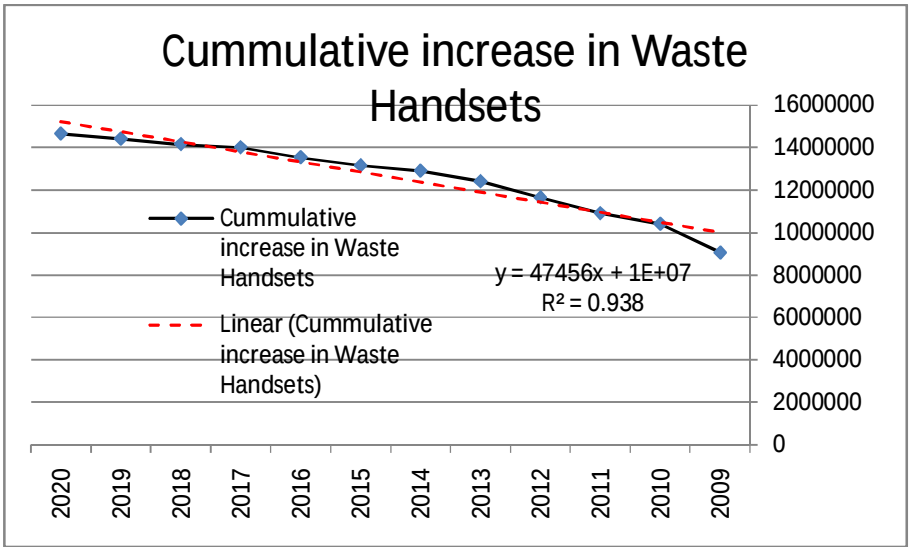


Figure (7) Projected end of life mobile phone handsets for 2009-2020

4-3 Estimating e-waste generation from Computer equipment

Computer equipment can simply be represented by personal computers. Personal desktop computer, including the central processing unit and all other parts contained in the computer. Personal notebook and laptop computer, including the docking station, central processing unit and all other parts contained in the computer. Computer monitor (Cathode Ray Tube monitors; CRT), including the following types of computer monitor: (a) cathode ray tube; (b) liquid crystal display; (c) plasma. Computer peripherals include keyboard, mouse, cables, and computer printer: (a) including the following types of computer printer: (i) dot matrix; (ii) inkjet; (iii) laser; (iv) thermal and (b) including any computer printer with scanning or facsimile capabilities, or both.

For the purpose of the present study we consider a personal computer as either a personal desktop computer including the monitor (CRT), a keyboard and a mouse or a laptop computer. Data used for estimating the number of PCs with individuals based on indicators appeared in the World Bank document on World Development Indicators (1998, 1999,2002

an 2004, and African Development Indicators report, 2002, along with official reports and sinuses data from Egyptian Central Agency for Public Mobilization and Statistics, personnel communication and survey on a small population of individuals , institutes and companies (including business offices, internet cafe, banks, etc).

Current estimates of the number of PCs owned by individuals refer to a number approaching 10,000,000 (ten million) unit, in addition to another 4,000,000 (four million) PCs kept by institutes and companies, summing up to about 14 million PCs. Assuming a life time of a computer equipment and its monitor as 5 years, mere estimate of the personal computers waste in five years should not be less than 2.67 million waste CPU unit and in addition to the same number of monitors. Figure (8) depicts the increase in number of individuals owned PCs between 1992 until 2008 in both histogram and trend charts.

