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Assessment of Current and Future Generated Selected E-Waste Quantities in Abu Dhabi

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ASSESSMENT OF CURRENT AND FUTURE GENERATED SELECTED E-WASTE QUANTITIES IN ABU DHABI

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This thesis is submitted in partial fulfilment of the requirements for the degree of Master of Science in Environmental Sciences

Under the Supervision of Dr. Mohamad Mostafa Ahmed Mohamed

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Declaration of Original Work

I, Khaleel Ibrahim Abdulla Al Nasseri, the undersigned, a graduate student at the United Arab Emirates University (UAEU), and the author of this thesis entitled *Assessment of Current and Future Generated Selected E-waste Quantities in Abu Dhabi*, hereby, solemnly declare that this thesis is my own original research work that has been done and prepared by me under the supervision of Dr. Mohamed Mostafa A. Mohamed, in the College of Science at UAEU. This work has not previously been presented or published, or formed the basis for the award of any academic degree, diploma or a similar title at this or any other university. Any materials borrowed from other sources (whether published or unpublished) and relied upon or included in my thesis have been properly cited and acknowledged in accordance with appropriate academic conventions. I further declare that there is no potential conflict of interest with respect to the research, data collection, authorship, presentation and/or publication of this thesis.

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Abstract

E-waste is a term used to describe electrical and electronic products that enter the waste stream. Currently, it is the fastest growing stream of municipal waste. Informal disposal of E-waste may cause serious health and pollution problems to humans as well as the environment. Although E-waste may represent less than 5% of the total waste discarded into landfills, yet it includes more than 70% of overall toxic waste. Not only the exact amount of E-waste generated in the UAE is unknown, but it is continuously increasing with the advent of new electronic products. Therefore, the main aim of this thesis is to assess the current and future quantities of E-waste in Abu Dhabi emirate. A questionnaire was developed to estimate the generated E-waste quantities for three products; namely, laptops, desktops and mobile phones. Copies of this questionnaire have been distributed to the public in Al-Ain and Abu Dhabi cities to collect data about the E- waste. This data was used to estimate the current and future quantities of E-waste. The estimated quantities of generated E-waste in Abu Dhabi are for three products 1,151,000 mobile phones, 464,000 laptops, and 300,000 desktops. The future quantities of E-waste are predicted based on the life span of each product. They were estimated to be 827,000 laptops, 223,000 desktops, and 1,618,000 mobile phones. The results also indicated that 78% of residents in Abu Dhabi are aware of the adverse effects of E-waste and they are ready to dispose E-waste in an environmental friendly manner. This study will help government and agencies to plan for E-waste management based on the estimated quantities of E-waste.

Keywords: E-waste, laptops, desktops, mobile phones, Abu Dhabi.

Title and Abstract (in Arabic)

تقديركمية النفايات الإلكترونية المختاره الحالية والمستقبلية في إمارة أبوظبي

الملخص

تهتم هذه الأطروحة بالنفايات الإلكترونية في إمارة أبوظبي. النفايات الإلكترونية هو مصطلح يستخدم لوصف المنتجات الكهربائية والإلكترونية التي تدخل مجرى النفايات. حاليا، هو من أسرع التيارات نموا من النفايات البلدية أو النفايات العامة . وفي الوقت نفسه، التخلص الغير سليم من النفايات الإلكترونية قد يسبب مشاكل صحية وتلوث خطيرة للبيئة. على الرغم من أن النفايات الإلكترونية قد تمثل أقل من 5٪ من مجموع النفايات التي جرى التخلص منها في مدافن النفايات، إلا أنها تضم أكثر من 70٪ من النفايات السامة بشكل عام. ليس فقط كميات النفايات الإلكترونية المتولدة في الإمارات العربية المتحدة غير معروف، ولكن أيضا في تزايد مستمر مع ظهور المنتجات الالكترونية الجديدة. ولذلك، فإن الهدف الرئيسي من هذه الرسالة هو تقدير الكميات الحالية والمستقبلية للنفايات الإلكترونية في إمارة أبوظبي. وقد تم توزيع استبيان للجمهور في العين وأبوظبي. وقد وضع الاستبيان لتمثيل ثلاثة من أصناف الاجهزة أو المنتجات: أجهزة الكمبيوترات المحمولة والكمبيوترات المكتبية والهواتف المتحركة. من البيانات التي تم جمعها تم تقدير الكميات المنتجة من النفايات الإلكترونية للفترة الماضية. حيث قدرة كمية نفايات الهواتف بنحو 1,151,000، أما بالنسبة إلى نفايات أجهزة الكمبوتر المحمول فقدرة الكمية بنحو 463,000، و 300,000 جهاز كمبيوتر مكتبي كنفايات إلكترونية. في المقابل تم حساب الكميات المستقبلة أيضا لكل منتج من المنتجات المذكورة أعلاه.

مفاهيم البحث الرئيسية: النفايات الإلكترونية، الكمبيوترات المكتبية، الكمبيوترات المحمولة، الهواتف المتحركة، أبوظبي.

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This thesis is dedicated to my family and my best friends. Next, I would like to thank my wife. Then, my thanks to Royale express company who helped me to conduct survey by distributing questionnaire to the public in Al Ain area. Last but not least, I would like to express my deepest appreciation to my supervisor Dr. Mohamed Mostafa Mohamed for his continuous support, guidance, and encouragements.

Dedication

To my family and Environment Agency - Abu Dhabi

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List of Abbreviations

BDE	Decabromodiphenyl ether
CPU	Central processing unit
CRT	Cathode Ray Tube
EEE	Electrical and Electronic Equipment
EoL	End of Life
EPA	California Environmental Protection Agency
EPR	Extended Producer Responsibility
EU	European Union
E-waste	Waste from electrical and electronic equipment
LCA	life-cycle analysis
MCA	Multi Criteria Analysis
MFA	Material flow analysis
NGOs	Non-governmental organizations
NZZ	Neue Zurcher Zeitung News
OECD	Organization for Economic Cooperation and Development
PCBs	Polychlorinated biphenyls
PPP	Polluter Pays Principle
SVTC	Silicon Valley Toxics Coalition
U.A.E	United Arab Emirates
UK	United Kingdom
UNEP	United Nations Environmental Programme
US EPA	United States Environmental Protection Agency
US	United States of America
WEEE	Waste of Electrical and Electronic Equipment
Dhs	Dirhams

Chapter 1: Introduction

E-waste is defined as a term used to describe electrical and electronic equipment that enter the waste stream (Namias, 2013). Electrical means any machine that transfers the electronic current into simple energy form such as heat, light or motion; for example, toasters and vacuum cleaners. Electronic means any device manipulate the electrical current itself to coax it and to conduct useful activities, for example, audio electronic devices and video devices (Namias, 2013).

1.1 E-waste

E-waste is "a generic term encompassing various forms of electrical and electronic equipment (EEE) that are old, end of electronic appliances and have ceased to be of any value to their owners. A practical definition of E-waste is any electrically powered appliance that fails to satisfy the current owner for its originally intended purpose" (Wanjau, 2011). Due to development of information and communication technologies, E-waste increased to the extent that lit could have direct impact on humans and environment (Wanjau, 2011; Vadoudi et al., 2015). In 2012, Tanskanen mentioned that annual generation of E-waste increased by 17 kg per person in the European Union countries, versus 1 kg of E-waste in developing market, such as China and India, and more increase is still expected (Tanskanen, 2012).

There are two levels of E- waste revealed by Colvin (2008) including

1. What does an electronic appliance constitutes of?

2. When does an electronic devise become waste?

With respect to the first question, the focus is on some of the devices, which are called “brown goods” such as televisions, taking into account the exclusion of “white goods” such as washing machines and refrigerators. Most of the legislations that deal with electrical and electronic equipment or electronic waste allow disposal within the same stream (Nnorom and Osibanjo, 2008). E-waste encompasses a broad and growing range of electronic devices ranging from large household devices such as refrigerators, air conditioners, cell phones, personal stereos, and consumer electronics to computers which have been discarded by their users’ (Widmer et al., 2005). This definition gives an indication of E-waste components. Similarly, a more precise definition is necessary not only legal, but also for practical purposes. Thus, it can be clearer that the definition of E-waste is any device using electrical energy reaching its end of life (Belis et al., 2015).

Finding answer to the second question was attempted by Rose et al., in 2002. According to them, an electronic devise does become waste, it refers that the product reaches the end of its life. The definition of the end-of-life (EoL) means the time when the product is no longer useful for the owner. On the other hand, these devices that have still not reached the EoL for the second buyer, it could be useful for him or the third buyer (Rose et al., 2002).

Advances in the technology during early nineties such as electronic mail and electronic trade, initiated the use of prefix “e” such as e-mail, e-trade and E-waste. E-waste had been increased recently due to vast development in technology. It causes a huge problem to municipalities. Even in developed countries the management of E-waste is being a major concern (Sinha, 2004). For the household solid municipal waste system, the E-waste is more complicated because of the content of posing toxic material. These toxic material transfers easily to the environment and harms the

ecosystems (Lim and Schoenung, 2010). This kind of waste needs special treatment to protect our environment and to avoid leakage and dissipation of extraneous toxic elements into environment (Sthiannopkao and Wong, 2013).

Proper management is a logical way to reduce the environmental impact aroused by E-waste (Shinkuma and Huong, 2009). The research outcomes on the quantity of E-waste, helps government to respond and to find effective solutions for its management. First law for E-waste management was passed in 1998 by the first nation, Switzerland, who were established first formed E-waste management (Widmer et al., 2005).

Also consumers in developing countries like India, the usage of electrical and electronic products is increasing, and greater amounts of those products are finding their way into a waste stream (Widmer et al., 2005). Managing this challenge is not only the responsibility of municipal governments, but it also goes to producers and consumers. They would have to rethink about what is happening to their product further down the stream (Widmer et al., 2005).

The fast production of electrical and electronic equipments and the low prices of the products can increase the sales causing the increase in waste. A report published by United Nation University (UNU) in 2007 shows that 44% of WEEE (Waste of Electrical and Electronic Equipment) are batteries, fridges and other cooling and freezing appliances, as well as household appliances (Ideho, 2012). Other parts of WEEE may include mobiles and computers. The stream of fast growth in these products, increases the toxic substances in the environment when it becomes waste. This leads to occupational and environmental health threat (Puckett and Smith, 2002; Belis et al., 2015).

1.2 E-waste Problem and its Relevance

E-waste is global problem causing serious threats to the human health and environment. The E-waste is creating three main problems (Babu et al., 2007):

1- The fast growing waste stream in both the developed and developing countries

2- Some methods of recycling E-waste cause environmental and human health problems in developing countries

3- The raw materials that used to the recycling of E-waste is rare and costly

The technological innovations are recently too fast than before. The life time of the electronic goods is getting shorter than before (Babu et al., 2007). A clear example is TVs, switching from analogue to digitals in a short period of time (Ongondo et al., 2011).

Quantities of E-waste are expected to be increased in the coming years due to advanced technologies and interest in developing the economic growth through E-products (Robinson, 2009). In the present days, technologies have been developed to reduce the size of the electrons. On the other hand, there is no reduction in the number of device produced (Hilty, 2005).

E-waste generation is increased in all developed and developing countries (Alabi and Bakare, 2011). It is predicted that it is going to be a major disaster in Asia, Eastern Europe, and Latin America as they progressively increase their use of E-devices (Robinson, 2009). It is estimated that the rate of production of PCs will be doubled by the year 2030 (Yu et al., 2010).

E-waste poses so much danger and have bad consequences to human health and environment mainly by two effects. Firstly, leaching of hazardous and toxic materials from the electronic, especially the lead, into the environment from E-waste landfills; secondly, the utilization of improper recycling-techniques in developing countries. Additionally, huge amount of toxic substances like lead, mercury, cadmium, hexavalent chromium and flame-retardants have been found in E-waste (Babu et al., 2007). If metals such as copper, gold and aluminum recovered from E-waste are dumped after improper treatment, the leachate from these waste also adversely affect the health and environment (Lim and Schoenung, 2010).

There is also some possible hazard due to the absence of proper management. In developed countries, some of recycling processes are regulated to avoid the huge impacts on the environment and human health. The regulation helps to reduce and control the impacts. On the other hand, few recycling process have no regulated rules on how to recycle E-waste or to reduce the impacts of recycling process into environment and human health. So that, in developing countries there are a lot of health conditions for the workers in the recycling process such as damages in DNA of the workers, premature aging and cancer (Lim and Schoenung, 2010).

The recycle process benefits for US and EU are small because of high costs to labor and the strict regulation on exporting E-waste to developing countries. During the process of recycling the high levels of pollutants may harm the workers working in many developing countries. This is due to unregistered process which emits dioxins, furans, and others (Kahhat et al., 2008). Some of the process which affects the labor during the metal separation may include acid bathing and heating using fire. A huge amount of pollution may emit from this process leading to the spreading of

toxic dust in the air, water, and soil. This could lead to serious health issues (Kahhat et al., 2008).

A lot of researches indicated that there are too many environmental impacts and health issues related to informal E-waste recycling in developing countries (Kahhat et al., 2008). Accumulations of some toxic materials were found higher in persons living near to informal E-waste recycling areas in China. Also, higher levels of toxic and hazardous substances were found in the soil, water and air around recycling plants in China and India due to lack in safety measurement near these recycling areas (Kahhat et al., 2008). On the other hand, around 20 % of E-waste in US was collected and recycled in 2007 and the remaining E-waste was thrown or dumped in landfills which could cause leakage of toxicity into environment (Grossman, 2007).

Some of electronics with printed wiring boards contain a mixture of substances that can be useful when recycled. There are some useful substances in electronics like copper, aluminum and gold which can be collected and reused as raw materials. Hence, the need of extraction of new raw materials required by mining activities will become less (Orlins and Guan, 2015).

During the period of 1999 – 2001, it was observed that decrease in amount of tantalum significantly, there were only two companies around the world which extracted tantalum (Hilty, 2005). China stopped exporting the rare earth metals to Japan. The cost for extracting rare earth metals are compositionally too high than recycling. So when China hindered exporting the rare earth metals, it was encouraged by EU and US to develop a technology for recycling (UNEP, 2009).

1.3 Thesis structure

This thesis contains five chapters as following: Chapter (1) elaborates on the background information of E-waste. The definition of E-waste was discussed at the beginning of this chapter. Next, this chapter described E-waste problem and its relevance.

Chapter (2) described the risks and hazards of this E-waste and the needed special treatment or recycling. Then, the lows and the definitions that are related to E-waste management are mentioned. Also, this chapter discussed E-waste in team of recent research activities related to the topic including available information about E-waste in Abu Dhabi.

Chapter (3) summarized the various steps employed in collecting information through questionnaires.

Chapter (4) represents the results of the survey conducted. Then, the estimated quantities of E-waste in Abu Dhabi were calculated. Finally, forecasting of future products and E-waste quantities are conducted.

Chapter (5) includes summary and conclusions of this study as well as recommendation for future research work.

Chapter 2: Literature Review

During last decade, a significant increase in the private development of technology, especially in the field of communications was observed. Currently, E-waste is the fastest growing stream of municipal waste (Khetriwal, 2009). More than 80% of electronic products worldwide (about 50 million tons) were discarded as E-waste, in landfills or incinerators last year and nearly 2% of American waste were found on the dumping sites (Namias, 2013).

2.1 The importance of managing E-waste

Once an electronic devise reaches its EoL, it will not be useful to owners any more. Care should be taken and disposed in a proper way (Sthiannopkao and Wong, 2013). E-waste management is not only disposal or recycling of waste; it also includes proper collection and transportation before its disposal or recycling (Oliveira et al., 2012). Strategies of reducing the total E-waste exercise the 4R (Reduce, Recover, Reuse and Recycle) (Oliveira et al., 2012).

E-waste management is important, as the usage of electronics items became part of essential commodity of the human life. Lowering of cost of product is also a reason for high quantities of E-waste. On the other hand, the life span of electronic products becomes less; while, there is no proper disposal or recycling for the old e-device (Oliveira et al., 2012).

2.1.1 Resources depletion

It is clear that the E-waste is a good source of raw material and can be extracted (Taye and Kanda, 2011). Electronic and electrical products are mixture of many precious metals and materials like gold and silver (Hilty 2005). Those materials

can be classified into many types like the plastic, ferrous and nonferrous metals, precious metals, etc. In addition to that, a research in Switzerland on E-waste found that more than 50% of the total composed of various metals, plastics and plastic metal mixtures and 20% Cathode Ray Tube (CRT) (Widmer et al., 2005).

A decrease in average life span of central processing unit (CPU) from 4.5 to 3.1 years were noticed between 1992 and 1999, and it was predicted to be 2 years by 2005 (Lin, 2002). The electronic return (organization in charge of the collection and disposal of E-waste in Norway) said that there is an advanced recycling method through with maximum of 95 to 99% reduction can be achieved for recycling metals. Last two decades, the contribution of plastics has been increased in the appliances by more than 5% taking from metals share. However, the plastic are not highly lucrative to recycling must reduce. On the other hand, E-waste new manufacture and helps economically i.e. one desktop computer need about 240 kilograms of fossil fuels, 22 kilograms of chemicals and at least 1,500 liters of water in which it must be reduced (Williams and Sasaki, 2003).

2.1.2 Health and environment hazard

The main concerns from the environmental point of view about the E-waste are the hazards of uncontrolled release of substances into the environment, the use of less recyclable materials in the manufacturing process, unsuitable disposal of E-waste (Robinson, 2009). There are many health hazards coming from materials and element when there are direct contact with cadmium, mercury, lead and dioxins, and furans which emitted through the E-waste spin. Recycling of E-waste is also very dangerous, hence the effluent and emissions from this processes must be monitored carefully (Robinson, 2009).

Many NGOs (BAN, Toxics Link etc.) and newspaper reports (San Jose Mercury News, NZZ, Time of India, and Indian Express) mentioned that a lot of E-waste shipment is in progress from one country to another country, especially from developed countries to the developing countries (Sinha, 2004). This is mostly illegal in many countries to allow waste coming inside or outside the country. However it is not from the principle of environmental justice. This is too dangerous because of the countries which export to it does not have proper recycling process to avoid the environmental issues (Sinha, 2004).

2.2 Characteristics of the WEEE waste stream

E-waste has a lot of material in which are valuable and functional. Special management of E-waste must be done, because the unique characteristics of it. The reason for the production of the E-waste is EEE loss in technical and economic values (Sinha, 2004).

Electrical and electronic equipment can face conditions that different between each other regardless of the current user. Electrical and electronic equipment can be reused as a second hand and this is happening because of upgrading a small component to existing laptop. On the other hand, the owner of the first three classifications is disposing their products because of the rapid change in the technologies and highest cost to repairing the damages (Sinha, 2004). Electronic and electrical equipment waste is highly toxic, having banned substances in their parts, must be going through special management and handling process. E-waste can be toxic throughout the treatment and recycling processes, such as cable is not toxic on the normal position until burnt for recycling processes, the hazardous dioxins is emitted from this process causing the toxicity (Sinha, 2004).

It is difficult to predict the quantities of E-waste. So that the estimating quantity of waste flow becomes difficult and most of white and brown goods have several years life span. As indicated by Matthews et al., (1998), life time of the product depend on the way in which consumer dealing with the product. Like selling as second hand or storing the product for a long time, in 2001, three-fourth batteries in Japan went into hoarding more than the expensive equipment. Hence, estimation is difficult because of the different paths of the product before the final disposal (Sinha, 2004).

2.3 E-waste management

Some national governments and international communities understood that, they must have a specific regulation and monitoring system to control the disposal of E-waste (Nnorom and Osibanjo, 2008).

Basel convention 1989, is a global agreement in the field of managing the hazardous waste (Schluep, 2013) was put into force on 5th of May 1992. It is tracking the transportation of hazardous waste outside the boundary of the countries. The convention includes countries which are also reduce the hazardous waste to the minimum levels in which it will help to protect human health and to reduce the environmental issues due to regulating trans boundary movement of those waste (Schluep, 2013). This will lead to dealing with the countries that make illegal traffic and criminal offence. The waste that have polychlorinated biphenyl, compounds of cadmium, mercury, lead, beryllium, hexavalent chromium, arsenic or components set as hazard substances are comes under Basel convention. However, Basel convention excluded the electronic equipment which is in working condition, which are transported legally between countries as they can use it for the second time (Schluep,

2013). Second hand use includes electrical and electronic assemblies, there are some confusions on the use of electrical and electronic assemblies and the E-waste. So that they made or study the case and add a lot of condition on the Basel convention to have something suitable called Basel Ban convention after the additional information ofexporting hazardous waste, in which it includes E-waste still not under the force because it does not been rectified by the vast majority of the countries that is on the convention. However it is less effective to implement than expected because of the areas in which are open to interpretation (Sinha, 2004).

2.4 Extended Producer Responsibility (EPR)

This term was suggested by the Swedish Ministry of the Environmental and Natural Resources (Lindhqvist, 1990). The objective of this term is to expand the responsibility of the producer to reduce or decrease the total environmental impacts of the product and save the natural resources. Therefore, the manufacturer will be responsible for the product life cycle especially at the EoL (Lindhqvist 1992; Manomaivibool, 2009).

From the definition mentioned above, it is clear that the manufacturing companies are responsible to recycle the final disposal. Environmental considerations must be accounted and by defining EPR. Responsibilities can be shifted from municipalities to the producers. This will expand the responsibilities of the manufacturer to the end of life cycle (Sachs, 2006).

Therefore, the environmental impacts of the products will be reduced as the manufacturer will be responsible for the products. They will choose effective materials to avoid the environmental impacts and they will think about the resources which need to be recycled similarly to reduce the waste of the products and to reduce

the cost of the take back (Sachs, 2006). The manufacturers responsibly WEEE directive states that: the manufacturer have to or encouraged to design their electrical and electronic equipment that can have better option for repair, or possible upgrading, reuse, disassembly, and recycling (Sachs, 2006). Financing for management of waste from the products is the best and will give effect to the responsibilities concepts for the manufacture (Sachs, 2006).

According to Life set (1993), EPR stimulus can be plunk into four components:

1. Accomplishment of high levels of reuse, recycling and concerning forms for recovery or repair

2. Change in decisions on product design and materials that can be used in the product

3. Change the design of the manufacturer for the products and marketing goods

4. Owning the financial resources in which it can motivate the waste management

In the United States, the Northwest Product Stewardship Council (NWPSC) has defined the product stewardship as “An environmental management strategy that means whoever designs, produces, sells, or uses a product takes responsibility for minimizing the product's environmental impact throughout all stages of the products' life cycle”. The greatest responsibility lies with whoever has the most ability to affect the life cycle environmental impacts of the product (Nicol and Thompson, 2007).

The definition which mentioned above is clouding the stakeholder in which they are participating in managing the product throughout the life cycle (Nicol and Thompson, 2007).

NWPSC defines and includes the incorporation of waste management problems in product methods that is additionally repeated by EPR because the producers are chargeable for their merchandise throughout the life cycle. In practice EPR and merchandise stewardship are totally different. EPR needs the producers to pay money for the value of utilization of their post-consumer waste whereas merchandise spot doesn't specifically target producers. It depends upon the stakeholders as an example the customers meet the value of merchandise utilization (Sachs, 2006).

Recycling products stewardship is not without targets while the EPR set targets for utilization (Sachs, 2006). The perfect splitting of responsibilities beneath the merchandise for the stakeholders is predicated on the subsequent model: producers make sure that assortment and utilization infrastructure is in situ, customers pay levies and deliver the product to the gathering purpose, retailers participate in assortment of waste and therefore the Government establishes standards and guarantee there are not any free riders (Sachs, 2006).

