Ministry of Environment

BASELINE REPORT

WEEE/E-WASTE IN PHNOM PENH MUNICIPALITY AND CURRENT MANAGEMENT SYSTEM

Prepared by the Ministry of Environment (MoE)
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Table of Contents

List of Tables

List of Figures

List of Appendices

Executive Summary

Double-digit economic growth rates in recent years have triggered an economic boom in Cambodia, with new hotels, restaurants, and residential buildings springing up around the PPM. Due to improved living standards, globalization, international trade, and tourism, the consumption of electrical and electronic equipment (EEE) has rapidly increased in the urban centres in the country. Rural population in Cambodia still does not have capability to afford brand new or secondhand EEE because of low family income, and no access to electricity supply. Since Cambodia does not have manufacturing base for electrical and electronic equipment (EEE), it is importing both brand new and second hand EEE to cater to existing demand. This is leading to generation of E-waste and its management as a major issue in cities/ urban centers in Cambodia. Earlier studies carried out by Basel Convention Regional Centre in China in 2005 and CEA in 2007 identified Phnom Penh as the major centre for E-waste generation. Further, the study indicated usage of low repairing/dismantling technology with inappropriate facilities in study areas, which threaten the environment and public health.

Different needs, which were identified by MOE, Government of Cambodia as an outcome of these studies included development of an action plan for the environmentally sound management of E-waste along with need for capacity building and close collaboration among stakeholders. In this context, a comprehensive pilot project has been conceptualized by MoE, Government of Cambodia to build the local capacity for proper E-waste management, including recovery of valuable materials with support from UNEP-DTIE-IETC in the Phnom Penh Municipality. Specific objective of the proposed pilot project include building the national and local capacity in Cambodia on inventorization and management of E-waste by undertaking various activities, including the inventory of E-waste and a pilot project to process E-waste in and environmentally sound manner with optimum level of recovery for recycling. The other objective aimed to bring out the guidelines and training materials for dissemination for other developing countries to replicate similar projects and capacity building process.

The current capacity building effort is being targeted in two major areas i.e. E-waste inventorization and E-waste management. UNEP has already produced two volumes of E-waste Manual. The first volume provides guidelines for E-waste inventorization, while second volume provides guidelines for E-waste Management. This project has utilized these manuals as part of their comprehensive approach and methodology for capacity building of the target audience. The project was launched by Government of Cambodia/ UNEP-DTIE-IETC on 10 February 2009 in PPM. The project launch ceremony aimed at: (i) addressing current gaps and future needs to properly manage E-wastes in the PPM; (ii) introducing the project to participants about major inputs, activities and outcomes of the project, including its work-plan as well. Fifty participants, who attended the ceremony included experts/ representatives from government and private institutions, including NGOs, academic and private sectors. The government institutions, which participated included MoE, MIME, MoC, MoP, MoInt., PPM Dept. of Environment, MoPWT, PPWM, MoH, RUPP, and MAFF. Two NGOs, CEA and COMPED and ten representatives from private sector also attended the project launch ceremony. The first three day training program was conducted after project launch ceremony in February 2009.

Three different sessions were conducted as part of this training workshop. First session included awareness raising workshop on E-waste as result of which an E-waste project

field team consisting of twelve personnel from different stakeholders was constituted. These members represented different national and local government departments e.g. Ministry of Environment, Ministry of Industry and Mines, Department of Kam Control, Phnom Penh Municipality and expert institutions such as academia e.g. Phnom Penh Royal University and local NGO, CEA. In the second session, the project team was trained based on UNEP DTIE/ IETC E-waste Manual 1 to build local capacity to carryout E-waste inventory assessment. The major focus of the training program was to impart conceptual understanding of E-waste inventory assessment to the participants. Sessions on E-waste definition, E-waste market assessment, methodologies used for E-waste inventory assessment and usage of tools/ techniques/ formats/ questionnaires for assessment were conducted. A case study from the E-waste manual 1 supported by relevant movie clips were used to strengthen the existing knowledge base of the participants. In session 3, field work was carried out, which focused on demonstration of applying the conceptual understanding gained during class room training program within the municipal limits of Phnom Penh. The concept of material flow, E-waste trade value chain and identification of different stakeholders involved in trade value chain was demonstrated to project team on the 3rd day of the training program. The field work provided them hands-on training to collect and analyze the information leading to development of E-waste Inventory. Based on "tracer technique," an attempt was made to show the "material flow" by first taking them to the shops selling new goods, then to the shops doing repair and selling used goods, and finally to informal dismantlers/ recyclers. Tools, which were used in field application included transect walk, formal and informal sector questionnaire, mapping of E-waste life cycle in the geographical context. The majority of project team members got exposure for the first time to go to such places and conduct surveys.

The outcome of this training program resulted in the development of the first report on E-waste inventory for the PPM by the project team. The major findings of this report have been described in six chapters. The major chapters include description of regulatory framework, E-waste market assessment, its geographical distribution, development of E-waste trade value chain, selection of methodology for E-waste inventory assessment followed by E-waste inventory assessment and finally formulation of conclusions and recommendations. Some of the important findings, conclusions and recommendations are described below.

Definition of electrical and electronic equipment is not covered under the existing regulations. One of the major gaps, which have been identified, is the lack of clear definition of E-waste. There is very little difference between definition of used EEE and E-waste. Since Cambodia is signatory to Basel Convention, it is assumed that all the definitions and items related to E-waste in the convention are covered in the existing regulations (article 20 and 21). Words like "used goods/ scrap/ waste", "discarded" and "disposal" are covered in existing regulations. Reuse and recycling are defined in the draft strategy on 3R.The sub decree on solid waste management defines the hazardous waste criteria. As per the criteria, some of the E-waste is listed in items 6, 11, 13, 14, and 21 of annexure of this sub decree. Role of collector/ transporter is defined only in the context of hazardous waste and solid waste.There is no specific definition of generator or producer of E-waste. However, definition of importer of Used EEE is mentioned in the existing regulation.There is a need to cover E-waste either under existing regulations or a separate regulation depending on the time frame and capacity of regulatory agencies to implement it. Since draft 3R strategy is being formulated in the

country, E-waste can also be brought under its purview so that necessary regulatory interventions can be planned and implemented.

EEE market is organized in three different types of market segments i.e. shops selling brand new EEE, shops selling brand new as well as second hand EEE and shops selling second hand EEE. The major findings of E-waste market are summarized below. The majority of EEE market in PPM is organized in mixed market conditions with shops selling a combination of new and second hand items and shops selling second hand items. The market share of second hand EEE is increasing every year, although, some of brand-new items are cheaper. Consumers prefer branded EEE even when it is second hand. Shops selling second hand EEE have multiple functions of selling, repairing, refurbishing and dismantling. Geographically, it is organized in different hubs catering to ICT and white goods sector. It is observed that the major hubs of AC refurbishing / dismantling also serve as major hubs for refrigerator refurbishing/ repair and dismantling. Major hubs for TV and PC are located at different places. However, hubs at Chamkamorn and Toul Kok serve as two major hubs for TV and PCs. Chamkamorn, Toulkok and Meanchay also serve as major repairing/ refurbishing centre for washing machine. Therefore, four functions can be geographically addressed at one place while considering future interventions. There are twelve processes, which need to be considered for environmentally sound management while planning for future interventions since no chemical processing is occurring within municipal boundary of PPM. The E-waste trade value chain consisting of stakeholders implementing twelve processes indicates that future interventions are required at level 1 and level 2 consisting of primary E-waste generators and secondary E-waste generator.

A combination of two methods, “Carnegie Mellon Method” and “Tracer Technique” has been used to quantify E-waste inventory in PPM. These techniques are applied on respective parts of the E-waste trade value chain. There are four steps, which have been used to describe the conceptual approach to estimate E-waste inventory. These include establishing the installed base of selected EEE items with future projections till 2019, carrying out the scenario analysis using assumed average life cycle of each EEE item followed by confirming the average life cycle using “Tracer Technique” and quantification of E-waste inventory with projections. Tracer technique confirmed the average life cycle for TV, PC, MP, refrigerator, air conditioner and washing machine to be 14, 11,6, 13, 13 and 18 years. The results of E-waste inventory in PPM showed that it is expected to grow exponentially during the next decade both in terms of numbers and weight. In terms of numbers E-waste from mobile phones is expected to grow at a higher rate followed by TVs, PCs, refrigerator, air conditioners and washing machine. This will form the basis of planning for product wise intervention. E-waste inventory in terms of weight ranges from 6792 metric tons in 2008 to 22,443 metric tons in 2019. In terms of weight, E-waste from TV is expected to grow at a higher rate followed by PCs, refrigerator, air conditioners, washing machine and mobile phones. This will form the basis of planning for any collection, transportation and recycling facility in future.

Finally, the E-waste inventory projections in PPM provide the information on E-waste generation potential. Further, these projections both in numbers and weight show significant growth starting from the year 2012 onward. It gives policy planners, implementers and other stakeholders three years to plan and implement future interventions starting from the year 2009.

Chapter 1: Introduction & Background

1.0 Introduction

Phnom Penh Municipality (PPM) is the capital city of the Royal Kingdom of Cambodia with a total land area of 376.95 Km^2. It is equal to 0.20% of the total land area of the country. Administratively, PPM is divided into 7 districts (up to 2008) but now one more district has been determined, 76 communes, 689 villages and 4,320 groups. The population of the city is approximately 1,080,519 consisting of 188,769 households out of which 43% live in urban area and 57% in rural area. Population growth in the city is 3.92%.