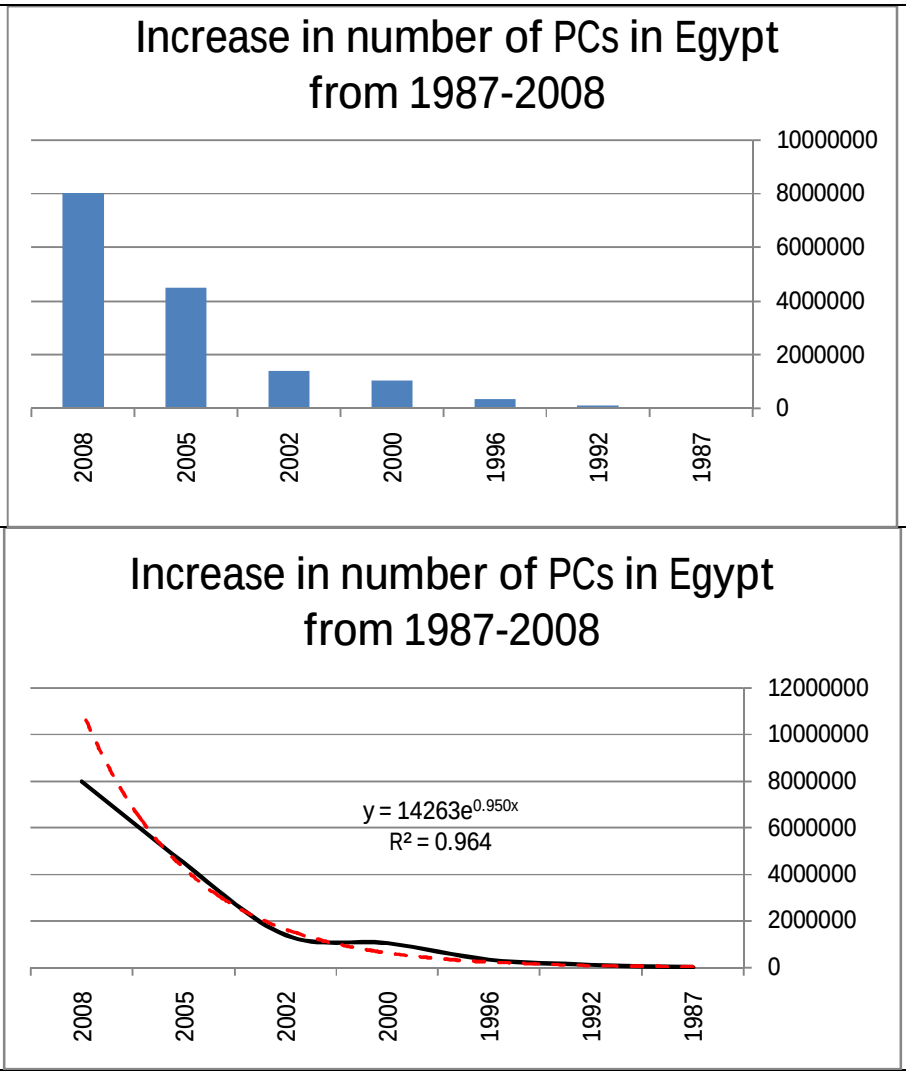


Figure (8) Increase in the number of PCs owned by individuals between 1987 until 2008 in (a) histogram and (b) trend.

It is evident from the graphs that the increase shows an exponential trend over the selected period. This trend is expected to persist may be for a few more years and then will change into a steady state increase due to the economic crises.

Figure (9) depicts the corresponding increase in waste PCs owned by individuals. The figure show the exponential trend which dictate a quick response and actions.