2.4.1 Types of responsibilities

Lindhqvist (1992 and 2000) have been categorized the different types of responsibilities as the follows:

- Economic responsibility
- Physical responsibility

- Informative responsibility
- Ownership

The categorization of the responsibility can be defined as the following terms:

Liability refers to a responsibility for verified environmental damages caused by the merchandise. The extent of the liability is set by legislation (Lindhqvist, 2000).

Economical financial responsibility suggests that the producer will cowl all or a section of the costs for e.g. the gathering, usage or final disposal of the merchandise for his product. These costs are procured directly by the producer or by a special fee (Lindhqvist, 2000).

Physical responsibility is utilized to characterize the systems where the manufacturer thinks about at intervals where about the particular physical management of the merchandise or the implications of the merchandise. The manufacturer may also retain the possession of his merchandise throughout their life cycle, and consequently even be coupled to the environmental problems with the merchandise. The producer retains possession of the merchandise through leasing of the merchandise (Lindhqvist, 2000).

Informative responsibility signifies several potentialities to extend responsibility for the merchandise by requiring the producers to produce data on the environmental properties of the merchandise (Lindhqvist, 2000).

The different kinds of responsibilities illustrate that associate EPR program has to be specific regard to who is accountable and what his responsibility is (Lindhqvist, 2000). Allocation of responsibility within the case of EEE has been contentious issue amongst the varied stakeholders. Most EPR legislation within the electronic business obliges a mix of economic, physical and informative

responsibilities on the producers (Lindhqvist, 2000). The EoL management call with the ultimate holder of the EEE; he/she can decide once and the way to discard it, in some instances the ultimate holder might not discard it in associate environmentally sound manner, so the necessity for info and awareness (Lindhqvist, 2000).

The economic and physical responsibilities essentially ought not to be equally spilt to confirm security of an inexpensive correct inclusion of the prices which was incurred in handling the merchandise, the mix economic and physical responsibility also be proportioned. The management of the systems organization holds the stakeholders liable for the value component. This builds incentives for price improvement and enhancements into the merchandise system (Lindhqvist, 2000). In point of fact, the sharing of responsibilities on associate equitable basis isn't a straightforward task. EPR divides the responsibilities as per the actions from the ultimate holder of the EEE to the environmentally sound disposal. The responsibilities as returning E-waste for separate collection to the final holder, taking-back or returned E-waste to the distributor, collection of E-waste producer, management of collection points and authorities, producers, transferring of E-waste from collection points to the distributor, authorities, treatment producer and recovery producer (Lindhqvist, 2000).

Effective points have been shown in EPR:

- The end of life of the product as waste generated are having specific focus
- Defining the responsibility from the financial point of view regarding to collection, transportation, and recycling of their products
- It shows clearly the well set and meaningful for the collecting and recycling targets
- Recycling from waste to energy technologies are differentiated clearly

- The enforcement mechanism is part of EPR program as well as reporting
- EPR has also motivation for manufacturer to produce their products with re-use and recycling, and farther more the motivation for the consumers to return their used products (Lindhqvist, 2000)

2.4.2 Benefits of EPR

The principle of EPR and strategy are to reduce the total environmental impacts and to protect the environment. The producer of the products has the responsibility for the whole product life cycle, and respect to the products taking-back by recycling and final disposal. EPR benefits are many and can be useful for manufacturer, municipality, environmental and societal benefits. Some of the benefits are discussed below (Tojo et al., 2006).

2.4.3 Benefits to producer

Encouragement of product chain management that offers the probabilities for closing material loops. Closing of material loops results in advanced efficient and effective use of natural resources; as lesser resources would be needed within the production methods (Tojo et al., 2006). The responsibilities have extended to producers for the management of waste from mobile phone as a result of reuse and recycling (Tojo et al., 2006).

Foster integrated environmental management as EPR lays stress on the product life cycle, these can offer feedback loops from downstream (end -of- life management) to upstream (design of products). This can also minimize the associated prices of end-of-life management because the products are going to be designed for

recyclability, dismantling and ease EoL management (Tojo et al., 2006) Foster can promote economic and competitive producing.

Municipalities

- Taking the responsibility for the municipalities will make the burden less. It form the financial and physical burden upon waste management authorities as the manufacturer will take the burden instead of the municipalities (Tojo et al., 2006).

Environmental benefits

- The environmental impacts will be less as it was associated with the final disposal of the products.
- The methods that lead to reuse and refurbishment of the products will increase life time of the product which leads into less environmental impacts.
- Lowering the use of hazardous chemical in the products as the manufacturer to give cleaner production (Tojo et al., 2006).

Societal benefits

- Encourage and cultivate the culture of use and recycle of product that successively improves the look for dismantling
- Nurturing product recycle and use that successively demand for the event of collection/recycling technology
- Improve relationships between the communities as shoppers and also the producers of the product
- Reduction in waste management price and inflated potency of waste management practices owing to the involvement of personal actors (Tojo et al., 2006).

EPR Policy instruments

EPR could be a policy principle that promotes total life cycle environmental enhancements of product systems. It can be done by extending the responsibilities of the manufacturer of the merchandise to varied components of the product's life cycle, and especially to the take-back, recovery and final disposal (Lindhqvist, 2000). The understanding of EPR from the definition captures the variability of instruments that may be enforced as EPR programs (Tojo et al., 2006). The EPR instruments will vary from body instruments, economic instruments and informative instruments.

EPR programs unremarkably adopt one policy instrument to realize supposed results. The policy instruments also can be applied in non EPR instruments as they're not inherently EPR oriented (Manomaivibool et al., 2009). Elements of a number of the EPR policy instruments have already been mentioned. The instruments are categorized as necessary instruments or voluntary instruments reckoning on the amount of coerciveness (Tojo et al., 2006). The necessary initiatives area unit enforced by legislation that compels all actors concerned to fulfill the explicit necessities whereas the voluntary initiative is left to the actors to line up the goals and attempts to realize them. At present in Kenya is predicated on the voluntary initiative of corporations as there's no regulation encompassing EPR (Tojo et al., 2006).

2.4.4 Components of EPR policy instruments

A policy principle is the basis for choosing the combo of policy instruments that area unit to be utilized in a selected case (Lindhqvist, 2000). It also provides the assorted EPR policy instruments and their applicability to the assorted waste streams, the stage at that they're applicable within the product chain, the assorted responses to the policy instrument and also the implementing body. Lindhqvist (2000) points out

the role of EPR is to offer direction for a way the combo of policy instruments during this field may be well configured and to be economical (Tojo et al., 2006).

2.5 Waste in Abu Dhabi Emirate

Statistics Center is the government agency in the UAE that owns all waste statistics. The waste is classified into two categories which are non-hazardous and hazardous. The first one is defined as waste materials that are not accompanied by hazardous environmental problems. At the same time, facilitates can dispose waste in a safe manner for environmental, such as construction and demolition activities, industrial, commercial and agricultural activity. Hazardous waste which is defined as a waste consists of medical waste and its vitality. The total volume of such waste was around 82.7 thousand tons in 2013. While the statistic shows that 32% of hazardous solid waste were dumped to landfills. The statistics in year 2013 show that the quantities of hazard and non-hazard waste in Emirate of Abu Dhabi and Al Ain was about 11.9 million tons. Out of which, and non-hazardous waste accounted for 99.6%. The amount of hazardous waste was small percentage i.e. up to about 0.4% only.

Solid waste generation quantify its emerging waste in the Emirate of Abu Dhabi by source and activity of economic, also illustrates the change emerging between the two periods from 2009 to 2013, where the total quantum of increased waste is about 20.9%, and the daily per person of municipal waste was approximately 1.7 kg / day.

The management and methods for the disposal of waste by recycling has increased from 23.6% in (2009) to 27% in (2013) compared to the amount of waste arising for the same years. The rate of solid waste also rose from 1.7% to 3.9% for the same years.

On the other hand, the E-waste was not mentioned on the statistics or on the definition that appear in the statistic center. The outcome of the article about E-waste management in UAE indicates that there is no official statistic data about E-waste.

Going back to 2009, Allam studied E-waste Management Practices in Arab Region and discussed some information about UAE and about collection of the used mobile phone and batteries for recycling purposes. That study conclude that UAE was also concentrating on waste stream (Allam, 2009).

There are many policies, regulation and rules for E-waste that are under study in the development countries, like United Arab Emiratis, in 2012 an article mention that U.A.E have available solid waste inventory but they have no specific E-waste inventory in which a national legislation is planned and being prepared for this issues (Chehade et al., 2012).

On the other hand, Abu Dhabi emirate has many landfills, 24 of them are official, as shown in Figure 1. Meanwhile many other unofficial damping site also exist in AD (Figure 2).

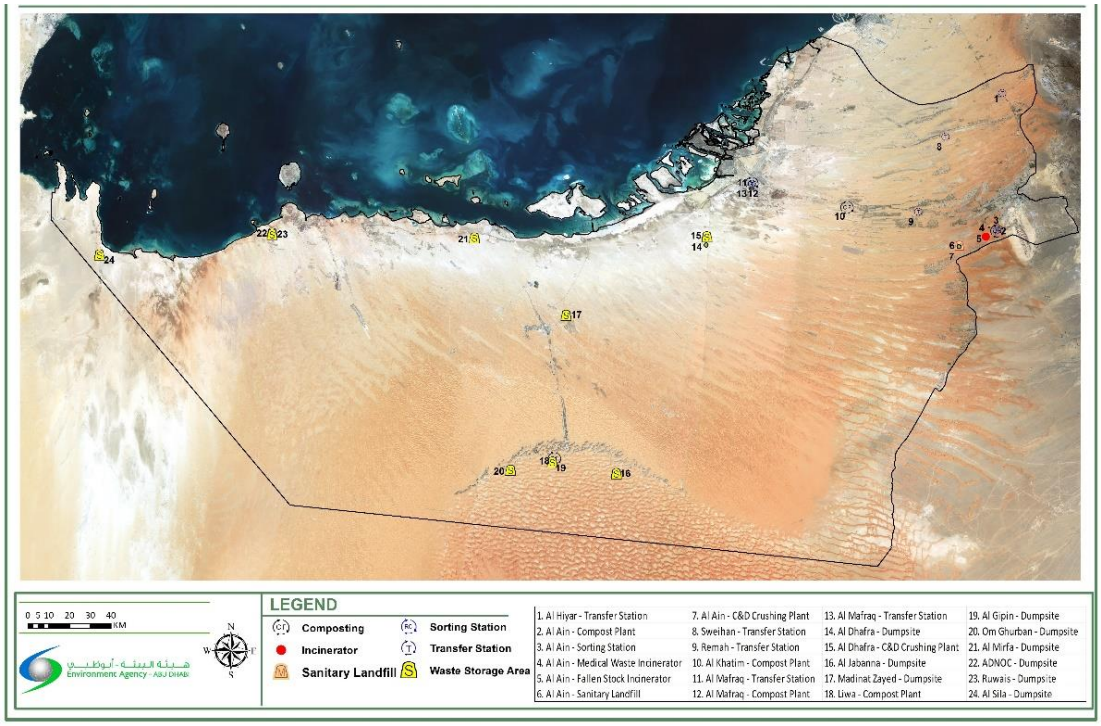

Figure 1: Official disposal sites and waste facilities in Abu Dhabi emirate (EAD, 2012)

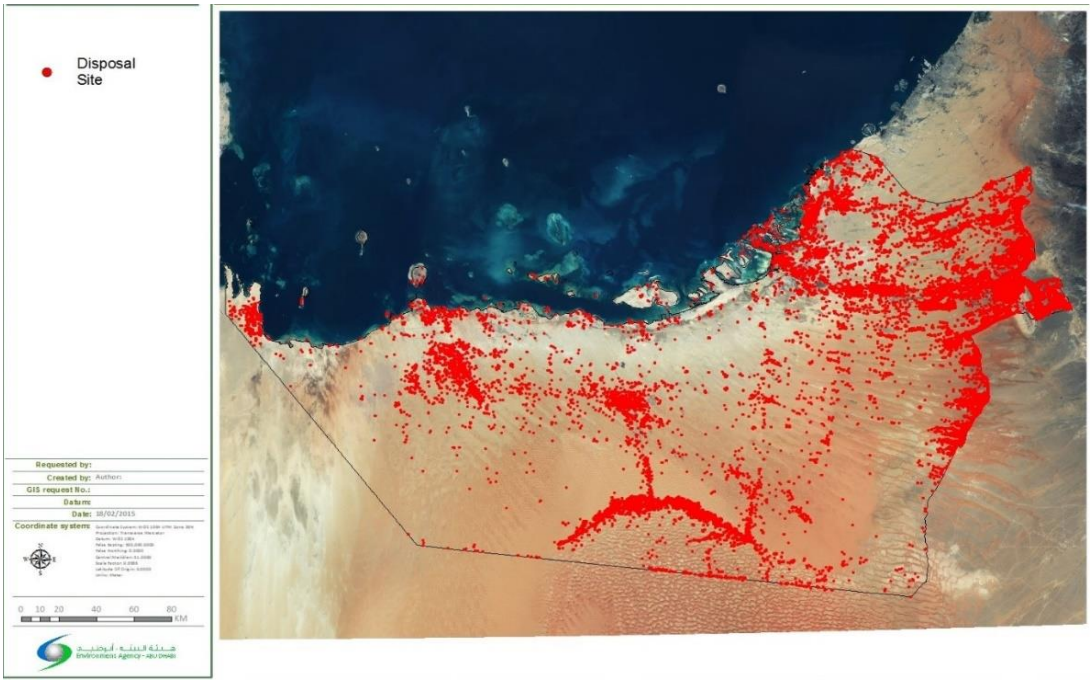

Figure 2: Unofficial disposal sites in Abu Dhabi emirate (EAD, 2012)

In UAE, consumers spent more than 13 billion dirhams on electronics in 2012 which is considered a huge amount of the consumer budget (Dubai chamber, 2012). Meanwhile, UAE is one of the world's lowest life expectancy of electronics this maybe for many reason such as the low cost of the new electric and electronic devices and the high income level for most of the population in UAE. And at the same time this may be an indicator of low awareness of E-waste pollution in among people. Consumers in UAE change their smartphones, on average, every two years which may be less than the half life time for the cell phone. Until now, about 90% of them have never recycled their phones; placing the country among the top -per person- E-waste producers (Dubai chamber, 2012).

In 2013, Business Monitor International found that handset in UAE sales reaches about 1.68 billion USD. More than this, they spend about 4.1 billion USD per year on buying new electronics (Abbas, 2014). In UAE, E-waste is dumping into landfills. Improper disposal of E-waste and unscientific methods of E-waste disposal may cause serious health and pollution problems. Although E-waste may represent less than 5% of total waste discarded into landfills in the world (Namias, 2013).

As a result of growth the information and commiseration technology increased the use of electronics and electrical equipment to meet the interst of people (Chehade et al., 2012; Wanjau, 2011; Tanskanen, 2012) especially in U.A.E (Chehade et al., 2012). These electrical tools include communication products, broadcast and television products, computers and others (Jian, 2012). As a result of this interest changes in market appears, especially with mobile phones which were rapidly adopted on the worldwide. In 2010, the average rate of subscription for mobile phones was 78 for every 100 inhabitants (Wanjau, 2011) throughout the world. It is also reported 97

subscription for mobile phones for every 100 inhabitants in the world (Wikipedia, 2015).

E-waste is significantly hazardous, as it contains a lot of hazardous toxic components like; heavy metals and harmful chemicals. (Lead, cadmium, mercury, chromium, polychlorinated biphenyls (PCBs)) etc. (Dwivedy and Mittal, 2012; Schluep et al., 2009; Rao, 2014). So that the E-waste could cause irreversible damage to the groundwater, air, and soil. Hence, posing huge threat to the public health and the environment (Chehade et al., 2012; Dwivedy and Mittal, 2012; Rao, 2014). Studies in US in 2003, found that in the landfills, a huge amount of heavy metals comes from the E-waste (Dwivedy and Mittal, 2012). The huge amount of lead alone in E-waste can cause various health issues like damage to the central nervous systems, cardiovascular diseases, and kidney problems in humans (Rao, 2014). However, by using the right recycling system to E-waste, damages can be reduced to some extend (Dwivedy and Mittal, 2012). A mobile phone is a great example of E-waste contents and resources usage i.e. one mobile phone contains more than 40 elements from the periodic table (Heacock et al., 2015).

Dumping E-waste in to landfill without barrier may cause leaching of hazardous material to the groundwater (Dwivedy and Mittal, 2012; Kidee et al., 2013). This leaching can cause a huge problem in which it can affect the human health status (Dwivedy and Mittal, 2012; Kidee et al., 2013). A lot of studies has been done in leaching inside landfill, the ability of the hazardous material to reach the groundwater and wider ecosystem (Kidee et al., 2013). Huge investigation were made in many countries like Japan in 2004, Canada in 2006, South Africa in 2009 and other countries regarding the leach and the results were proving the contamination of hazardous material around the landfill (Kidee et al., 2013).

Worldwide E-waste life cycle assessment is understudy in the past decades, this is because of the environmental impact that appear, and on the other hand for the economic issues (Jain, 2012). In many researches, the objective of E-waste life cycle assessment is to reduce the E-waste and find a proper way for reusing and recycling in which the impacts on the environment will became less (Jain, 2012). The conceptual life cycle of electrical tools starts from raw materials, production, sales, consumption and waste generation in which it reuse or complete the cycle to treatment and disposal to the landfilled (Jain, 2012; Dwivedy and Mittal, 2012).

Lot of policies, regulation and rules for E-waste disposal is understudy in the development countries, like United Arab Emiratis. In 2012, an article mentioned that U.A.E have available solid waste inventory, but they have no specific E-waste inventory in which a national legislation is planned and being prepared for this issues (Abbas, 2014).

National and international mitigation for the E-waste have been issued by E-waste management in which they are trying to reduce the amount of these kinds of waste, by many ways like:

- LCA (Life Cycle Analysis)
- MFA (Material Flow Analysis)
- MCA (Multi Criteria Analysis)
- EPR (Extended Producer Responsibility) (Jian, 2012; Kidee et al., 2013).

The purpose of E- waste management is to reduce the effect of the waste and to find environmental friendly alternative products, easy to recycle or deal with it (Kidee et al., 2013).

In 2013, Masdar Institute of Science and Technology carried out a study on life cycle assessment for streetlight technologies for minor roads in UAE (Hadi et al., 2013). Other studied E-waste life cycle assessment (e.g. Chehade et al., 2012). Unfortunately, there is no available study of current situation or estimation of E-waste quantities in UAE.

Assessment of E-waste quantities depends on the technique used to fit research objectives and outcomes. Many use life span of the products and estimations mainly depend of the sales quantities (Ahmed et al., 2014; Steubing et al., 2009; Robinson, 2009). This way is appropriate if the selling quantities are available. However, the method of taking per person usage by using manual distributed surveys is used in this study that helps on determining the quantities in use (Oomman, 2014). The use of internet distributed survey was done before for the same purposes but in a wider range (Saphores et al., 2009). Other researchers used surveys as well as meeting and workshops (Amoyaw-Osei et al., 2011).

Chapter 3: Data collection

3.1 Data sources

The data used in this thesis have been collected from:

1. The annual book of Environmental Agency Abu Dhabi (Environment Agency-Abu Dhabi and The Center of Waste Management – Abu Dhabi, 2015).
2. The annual statistic from Statistic Center in Abu Dhabi how in which the number of population in Abu Dhabi emirate during 2012 was used (Statistics Centre - Abu Dhabi, 2014).
3. Questionnaire collected form the public, it was collected manually and from a web site created to gather data from the public (https://www.surveymonkey.net/).
4. Information from previous studies in and around U.A.E. (Allam, 2009; Chehade, 2012; Hadi, 2013)

In this study, no field estimation have been done, because of lack of information in the area of study about E-waste and its landfill.

3.2 Study location and target population

The study was carried out in Abu Dhabi, questionnaires were conducted among both UAE national and expat residents in the Emirate of Abu Dhabi. Incomplete surveys were excluded.

3.3 Questionnaire

The questionnaire has been adopted from a training and references manual, which was developed for a project by Swiss Federal Laboratories. This questionnaire was developed to assess the E-waste in developing countries (Schluep, 2012). Some questions were excluded from the original questionnaire because it was long -about 50 pages- in which it must be reduced, so that this study is restricted to only three categories of electronics including laptops, desktops, and mobile phones in this study. The questionnaire contained simple questions easy for the public (Appendix A).The questions have been designed into six groups as follows:

Group (1): questions 1-4 are Sociodemographic questions. They were included to identify the age, location, educational level, and the total number of people inside the household of the interviewed person.

Group (2): questions 5-11 examine the level of the respondent's education and their awareness of E-waste hazard.

Group (3): questions from 12 to 19 intended to collect information about laptops. Those questions were chosen to assess the current and future quantities of laptops in the study area.

Group (4): questions from 20 to 27 intended to collect information about desktops. Those questions were chosen to assess the current and future quantities of desktops in the study area.

Group (5): questions from 28 to 35 intended to collect information about mobile phones. Those questions were chosen to assess the current and future quantities of mobile phones in the study area.

Group (6): questions from 36 to 38 were about the level of responsibility and awareness of disposing the E-waste.

The questionnaire was designed in a website (https://www.surveymonkey.net specially made for designing and distributing questioners for the public in a wide range) in both language Arabic and English (Appendix). This website was also designed to have surveys that can be answered throughout computer, mobile phones, and tablets. Results can be analyzed through the same website. Four ways have been done for distributing the questionnaire:

1. Through emails in which it was design also in both language Arabic and English
2. Through blackberry contact in which it was more than 600 contacts
3. Through what's up contact in which it was more than 150 contacts
4. Finally, through a manual hard copy for a public through friend volunteers

3.4 Data analysis

A database was created in the website in which respondents were identified by using their device IP Address. The manual data collected were stored in the same website. Data was monitored and then analyzed in order to detect uncompleted values or mistakes in data entry. Incomplete data were excluded from the website. Almost 139 responds were identified without any error out of 400 responds.

Calculations have been conducted to show the numbers and quantities of laptops, desktops and mobiles. The population of Abu Dhabi emirates is about 2335000 as per Statistics Centre (Statistics Centre - Abu Dhabi, 2014).

Life span of the electronic equipment will help to find out the amount of E-waste (Ahmed at el. 2014). Table 1 shows that the life span of a laptop is 4 years, desktop is 5 years and mobile phone has the highest life span of 6 years (Ahmed at el. 2014).

Table 1: Average life span in years for a laptop, a desktop, and a mobile phone

Equipment	Average life span in years
Laptop	4
Desktop	5
Mobile phone	6

Chapter 4: Results and Discussion

4.1 Group (1) Socio-demographic Data

The results of this study are based on 139 respondents to the questionnaire. Results of the first group of questions are presented in Figures 3 through 7. The ages of the respondent were from 17 to 60 years old. This is more or less the same as other reported Socio-demographic questions for similar studies (Saphores et al., 2009; Oomman, 2014). About 42% of respondent were aged from 30 to 39 from the total number of respondent as in Figure 3. By contrast, about 47% were from Al Ain, and almost 53% were from Abu Dhabi as in Figure 4. Almost 44% had Bachelor degree and 4.3% did not complete high school as in Figure 5. Figure 6 shows that the number of persons living in the same household varied from 4 to 6. Whereas about 23% of the respondents indicated that 7 to 9 individuals live in the same household. Figure 7 shows that about 32% of the respondents indicated that the household monthly income is more than 45,000 dirhams. Whereas, about 8% of the respondents reported that household monthly income was less than 17,000 dirhams.