Double-digit economic growth rates in recent years have triggered an economic boom in Cambodia, with new hotels, restaurants, and residential buildings springing up around the PPM. Due to improved living standards, globalization, international trade, and tourism, the consumption of electrical and electronic equipment (EEE) has rapidly increased in the urban centers in the country. Since Cambodia does not have manufacturing base for electrical and electronic equipment (EEE), it is importing both brand new and second hand EEE to cater to existing demand. This is leading to generation of E-waste and its management as a major issue in cities/ urban centers in Cambodia. According to the CEA survey report of E-waste in Cambodia, it was found that there exists some environmental and human health concerns though the utilization of second hand EEE/ Used EEE. Therefore, there is a need to further consider strengthening, monitoring and managing imported EEE with reasonable and useable conditions.

1.1 Identification of E-waste problems in Phnom Penh

As per Basel Convention, “Report on the Survey of the Import and the Environmentally Sound Management of Electronic Wastes in the Asia-Pacific Region,” E-waste release per annum is roughly calculated as 276 units of computer, 2,760 units of TV sets, 5,520 units of mobile phones and 690 units of fixed phones. This report also indicates that there is a rapid increase in the import of electronic equipment in the country. Moreover, with rapid increase in internet and information technology penetration and decrease in the retail prices of EEE, their end of life is getting reduced. Therefore, a need was identified to carry out due diligence as part of preparatory work for developing E-waste action plan for Cambodia.

As a next step, the MoE of KoC got support from SBC and MoE of Japan, to implement the project “Environmentally Sound Management of Electrical and Electronic Waste in Cambodia” in 2006-07. A technical field study was conducted by local NGO, namely, Cambodia Environment Association (CEA) in a selected sample of provinces and cities that have different socio-economic conditions of high, medium and low income families in order to prepare a detailed E-waste inventory in the country. This study was carried out under supervision of the MOE of Cambodia, MoE of Japan and EX Corporation. The study items included E-waste from TV, computer, air-conditioners, mobile phone, refrigerator and washing machines. The major findings of this study included E-waste estimation as of 2007, which consisted 40,983.00 kg from TV, 13,318.80 kg from air-conditioners, 2,016.24 kg from mobile phones and 1,310.40 kg from personal computers. It was also found that major quantities of E-waste are generated in Phnom Penh City. Further, the study indicated usage of low repairing/dismantling technology

with inappropriate facilities in study areas, which threaten the environment and public health. In Phnom Penh, many small family workshops, within houses, have been established to recover reusable and recyclable materials from E-waste without proper precautions. The residual E-waste is disposed off as municipal solid waste in bins and landfill sites. Since EEE contain hazardous materials, these family level operations create a direct risk to workers and their families, to the community and to the environment, especially due to release of hazardous substances in soil, water and air.

1.2 Need for Proper E-waste Planning & Management in Phnom Penh City

CEA report concluded that an action plan for the environmentally sound management of E-waste should be prepared and implemented in Cambodia *(selected area: Phnom Penh Municipality).* Further, the report recommended that implementation of this action plan at the national level requires capacity building and close collaboration among stakeholders. In this context, some of the major needs, which have been identified, are given below.

- Need to strengthen, monitor and manage imported EEE

- Need to improve operating practices of repairing and dismantling of EEE. At the moment, this is being done manually, without any intervention of high-end technology.

- Need for proper E-waste collection and transportation system. Currently, E-waste residues are improperly disposed in dustbin and at dumpsite mixed with other urban wastes.

- Need for proper occupation health and safety system in E-waste management. Currently, occupational health is an issue with E-waste collectors/ workers/ and/or repair shop owner and managers. They commonly carry out dismantling operations without using appropriate tools and personal protective equipment, e.g. safety tools, masks, glasses, gloves, etc.

- Since E-waste repairing & dismantling operations fall in small scale informal sector, they do not receive assistance or contribution from government institutions, e.g. assistance in technological transfer, partnerships and investments etc.

In order to achieve improved environmental conditions and high economic values from E-waste prior to its disposal, these constraints should be minimized and phased out by using appropriate interventions. Therefore, a pilot project is being planned in Phnom Penh since this city is considered to largely generate E-waste than other provinces and cities in Cambodia.

1.3 Project on "Waste Electronic and Electric Equipment/ E-waste Management in Phnom Penh City

Based on the current situation of E-waste handling in Phnom Penh, a comprehensive pilot project is designed to build the local capacity for proper E-waste management, including recovery of valuable materials. The local capacity building effort is aimed at national and local government level including small businesses and private sector. In this

regard, MoE, Government of Cambodia has received a support from UNEP-DTIE-IETC to implement the project, "E-waste Management in the Phnom Penh Municipality". The project has started in earlier 2009, after the official signing by the representatives of MoE and UNEP-DTIE-IETC.

1.3.1 Project Objectives

The objective of the proposed project is to formulate, design and implement an integrated WEEE/E-waste management pilot project in PPM. After augmentation of local capacity, the level of effort could be scaled up to the national level and replicated in other countries. Specific objectives of the proposed pilot project are given below.

- Build the national and local capacity in Cambodia on inventorization and management of E-waste by undertaking various activities, including the inventory of E-waste and a pilot project to process E-waste in and environmentally sound manner with optimum level of recovery for recycling.

- Bring out the guidelines and training materials for dissemination for other developing countries to replicate similar projects and capacity building process.

1.3.2 Brief Approach and Methodology

The capacity building is designed for government institutions, private sector and local NGO. The current capacity building effort is being targeted in two major areas i.e. E-waste inventorization and E-waste management. UNEP has already produced two volumes of E-waste Manual. The first volume provides guidelines for E-waste inventorization, while second volume provides guidelines for E-waste Management. This project will utilize these manuals as part of their comprehensive approach and methodology as described below:

Activity 1: Inventory of E-waste

- Assessment of the Phnom Penh City with respect to generation of E-waste from various sources (residential, commercial, industrial, inter-city, etc.)
- Establishment of Material flow with respect to E-waste generation in Phnom Penh City and identification of stakeholders
- Quantification and characterization of E-waste in Phnom Penh City, including quantity of various types as well as characterization of each type of E-waste
- Technical assistance to institutionalize E-waste inventory and its updating with Phnom Penh City Government

Output: *Report on current inventory and future projections of WEEE/ E-waste and mechanism for its update.*

Activity 2: Study of E-waste recycling structure

- Study of E-waste recycling/ other recycling infrastructure (formal/informal) and its capacity
- Study of E-waste toxic footprint by inventorizing E-waste recycling sites in case recycling occurs in informal sector in Phnom Penh City

- Study of the feasibility of the level of treatment of E-waste in formal sector in Phnom Penh City

Output: *Status report on existing recycling system and its capacity.*

Activity 3: Design of pilot project for E-waste storage, collection and transportation system

- Study of consumer behavior for E-waste storage, collection, transportation and disposal in Phnom Penh City
- Study of existing infrastructure for storage, collection and transportation system in Phnom Penh City
- Pilot testing of E-waste storage, collection and transportation system using existing infrastructure

Output: *Feasibility report on E-waste collection and transportation system.*

Activity 4: Identification of best practices and enabling policy/ regulatory requirement to ensure E-waste management including collection, transportation, and treatment and disposal system includes possibilities of public private partnership

Output: *Feasibility report on a model E-waste management.*

Activity 5: Identification of stakeholders (manufacturing industry) and initiating a dialogue with them to involve them in future work related to EPR/e-design of key electronic components (e.g. computers – keyboard manufacturers)

Output: *Stakeholders Workshop and Report*

Activity 6: Dissemination of the project experiences, including guidelines and E-waste Plan for Phnom Penh City, at national level. This will help other cities to develop their own plans based on local data

Output: *National Workshop and Report*

1.3.3 Outcome

The outcome of the project will be demonstration of a model E-waste management system including identification and implementation of best practices in Phnom Penh City.

1.3.4 National Workshop and Training Program

Government of Cambodia with assistance from UNEP-DTIE-IETC organized the project launching ceremony on 10 February 2009 in PPM. The project launch ceremony was presided over by H.E. Khieu Muth – Secretary of state of the MoE, and Dr. Mushtaq Ahmed Memon – UNEP-DTIE-IETC representative. The project launch ceremony aimed at: (i) addressing current gaps and future needs to properly manage E-wastes in the PPM; (ii) introducing the project to participants about major inputs, activities and outcomes of the project, including its work-plan as well. Fifty participants, who attended

the ceremony included experts/ representatives from government and private institutions, including NGOs, academic and private sectors. The government institutions, which participated included MoE, MIME, MoC, MoP, MoInt., PPM Dept. of Environment, MoPWT, PPWM, MoH, RUPP, and MAFF. NGOs, which participated included CEA and COMPED. Remarkably, ten representatives from private sector also attended the project launch ceremony.

Secretary of state gave an overall view of environment sector in Cambodia and highlighted the need for capacity building in the area of E-waste. UNEP technical staff provided opening speech and made presentation to brief the participants on E-waste Management Project, which included conducting two capacity building training programs. The first three day training program was conducted after project launch ceremony in February 2009. Dr. Mushtaq Ahmed Memon – UNEP-DTIE-IETC and Mr. Amit Jain – Consultant conducted the first training program as faculty members. This training program was divided into three sessions as described below.