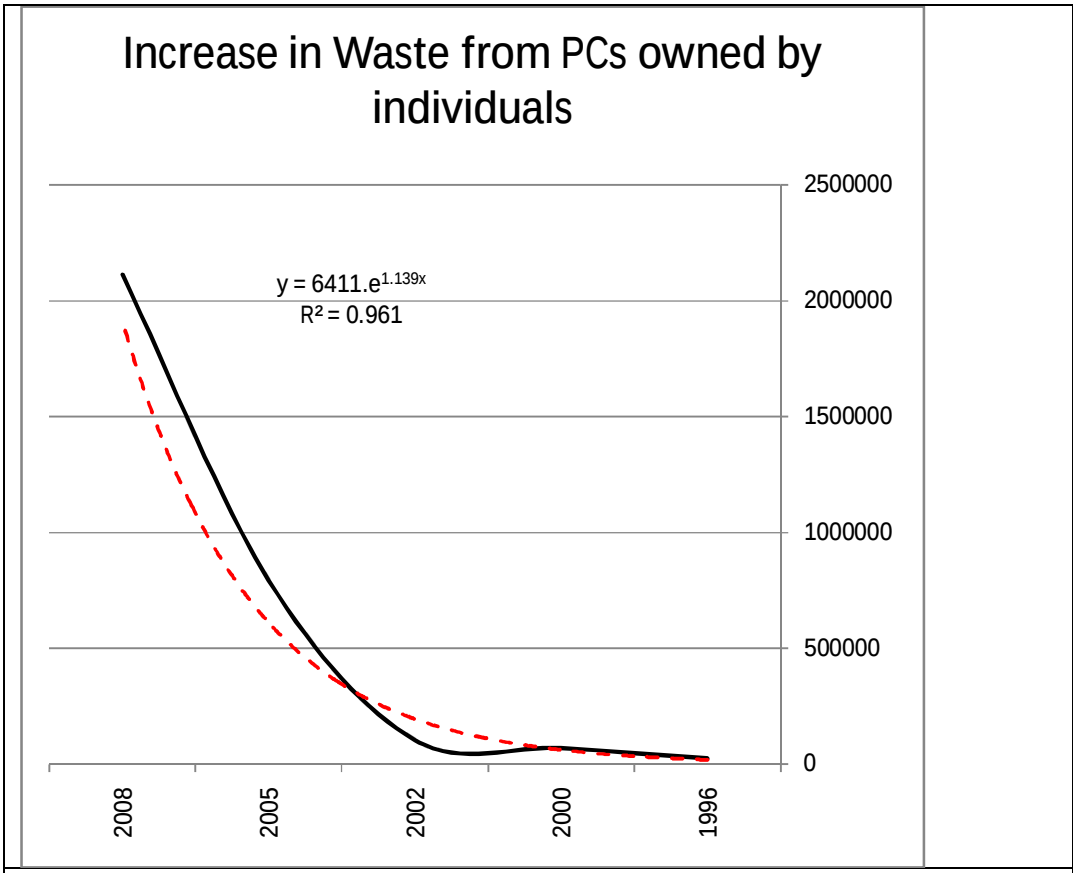
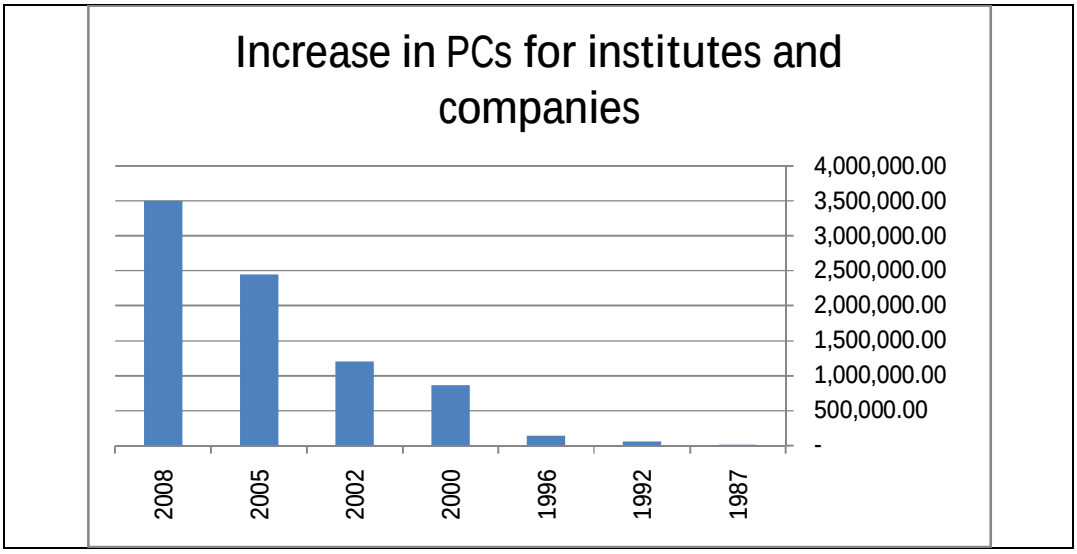
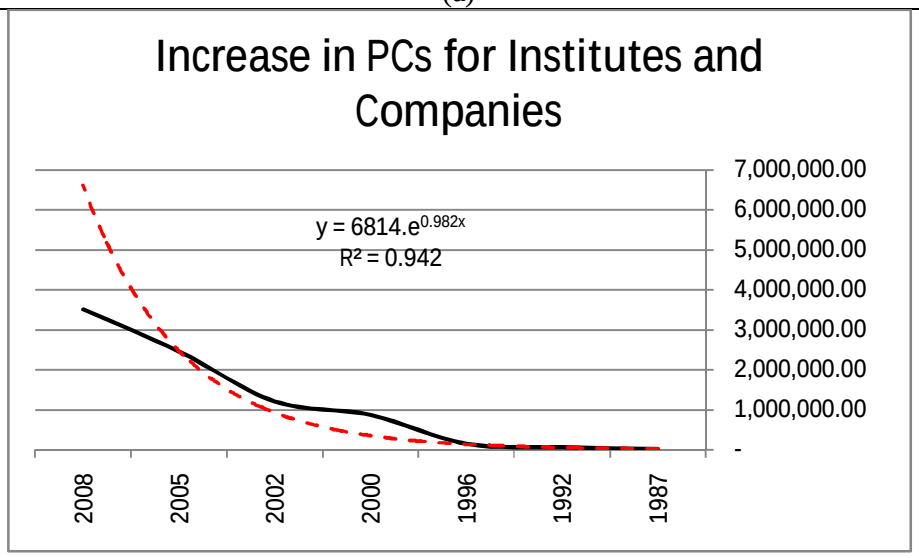