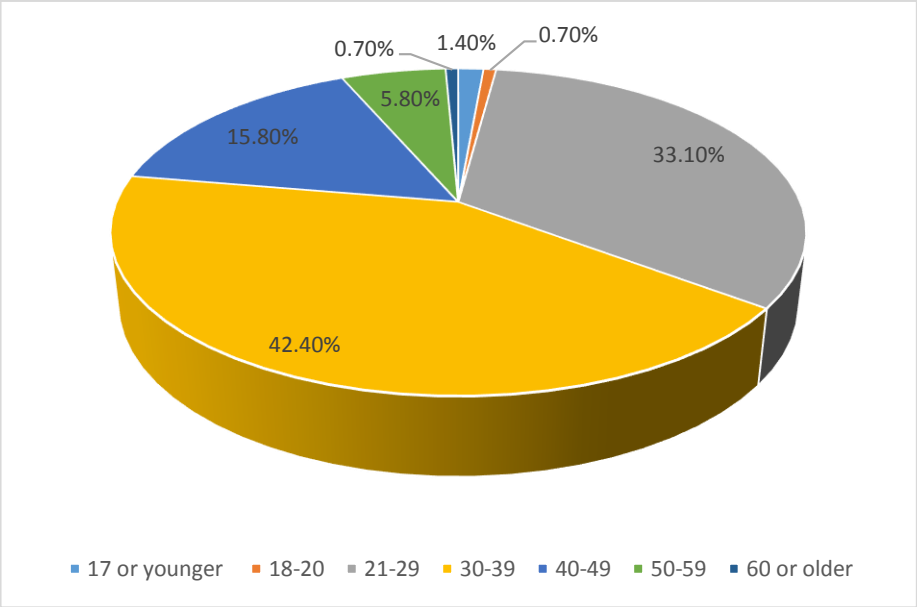

Figure 3: Socio-demographic data, the age of the respondents in years

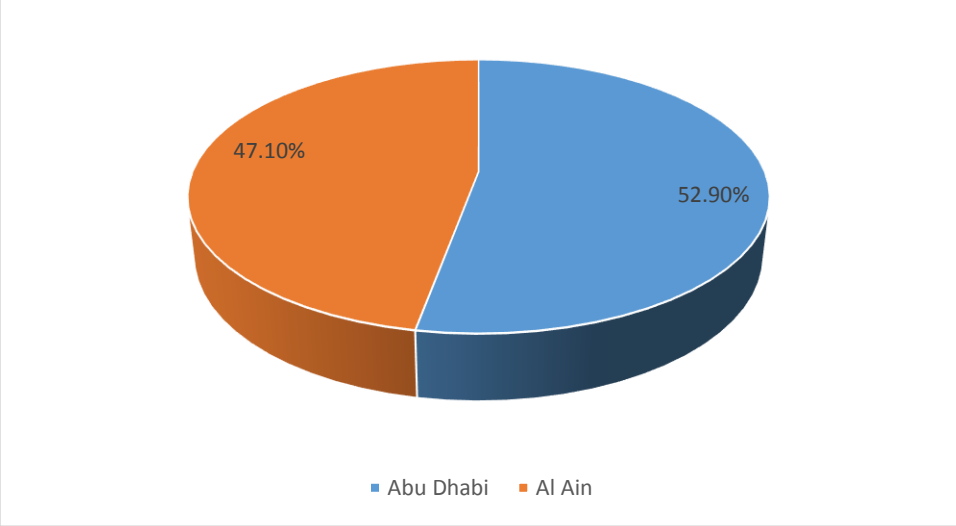

Figure 4: Socio-demographic data, the location of the respondents

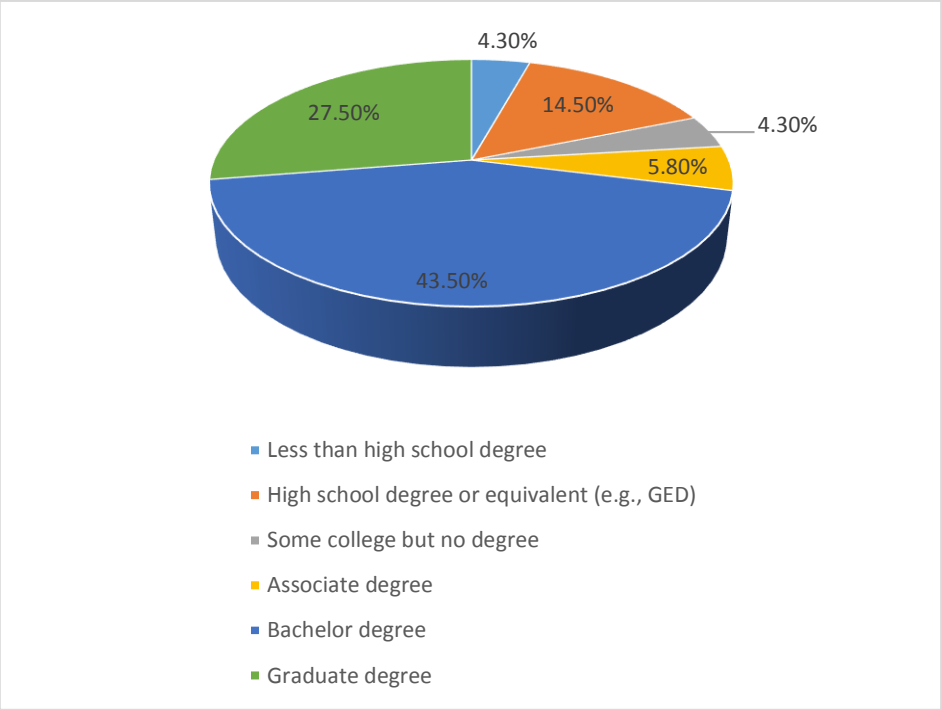

Figure 5: Socio-demographic data, educational level of the respondents

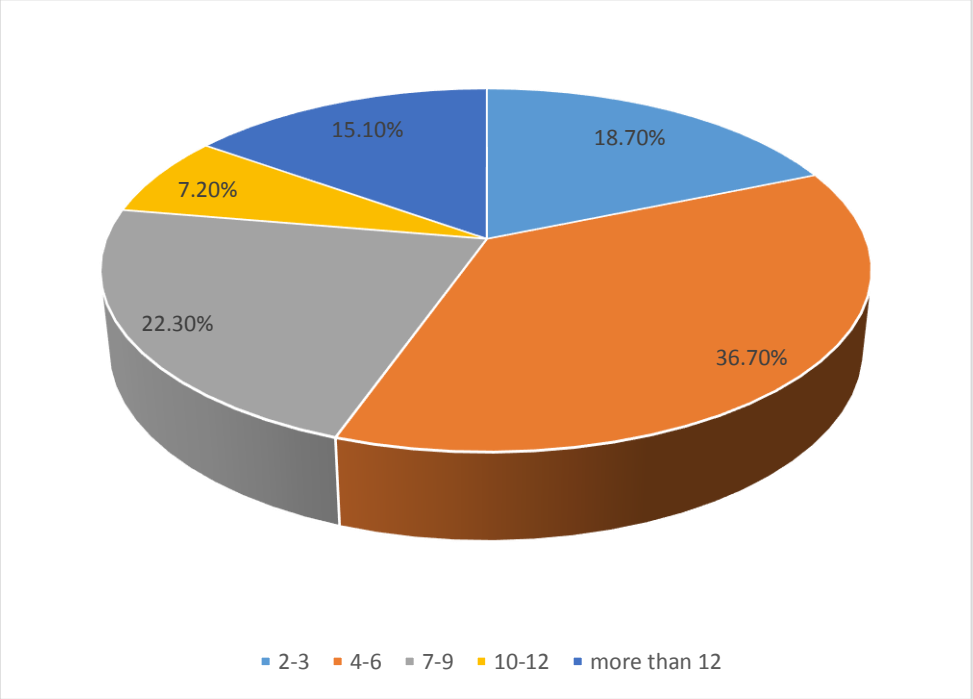

Figure 6: Socio-demographic data, number of persons living in the respondent's house

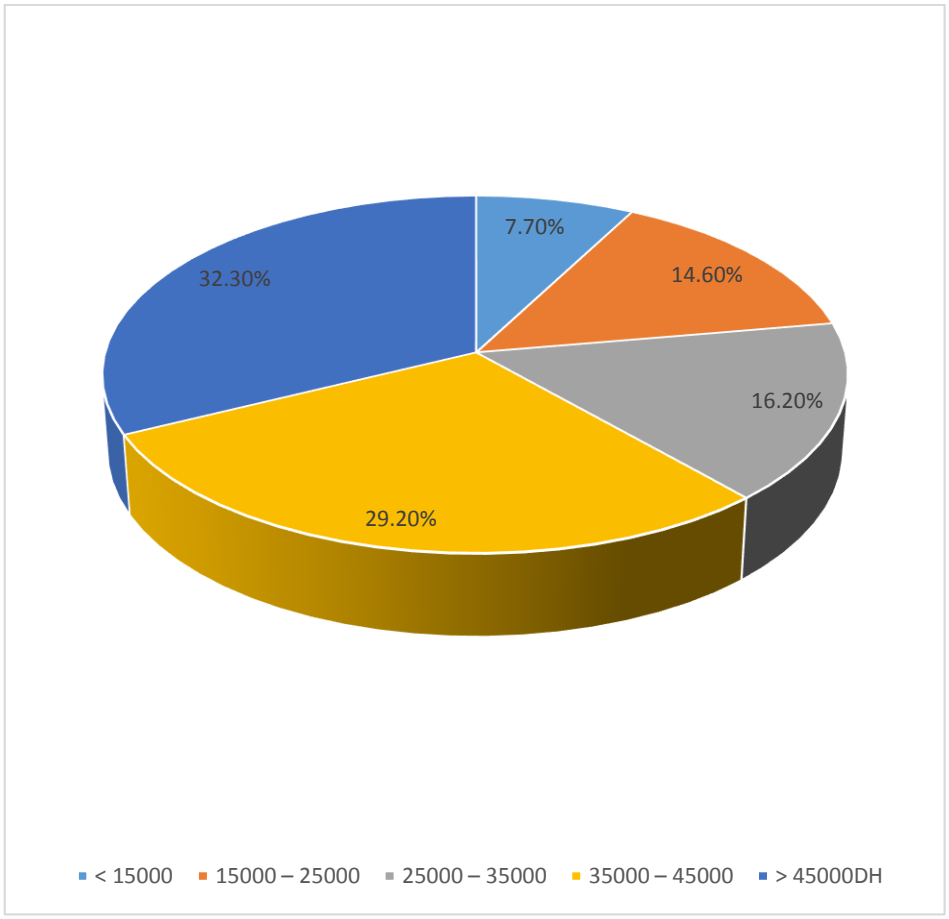

Figure 7: Socio-demographic data, the monthly income in the household

4.2 Group (2) Level of awareness and background

Figures 8 through 12 summaries Group (2) of questions illustrate the level of awareness and the educational background of the respondents. Nearly 70% of the respondents are aware of E-waste hazard. 59.9% of respondents are aware that some hazardous fractions in E-waste needed a special treatment in order to be safely disposed as in Figure 9. 91.2% of the respondents indicated that waste collectors normally pick up waste from their houses as shown in Figure 10, however, 51.8% of them indicated that the waste collectors do not pick up E-waste with normal waste as shown in Figure 11. Meanwhile, 75.8% of the respondents indicated that the current E-waste collection scheme is not suitable as shown in Figure 12. A similar research indicated that 30.5% were aware of danger of E-waste (Oomman, 2014). In this same research, it was mentioned that above 11.5 % are aware that that E-waste needed special treatment (Oomman, 2014).

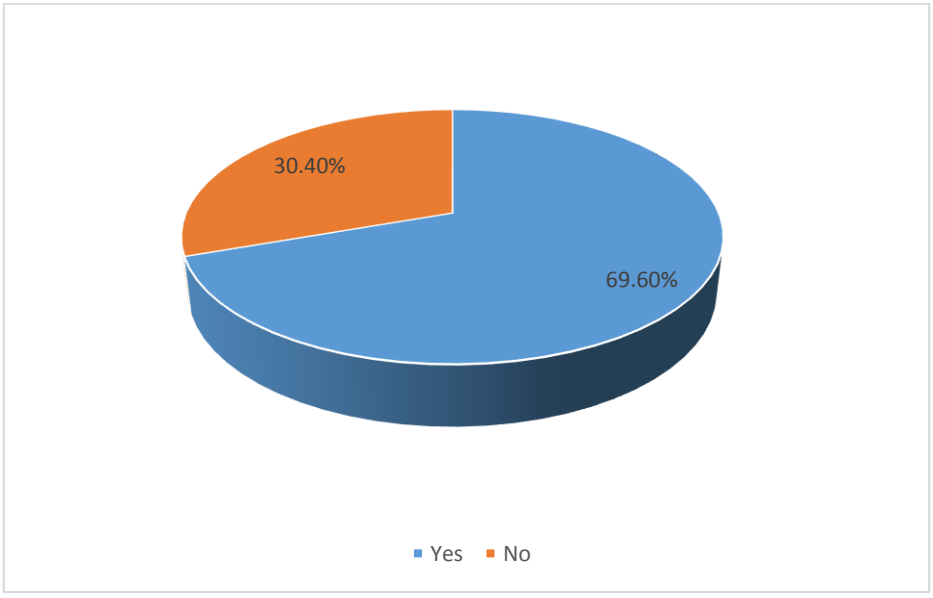

Figure 8: Awareness levels, Do you know what E-waste or waste of electrical and electronic equipment is?

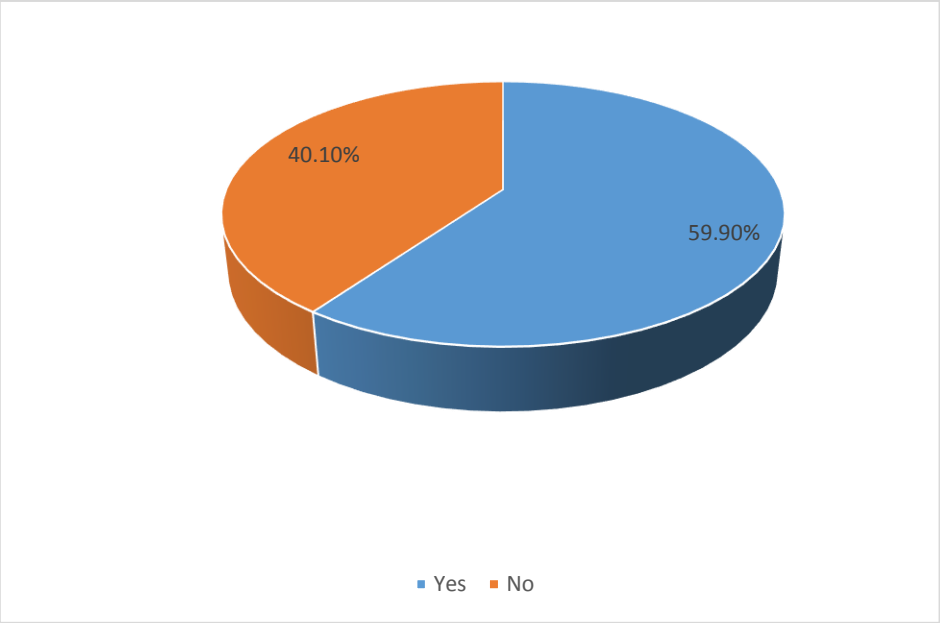

Figure 9: Awareness levels, Are you aware that some hazardous fractions in E-waste need a special treatment in order to be safely disposed of?

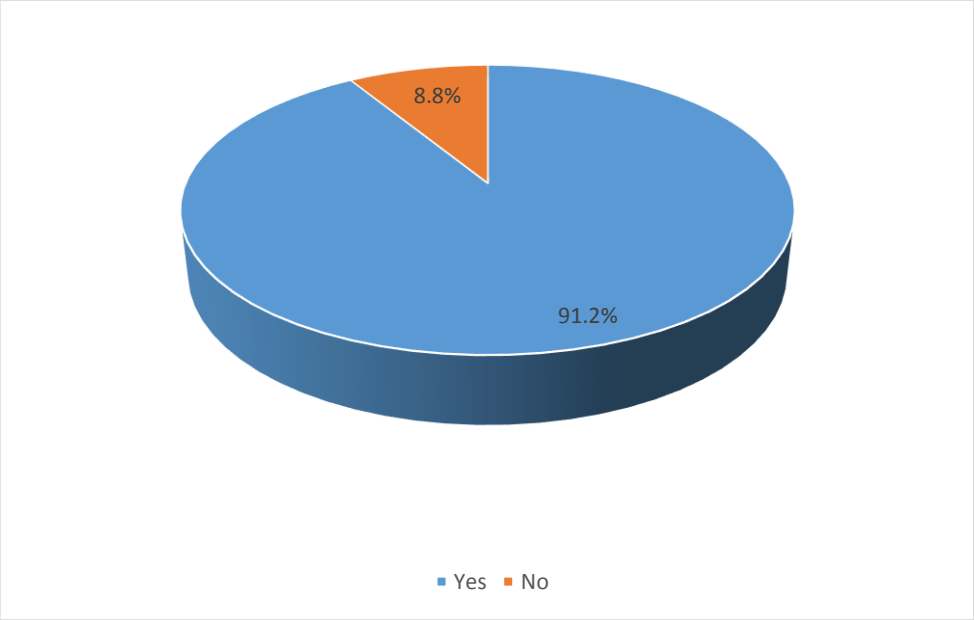

Figure 10: Awareness levels, Do waste collectors pick up waste at your door?

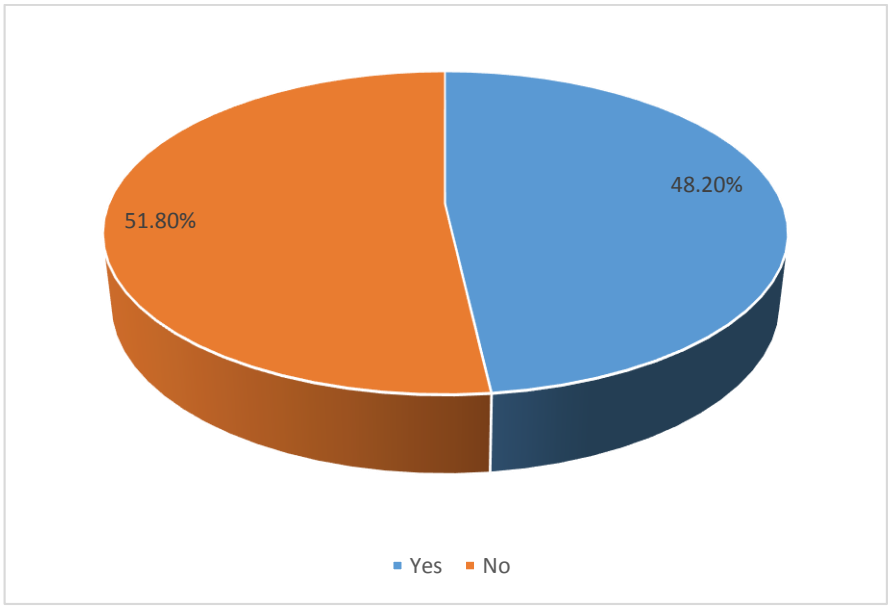

Figure 11: Awareness levels, Do they pick up E-waste too?

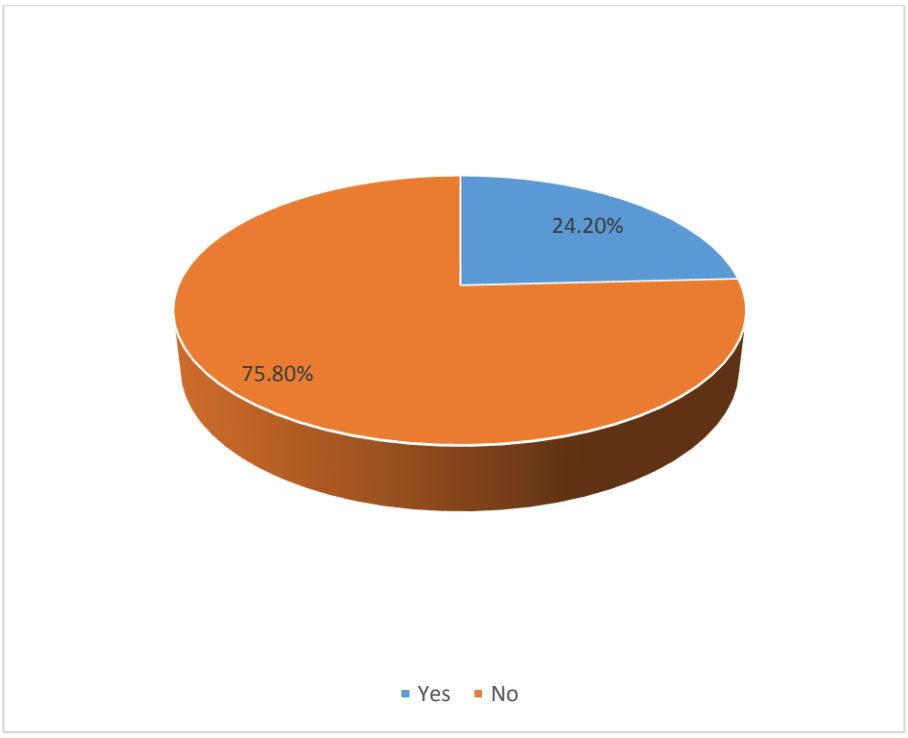

Figure 12: Awareness levels, Is the current E-waste collection suitable to you?

4.3 Group (3) Laptops and quantities

Figure 13 represents mean number of the laptops used in the household. This figure indicates 2.5 laptops are on average currently in use in each household. While, the average laptop per household is one laptop in India and US (Somavat and Namboodiri, 2011). The number of laptops per person can be calculated using this equation:

$$\text{Product per person} = \frac{\text{Average number of product in the household}}{\text{Average people in the household}} \quad (1)$$

The average number of persons in the household is calculated to be about 7 from equation (2). While, the average people in the household in US is 2.59 and 4.8 people in India (Somavat and Namboodiri, 2011).

The average number of persons in the household = (Average persons in first answer of question 4 from questionnaire * percentage of respondent for the first answer) + (Average persons in second answer of question 4 from questionnaire * percentage of respondent for the second answer) +…. + (Average persons in fifth answer of question 4 from questionnaire * percentage of respondent for the fifth answer). (2)

Based on results shown in figure 6. Using equation 1, the average number of laptops currently in use per person is about 0.35. Figure 13 also indicates that 1.73 laptops per household are not in use but stored at home and 1.39 laptops per household are not in use but disposed. Most of the respondent 45.5% prefer to give or sell the laptops to a scrap dealer as shown in Figure 14.

Figures 15 (a, b, c, d, e) display the average numbers of laptops in the household according to currently in use, not in use and stored, not in use and

disposed. Also the figures divided according to the income of the household. (<15,000, 15,000 – 25,000, 25,000 – 35,000, 35,000 – 45,000, and >45,000). The figures are nearly similar to each other, the highest choice is currently in use, as that the lowest choice is not in use and disposed.

The average number of laptops currently in use was the first choice for the group with income more than 45,000 Dhs (3.10). While, the group of sample with salary less than 15,000 Dhs are the lowest in not in use and disposed with 0.5 score.

Both Abu Dhabi and Al Ain groups are having almost the same quantities of currently in use and the not in use and disposed. From the other hand, the average for not in use and stored is more in Al Ain as shown in Figures 16 (a, b).