Session 1- Awareness-raising workshop on E-waste

This workshop was aimed to raise the awareness on E-waste and future challenges. Over 40 participants attended this workshop. The major presentations made were, Status of E-waste Management in Cambodia; E-waste Management – Learning from International Experiences; Need for a project team; its role and capacity building; the action plan for UNEP Project on E-waste Management. There were interactive discussions on current and future challenges for Kingdom of Cambodia in general and Phnom Penh City in particular. The outcome of this workshop led to generation of a strong will from all stakeholders to support this project and evolution of project team to implement it.

Project Team

A project team of 12 members, representing different national and local government departments e.g. Ministry of Environment, Ministry of Industry and Mines, Department of Cam Control, Phnom Penh Municipality and expert institutions such as academia e.g. Phnom Penh Royal University and local NGO, CEA was formed under the team leadership of Dr. Chirn Sokha, Deputy Director General, MOE Cambodia. The name of the team members are given below.

1) Dr. Chrin Sokha, MoE
2) Mr. Sophal Laska, MoE
3) Mr. Sreng Sophal, MoE
4) Mr. Pet Pichhara, MoE
5) Mr. Te Ith Leang, MoC
6) Mr. Sreng Sokvung, MIME
7) Mr. Tes Norarith, DoE of PPM
8) Mr. Khuy Kuyny, DoE of PPM
9) Mr. Hak Mao, CEA
10) Mr. Chin sothun, CEA
11) Mr. Yim Mongtoeun, RUPP

Session 2 - Training on E-waste Inventory

This training was first in the series for this project and aimed to build local capacity to carryout E-waste inventory assessment on their own. A two-day class room training program was conducted based on UNEP DTIE/ IETC E-waste Manual 1. The agenda of the workshop has been described in appendix 1. The major focus of the training program was to impart conceptual understanding of E-waste inventory assessment to the participants. Sessions on E-waste definition, E-waste market assessment, methodologies used for E-waste inventory assessment and usage of tools/ techniques/ formats/ questionnaires for assessment were conducted to impart conceptual understanding of E-waste inventory assessment in a geographical context. A case study from the E-waste manual 1 supported by relevant movie clips were used to strengthen the existing knowledge base of the participants.

Session 3 - Fieldwork for E-waste Inventory Assessment

The field work focused on demonstration of applying the conceptual understanding gained during class room training program within the municipal limits of Phnom Penh. The concept of material flow, E-waste trade value chain and identification of different stakeholders involved in trade value chain was demonstrated to project team on the 3rd day of the training program. The field work provided them hands-on training to collect and analyze the information leading to development of E-waste Inventory. Based on "tracer technique," an attempt was made to show the "material flow" by first taking them to the shops selling new goods, then to the shops doing repair and selling used goods, and finally to informal dismantlers/ recyclers. Tools, which were used in field application included transect walk, formal and informal sector questionnaire, mapping of E-waste life cycle in the geographical context. The majority of project team members got exposure for the first time to go to such places and conduct surveys. Photo album of the class room training session and field work is given in appendix 2.

1.4 Format of Report

The outcome of the training session resulted in field work to collect data followed by its collation and interpretation and development of E-waste inventory within the municipal limits of Phnom Penh. This report describes the E-waste inventory assessment after completion of activity 1 and 2 mentioned in section 1.3.2. The report consists of six chapters. Chapter 1 gives background information, need for the project, approach and methodology used, training and its outcome and format of the report. Chapter 2 describes elements of E-waste definition in the context of existing regulatory framework. Chapter 3 describes E-waste market assessment in Phnom Penh. This includes description of E-waste material flow, identification and description of different stakeholders, facilities for material recovery and socio-economic aspects. Chapter 4 describes selection of methodology for E-waste inventory assessment based on E-waste market assessment, an output of chapter 3. Chapter 5 describes E-waste inventory based on selected methodology and confirmation by tracer technique. Chapter 6 describes conclusions and recommendations.

Chapter 2: E-waste Definition & Regulations

2.0 Introduction

The composition of E-waste is very diverse and differs in products across different categories. It contains more than 1000 different substances, which fall under "hazardous" and "non-hazardous" categories. Broadly, it consists of ferrous and non-ferrous metals, plastics, glass, wood and plywood, printed circuit boards, concrete and ceramics, rubber and other items. Iron and steel constitutes about 50% of the E-waste followed by plastics (21%), non ferrous metals (13%) and other constituents. Non-ferrous metals consist of metals like copper, aluminum and precious metals like silver, gold, platinum, palladium etc. The presence of elements like lead, mercury, arsenic, cadmium, selenium, hexavalent chromium and flame retardants beyond threshold quantities in E-waste classifies them as hazardous waste. Therefore, the E-waste definition, its classification and coverage under the "hazardous", "non hazardous" or a "separate category waste" in regulatory regime drives its monitoring and trade both at local and international level. In this context, it is important to identify and understand the elements of E-waste definition or E-waste coverage in "hazardous", "non hazardous" or "separate waste" regulations under the existing regulatory framework in Kingdom of Cambodia. The following sections describe each of these items followed by analysis, identification of drivers and evolution of future regulations.

2.1 Existing Laws

Cambodia has no law on E-wastes management. However, it is signatory to Basel Convention, which regulates the tansboundary movement of hazardous waste. Therefore, Cambodia has paid great attention to permission processes for the import and use of second hand electronic products. It focuses on the management of used electrical and electronic equipment (UEEE) such as television, mobile phone (MP), air conditioner, washing marchine and computer. The government has made an effort by assigning different ministries to undertake safe and sound management of E-waste through its whole lifecycle, i.e. import, transportation, distribution, stockpile, use and disposal. In this section, numerous key legal instruments are briefly described, which directly or indirectly relate to E-waste management in the country.

- The 1993 Constitution of the Kingdom of Cambodia's article 54 and 64 establishes an obligation on the state to protect state property, natural resource and the environment, and human health from any harmfull substances.

- The 1996 Law on Environmental Protection and Natural Resource Management was ratified to "protect and promote environmental quality and public health" by preventing and controlling pollution and also by conducting environmental impact assessments on all projects before their implementation. More specifically, this law also encompasses measures to protect the Cambodian environment from the adverse affects of toxic chemicals and other hazardous waste. The law covered the need to inventory pollutants being produced, imported, stored and released. In fact, Article 13 in Chapter 5 reads, "*The prevention, reduction, and control of airspace, water, [and] land pollution, noise, and vibration disturbances, as well as wastes, toxic substances, and hazardous substances, shall be determined by a Sub-Decree following a proposal of the Ministry of the Environment."*

- The 2000 Management of Quality and Safety of Products and Services Law provides general obligations to protect human health from contaminated products and goods. In particular, Article 6 states "when the products, goods, or services could harm the health or safety of consumers, their manufacturing and commercialization shall be subject to a prior submission of a declaration to the competent institutions and have a prior authorization by the competent institutions following an inspection and an indication of usage guidelines in Khmer language." As such, this law strictly prohibits producing or placing into commerce, products, goods, or services mentioned in Article 6 when no prior disclosure has been made or no prior authorization has been issued by the competent institutions.

- The 2007 Road Traffic Law governs road transportation. One of the main purpose of this law is to protect human, animals and the environment from negatives effects of road transportation of hazardous cargo.

2.2 Subdecrees

- The 1999 Sub-decree on Water Pollution Control provides regulation for monitoring, record keeping, pollution prevention and control. Negative effects from Junkshop dismantled E-wastes are not only limited to dismantler in the vicinity of their shop, but are also manifested through the contamination of the wider environment, particularly of water systems and food chain.

- The 1999 Sub-decree on Solid Waste Management regulates solid waste management in a scientific manner and mandates provision of safety precautions in order to ensure the protection of human health and the conservation of biodiversity. This sub-decree covers all activities related to disposal, storage, collection, transport, recycling, dumping of garbage, and hazardous waste. It provides the classification of waste into household waste and hazardous waste (32 categories) as given below.

  1) Fibrous and clothing wastes from textile and garment industry
  2) Paper waste from paper-mill industry
  3) Sludge waste from factory wastewater treatment and product manufacturing processes
  4) Combustion residues from coal-fired power plants
  5) Plastics waste from production or use of plasticizers
  6) PCB waste from use of PCB contained in discarded air conditioners, TVs and microwaves
  7) Rubber waste from production or use of resins and latex
  8) Oil waste from oil refinery, use of lubrication oils, washing oils
  9) Acid waste
  10) Alkali waste
  11) Metal waste and their compounds: Zinc (Zn), Selenium (Se), Tin (Sn), Vanadium (V), Copper (Cu), Arsenic (As), Barium (Ba), Cobalt (Co), Nickel (Ni), Antimony (Sb), Beryllium (Be), Tellurium (Te), Lead (Pb), Titanium (Ti), Uranium (U), and Silver (Ag)
  12) Soot and dust waste from incineration facilities, treating exhaust gas
  13) Wastes from used or discarded electricity lamp
  14) Wastes from production or use of battery
  15) Wastes from production and use of paints, lacquers and pigments
  16) Wastes from production and use of inks and dyes

17) Explosive wastes
18) Infectious diseases wastes
19) Agriculture drugs wastes
20) Ash wastes from incinerators
21) Wastes from expired products
22) Wastes from production and use of film
23) Waste from treatment of polluted soil
24) Waste from production of drugs and medicines, and expired drugs
25) Inorganic fluorine wastes
26) Cyanide wastes
27) Asbestos wastes
28) Phenols wastes
29) Ethers wastes
30) Wastes from production and use of solvents
31) Wastes from production and use of dioxin and furan
32) Radioactive wastes
33) Wastes produced as a result of treating above item 1-32

- The 2000 Sub-decree on Air Pollution Control and Noise Disturbance covers air quality standards for ambient air quality, sets emission limits for stationary and mobile sources, and limits hazardous substances in the air. The purpose of this sub-decree is to protect the environment and public health from pollutants and noise disturbance through monitoring, curbing and mitigating activities. This sub-decree applies to all movable sources and immovable sources of air pollution and noise disturbance. It also provides a standard of ambient air quality and a standard for toxic substances emitted from different sources.