Figure (9) Increase in e-wastes from personal computers owned by individuals. The numbers reflect the waste PC units including CPU and Monitor.

Other source of waste PCs are academic institutes, companies, net café, banks and other business entities. The increase in using PCs for these sectors is depicted in figure (9).



(a)



(b)

Figure (10) Increase in the number of PCs kept by institutes and companies between 1987 until 2008 in (a) histogram and (b) trend.

Figure (11) again, depicts the corresponding increase in waste PCs from institutes and companies. The figure shows also the exponential increase.

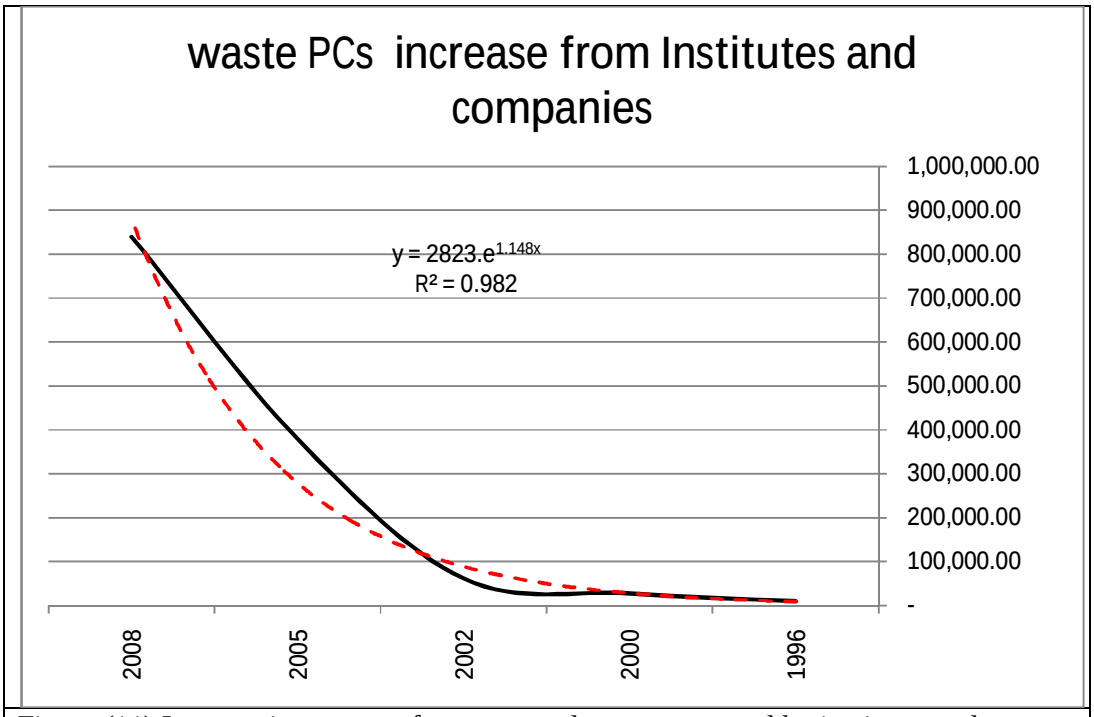
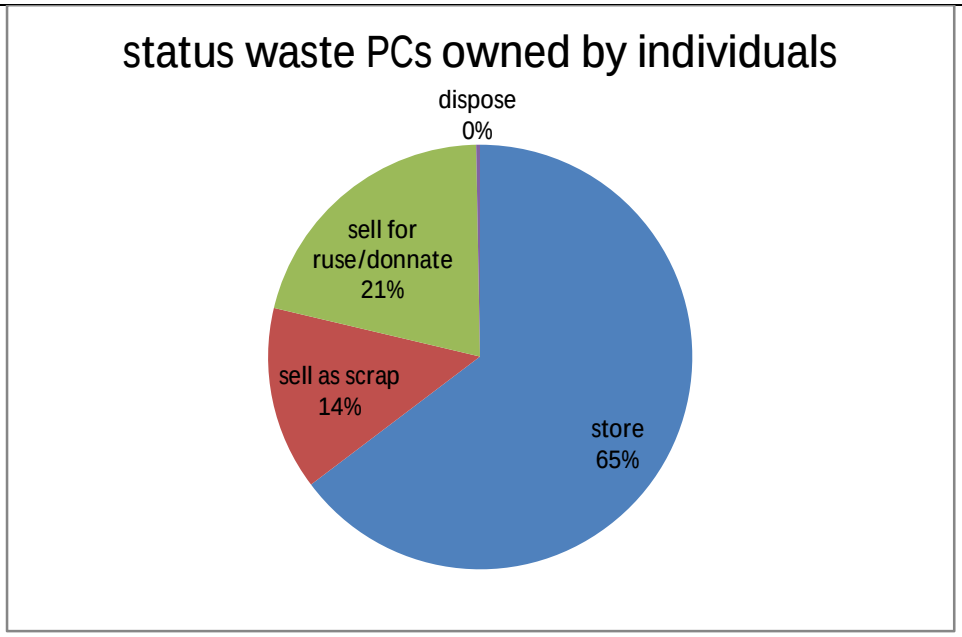