Figures 17 (a, b, c, d) reflect the relationship between average laptops per household and educational level as divided to currently in use, stored, and disposed. The highest choice for currently in use was for graduate level of education with 2.82 score. While, in stored was 2.8 for high school or less, and 1.88 in disposed for high school or less also. On the other hand, 1.87 for high school or less currently in use, 1.42 for graduate in stored, and 1.22 for some college but for no degree and associate degree for the disposed were least choice in the figures among the groups.

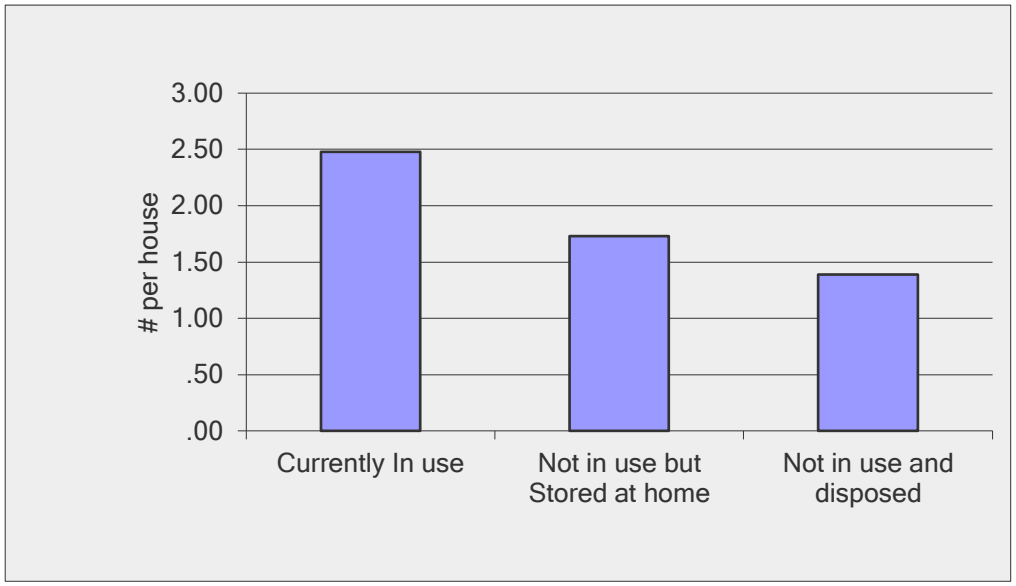

Figure 13: Number of Laptops per house

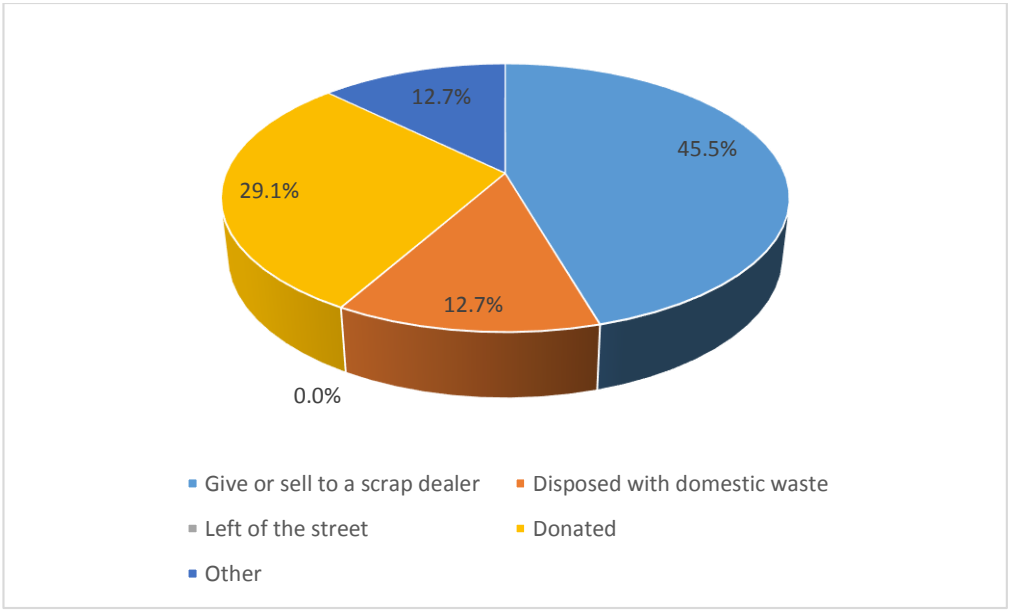

Figure 14: Percentage of response on the intention of stored laptop

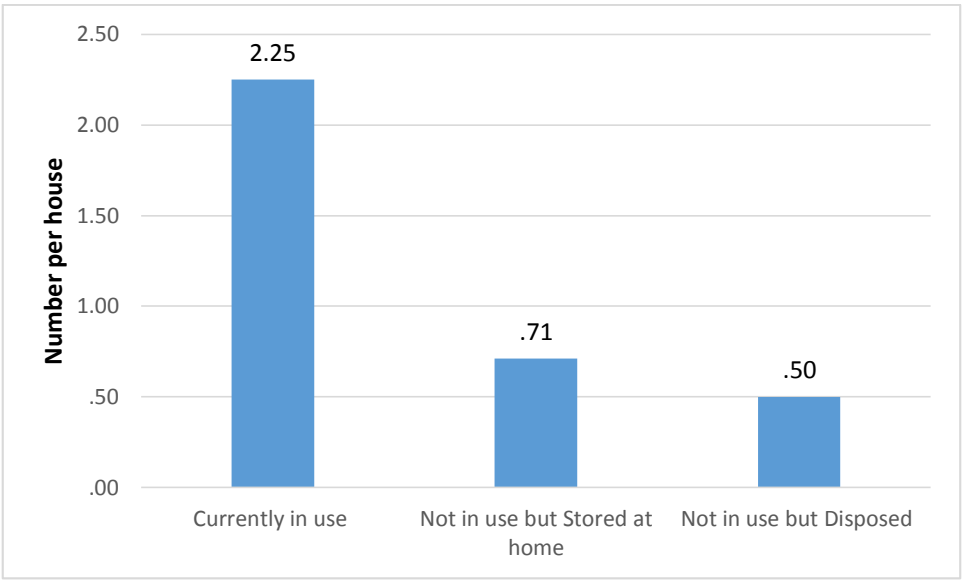

Figure 15 (a): Number of Laptops per households with income less than 15,000 Dhs

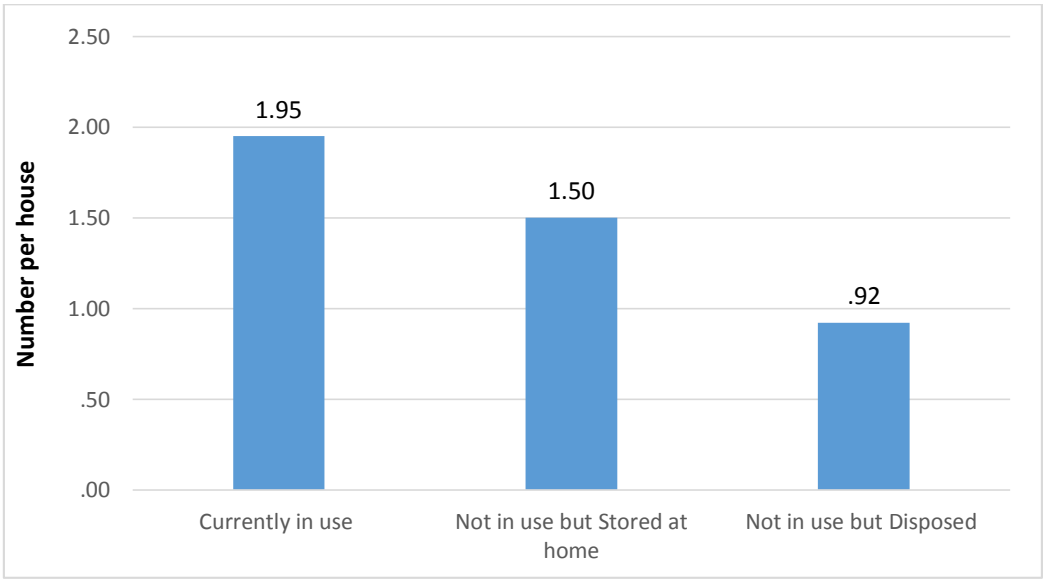

Figure 15 (b): Number of Laptops per households with income 15,000 – 25,000 Dhs

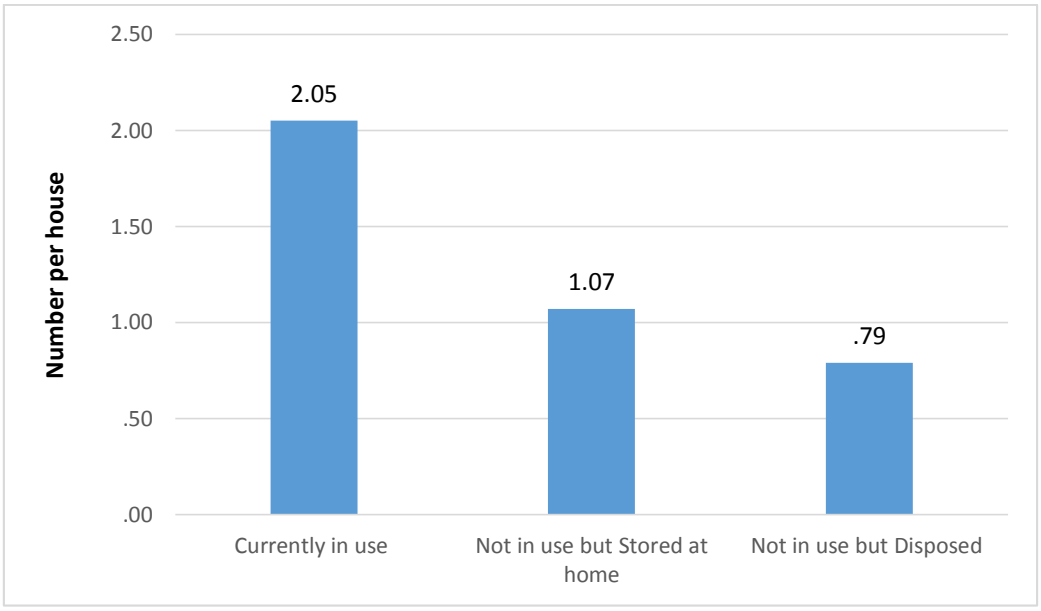

Figure 15 (c): Number of Laptops per households with income 25,000 – 35,000 Dhs

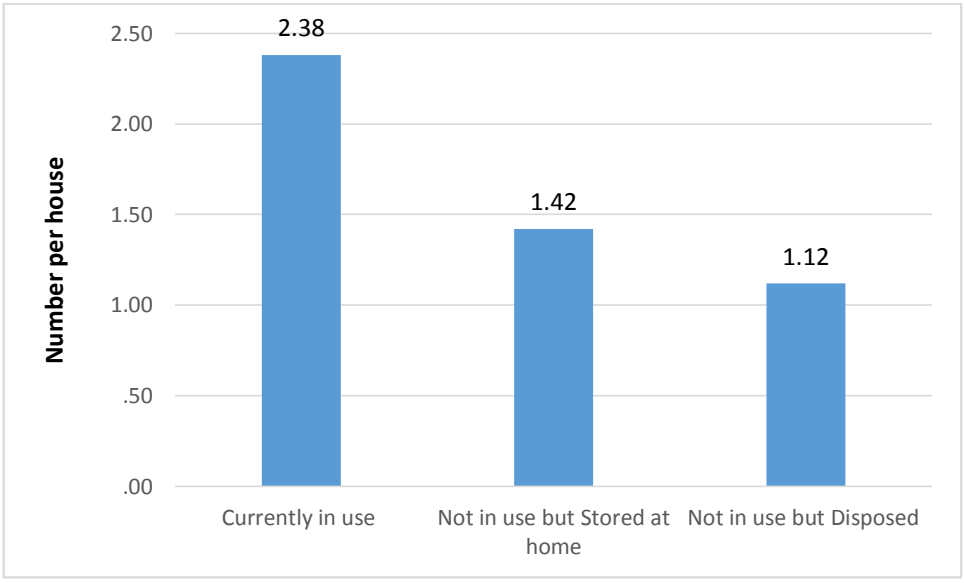

Figure 15 (d): Number of Laptops per households with income 35,000 – 45,000 Dhs

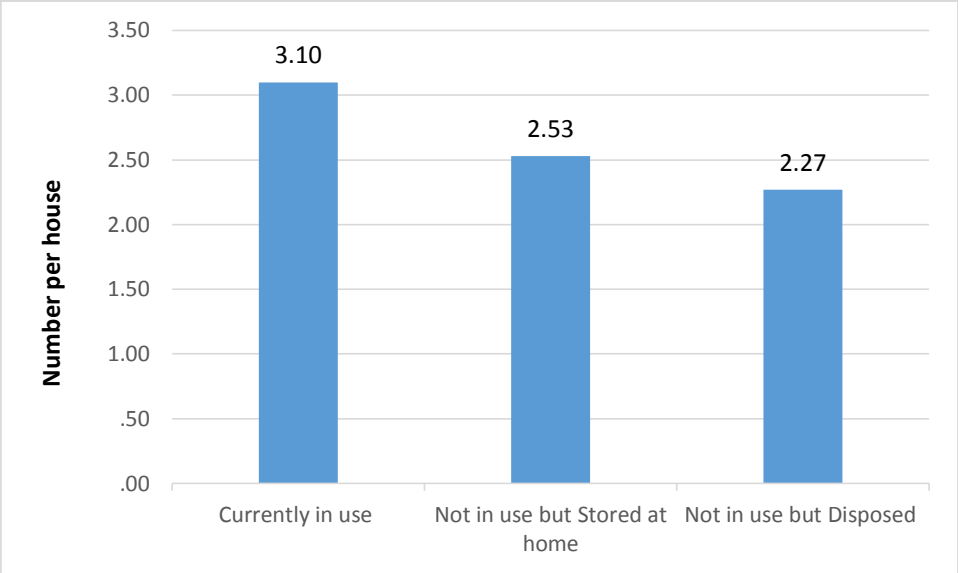

Figure 15 (e): Number of Laptops per households with income 45,000 Dhs

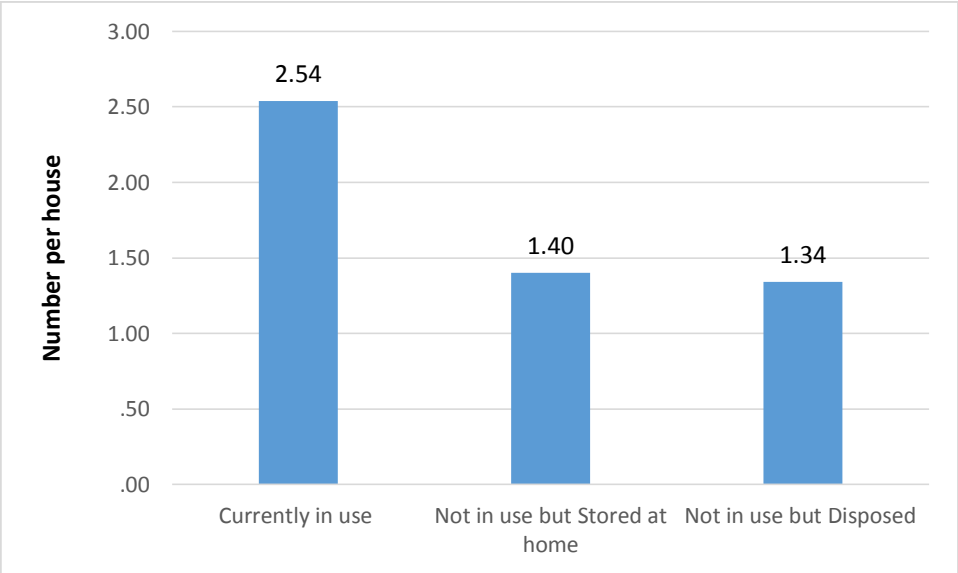

Figure 16 (a): Number of Laptops per households in Abu Dhabi area

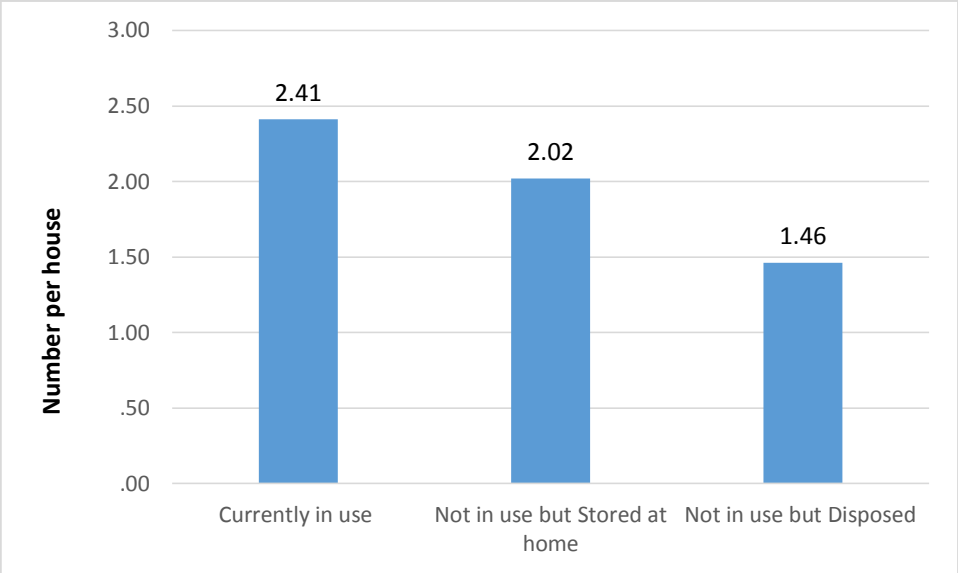

Figure 16 (b): Number of Laptops per households in Al Ain area

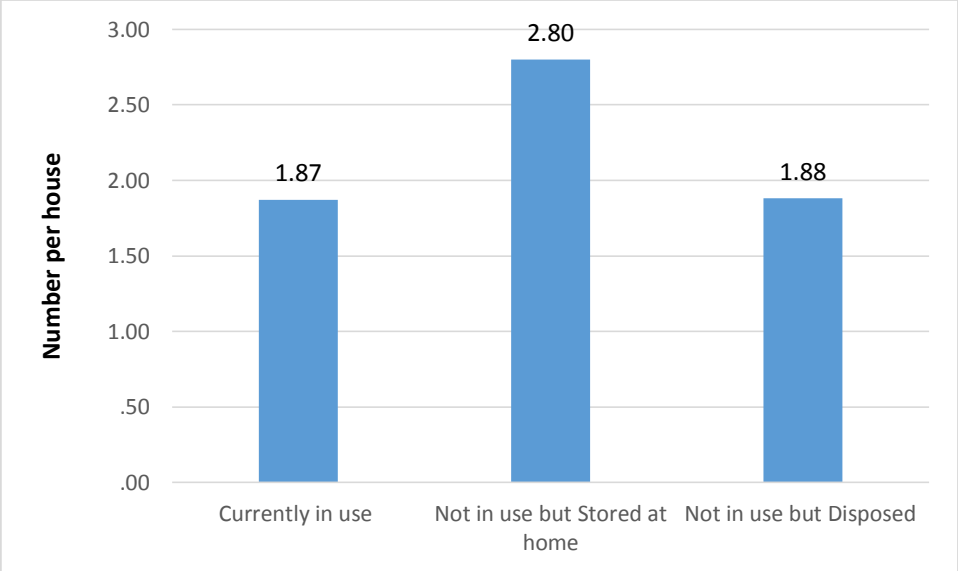

Figure 17 (a): Number of Laptops per households with educational level less than high school and high school

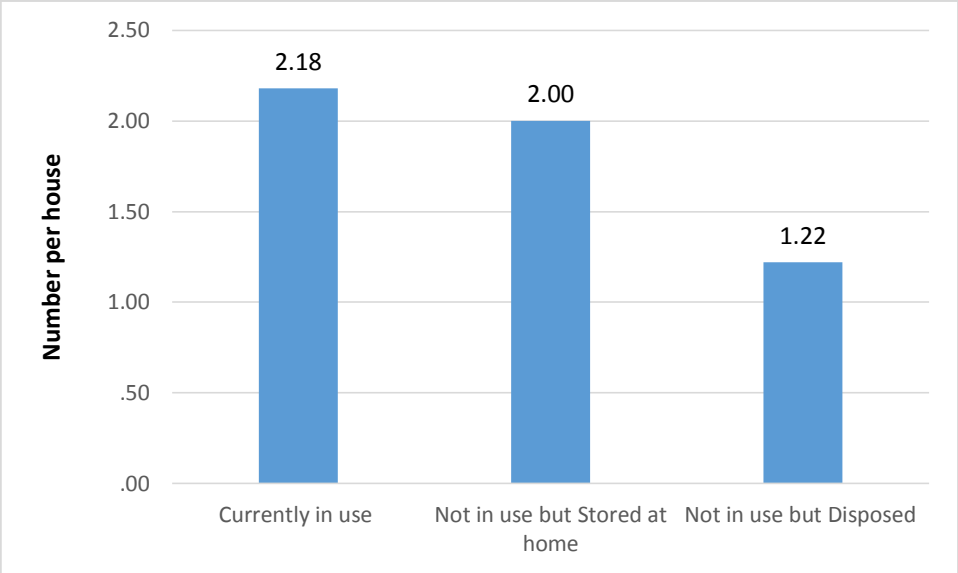

Figure 17 (b): Number of Laptops per households with educational level some college but no degree and associate degree

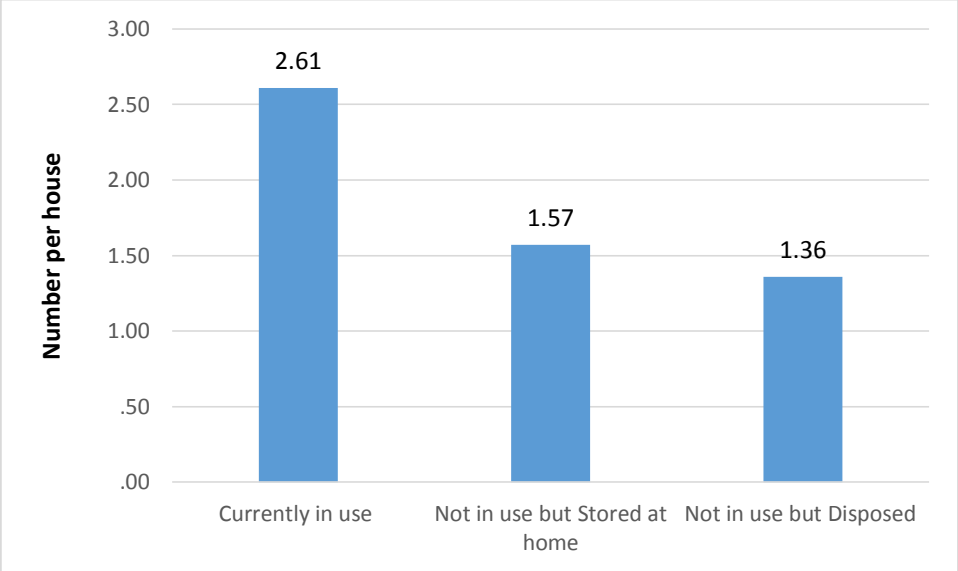

Figure 17 (c): Number of Laptops per households with educational level bachelor degree

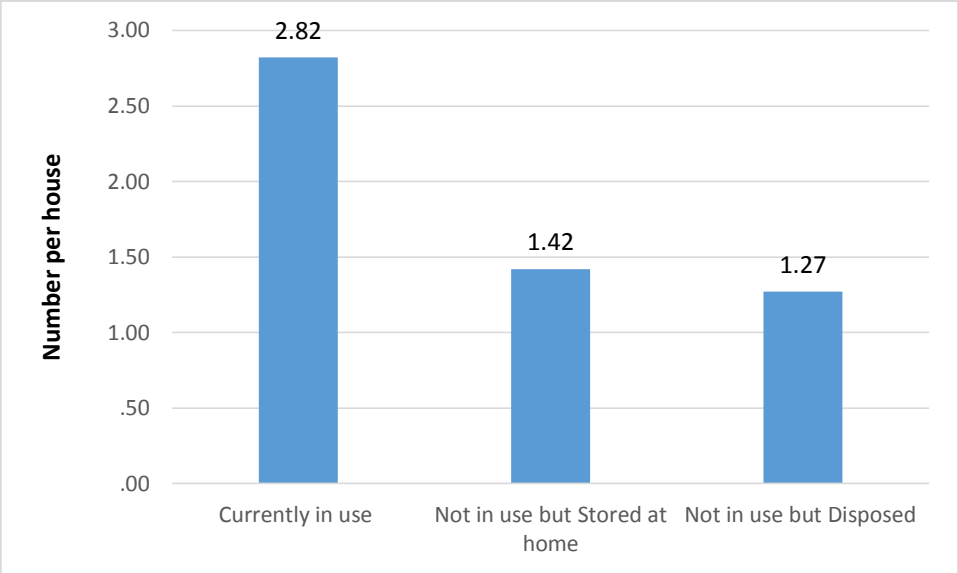

Figure 17 (d): Number of Laptops per households with educational level graduate degree

4.4 Group (4) Desktop Computers quantities

Figures 18 represents mean number of the desktops per household. This figure shows that about 0.67 desktops are currently in use per household. The average number per household in India and US is one desktop (Somavat and Namboodiri, 2011). The calculation of desktops per person is about 0.1 desktops. Same figure indicates that and average of 0.31 desktops per household are not in use but stored at home and 0.9 desktops were accounted for not in use and disposed in the past. Many of the respondents (39.4%) prefer to give or sell the desktop to a scrap dealer as in Figure 19.Figures 20 (a, b, c, d, e) display the average numbers of desktops in the household according to currently in use, not in use and stored, not in use and disposed. Also the figures divided according to the income of the household. (<15,000, 15,000 – 25,000, 25,000 – 35,000, 35,000 – 45,000, and >45,000). The figures are similar to each other, the highest choice is vacillating between currently in use and disposed. The average number of desktops currently in use was the first

choice for the group with income 35,000 - 45,000 Dhs (1.18). While, the group of sample with salary 35,000 - 45,000 Dhs are the lowest in not in use and disposed with 0.43. Both Abu Dhabi and Al Ain groups are having different quantities of currently in use, not in use and stored and not in use and disposed. From the other hand, the average not in use for both disposed and stored are more in Al Ain as shown in Figures 21 (a, b).