- In 2001 Sub-decree on the Industrial Standardization of Cambodia was established to control industrial products, improve the quality of industrial products, and safeguard the public safety and consumer's health from fake and disqualified products.

- The 2005 Sub-decree on Ozone Depleting Substances was put into place to respond to the obligations under the Vienna Convention and the Montréal Protocol. Its objective is to stop the use of ozone depleting substances and manage all business activities and consumption identified by the Convention and the Protocol. This sub-decree applies to the import, export, handling, production and the use of ozone depleting substances.

- Cambodia is a signitory of Basel Convention, which regulates the transboundary movement of hazardous waste. Article 20 and 21 on the Law on Natural Resources Management and Environmental Protection controls the transboundary movement of hazardous waste.

2.3 Relevant Regulations

- The Joint Declaration Ministry of Interior and Ministry of Environment on Solid Wastes and Litter Management in Cambodia provides a mechanism to promote responsible authorities and relevant agencies to effectively manage solid wastes and litter at provincial and municipal levels aimed at protecting public health,

environmental quality and biodiversity. This declaration covers activities of collecting, cleaning, storing, transporting, recycling solid wastes in Cambodia. It also calls for joint cooperation and responsibility among relevant agencies in order to protect human health and the environment.

- The Environmental Guideline on Solid Waste Management in Cambodia was developed in 2006. This Guideline specifically addressed the solid waste management to assist the relevant agencies at all levels to increase solid waste safety and enhance the sound solid waste management in Cambodia.

- A draft National 3R Strategy on Wastes Management in the KoC has been developed in 2008. This strategy provides the country to establish programs for proper recycling, or otherwise disposing of televisions, computer monitors, and other electronic equipment and components of such equipment in an environmentally sound manner.

2.4 Analysis of Existing Regulatory Framework

The analysis of existing laws, sub decrees and regulations is shown in figure 2.1. It shows that items related to electrical and electronic equipment/ E-waste are mentioned partly in the existing regulatory framework.

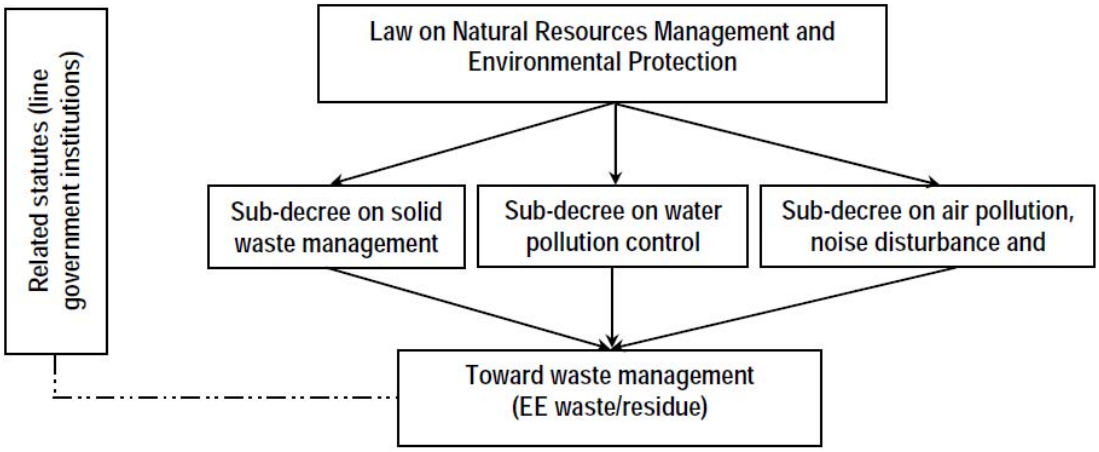


Figure 2.1: Existing regulatory framework in Cambodia

Source: Pic. 26, Technical Report on National Inventory of Used EEE in Cambodia, prepared by Cambodian Environmental Association (CEA), May 2007.

The salient features of this analysis are given below.

1. Law on Natural Resources Management and Environmental Protection is an umbrella law covering all issues related to environment and pollution control.

2. Sub decrees on water pollution, air and noise and solid waste deal with specific pollution related issues to water, air, ambient environment and on account of hazardous and non hazardous waste.

3. The major emphasis of the existing regulation is on "pollution control". However, the formulation of recent draft national strategy on 3Rs shows that it is shifting to pollution prevention, reduce, recover and recycle.

In the context of E-waste, an effort has been made by defining a reference matrix in table 2.1with respect to three drivers like definition of "electrical and electronic equipment", description of its 'loss of utility" and "way of disposal". This matrix also shows part coverage of E-waste under the existing regulations.

Table 2.1: E-waste reference in Cambodian regulations with respect to identified drivers

Regulation/ Drivers	Drivers			
	Definition of Electrical and Electronic Equipment (Yes/ No)	Definition of loss of utility (Yes/ No)	Definition of way of disposal (Yes/ No)	Remarks
"Hazardous" waste	No	Yes (partly)	Yes (partly)	Partly covered under 1992 sub decree of solid waste
"Non-Hazardous" waste	No	Yes (partly)	Yes (partly)	Partly covered under 1992 sub decree of solid waste
Regulation related to Basel Convention	Yes	Yes	No	Article 20 and Article 21 of the umbrella law
Any other regulation	No	No	No	

The major findings of the reference matrix are described below.

1. Definition of electrical and electronic equipment is not covered under the existing regulations.

2. Since Cambodia is signatory to Basel Convention, it is assumed that all the definitions and items related to E-waste in the convention are covered in the existing regulations (article 20 and 21). As per these articles, all imports of brand new/second hand EEE and other items must be clearly declared in writing by importers to competent authorities, namely, Dept. of Customs and Excises (MoEF), and Dept. of Kamcontrol (MoC) for approval based on the national legal tools and international procedures. At functional level, imported

materials/products including EEEs/UEEEs are controlled at check-points by both competent authorities before allowing their transport to their final destination. In March 2002, the Department of Customs and Excises issued an important announcement to SGS office in Cambodia and all custom-officers, which emphasized the Government's principle to intercept and ban the import of old computers/spare parts from 01 April 2002, unless this import is declared for self consumption and/or for charity purposes with official permission from competent authorities.

3. Words like "used goods/ scrap/ waste", "discarded" and "disposal" are covered in existing regulations.

4. Reuse and recycling are defined in the draft strategy on 3R.

5. The sub decree on solid waste management defines the hazardous waste criteria. As per the criteria, some of the E-waste is listed in items 6, 11, 13, 14, and 21 of annexure of this sub decree.

6. One of the major gaps, which have been identified, is the lack of clear definition of E-waste.

7. There is very little difference between definition of used EEE and E-waste.

8. Role of collector/ transporter is defined only in the context of hazardous waste and solid waste.

9. There is no specific definition of generator or producer of E-waste. However, definition of importer of Used EEE is mentioned in the existing regulation.

2.5 Conclusions

Environmental issues and trade associated with E-waste will drive the definition of E-waste both at national and international level. Since E-waste is partly covered under the existing regulations and there is no specific definition on E-waste, there is a need to cover it either under existing regulations or a separate regulation depending on the time frame and capacity of regulatory agencies to implement it. Since draft 3R strategy is being formulated in the country, E-waste can also be brought under its purview so that necessary regulatory interventions can be planned and implemented.

Chapter 3: E-waste Market, Process Study, Geographical Distribution & E-waste Trade Value Chain

3.0 Introduction

E-waste assessment in a geographical area requires understanding of existing E-waste market and mechanism of E-waste trade. The major objective of this chapter is to identify and establish E-waste dismantling process, identify major stakeholders and their geographical distribution and E-waste flow in PPM. This will assist in establishment of E-Waste trade value chain, E-waste movement along this chain and description of different stakeholders in geographical context in PPM. The following sections describe each of these items in PPM.

3.1 Status of EEE Market in PPM

The growths of population, industries, tourism and urbanization have been identified as major drivers of EEE market in Cambodia. As per 2007 estimates there are 281 shops, which are selling EEE in PPM. EEE market is organized in three different types of market segments as described below.

1. Shops selling brand new EEE
2. Shops selling brand new as well as second hand EEE
3. Shops selling second hand EEE

The salient features of EEE market in the PPM based on observations carried out during field survey are summarized below.