Figure (11) Increase in e-wastes from personal computers used by institutes and companies sector. The numbers reflect the waste PC units including CPU and Monitor.

According to the estimated figures of waste PCs from both individuals and from institutes and companies sector, it is expected that more than 3.5 million personal computer and CRT monitors are put off and can be considered as wastes.

The status of these computers was also analyzed via a field survey over a small sample population selected carefully to represent the whole population. The results of the survey are summarized in figure (12).



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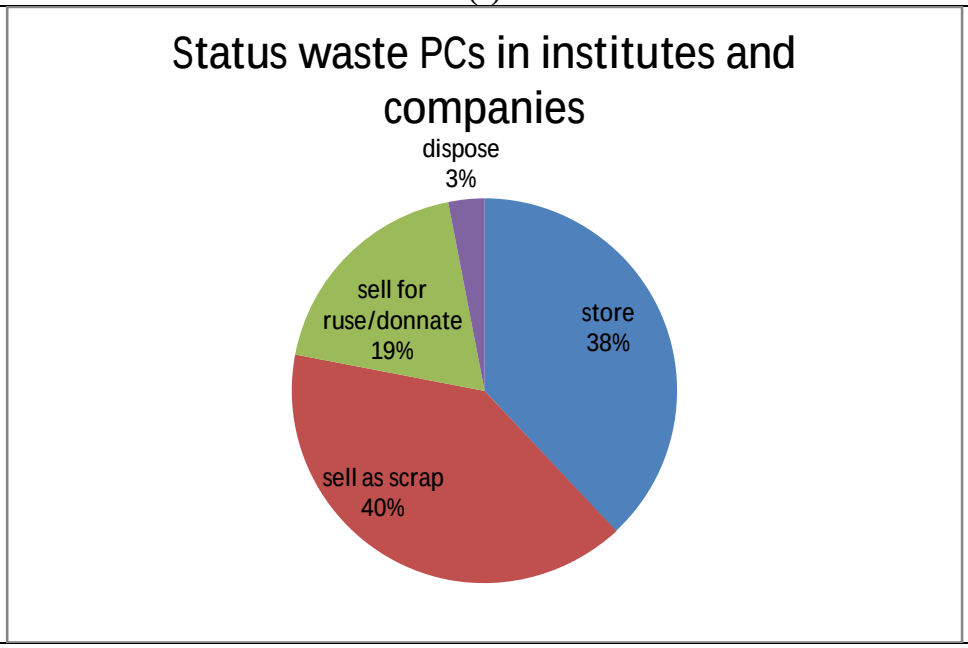