Figures 22 (a, b, c, d) reflect the relationship between average desktops per household and educational level as divided to currently in use, stored, and disposed. The highiest choice for currently in use was for bachelor level of education with 0.95 score. While, in stored was 0.89 for high school or less, and 0.92 in disposed for high school or less also. On the other hand, 0.19 for high school or less currently in use, 0.00 for college but no degree and associate degree in stored, and 0.81 for some bachelor for the disposed were lowest choice in the figures among the groups.

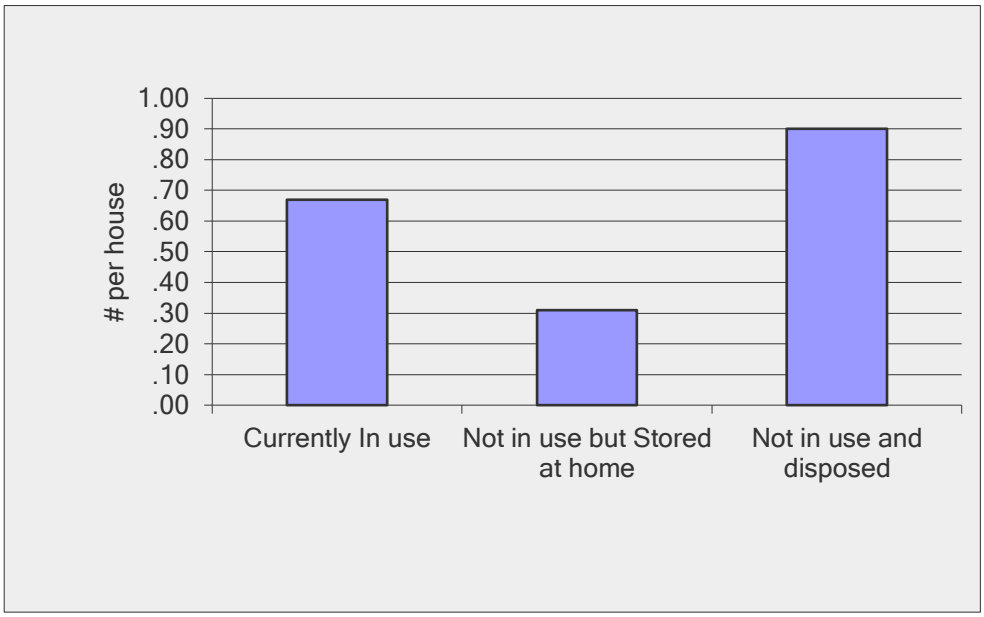

Figure 18: Number of desktop per house

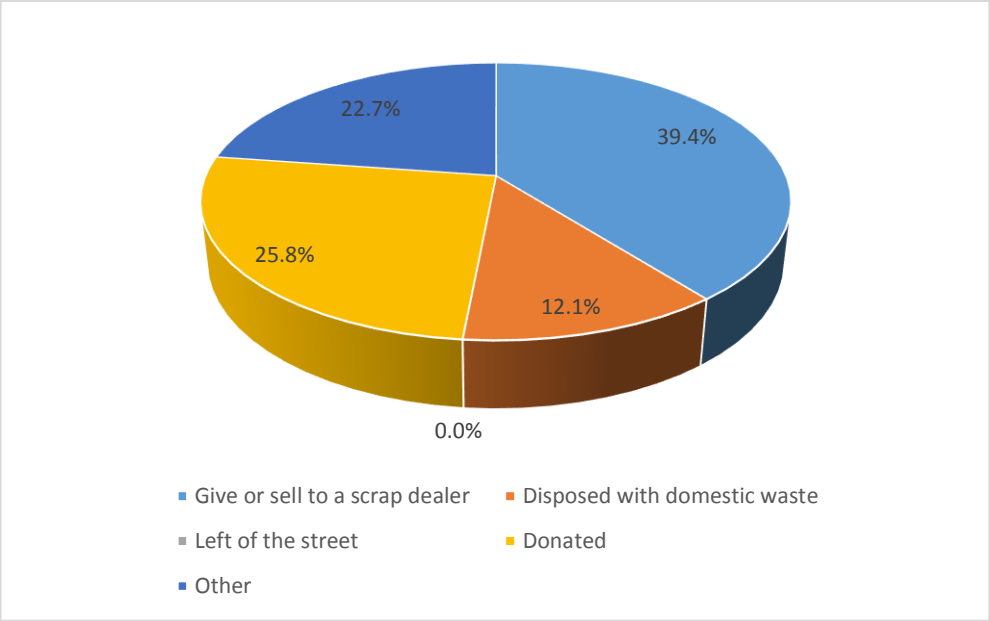

Figure 19: Percentage of response on the intention of stored desktops

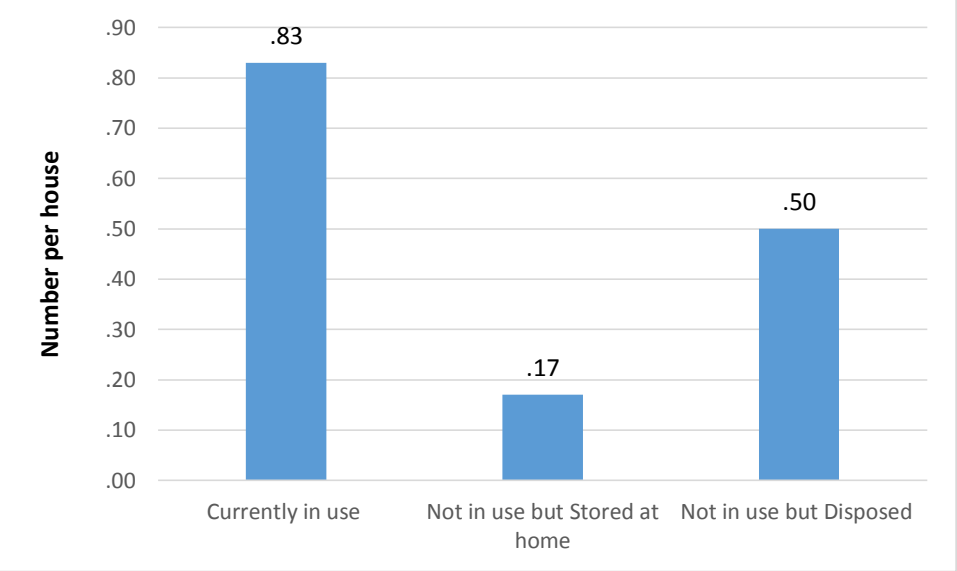

Figure 20 (a): Number of Desktops per households with income less than 15,000 Dhs

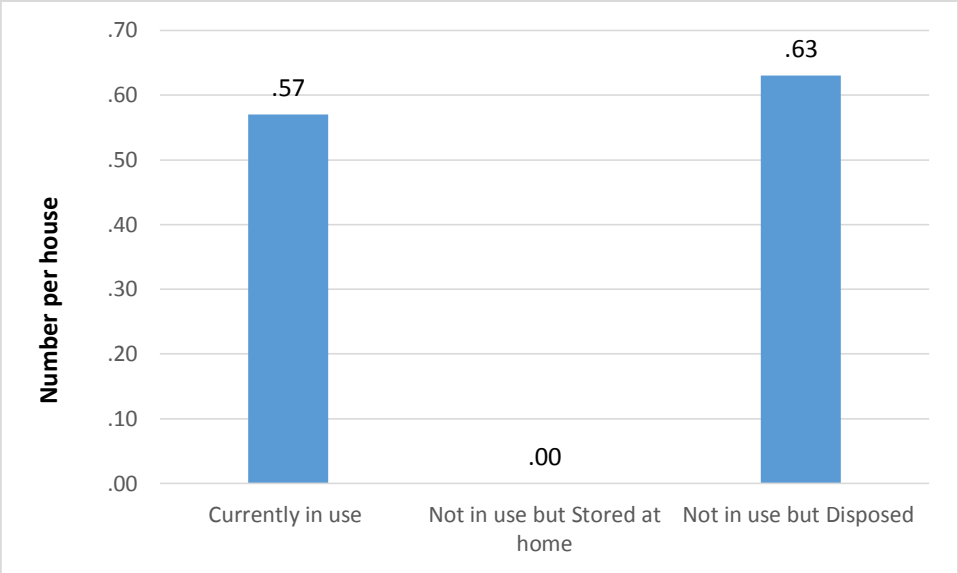

Figure 20 (b): Number of Desktops per households with income 15,000 – 25,000 Dhs

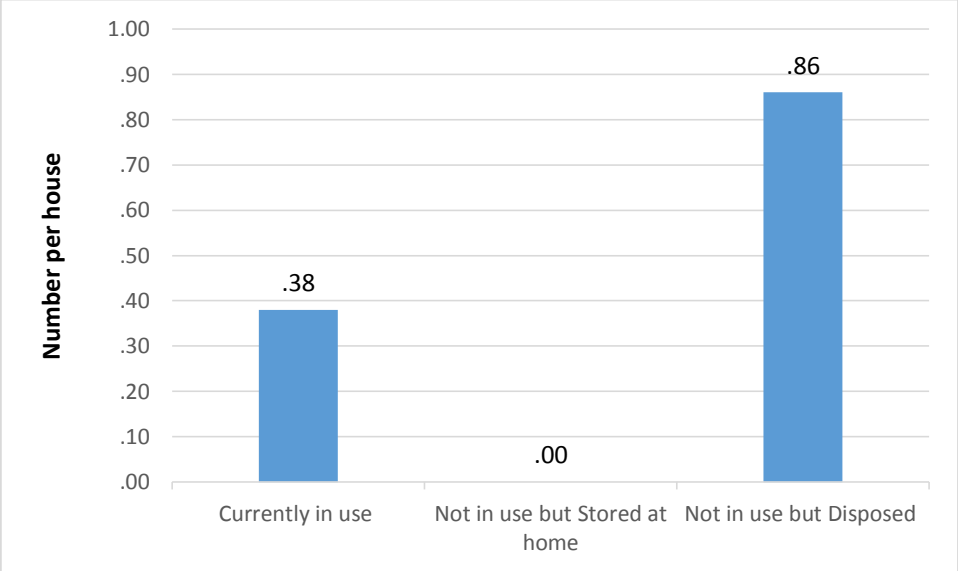

Figure 20 (c): Number of Desktops per households with income 25,000 – 35,000 Dhs

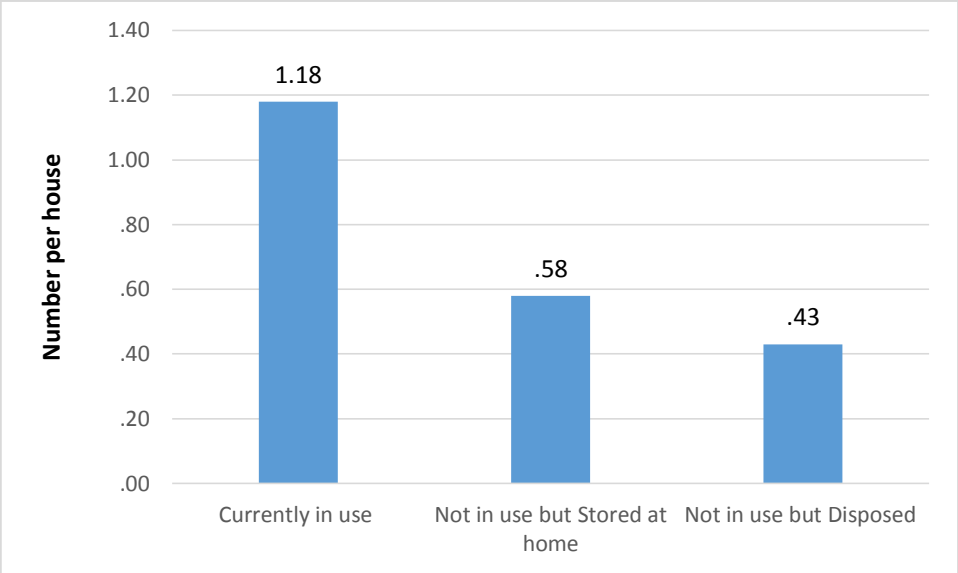

Figure 20 (d): Number of Desktops per households with income 35,000 – 45,000 Dhs

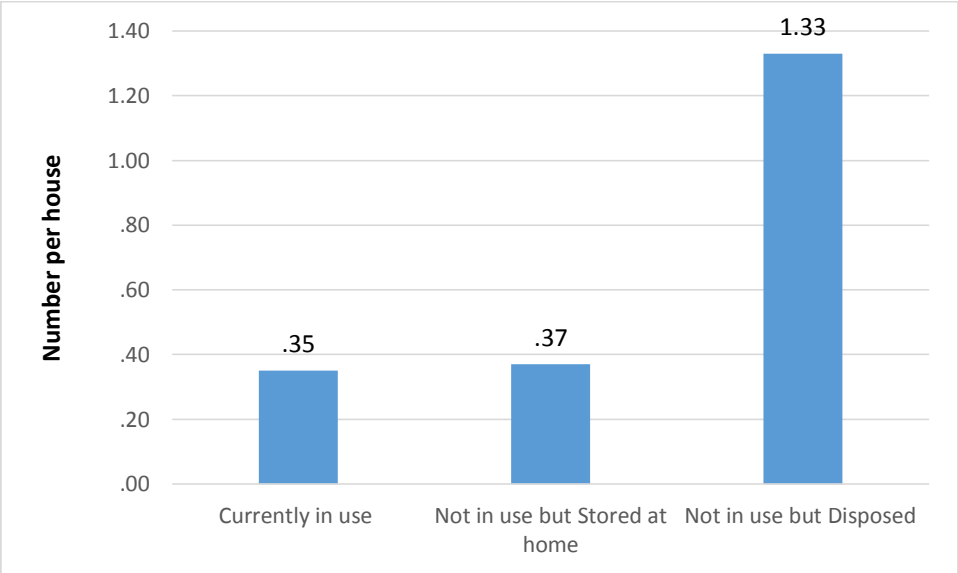

Figure 20 (e): Number of Desktops per households with income 45,000 Dhs

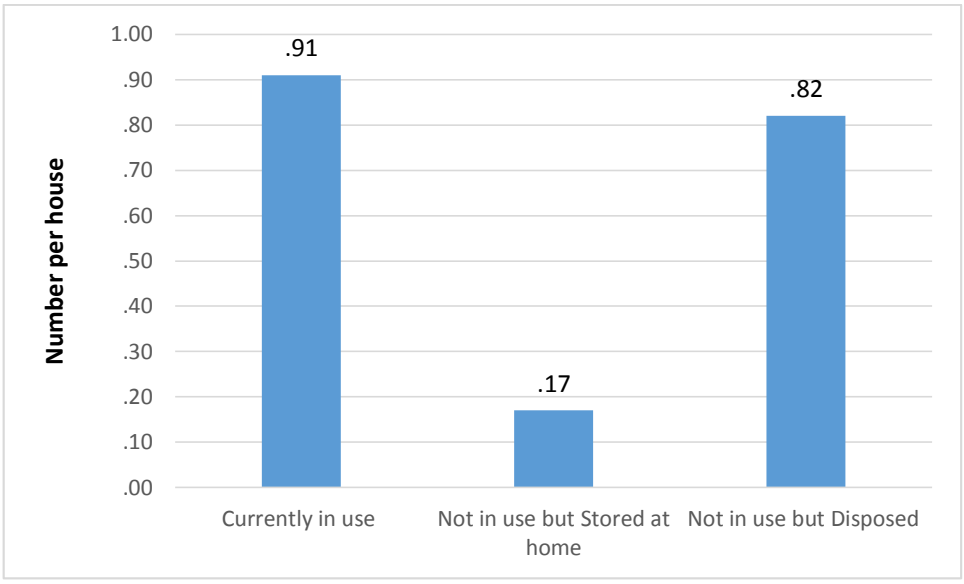

Figure 21 (a): Number of Desktops per household in Abu Dhabi area

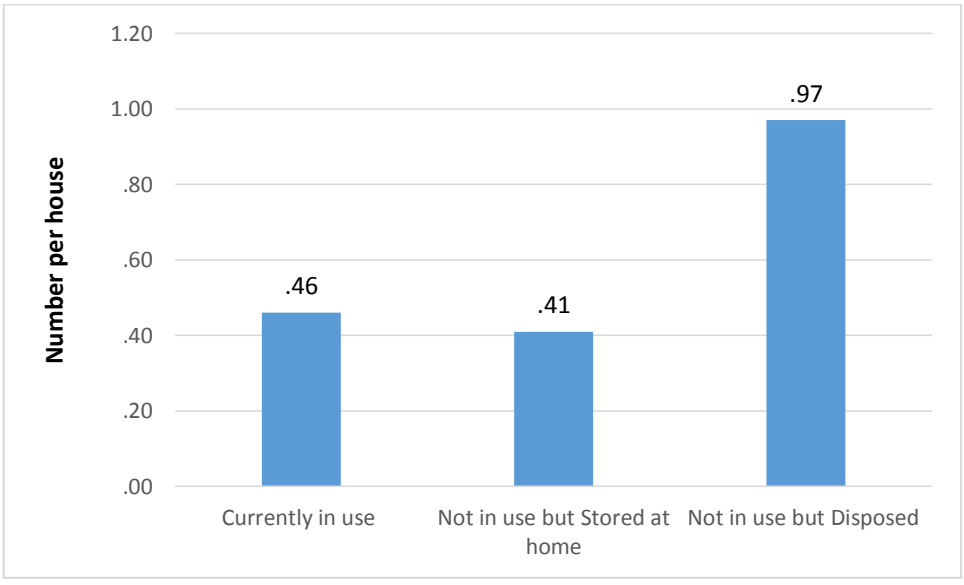

Figure 21 (b): Number of Desktops per households in Al Ain area

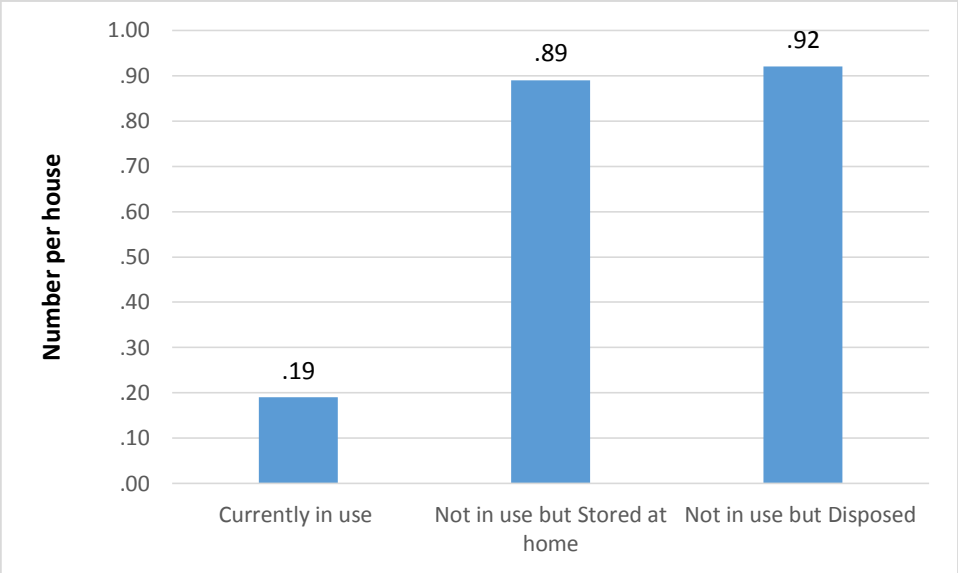

Figure 22 (a): Number of Desktops per households with educational level less than high school and high school

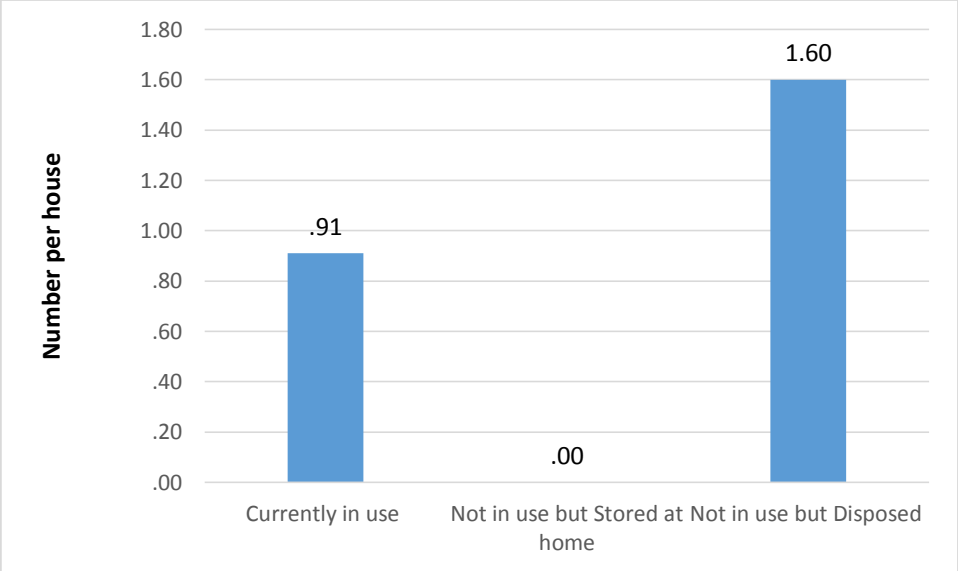

Figure 22 (b): Number of Desktops per households with educational level some college but no degree and associate degree