1. The majority of EEE market in PPM is organized in second and third type of segment. The EEE market in first segment is low.
2. It has been observed that the market share of second hand EEE is increasing every year, although, some of brand-new items are cheaper[1].
3. Consumers prefer branded EEE even when it is second hand.
4. Shops selling second hand EEE have multiple functions of selling, repairing, refurbishing and dismantling.

The EEE market segmentation is an indicator of consumer behavior and the paying capacity. Consumer preferences of used branded EEE over new EEE item of lower brand image indicates dominance of refurbished EEE market in PPM, where the residual life of EEE gets extended by retrofitting and repair. This trend indicates that though the overall end of life of EEE gets extended, the actual life of EEE as a second hand item is small when compared to the new EEE, thereby supporting a replacement market. This phenomenon supports a market where shops carry out multiple functions of refurbishing, repairing and dismantling while selling brand new as well as used EEE at one place. Therefore, these shops serve as starting point of E-waste generation in the formal sector in PPM leading to identification of different stakeholders involved and provide insights into the E-waste trade mechanism. A reconnaissance visit of the PPM city as per the above market segmentation led to the identification of different areas summarized in appendix 3 for each EEE, which serve as major hubs for E-waste generation based on

[1] *It was made in China*

the study carried out earlier by the team in 2007. Various processes, which have been observed to be occurring in these areas, are described below.

3.2 E-Waste Process Study

There are various processes involved for recycling / reusing of electronic waste in the PPM. The major process for different types of electronic items is mentioned in table 3.1.

Table 3.1: Processes involved for E-waste recycling in PPM

S. No.	Process name	Process status
1.	IC's Extraction from PCB	Yes
2.	Manual extraction of other components from PCB	Yes
3.	Dissembling of Monitor and extraction of components	Yes
4.	Yoke core and Copper	Yes
5.	Metallic Core of Transformer and Copper	Yes
6.	Rare Earth Core of Transformer	Yes
7.	Wire PVC and Copper	Yes
8.	Plastic Shredder	Yes
9.	Dismantling of Refrigerator and Compressor	Yes
10.	Extraction of components containing Gold from PCs	Yes
11.	Acid Bath for PCB	No
12.	Regunning CRT's	No
13.	Glass Recovery from CRT	No
14.	Dismantling of washing machine and motor	Yes
15.	Dismantling of cellular phones	Yes

Though extraction of components containing gold from PCs has been reported, it was informed that gold is not chemically processed within the municipal boundaries of the city. The process details of fifteen processes are given in table 3.2 while photo documentation captured in different parts of PPM is given in table 3.3.

Table 3.2: E-waste Recycling/reusing Process Details

S. No.	Processing Components	Process Details	Processing	Remarks
Personal Computer				
1	Cathode ray tube (CRT), Computer casing, Printed circuit boards (PCBs), Integrated circuits (ICs), Yoke copper and Copper, Computer casing, Rare earth core and Gold from PCs.	Dissembling of Monitor and extraction of components	Yes	In local market
2		Regunning of CRTs	No	CRT is thrown and broken
3		IC's Extraction from PCB	Yes	Reselling and reuse in local market
4		Acid Bath for PCB	No	Does not occur
5		Extraction of other components	Yes	Reselling and reuse in local market
6		Wire PVC and Copper	Yes	Reselling and reuse in local market
7		Plastic Shredding	Yes	In local market/ exported
8		Gold Extractions from PCs	Yes	Sent outside PPM for extraction/ export
9		Yoke core and copper extraction from wire	Yes	Reselling and reuse in local market/ exported
10		Metallic Core of Transformer and Copper	Yes	Reselling and reuse in local market/ exported
11		Rare Earth Core of Transformer and Copper	Yes	Reselling and reuse in local market/ exported
12				
Television				
13	TV cabinet, CRT, Yoke core and PCB	Dismantling of TV cabinet and CRT	Yes	In local market
14		Regunning of CRTs	No	CRT either thrown or broken
15		Yoke core and copper extraction from wire	Yes	In local market for reuse/ exported
16		Plastic shredding	Yes	Reselling and reuse in local market/ exported
Cellular Phone				
17	Aerials, Battery connectors, PCBs, Gold-coated edge contacts on PCBs, ICs, Keyboards, LCD screens, Lenses, Microphones, Phone housings, Screws, SIM card assemblies and Speakers.	Separate metals recovery (including precious and semiprecious metals)	Yes	Reselling and reuse in local market/ exported
18		Batteries repairing and reselling	Yes	Repairing and reuse in local market/ exported
19		Outer body plastic granulation	Yes	In local market/ exported
20		Reuse of valuable components (flash memory devices, PCBs, ICs, keyboards, LCD screens, lenses, microphones, phone housings, and speakers) with minor repairing	Yes	Repairing and reuse in local market
Refrigerator				
21	Casing, Cotton insulator, Evaporator, Heating rod,	Dismantling of refrigerator and segregation of compressor and cooling box	Yes	Reselling/ reuse in local market/ exported

22	Condenser, Compressor, Fan and Motor	Extraction of steel and copper from heating rod	Yes	Reselling in local market/ exported
23		Extraction and shredding of ABS plastic from fan	Yes	Reselling and reuse in local market/ exported
Washing Machine				
24	Casing, motor, metal and plastic	Dismantling of washing machine removal of iron, plastic and motor	Yes	Reselling in local market/ exported

Table 3.3: Processes involved for E-waste recycling in Mumbai markets

S. No.	Process name	Process status	Photo-documentation
1.	IC's Extraction from PWB	Yes	 
2.	Manual extraction of other components from PCB		
3.	Dissembling of Monitor and extraction of components	Yes	 

S. No.	Process name	Process status	Photo-documentation
4.	Yoke core and Copper	Yes	
5.	Metallic Core of Transformer and Copper	Yes	
6.	Rare Earth Core of Transformer	Yes	

S. No.	Process name	Process status	Photo-documentation
7.	Wire PVC and Copper	Yes	
8.	Plastic Shredder	Yes	 
9.	Dismantling of Monitor	Yes	  

S. No.	Process name	Process status	Photo-documentation
10.	Extraction of components containing Gold from PCs	Yes	
11.	Dismantling of Refrigerator / Air Conditioner and Compressor	Yes	 
12.	Dismantling of washing machine and motor	Yes	

S. No.	Process name	Process status	Photo-documentation
13.	Dismantling of cellular phones	Yes	

3.3 Geographical Distribution of E-Waste Business

The second step of this assessment is to identify geographical locations of formal and informal sector of E-waste generation in PPM, where the twelve processes identified above are occurring. Formal/ Organized sectors covers commercial areas consisting of shops/ hotels/ offices/ markets etc. and informal/ unorganized sector comprises of material extractors, recyclers and scrap dealers / dismantlers.

Formal/ Organized Sector

The study area has been segregated into 2 broad sub-heads, namely: Commercial Areas, and markets in PPM. These major centres are located on the major streets of the city as shown in figure 3.1. Some of these major centres are hubs of used EEE refurbishing and dismantling as shown in figure 3.2. It is observed that the major hubs of AC refurbishing / dismantling also serve as major hubs for refrigerator refurbishing/ repair and dismantling. . Major hubs for TV and PC are located at different places. However, hubs at Chamkamorn and Toul Kok serve as two major hubs for TV and PCs. Chamkamorn, Toulkok and Meanchay also serve as major repairing/ refurbishing centre for washing machine.

Informal/ Unorganized Sector

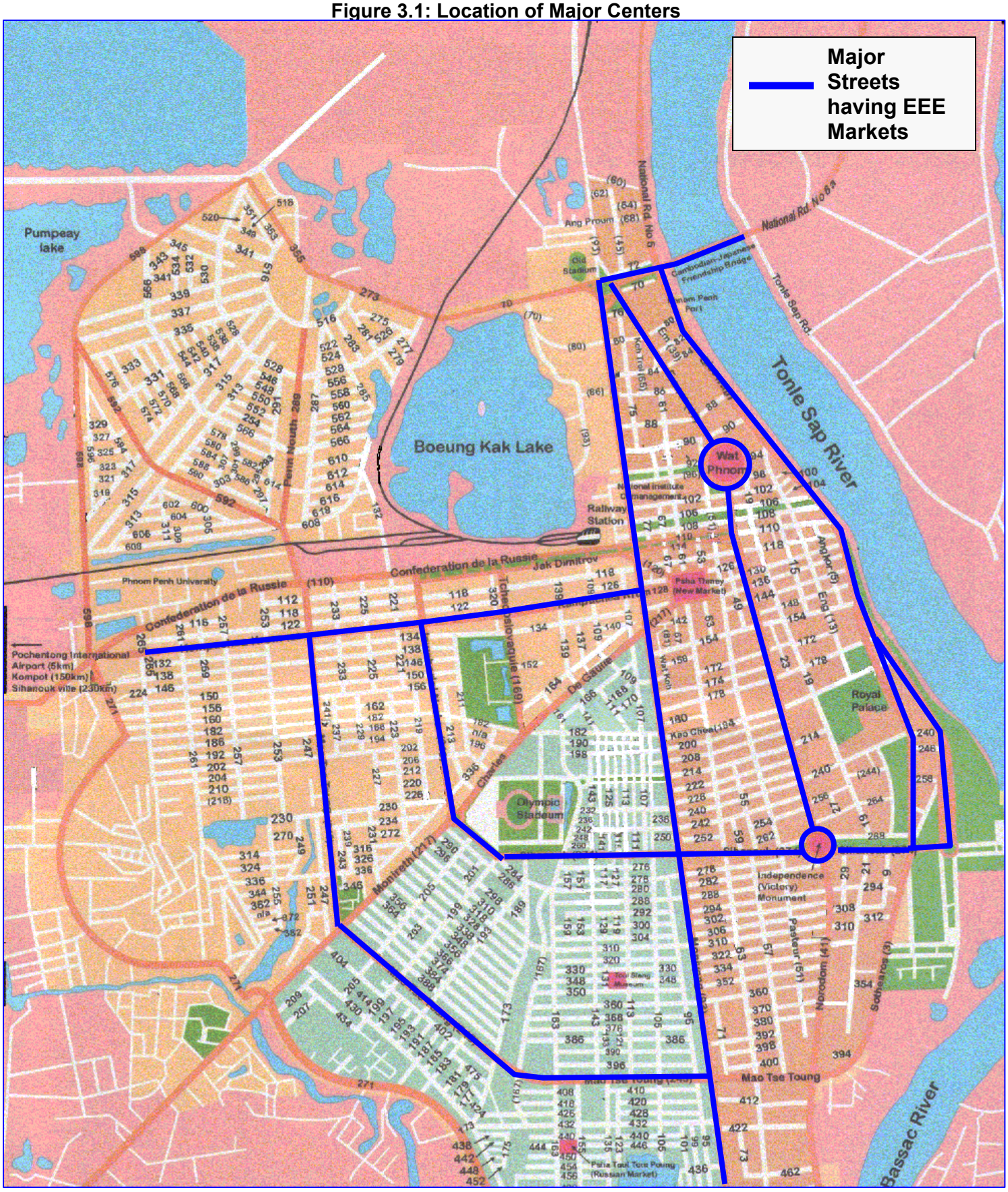
The details of the area with E-waste reuse/ dismantling practices in informal/ unorganized sector in PPM are given in the Table 3.4.