Figure (12) status of end of use personal computers (a) for individuals (b) for institutes and companies sector.

It is seen from figure (11) fortunately that the portion that disposed into the landfills does not exceed 3% for the institutes and companies sector and is less than 1% for the individuals.

5- E-waste Management Practices

E-waste is a new type of waste allover the world, and Egypt is no exception. The recent remarkable increase in utilizing electric and electronic equipment increased the potential for generating e-wastes. The environmental sound management practices of e-wastes are still restricted to few developed countries. The common practices in developing countries are considered primitive and most probably impose a lot of risk to workers and to the environment.

In Egypt, a small part of e-waste reaches as scrap to the scrap market. Very common that TV sets and CRT monitors are tested for functioning. If not it is dismantled manually and some of the CRTs are sent to TV factories, while others are stocked as spare parts. The majority of the PC monitors are sent for recycling centers for recovering raw materials.

For CPUs, functioning power supplies, hard drives, memory and graphic cards are dismantled for resell, mother boards are collected by informal merchant who claim shipping abroad. So far, no formal programs for e-waste management neither initiated by private or the government sector exist. All practices are carried out by the informal sector.

Much work is still needed to assess the current e-waste management practices in Egypt.

6- Conclusions and recommendations

The present study gave an overview over the major constituents of e-waste in Egypt and provided estimates of the current quantities. The study also provided an overview of the current management practices for the different e-waste streams considered. It is estimated that if the current generation rate of e-wastes persisted for the coming 10 years there will be a huge stockpile and sooner or later the portion that disposed into the landfills and dumpsite will remarkably increase, increasing the risk to human health and to the environment.

In order to reduce the risk of waste electronic and electric equipment there must be a concerted and cooperative effort among the population, the government and the private sector. One should take its responsibility that is extended over the life cycle of an electronic or electric product. There are a lot of measures taken by developing countries to limit e-wastes going into the landfills and to encourage reuse and recycle. Some of the measures taken are; extended producer responsibility for its e-wastes, applying prepaid recycling fees on e-goods, providing incentives for recycling agents and many other types of incentives. For the situation in Egypt and probably in the rest of the Arab countries one can recommend the following both to the population and to the other stakeholders:

1- Proper use and maintenance of electronic products will extend their useful life, keep costs down and limit wastes sent to landfills and thus reduce risk.
2- Discarded CRTs are considered hazardous because of the amount of lead they contain and must be handled appropriately. All electronic equipment, including computers and televisions, should be reused or recycled to recover useful materials and reduce disposal, legislations should provide for limiting irresponsible disposal and for promoting recycling.

3- Resell or donate still operating or repairable equipment once you decide to use a newer one, otherwise its value will rapidly decrease and is added to the potential e-waste stockpile..
4- Competent authorities should coordinate end-of-life equipment management through their regional and local administration offices, and design and encourage proper collection and recycling programs.
5- Use universal accessory items that can be used with several electric and electronic equipment (like chargers that can be used for mobile handsets, digital cameras, MP3 and MP4) to reduce waste.

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[i] Source: www.gsmworld.com
[ii] Source: www.etoxics.org
[iii] Waste here is used to reflect end of useful life or end of use.