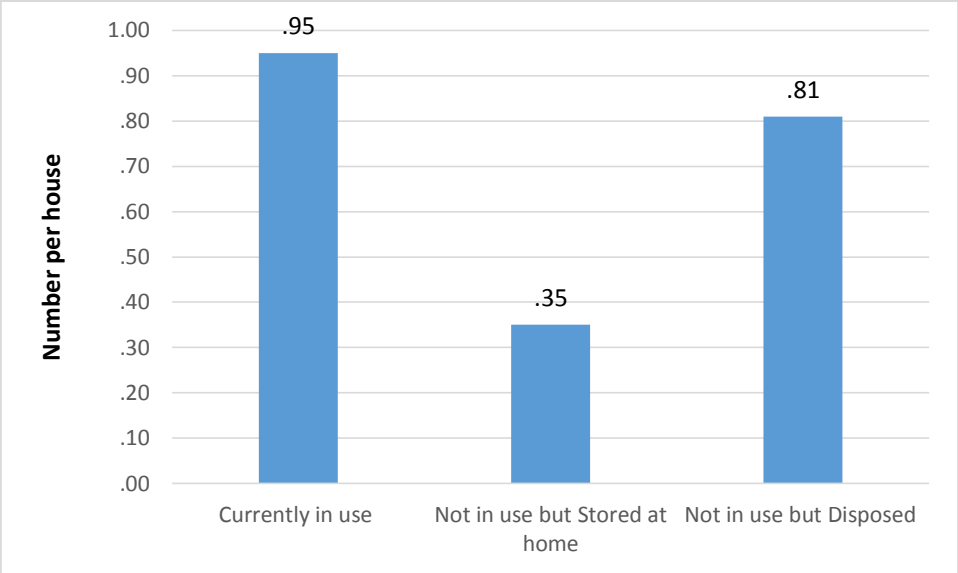

Figure 22 (c): Number of Desktops per households with educational level bachelor degree

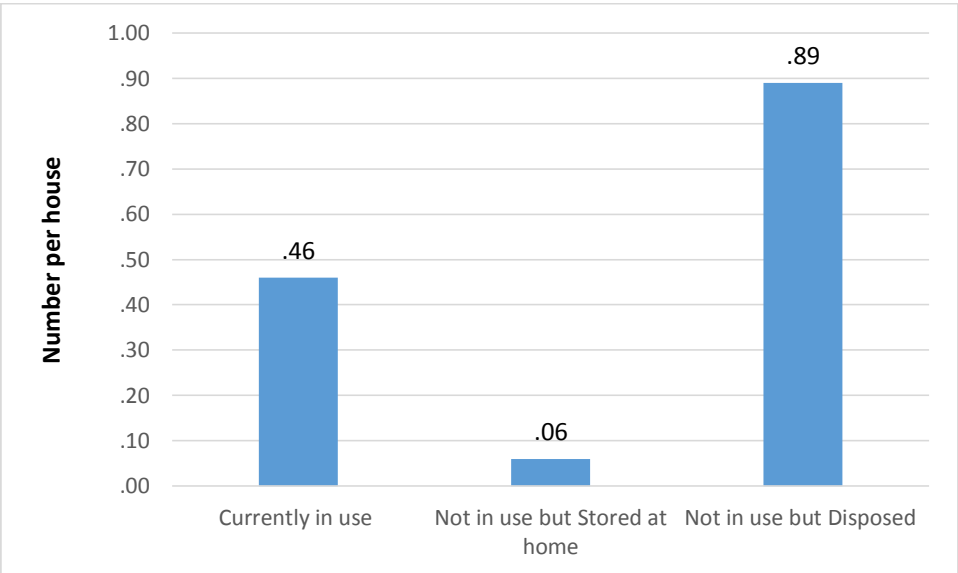

Figure 22 (d): Number of Desktops per households with educational level graduate degree

4.5 Group (5) Mobile Phones quantities

Figure 23 represents mean number of the mobile phones in the household. This figure shows that on average about 4.85 mobiles are currently in use in each

household. While, two mobile phones in India and US per household (Somavat and Namboodiri, 2011). Using equation 1, this will result in an average of 0.69 mobile per person. Meanwhile, 5.27 mobiles are not in use but stored at home. Number of mobiles not in use and disposed in the past is 3.45 mobiles per house. 38.2% of respondent prefer to give or sell the mobiles to a scrap dealer (Figure 24).

Figures 25 (a, b, c, d, e) display the average numbers of mobile phones in the household according to currently in use, not in use and stored, not in use and disposed. Also the figures divided according to the income of the household. (<15,000, 15,000 – 25,000, 25,000 – 35,000, 35,000 – 45,000, and >45,000). The figures are similar to each other except Figure 25 (b), the highest choice is for not in use and stored. The average number of mobile phones currently in use was the first choice for the group with income more than 45,000 Dhs (5.51). While, the group of sample with salary less than 15,000 Dhs are the lowest in not in use and disposed with (1). Both Abu Dhabi and Al Ain groups are having different quantities of currently in use, not in use and stored and not in use and disposed. From the other hand, the average currently in use and not in use but stored are more in Al Ain as shown in Figures 26 (a, b). Figure 27 (a, b, c, d) reflect the relationship between average mobile phones per household and educational level as divided to currently in use, stored, and disposed. The highest choice for currently in use was for college but no degree and associate degree level of education with 5.54 score. While, in stored was 6.65 for high school or less, and 3.86 in disposed for graduate. On the other hand, 4.23 for graduate currently in use, 4.14 for graduate also in stored, and 3.05 for some bachelor for the disposed were lowest choice in the figures among the groups.

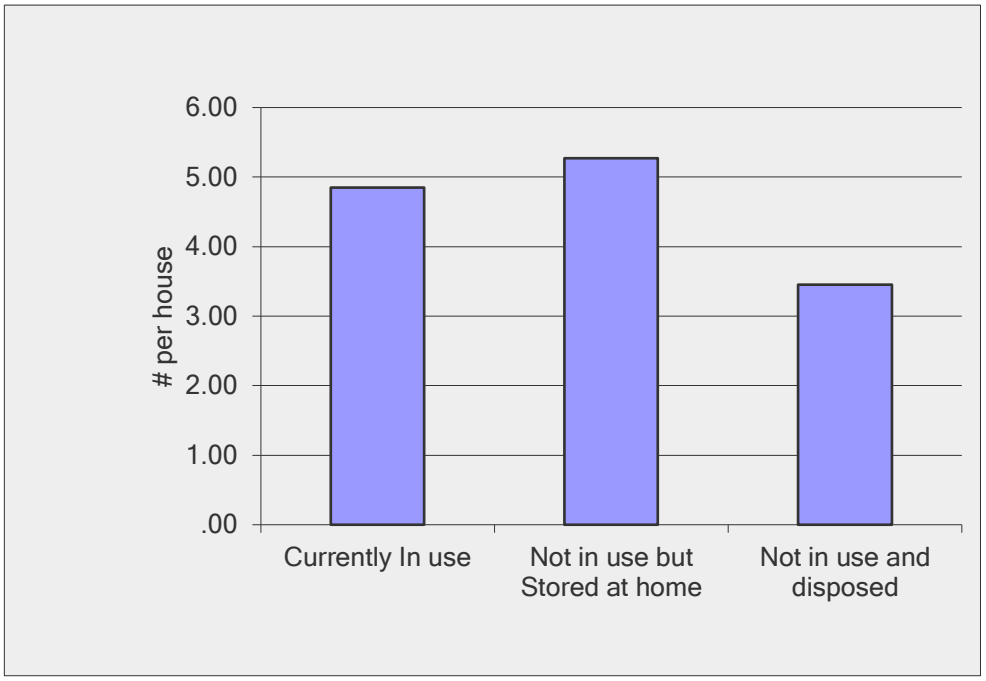

Figure 23: Number of Mobile Phones per house

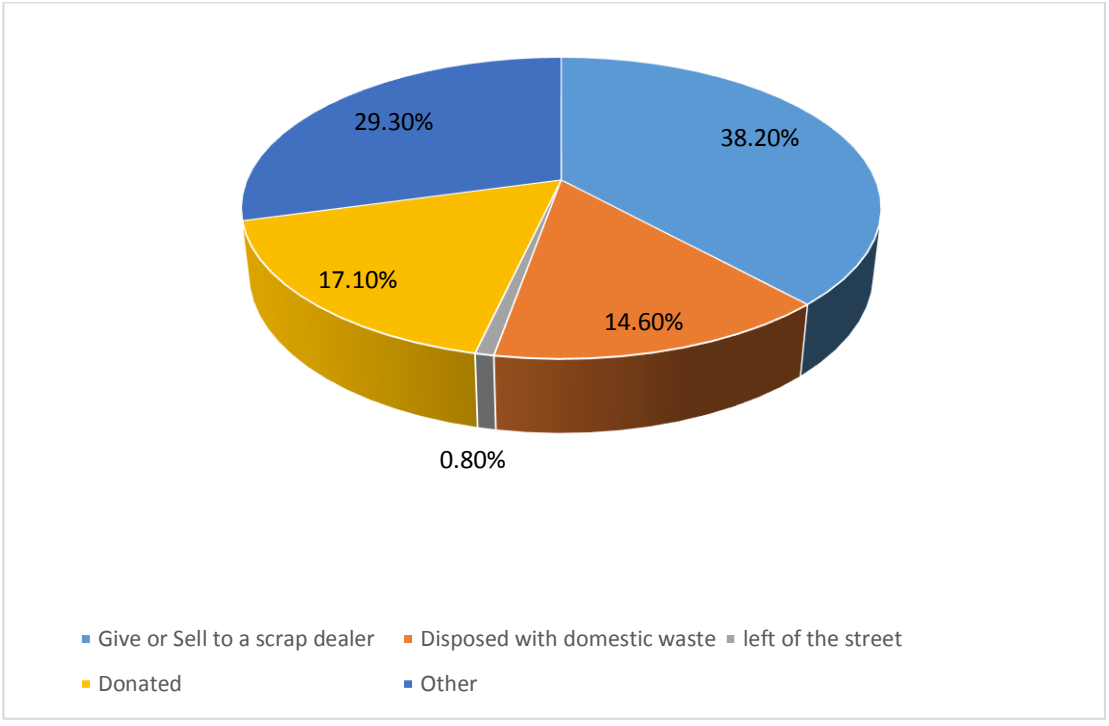

Figure 24: Percentage of response on the intention of stored mobile phones

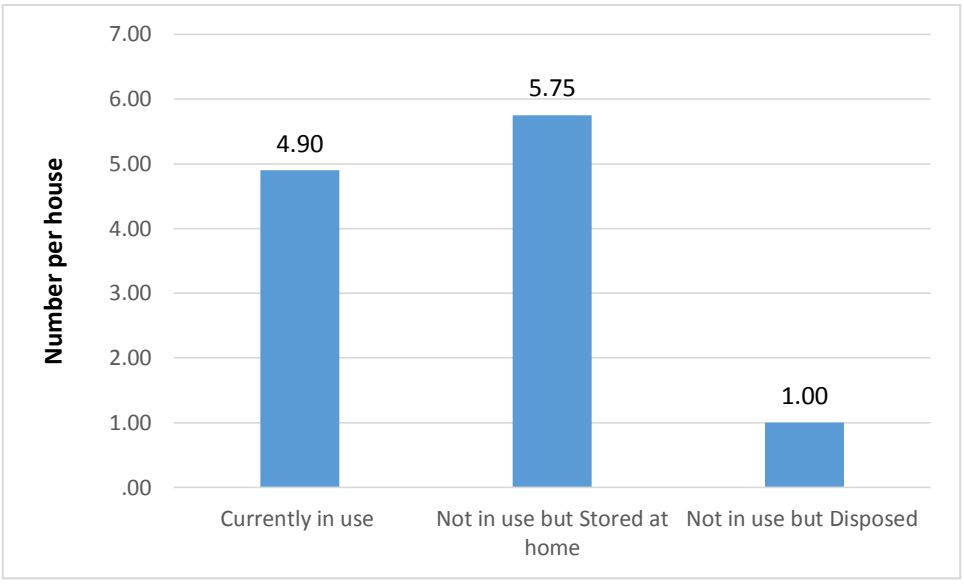

Figure 25 (a): Number of Mobile Phones per household with income less than 15,000 Dhs.

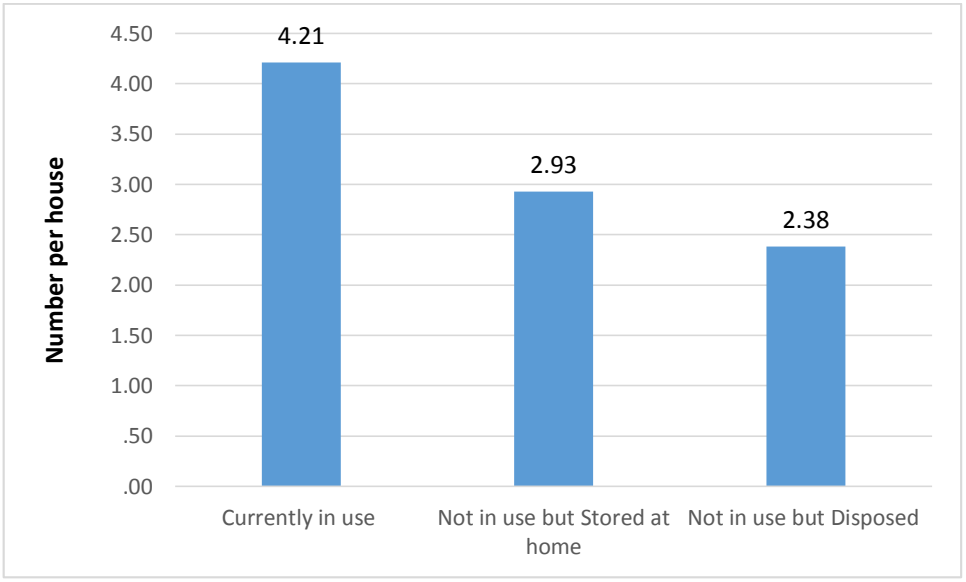

Figure 25 (b): Number of Mobile Phones per household with income 15,000 – 25,000 Dhs income

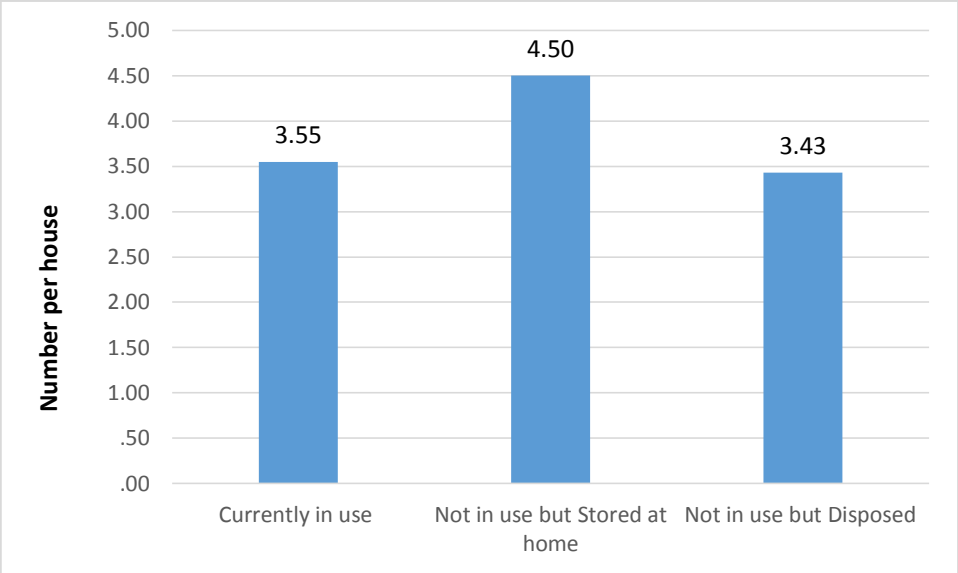

Figure 25 (c): Number of Mobile Phones per household with income 25,000 – 35,000 Dhs

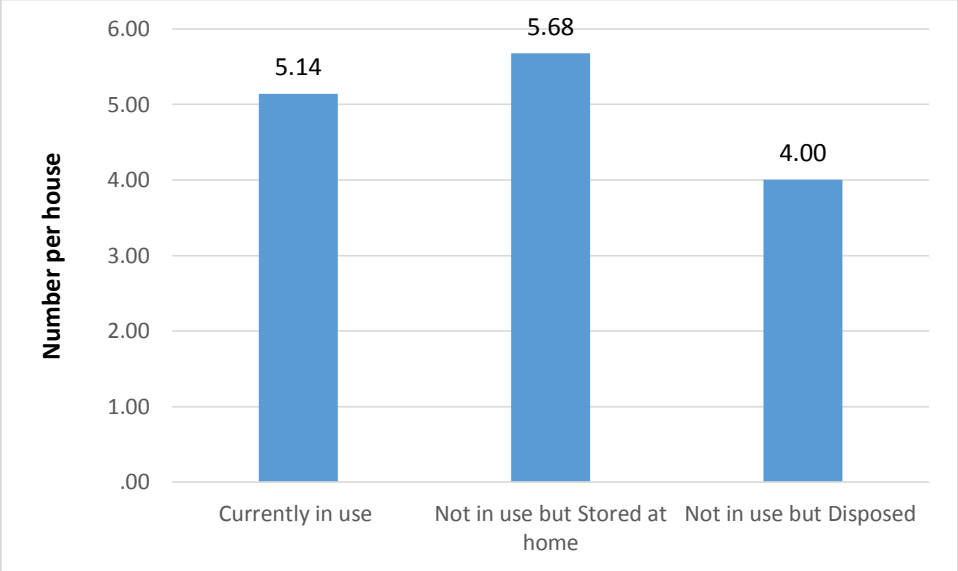

Figure 25 (d): Number of Mobile Phones per household with income 35,000 – 45,000 Dhs income

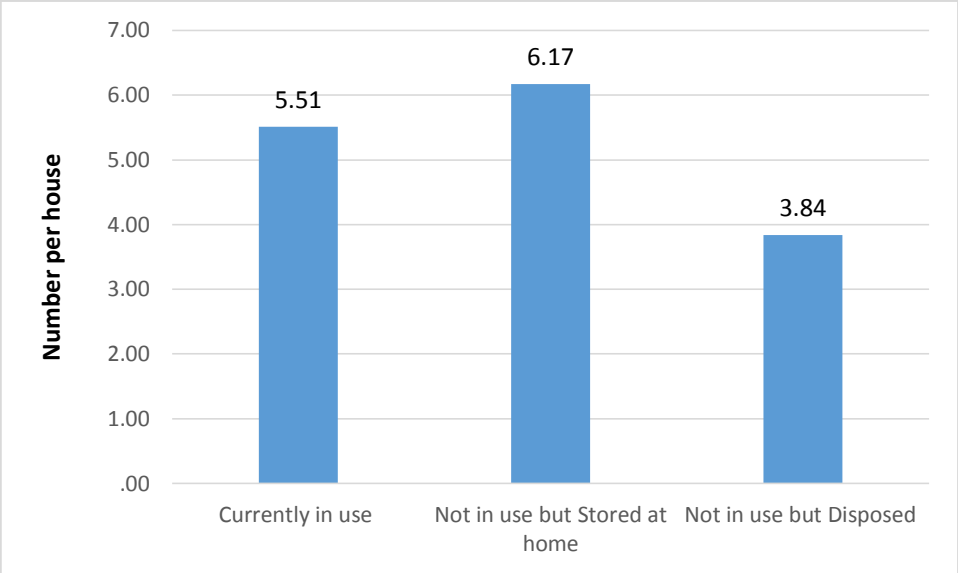

Figure 25 (e): Number of Mobile Phones per household with income 45,000 Dhs

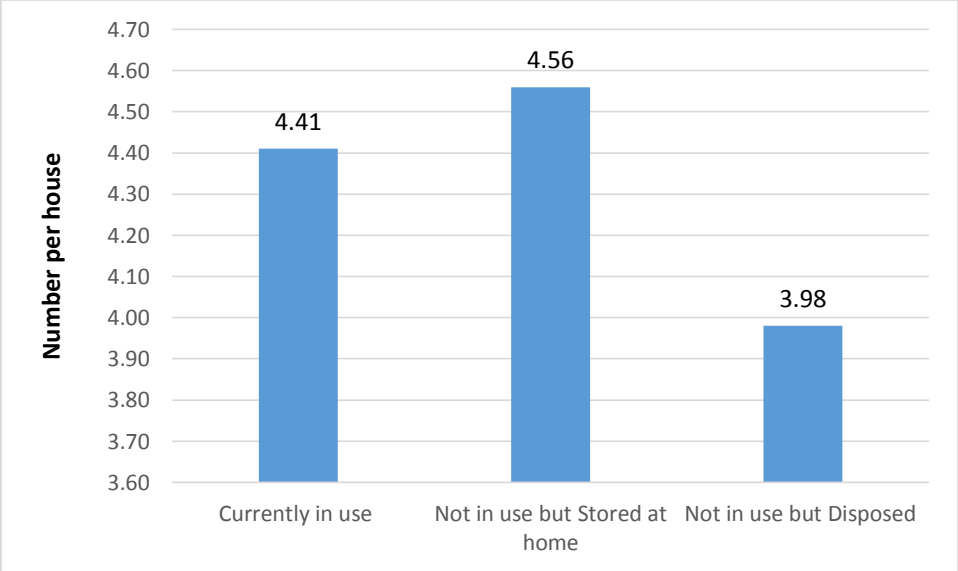

Figure 26 (a): Number of Mobile Phones per household in Abu Dhabi area

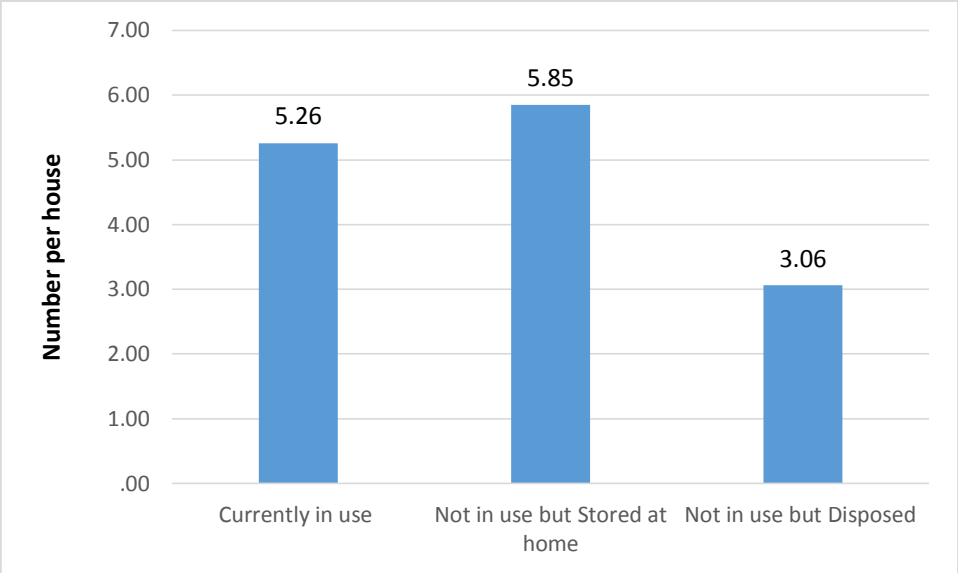

Figure 26 (b): Number of Mobile Phones per household in Al Ain area

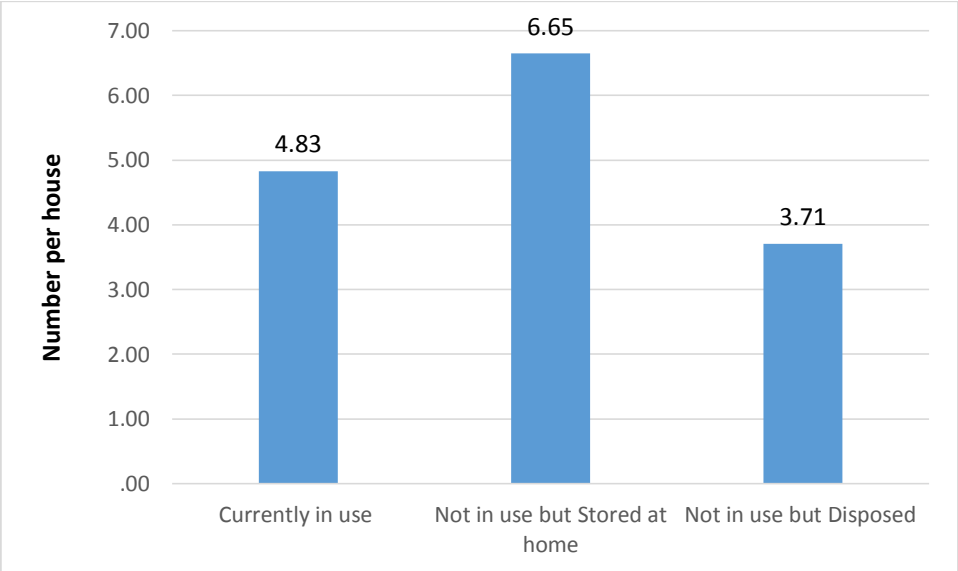

Figure 27 (a): Number of Mobile Phones per household with educational level less than high school and high school