Table 3.4: Recycling and reused of different parts of electronic items in PPM

Major Location	Type of E-business
Chamkamorn	Dismantling of AC
	Dismantling of PC
	Dismantling of Mobile Phone
Meanchay	Dismantling of washing machine
Toul Kok	Dismantling of AC/refregerator
	Dismantling of PC
	Dismantling of TV
	Dismantling of Mobile Phone

The geographical distribution of organized/ formal and unorganized/ informal sectors in PPM is shown in Figure 3.2. The identification of formal and informal sector in E-waste trade and their geographical distribution has assisted in developing E-waste trade value chain described below. Figure 3.2 also shows the land use and drainage features of the PPM versus E-waste. It can be seen that none of the identified sites are close to river/ water bodies.

Figure 3.1: Location of Major Centers



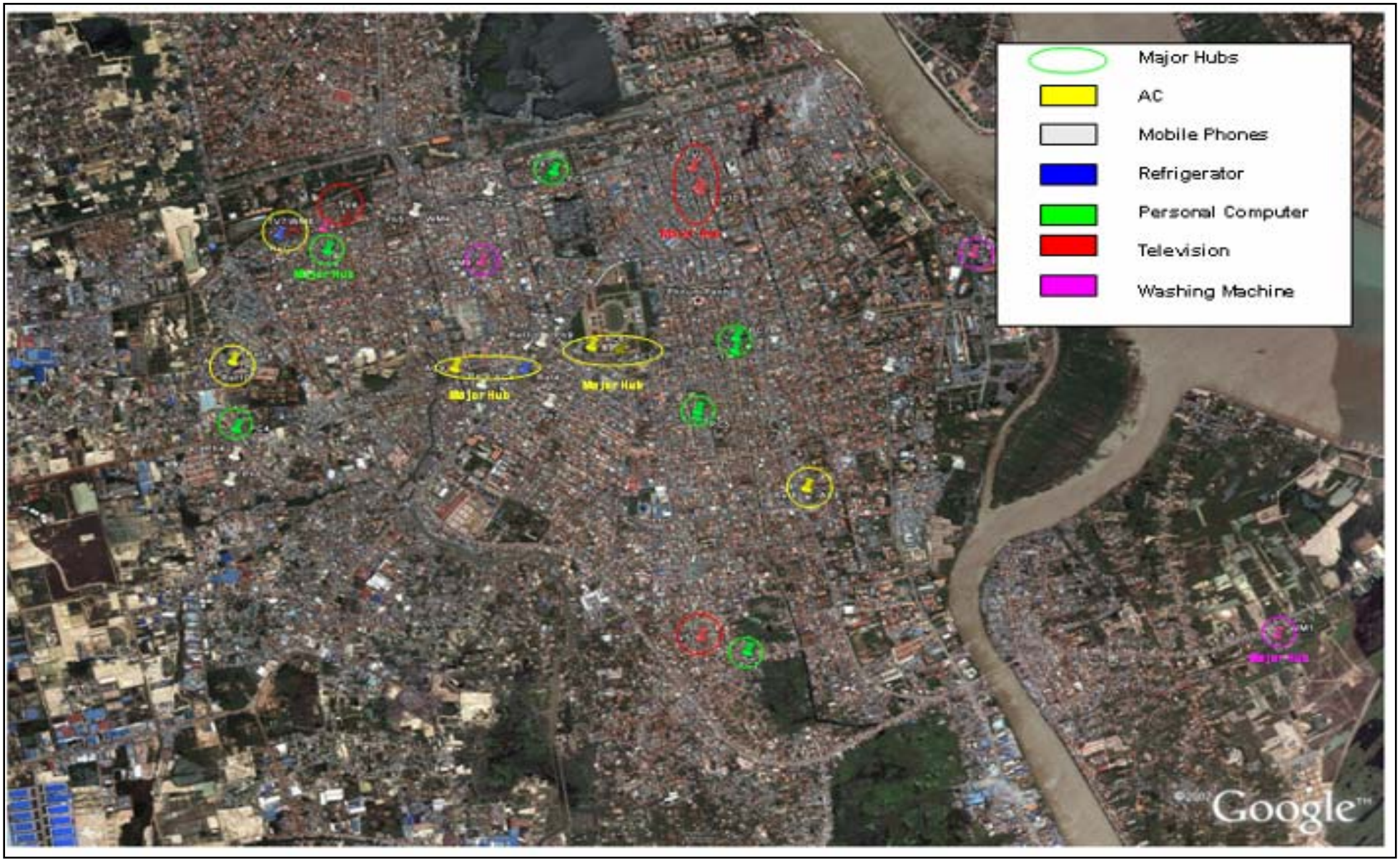


Figure 3.2: Geographical Distribution of Organized & Unorganized Sectors in PPM

3.4 E-waste Trade Value Chain in PPM

E-waste trade value chain in PPM has been established by studying the conceptual life cycle of E-waste and then customizing it to PPM as per geographical distribution of identified process.

Conceptual E-waste life cycle/ Material Flow Chain

The establishment of material flow within a geographical boundary assists in identifying, networks / chain connecting different phases of life cycle of electrical and electronic equipment and associated stakeholders. Conceptual E-waste material flow chain is shown in figure 3.3.

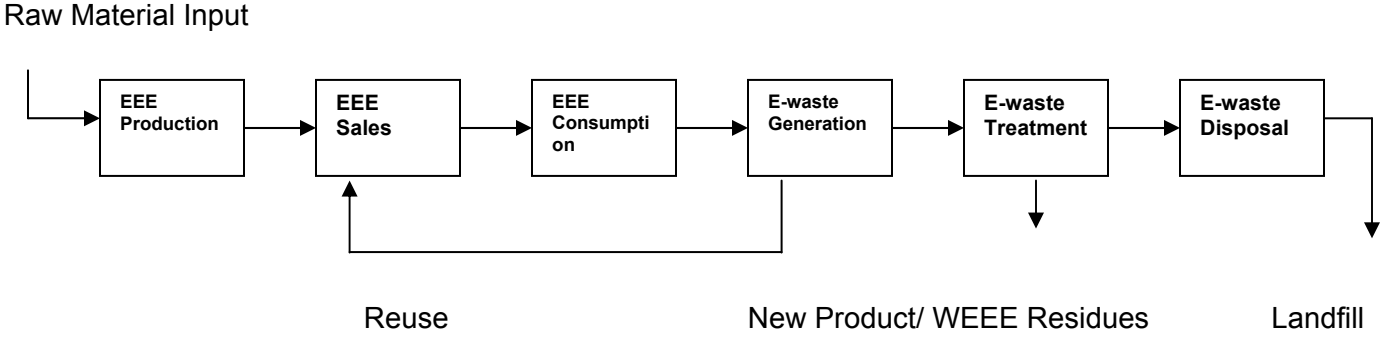


Figure 3.3: Conceptual Life Cycle of Electrical and Electronic Equipment

1. EEE production: import/ manufacturing of EEE
2. EEE sales
3. EEE consumption (stock)
4. E-waste generation
5. Re-use / down cycle
6. E-waste treatment/ Re-cycle
7. Secondary raw material / disposal

The present study has focussed on the 15 core processes, which may occur in PPM as described below.