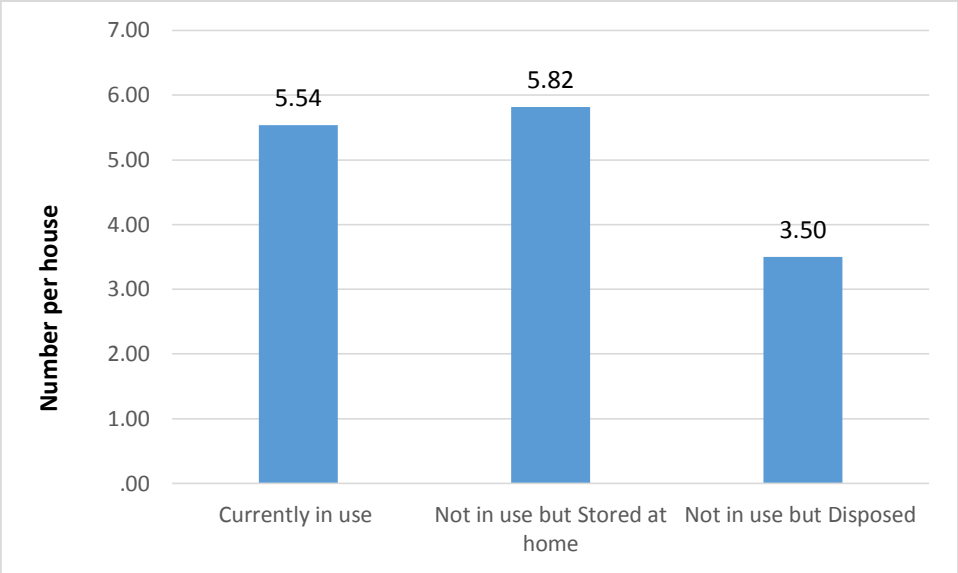

Figure 27 (b): Number of Mobile Phones per household with educational level some college but no degree and associate degree

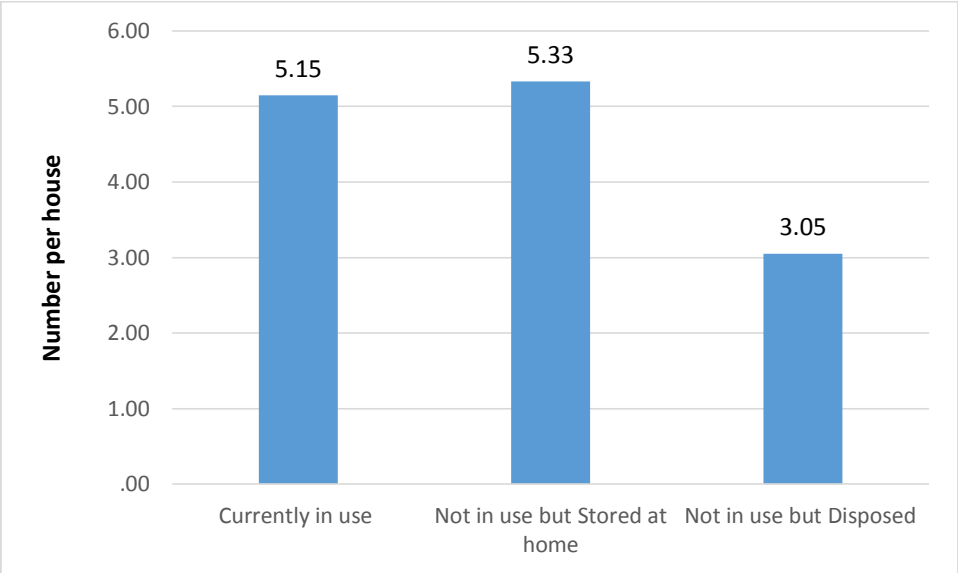

Figure 27 (c): Number of Mobile Phones per household with level bachelor degree

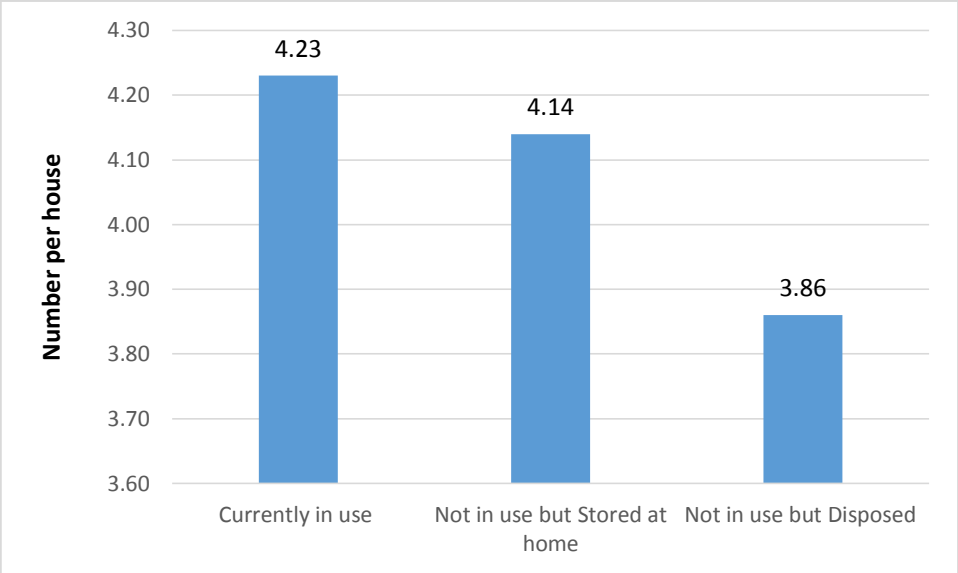

Figure 27 (d): Number of Mobile Phones per household with educational level graduate degree.

4.6 Group (6) Awareness of Disposing

Table 2 represents the level of responsibility and awareness of disposing the E-waste. Most of the respondents (78.7%) prefer to dispose E-waste to the waste collector for free if it will be disposed safely to the environment.

Table 2: The feel of responsibility and awareness of disposing

Would you give out your E-waste to the waste collectors for free if you could be sure that the waste will be well taken care of in a way that is useful and that does not pollute the environment?		
Answer Options	**Response Percent**	**Response Count**
YES	78.7%	100
NO	21.3%	27

4.7 Quantities of products currently in use in Abu Dhabi

Since no data is available about E-waste quantities in UAE, the surveys were used to obtain an estimation of these quantities. Figures 28, 29 and 30 represent the estimated quantities in Abu Dhabi Emirate for the three products laptops, desktops, and mobile phones, respectively. The quantities mentioned were calculated by multiplying the population of Abu Dhabi Emirate with the average number per person for each product using equation 2. The quantities are calculated for the three categories; namely, currently in use, stored, and disposed.

Estimated number of product = Number of population * product per person (3)

The current number of laptops in use per person is 0.35, and by using equation 3 the estimated total number in use can be calculated to be 827,000 laptops in Abu Dhabi emirate. For the stored laptops, the estimated number in Abu Dhabi is 577,000 laptops. Meanwhile, the estimated number of the disposed laptops is 464,000 as in Figure 28.

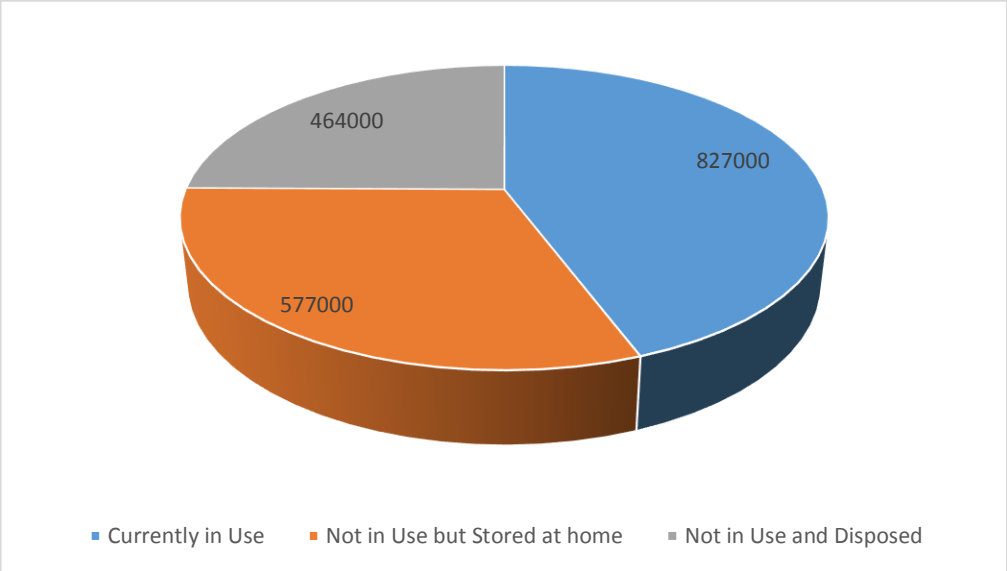

Figure 28: Estimated quantities of laptops in Abu Dhabi Emirate

On the other hand, the number of desktops is found less than laptops per person. The current per person value is 0.1 desktops as indicated before. The estimated quantity of currently in use desktops in Abu Dhabi is equal to 223,000. The estimated number of the desktop not in use but stored at home is smaller, about 103,000. Whereas, the number of disposed desktops is 300,000, as shown in Figure 29. This means that desktops were on the market for a long time, and it seems to be decreasing in use because they are replaced by the laptops and mobile phones as well as other devices.

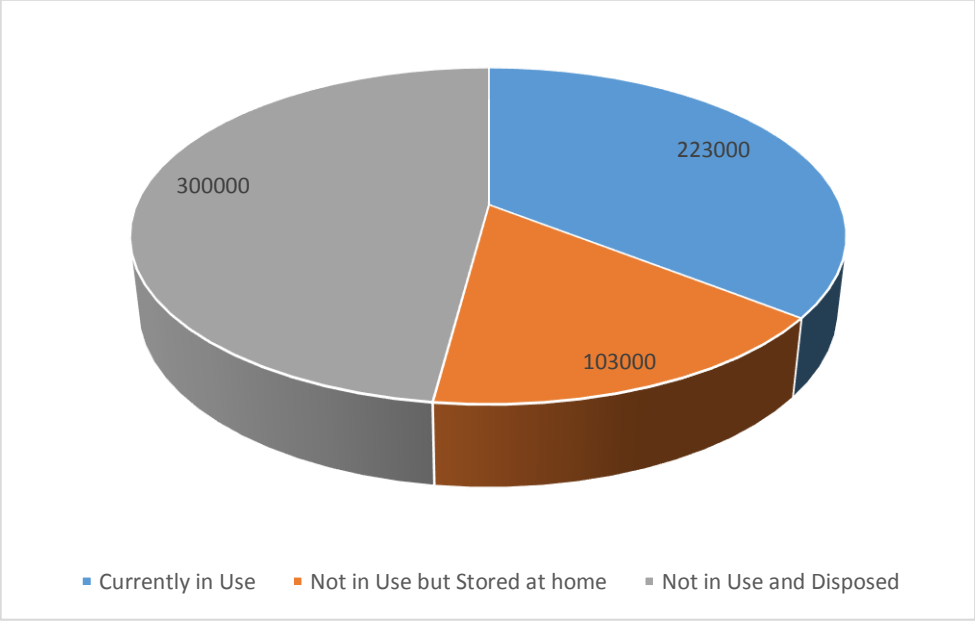

Figure 29: Estimated Desktops quantities in Abu Dhabi Emirate

When compared with other products, mobiles have the highest quantities in all categories including the currently in use, stored, and disposed. Currently 1,618,000 mobiles are in use in Abu Dhabi emirate. The estimated stored quantity is about 1,758,000 mobiles. Finally, the disposed number of mobile phones quantified to be about 1,151,000. Figure 30 shows the numbers of mobile in all three categories. The

highest number of stored products is for mobiles since they normally contain photos of family member of the user. Hence, many people prefer to keep their old mobiles at home.

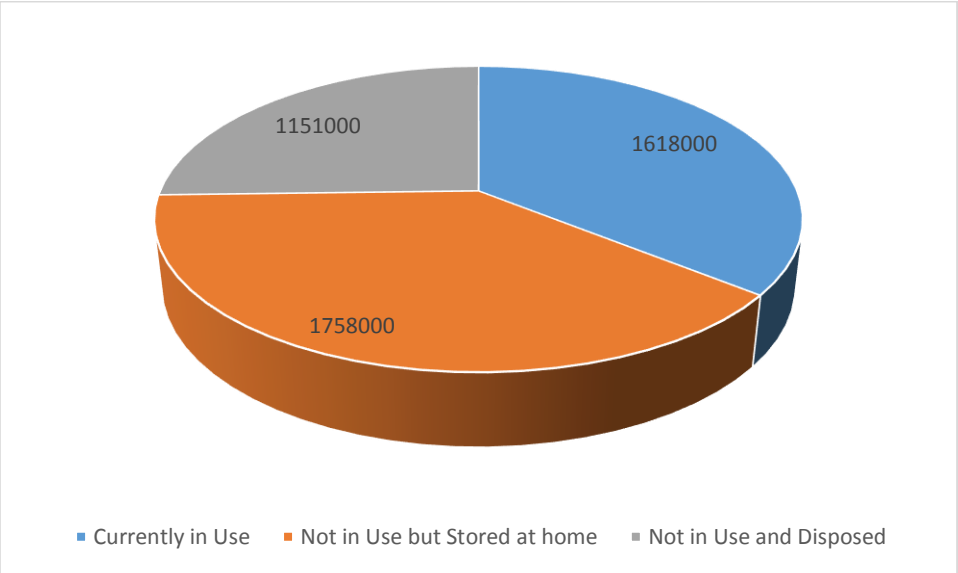

Figure 30: Estimated quantities of mobiles phones in Abu Dhabi Emirate

4.8 Estimation of current E-waste quantities in Abu Dhabi

No official data is available in Abu Dhabi, or in UAE, about quantities of E-waste. The questionnaire survey was used to estimate these quantities. Figure 31 represents the number of products that were disposed in Abu Dhabi emirate. The number of mobile phones holds the first place in term of quantity which is estimated to be around 1,151,000 followed by 464,000 laptops and 300,000 desktops.

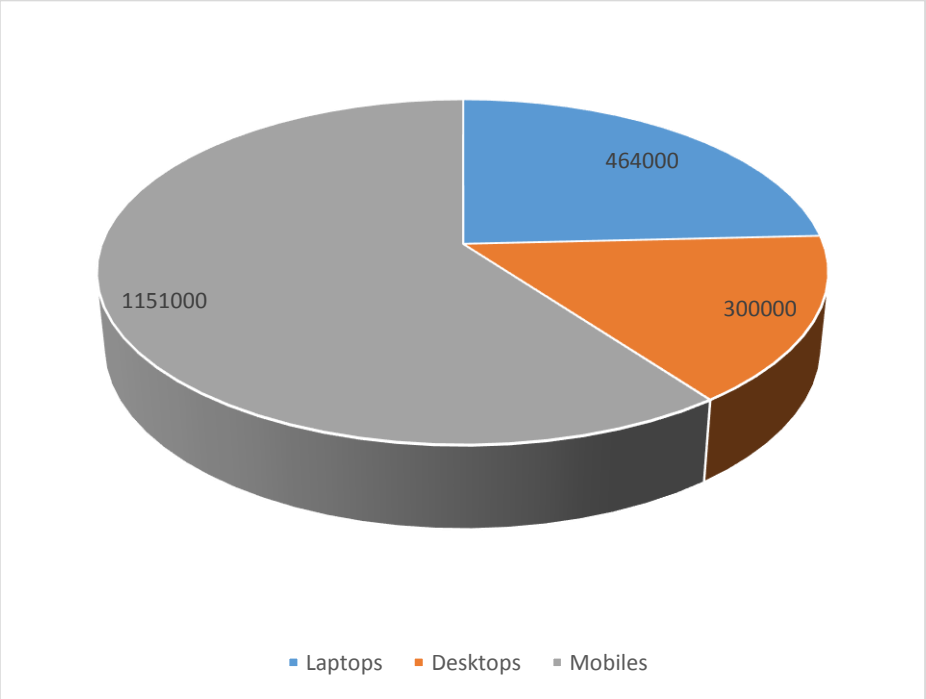

Figure 31: Estimated E-waste in Abu Dhabi Emirate in the last period

4.9 Forecasting of future products and E-waste quantities

Forecasting the quantities of waste requires population forecasting as well as shown in table 3 (Department of Transport, 2015). Figure 32 indicates increase in the number of products used in the future. This will result in increase of the number of products that will be used. In 2020 the number of laptops, desktops, and mobile phones will be 1,134,000, 306,000 and 2,218,000, respectively (Table 3).

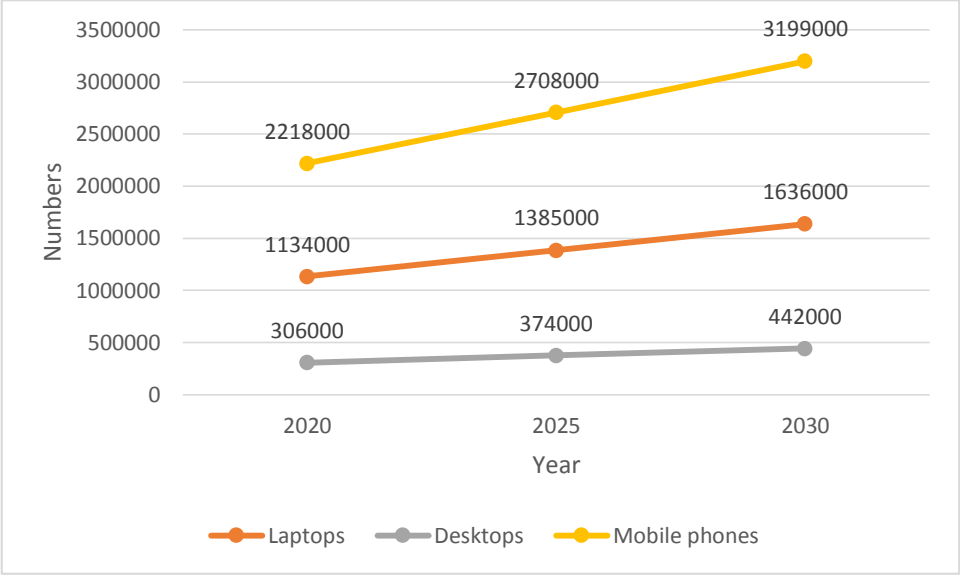

Figure 32: Forecasting of future quantities of products

Table 3: Forecasting of future quantities of laptops, desktops mobile phones

Year	Population	Laptops	Desktops	Mobile phones
2020	3201000	1134000	306000	2218000
2025	3909000	1385000	374000	2708000
2030	4617000	1636000	442000	3199000

Since the laptops life span is 4 years, as mentioned before, the currently in use laptops will become E-waste in 4 years. Table 4 represents the forecasted E-waste quantities of laptops. Results for the desktops, with life span of 5 years, forecasted E-waste quantities are shown in Table 5. It shows that the number of desktops to become waste in 2025 is 306,000. Finally, for mobile phones the life span is 6 years as mentioned before. The estimated quantities of mobile phones E-waste quantity is mentioned in Table 6.

Table 4: Forecasting of future E-waste quantities of laptops

Years	Laptops	Population
2024	1,134,000	3,201,000
2029	1,385,000	3,909,000
2034	1,636,000	4,617,000

Table 5: Forecasting of future E-waste quantities of desktops

years	Desktops	Population
2025	306,000	3,201,000
2030	374,000	3,909,000
2035	442,000	4,617,000

Table 6: Forecasting of future E-waste quantities of mobile phones

Years	Mobile phones	Population
2026	2,218,000	3,201,000
2031	2,708,000	3,909,000
2036	3,199,000	4,617,000

Table 7 represents the future waste for the three products. In 2019, the number of laptops waste will reach 827,000. The estimated desktops waste will be 223,000 in 2020. Finally 1,618,000 mobile phones will be considered as waste in 2021.

Table 7: Future E-waste for the current products that available with the respondent

	Average life span in years	Current Products Quantities	Products will be E-waste in
Laptop	4	827,000	2019
Desktop	5	223,000	2020
Mobile phone	6	1,618,000	2021

Chapter 5: E-waste Management

Electrical and electronic waste equipment disposal is hard to deal with. As final step to E-waste is damping because the reuse and recycle cannot be used because the equipment reach the end of life and it is not useful for anybody any more (Wanjau, 2011). The toxic content made the waste danger for the media in tach with (Vadoudi et al., 2015). For example the mobile phone have 40 elements from the parodic table, this can made danger because the degradation of some elements are too long and cause some health issues to living things or damage the environment (Heacock et al., 2015; Vadoudi et al., 2015). Meanwhile those metals will go through the ground layers reaching the groundwater. As mention before E-waste have heavy metals, if those heavy metals reach the groundwater it will be a disaster as the health consequences from using or drinking the water contaminated with (Dwivedy and Mittal, 2012; Kidee et al., 2013). Using the water can made the accumulation on trees as the animals will use the trees as feeding or the humans themselves wither direct feeding or indirect feeding (Kidee et al., 2013).