1. IC's Extraction from PCB
2. Extraction of components from PCB
3. Dissembling of Monitor and extraction of components
4. Yoke core and copper
5. Metallic core of transformer and copper
6. Rare Earth Core of Transformer
7. Wire PVC and Copper
8. Plastic Shredder
9. Dismantling of refrigerator and compressor

10. Extraction of components containing gold from PCs
11. Acid bath for PCBs
12. Re-gunning of CRTs
13. Glass recovery from CRT
14. Dismantling of washing machine and motor
15. Dismantling of cellular phones

In these areas, no evidence of CRT re-gunning and gold and metal extraction using acid bath process and glass recovery has been observed. Only plastic shredding and granulation is occurring in PPM. Therefore, the step of "E-waste treatment" in conventional E-waste material flow chain is partly occurring in PPM. The conceptual E-waste material flow chain, after its application to E-waste flows in PPM has been modified and shown as E-waste trade value chain in figure 3.4. It is a five-step value chain covering the following aspects.

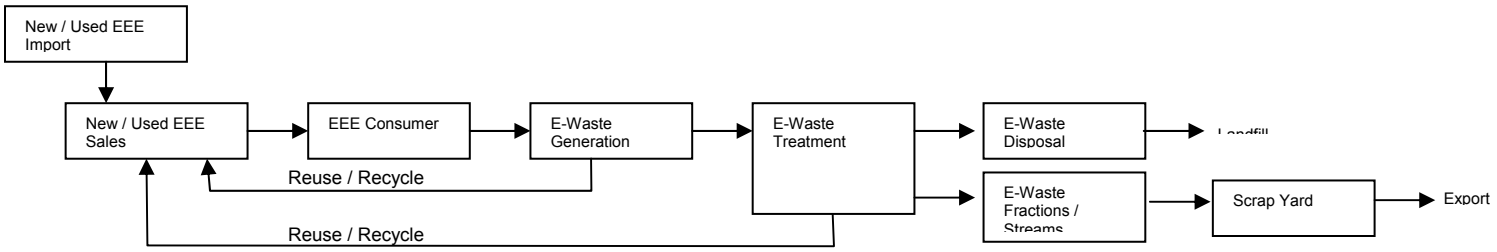


Figure 3.4: E-Waste Trade Value chain in PPM

3.4.1 Generation and Stockpiling

E-waste is purchased, used, and then stockpiled or discarded as electronic waste. These range from consumers, re-furbishers/ repair shops large and small businesses, households and government and private institutions.

3.4.2 Collection

A variety of entities are providing these services including the rag pickers, private dismantling operators and the public sector through the solid waste management and recycling infrastructure. This is based on the fact that CRTs/ cables have been found in landfill sites.

3.4.3 Handling & Brokering

The next link in the cycle is the handling and brokering services. Here computers, TVs, monitors and other collected electronics are consolidated and made ready for processing and/or sorted to determine what equipment can be refurbished or reused as whole units and what equipment must be disassembled for commodity processing.

3.4.4 Processing

After electronic equipment is dismantled, it is then processed into either feedstock for new production or refurbished into new equipment. Outputs from de-manufacturing activities include scrap commodities such as glass, plastics, and metals – the primary elements from which all electronic hardware is made. For export, and to a lesser extent national processing markets, there are significant issues associated with the environmental and health practices of current service providers in this part of the cycle.

3.4.5 Production

The final step in this cycle is to turn the processed commodities or refurbished whole electronics back into new products for sale and consumption by end users. There are many different stakeholders, which are involved in this production process. It may be noted that the trade value chain follows two levels of hierarchy of re-furbishers/ dismantlers. These levels are given below.

Level 1 - Primary E-waste generators
Level 2 - Secondary E-waste generator

The major stakeholders include importers, consumers (individual households, businesses, government and others), traders, retailers, scrap dealers, and dissemblers/ dismantlers. At each step in the flow, business transaction defines the movement of the EEE/UEEE in the flow. Roles and responsibility of each stakeholder in the PPM is given below.

a. Importers

There are a variety of used EEE and E-waste like monitors, printers, keyboards, CPUs, typewriters, projectors, mobile phones, PVC wires, etc are imported from various countries in the region and the globe as well. These items belong to all ranges, models and sizes, and are functional as well as junk materials.

b. EEE/UEEE Users

Government institutions, public or private sector, etc. are recognized to be the earliest users of IT and IT products. Today they account for a sizable amount of total installed ICT equipment. The inappropriateness of old systems to cater to present needs and requirement prompts them to pass the obsolete electrical and electronic equipment to dismantlers/repair shops.

c. Traders / Scrap dealers / Dissemblers/ Dismantlers

These key stakeholders fall under un-organised/informal sector. Soon after sorting out the E-waste from various sources, scrap dealers decide which items ought to be dismantled and retained for resale.

UEEE is imported from abroad by many private companies to meet domestic demands. Most of imported UEEE is stored at warehouses for distributing it to retail shops, and for sale to the consumers. Moreover, the respective whole sale or distributing location/depot has its own shop for repairing or dismantling process. According to the survey showed

that some second hand/retailed shops without repairing services, usually send non-functioning UEEEs to repair shop for fixing. E-waste generated arrives at the first level from the formal organized markets like manufacturers, importers, offices, and organized markets, where E-waste from domestic consumers comes either in exchange schemes or as discarded items. The recyclable parts of computers, mobile phones, AC, TV, refrigerators and washing machine are sold to waste pickers and dismantlers while the other parts that cannot be repaired are disposed in dustbins as domestic wastes. At second level, the waste pickers generally sell their collected E-waste to scrap yard owners for export. The transition of E-waste trade value chain to semiformal and informal sector is shown in figure 3.5.

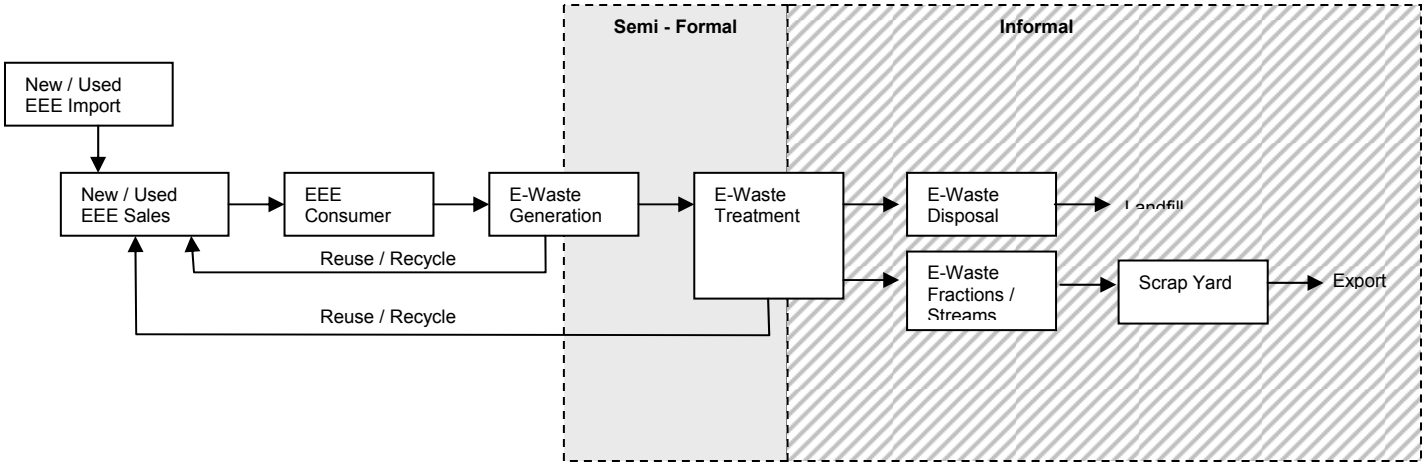


Figure 3.5: Sectoral Organization of E-Waste Trade Value Chain in PPM

3.4.6 Level of Repair/Refurbishment

There is no company/enterprise in formal sector that collects/purchases E-waste from households and offices in Cambodia. Cambodia has no modern technology to carry out repair/ dismantling /refurbishing. Its sector expertise is very limited and, therefore, the repairing processes of few items of TV, air-con, mobile phone, refrigerator, computer, washing machine, and other EEE are carried out using simple techniques. Some of these techniques include:

Picture 1: the repairer is screwing out to take usable parts

- Using the testing facility to identify non-functioning/broken parts of EEE/UEEE or identify useable parts (spare-parts) for next usage.
- Withdrawal/removal of non-functioning/broken parts, cleaning and installing spare-parts, and connecting them afterward. In the case of withdrawal

/removal of useable parts (from dismantled process), these parts will be used with others to make functional.

- Re-testing is done to emphasize whether repaired EEE/UEEE has function or not. If not, re-testing and repairing will do once more. Remarkably, Cambodia does not have a capacity including modern facility to repair a broken part, except using a spare-part instead.

Dismantling is usually applied to non-functioning/broken UEEE which needs careful repair by using sophisticated techniques. Reusable parts recovered from dismantling process are kept separately (by types) for selling to repair shops on demand basis. Besides reusable parts, recyclable materials are bought by collectors. As described above, waste collectors sell these recyclable parts/wastes to scrap yard's owners for export while the rests are disposed with municipal wastes. The survey outcome showed that most E-waste residues are generated from repairing and/or dismantling shops are disposed in dustbin and at urban dumpsite afterward by domestic waste collection service. Some E-wastes generation from households are also discarded by this method. Some areas where waste-collection trucks are not available, such kind E-wastes are discarded improperly close to/behind the repairing/dismantling shops, and finally burnt.