5.1 Estimation of landfill size

Especial dealing with E-waste must be done (Shinkuma and Huong, 2009). As some of hazard waste have especial landfills also E-waste, in which the landfills have protection in case of any leakages will happen form the waste to the ground (Lim and Schoenung, 2010). A special design to landfill is one of the choices can be done in Abu Dhabi as a protection from E-waste contamination consequences.

First of all, to design a good or professional landfill for E-waste, quantities of E-waste must be estimated to now the size of the landfill that will fit the waste. Second thing the design of the landfill in which it will not made the leakages wither to

the air, ground, and water. Then the material use must be as good as it will stay protecting the environment for a long time in which it will not affect the other generation in the future for the same area.

Landfill is organized as operational phase in three concepts of cell, daily cover, and lifts (Masters and Ela, 2008). The daily waste will overlie into a cell to be small layer to save the area of the landfill for the future waste. The cell volume depend in the quantities of the waste in which it could not be buried, so that the density must be known of the waste to know the volume and the waste in which it will not buried easily (Masters and Ela, 2008). Form the other hand, the cover also must be included to stop the gases and the other things in which it will go to the air. Also the lift area for the future waste must be also counted (Masters and Ela, 2008).

Table 8 represent the average weight of the studied products: laptops, desktops and mobile phones (E-waste guide, 2015)

Table 8: The average weight of the products in Kg

Product	Average weight in kg
Laptop Computer	3.5
Desktop Computer	9.9
Mobile Phone	0.1

In Table 7, the future E-waste for the current products that available with the respondent in which it will produced in 2019 for laptops, 2020 for desktops, 2021 for mobile phones. So that by using table 8 the quantities can be shown as Table 9.

Table 9: The average weight of the products quantities in Kg, per person, and per lbs

Product	Average weight in (kg)	Rounded Average weight of the quantities (Kg)	Converted to per person	Converted to lbs.	Year
Laptop	3.5	2,894,000	1.2	2.6	2019
Desktop	9.9	2,207,000	0.9	2	2020
Mobile Phone	0.1	161,000	0.07	0.15	2021

The volume of the waste and landfill size can be calculated by using Equation (4) (Masters and Ela, 2008), with using Table 9 information. The calculation will be for mobile phones for year 2021, laptops for year 2019 and finally for desktops for year 2020. In the calculation it will be assumed that the following numbers: a landfill density of 1,000 lbs/yd³ and one 10-foot lift per year and assuming that 20% of the cell volume is soil used for cover and also the population number will be 2335000 in Abu Dhabi.

Landfill size Equation:

$$V_{Product} = \frac{\text{lbs /Year} \times \text{Population}}{\text{Density}} \quad (4)$$

Calculation for Mobile phone:

$$V_{\text{Mobile phone}} = \frac{\text{lbs /Year} \times \text{Population}}{\text{Density}}$$

$$V_{\text{Mobile phone}} = \frac{0.15 \times 2{,}335{,}000 \text{ people}}{1000 \text{lbs/yd}^3}$$

$$V_{\text{Mobile phone}} = 350.25 \text{ yd}^3\text{/year}$$

$$V_{\text{Mobile phone}} = 268 \text{ m}^3\text{/year}$$

Since only 80% of a cell in land fill, the volume of the cell needed is

$$V_{\text{cell}} = \frac{350.25 \text{ yd}^3\text{/year}}{0.8}$$

$$V_{\text{cell}} = 437.8125 \text{ yd}^3\text{/year}$$

$$V_{\text{cell}} = 335 \text{ m}^3\text{/year}$$

The area of lift per year at 10- ft/year of depth

$$A_{\text{lift}} = \frac{437.8125 \text{ yd}^3\text{/year} \times 27 \text{ ft}^3\text{/yd}^3}{10 \text{ ft/year}}$$

$$A_{\text{lift}} = 1182 \text{ ft}^2\text{/year}$$

$$A_{\text{lift}} = 109.8 \text{ m}^2\text{/year}$$

Calculation for Laptops:

$$V_{laptops} = \frac{lbs\ /Year \times Population}{Density}$$

$$V_{laptops} = \frac{2.6 \times 2{,}335{,}000\ people}{1000 lbs/yd^3}$$

$$V_{laptops} = 6071\ yd^3/year$$

$$V_{laptops} = 4642\ m^3/year$$

Since only 80% of a cell in land fill, the volume of the cell needed is

$$V_{cell} = \frac{6071\ yd^3/year}{0.8}$$

$$V_{cell} = 7589\ yd^3/year$$

$$V_{cell} = 5802\ m^3/year$$

The area of lift per year at 10- ft/year of depth

$$A_{lift} = \frac{7589\ yd^3/year \times 27\ ft^3/yd^3}{10\ ft/year}$$

$$A_{lift} = 20490\ ft^2/year$$

$$A_{lift} = 1904\ m^2/year$$

Calculation for Desktops:

$$V_{Desktops} = \frac{lbs\ /Year \times Population}{Density}$$

$$V_{Desktops} = \frac{2 \times 2{,}335{,}000\ people}{1000 lbs/yd^3}$$

$$V_{Desktops} = 4670\ yd^3/year$$

$$V_{Desktops} = 3570\ m^3/year$$

Since only 80% of a cell in land fill, the volume of the cell needed is

$$V_{cell} = \frac{4670\ yd^3/year}{0.8}$$

$$V_{cell} = 5837\ yd^3/year$$

$$V_{cell} = 4463\ m^3/year$$

The area of lift per year at 10- ft/year of depth

$$A_{lift} = \frac{5837\ yd^3/year \times 27\ ft^3/yd^3}{10\ ft/year}$$

$$A_{lift} = 15761\ ft^2/year$$

$$A_{lift} = 1464\ m^2/year$$

5.2 E-waste Management

Management of E-waste need to be more careful about it not like the normal waste as domestic waste (Brigden et al., 2008). The growing of this kind of waste is normal but in case to reduce the quantities awareness is the first choice as first line defiance to reduce the quantities, but it will not solve the problem as expected (Brigden et al., 2008). At the end of this waste, it have those three ways in which it will end up in the landfill:

1. Reuse, Recycle, and Recover
2. Export
3. Dump

The first way is to reuse the product as a second hand use or third etc. recycling is by taking the important parts of the product and use it somewhere else to be useful again to the consumers. From the other hand, the exporting is one of the choices but it will transfer the problem from your country to the other countries (Brigden et al., 2008). It can be also worse for the other countries because the woman and children how will work with this transferred waste to find out about the wonted material from the waste (Brigden et al., 2008). An example in Ghana, they set up a fire to burin the E-waste to extract the wonted martials, this way will affect the environment and humans badly as smoke, ash, and other melting material in to the ground will made the damage (Brigden et al., 2008).

Damping E-waste needs some design for the landfill as mentioned above and can be one of the choices. Another solution can be added to E-waste in the Abu Dhabi or UAE in general, in which it is EPR. From the definition mentioned in chapter (2), it is clear that the manufacturing companies are responsible to recycle the final disposal

of E-waste. Environmental considerations must be accounted and by defining EPR. Responsibilities can be shifted from municipalities to the producers. This will expand the responsibilities of the manufacturer to the end of life cycle of E-waste (Sachs, 2006).

Chapter 6: Conclusions and Recommendations

6.1 Conclusions

The conclusions of the present study are listed as follows:

- Questionnaire survey carried out in Abu Dhabi and Al-Ain cities, to collect information about: socio-demographic pattern, awareness about management of E-waste, quantities of laptops, desktops and mobile phones in three categories including currently in use, not in use but stored, and disposed in the past. The outcomes based on this data were used to estimate the E-waste quantities in Abu Dhabi.
- Average numbers of laptops, desktops and mobile phones per person are estimated as follows: 0.35, 0.1 and 0.69, respectively, for the products currently in use; 0.25, 0.04 and 0.75, respectively, for the products not in use but stored at house; and 0.2, 0.13 and 0.49, respectively, for the disposed products.
- The estimated quantities of generated E-waste in Abu Dhabi are calculated to be 1,151,000, 464,000 and 300,000 for mobiles, laptops and desktops, respectively.
- The future quantities of E-waste are predicted based on the life span of the each product. They were estimated to be 827,000, 223,000 and 1,618,000 for laptops, desktops, and mobile phones, respectively.
- 78% of respondent were aware about the adverse effects of E-waste and they prefer to handle the E-waste to waste collector if it is to be disposed in an environmentally friendly manner.
- The manufacturing companies are responsible to recycle the final disposal of E-waste as mention in EPR the responsibilities can be shifted from municipalities to the producers.

6.2 Recommendations for Further Research

The following are the recommendations for future studies

- Future investigations should seek to select a larger sample size to reflect larger population from all around UAE.
- Future research could include more electronic devices/products.
- Awareness on E-waste management must be improved through e-seminars or lectures.
- Future investigations should also focus on E-waste which managed by municipalities.
- The design of E-waste landfill must be studied in deep to have suitable landfill with the country soil.
- The quantities of the E-waste is growing fast and it will not be stopped, so that, the solution must be made as soon as possible to prevent the world from the danger the consequences in future.

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Appendix

Questionnaire for Private Consumers - Households - for E-Waste

Assessment of Current and Future Generated E-Waste Quantities in UAE

This is survey for a Masters thesis, from United Arab Emirates University student , to Assess Current and Future Generated E-Waste Quantities in UAE, thank you for participating in this survey which will help us to study this subject.

Questionnaire for Private Consumers - Households - for E-Waste

Introducing question

1. What is your age?

- ◯ 17 or younger
- ◯ 18-20
- ◯ 21-29
- ◯ 30-39
- ◯ 40-49
- ◯ 50-59
- ◯ 60 or older

2. In what City do you currently reside?

- ◯ Al Ain
- ◯ Abu Dhabi
- ◯ Dubai
- ◯ Sharjah
- ◯ Ajman
- ◯ RAK
- ◯ Umm Al Quwain
- ◯ Fujairah

3. What is the highest level of school you have completed or the highest degree you have received?

- ◯ Less than high school degree
- ◯ High school degree or equivalent (e.g., GED)
- ◯ Some college but no degree
- ◯ Associate degree
- ◯ Bachelor degree
- ◯ Graduate degree

4. How many persons live in your household? (please tick)

- ◯ 2-3
- ◯ 4-6
- ◯ 7-9
- ◯ 10-12
- ◯ more than 12

Questionnaire for Private Consumers - Households - for E-Waste

Introducing question

5. Do you know what e-waste or waste of electrical and electronic equipment is?

- ◯ YES
- ◯ NO

6. Are you aware that some hazardous fractions in e-waste need a special treatment in order to be safely disposed of?

- ◯ YES
- ◯ NO

7. Do waste collectors pick up waste at your door?

- ◯ YES
- ◯ NO

8. Do they pick up e-waste too?

- ◯ YES
- ◯ NO

9. Type of waste collected?

10. Is the current e-waste collection convenient to you?

- ◯ YES
- ◯ NO

11. What could be improved?

Questionnaire for Private Consumers - Households - for E-Waste

Tracking Laptops

12. How many Laptops

Currently In use	
Not in use but Stored at home	
Not in use and disposed	

13. How many years have you used the Laptops? (From old to new)

(1 = First Laptop , 2 = second Laptop….. and so on)

1	
2	
3	
4	
5	
6	

14. In what condition did you buy the Laptops? (From old to new)

N – New

U – Used + Working

B – Broken

(1 = First Laptop 2 = second Laptop ….. and so on)

1	
2	
3	
4	
5	
6	

15. How many years do you intend to further use the currently use Laptop?

1	
2	
3	
4	
5	
6	

16. How many years did you store the Laptops ? (From Old To New)

1	
2	
3	
4	
5	
6	

17. What is the condition of the Laptop when it was stored or disposed ?

W – working

B – broken

F - broken but fixable

1	
2	
3	
4	
5	
6	

18. What do you inted to do with stord Laptops ?

- ◯ Give or Sell to a scrap dealer
- ◯ Dispode with domestic waste
- ◯ left of the street
- ◯ Donated
- ◯ Other

19. If Other please specify

Questionnaire for Private Consumers - Households - for E-Waste

Tracking Desktop Computers

20. How many Desktop Computers

Currently In use	
Not in use but Stored at home	
Not in use and disposed	

21. How many years have you used the Desktop Computers? (From old to new)

(1 = First Desktop Computer , 2 = second Desktop Computer….. and so on)

1	
2	
3	
4	
5	
6	

22. In what condition did you buy the Desktop Computers? (From old to new)

N – New

U – Used + Working

B – Broken

(1 = First Desktop Computer 2 = second Desktop Computer ….. and so on)

1	
2	
3	
4	
5	
6	

23. How many years do you intend to further use the currently use Desktop Computers?

1	
2	
3	
4	
5	
6	

24. How many years did you store the Desktop Computers ? (From Old To New)

1

2

3

4

5

6

25. What is the condition of the Desktop Computers when it was stored or disposed ?
W – working
B – broken
F - broken but fixable

1

2

3

4

5

6

26. What do you inted to do with stord Desktop Computers ?

- ◯ Give or Sell to a scrap dealer
- ◯ Dispode with domestic waste
- ◯ left of the street
- ◯ Donated
- ◯ Other

27. If Other please specify

Questionnaire for Private Consumers - Households - for E-Waste

Tracking Mobile Phones

28. How many Mobile Phones

Currently In use	
Not in use but Stored at home	
Not in use and disposed	

29. How many years have you used the Mobile Phones? (From old to new)

(1 = First Mobile Phone, 2 = second Mobile Phone….. and so on)

1	
2	
3	
4	
5	
6	

30. In what condition did you buy the Mobile Phones? (From old to new)

N – New

U – Used + Working

B – Broken

(1 = First Mobile Phone 2 = second Mobile Phone ….. and so on)

1	
2	
3	
4	
5	
6	

31. How many years do you intend to further use the currently use Mobile Phones ?

1	
2	
3	
4	
5	
6	

32. How many years did you store the Mobile Phones? (From Old To New)

1	
2	
3	
4	
5	
6	

33. What is the condition of the Mobile Phones when it was stored or disposed ?
W – working
B – broken
F - broken but fixable

1	
2	
3	
4	
5	
6	

34. What do you inted to do with stord Mobile Phones?

- ◯ Give or Sell to a scrap dealer
- ◯ Dispode with domestic waste
- ◯ left of the street
- ◯ Donated
- ◯ Other

35. If Other please specify

Questionnaire for Private Consumers - Households - for E-Waste

General information

36. Would you give out your e-waste to the waste collectors for free if you could be sure that the waste will be well taken care of in a way that is useful and that does not pollute the environment?

- ◯ YES
- ◯ NO

37. If NO Why ?

38. Do you have further comments or suggestions concerning e-waste management?

39. What is the monthly income in the household? (please tick)

- ◯ < 15000
- ◯ 15000 – 25000
- ◯ 25000 – 35000
- ◯ 35000 – 45000
- ◯ > 45000DH

استبيان خاص بالاستهلاك المنزلي للمخلفات الالكترونية

تقديركمية النفايات الالكترونية الحالية والمستقبلية في دولة الامارات العربية المتحد

استبيان خاص برسالة، لطالب ماجستير في جامعة الامارات العربية المتحدة، وذلك لتقديركمية النفايات الالكترونية الحالية والمستقبلية في دولة الامارات العربية المتحد، نشكركم على المشاركة في هذا الاستبيان الذي سيساعدنا في عمل دراسة على هذا الموضوع

استبيان خاص بالاستهلاك المنزلي للمخلفات الالكترونية

اسئلة عامة

1. ما هو عمرك ؟

- ◯ أصغر من 17
- ◯ 18-20
- ◯ 21-29
- ◯ 30-39
- ◯ 40-49
- ◯ 50-59
- ◯ أكبر من 60

2. في أي مدينة تسكن الآن ؟

- ◯ العين
- ◯ أبوظبي
- ◯ دبي
- ◯ الشارقة
- ◯ عجمان
- ◯ رأس الخيمة
- ◯ أم القوين
- ◯ الفجيرة

3. ما هو أعلى مستوى تعليمي أكملت أو أعلى درجة حصلت عليها ؟

- أقل من ثانوي عام
- ثانوي عام أو ما يوازي
- كلية ولكن بدون شهادة
- دبلوم
- درجة البكالوريوس
- أعلى درجة البكالوريوس

4. كم عدد الأشخاص اللذين يعيشون في منزلك ؟ يرجى وضع علامة

- 2-3
- 4-6
- 7-9
- 10-12
- more than 12

استبيان خاص بالاستهلاك المنزلي للمخلفات الالكترونية

أسئلة مفتاحية

5. هل تعلم ما هي المخلفات الالكترونية أو المخلفات الكهربائية والمعدات الالكترونية ؟

- نعم
- لا

6. هل عندك علم بالمخاطر الموجودة في المخلفات الالكترونية، وأنها بحاجة إلى طريقة خاصة للعلاج أو المعالجة للتخلص منها بشكل آمن ؟

- نعم
- لا

7. هل مجمعو النفايات يجمعون النفايات من أمام منزلك ؟

- نعم
- لا

8. هل يجمعون النفايات الالكترونية أيضا ؟

- نعم
- لا

9. ما هي أنواع النفايات المجمعة ؟

10. هل طريقة جمع النفايات الالكترونية الحالية مقنعة لك ؟

- نعم
- لا

11. ماذا يمكن أن يتطور في عملية الجمع ؟

استبيان خاص بالاستهلاك المنزلي للمخلفات الالكترونية

تتبع الكمبيوترات المحمولة

12. كم عدد الكمبيوترات المحمولة
لابتوبات

مستخدمة في الوقت الحالي	
ليست مستخدمة ولكنها مخزنة	
تم الاستغناء عنها تم استخدامها أو تخزينها سابقا	

13. كم سنة تم استخدام الكمبيوترات المحمولة ؟ من الاقدم إلى الاحدث

الكمبيوتر المحمول الأول ، 2 = الكمبيوتر المحمول الثاني ..... وهكذا = 1

1	
2	
3	
4	
5	
6	

14. في اي حالة تم شراء الكمبيوترات المحمولة : من الاقدم إلى الاحدث

جديد

مستخدم

معطل

الكمبيوتر المحمول الأول ، 2 = الكمبيوتر المحمول الثاني ..... وهكذا = 1

1	
2	
3	
4	
5	
6	

15. كم سنة تنوي استخدام الكمبيوترات المحمولة المستخدمة في الوقت الحالي ؟

1	
2	
3	
4	
5	
6	

16. كم سنة تم تخزين الكمبيوترات المحمولة ؟ من الأقدم إلى الأحدث

1	
2	
3	
4	
5	
6	

17. في اي حالة تم التخلص من الكمبيوترات المحمولة عندما كانت مخزنه أو تم الأستغناء عنها :

	يعمل	معطل	معطل ولكن يمكن تصليحه
1			
2			
3			
4			
5			
6			

18. ماذا سوف تفعل بالكمبيوترات المحمولة المخزنة

- ◯ إعطاء أو بيع لتاجر الخردة
- ◯ التخلص منها مع النفايات المنزلية
- ◯ تركها في الشارع
- ◯ التبرع بها
- ◯ أخرى

19. إذا أخرى أرجو التحديد

استبيان خاص بالاستهلاك المنزلي للمخلفات الالكترونية

تتبع الكمبيوترات المكتبية

20. كم عدد الكمبيوترات المكتبية

مستخدمة في الوقت الحالي	
ليست مستخدمة ولكنها مخزنة	
تم الاستغناء عنها تم استخدامها أو تخزينها سابقا	

21. كم سنة تم استخدام الكمبيوترات المكتبية ؟ من الاقدم إلى الاحدث

الكمبيوتر المكتبي الأول ، 2 = الكمبيوتر المكتبي الثاني ..... وهكذا = 1

1	
2	
3	
4	
5	
6	

22. في اي حالة تم شراء الكمبيوترات المكتبية : من الاقدم إلى الاحدث

جديد

مستخدم

معطل

الكمبيوتر المكتبي الأول ، 2 = الكمبيوتر المكتبي الثاني ..... وهكذا = 1

1	
2	
3	
4	
5	
6	

23. كم سنة تنوي استخدام الكمبيوترات المكتبية المستخدمة في الوقت الحالي ؟

1	
2	
3	
4	
5	
6	

24. كم سنة تم تخزين الكمبيوترات المكتبية ؟ من الأقدم إلى الأحدث

1	
2	
3	
4	
5	
6	

25. في اي حالة تم التخلص من الكمبيوترات المكتبية عندما كان مخزن أو تم الأستغناء عنه :

	يعمل	معطل	معطل ولكن يمكن تصليحه
1			
2			
3			
4			
5			
6			

26. ماذا سوف تفعل بالكمبيوترات المكتبية المخزنة

- ◯ إعطاء أو بيع لتاجر الخردة
- ◯ التخلص منها مع النفايات المنزلية
- ◯ تركها في الشارع
- ◯ التبرع بها
- ◯ أخرى

27. إذا أخرى أرجو التحديد

استبيان خاص بالاستهلاك المنزلي للمخلفات الالكترونية

تتبع الهواتف المتحركة

28. كم عدد الهواتف المتحركة

مستخدمة في الوقت الحالي	
ليست مستخدمة ولكنها مخزنة	
تم الاستغناء عنها تم استخدامها أو تخزينها سابقا	

29. كم سنة تم استخدام الهواتف المتحركة ؟ من الاقدم إلى الاحدث

الهاتف المتحرك الأول ، 2 = الهاتف المتحرك الثاني ..... وهكذا = 1

1	
2	
3	
4	
5	
6	

30. في اي حالة تم شراء الهواتف المتحركة: من الاقدم إلى الاحدث

جديد

مستخدم

معطل

الهاتف المتحرك الأول ، 2 = الهاتف المتحرك الثاني ..... وهكذا = 1

1	
2	
3	
4	
5	
6	

31. كم سنة تنوي استخدام الهواتف المتحركة المستخدمة في الوقت الحالي ؟

1	
2	
3	
4	
5	
6	

32. كم سنة تم تخزين الهواتف المتحركة ؟ من الأقدم إلى الأحدث

1	
2	
3	
4	
5	
6	

33. في أى حالة تم التخلص من الهواتف المتحركة عندما كانت مخزنة أو تم الأستغناء عنها :

	يعمل	معطل	معطل ولكن يمكن تصليحه	؟
1				
2				
3				
4				
5				
6				

34. ماذا سوف تفعل الهواتف المتحركة المخزنة

- ◯ إعطاء أو بيع لتاجر الخردة
- ◯ التخلص منها مع النفايات المنزلية
- ◯ تركها في الشارع
- ◯ التبرع بها
- ◯ أخرى

35. إذا أخرى أرجو التحديد

استبيان خاص بالاستهلاك المنزلي للمخلفات الالكترونية

معلومات عامة

36. هل ستسلم النفايات الالكترونية إلى جامعو النفايات الالكترونية مجانا ، إذا كنت متأكد بأنهم سيهتمون بالنفايات أو سيعالجونها بطريقة مفيدة أو آمنة لا تلوث البيئة ؟

- ◯ YES
- ◯ NO

37. إذا لا لماذا ؟

38. هل لديك المزيد من التعليقات أو الاقتراحات المتعلقة بإدارة النفايات الإلكترونية ؟

39. ما هوالدخل الشهري في المنزل؟ يرجى وضع علامة

- ◯ < 15000
- ◯ 15000 – 25000
- ◯ 25000 – 35000
- ◯ 35000 – 45000
- ◯ > 45000DH