3.5 Geographical Mapping of E-waste Trade Value Chain

Using techniques like transect and tracer walk in PPM, the geographical mapping of E-waste trade value chain has been carried out and shown in figure 3.6. Figure 3.6 shows the movement of E-waste towards two major hubs of Chamkamorn and Toul kok in PPM. This geographical mapping has assisted to implement tracer technique to further study material flow and assess E-waste inventory.

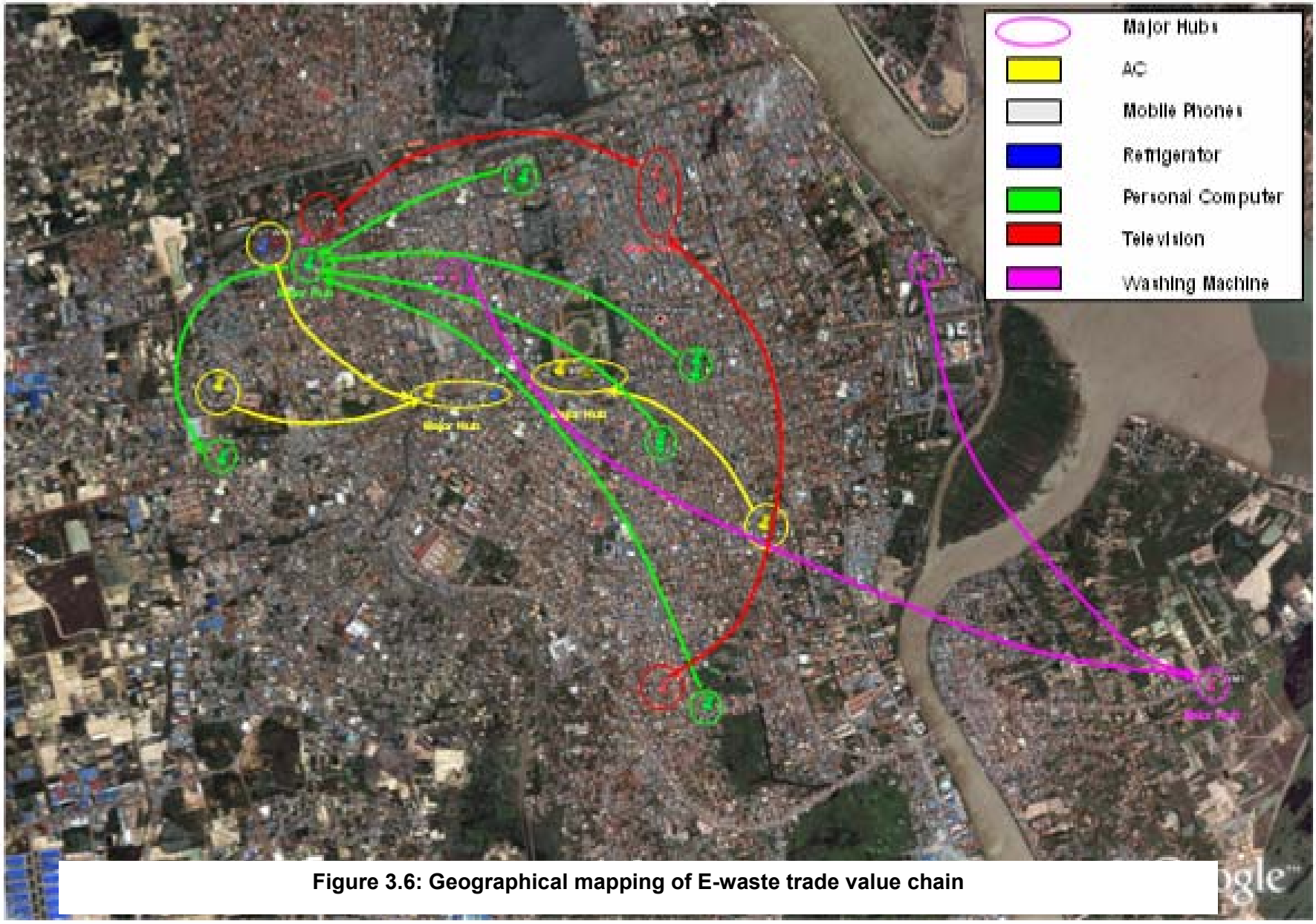


Figure 3.6: Geographical mapping of E-waste trade value chain

Chapter 4: Methodology for E-waste Inventorization

4.0 Introduction

E-waste inventory in PPM forms the basis of E-waste disposal/ treatment strategy. Globally, five methods have been used to determine E-waste inventory. Each of these methods use “Material Flow” model for assessment of inventory. This chapter describes the preferred method for inventory estimation, its application, constraints, advantages, data requirements and sources of data.

4.1 Approach & Methodology

The five methods, which have been used to assess the E-waste inventory globally, are given below.

1. The time step method
2. The market supply method
3. The Carnegie Mellon method
4. Approximate 1 formula
5. Approximate 2 formula

The key to apply any method is the availability of data and its quality. The type of data required to apply any methodology is given below.

- Saturation level of EEE at household and industry level
- Number of households
- Sales data related to export/ import/ manufacturing/production
- Stock data related to private and industry
- Average lifetime of EEE
- Data related to storage of EEE
- Data related to reuse and recovery
- Data related to landfill

4.2 Data Requirement and Data Sources

E-waste trade value chain in PPM forms the basis of data requirement and data source. This trade value chain has been described in figure 3.5 of chapter 3. The salient features related to data requirement and sources, which emerged out of the analysis of E-waste trade value chain, are given below.

1. EEE import, sales and consumption is in formal sector
2. Part of E- waste generation and E- waste treatment falls in semiformal sector
3. Part of E-waste treatment and entire disposal falls in informal sector

The trade chain beyond blue line on the right hand side falls in the informal sector. Therefore, possibility of data availability related to import, sales and consumption appeared high through published government and private sources. However, a need appeared for carrying out limited sampling to collect data related to E-waste generation, treatment and disposal. The strategy to collect this data is shown in figure 4.1.

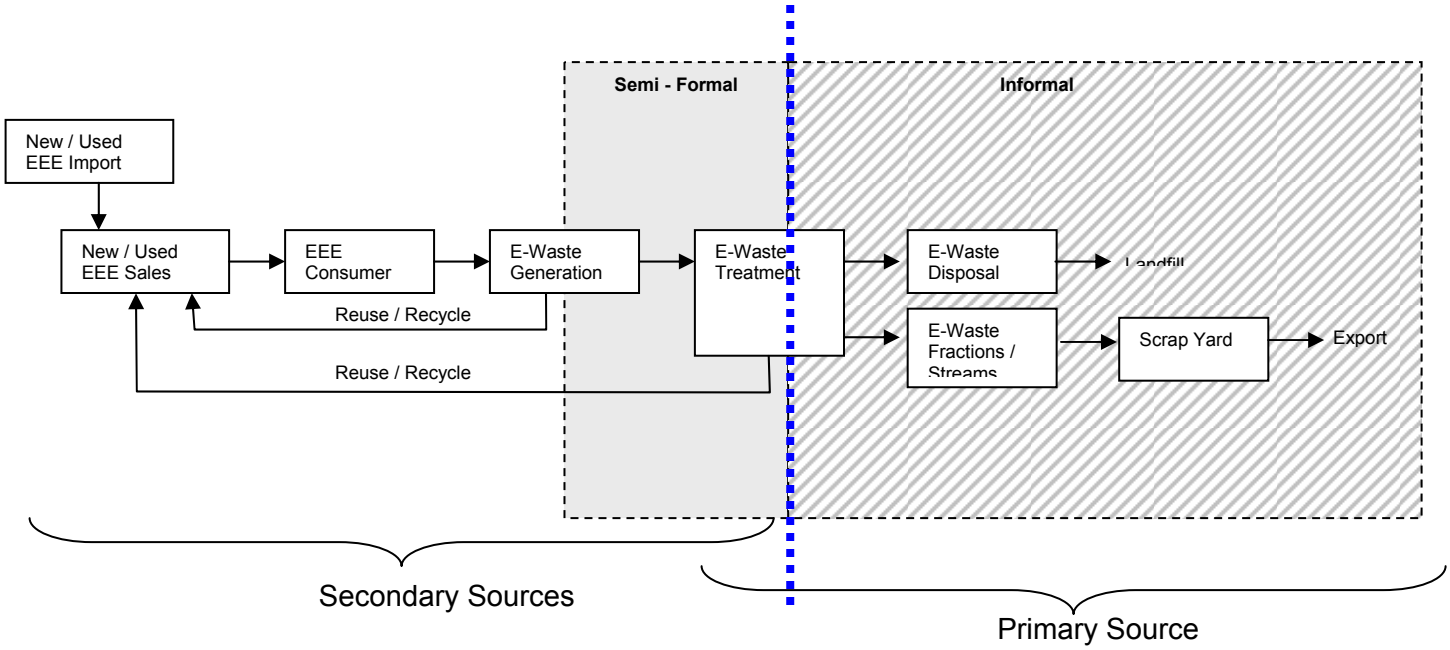


Figure 4.1: Tentative sources for data collection

The availability of above mentioned data was checked for PPM by referring to a number of sources including government and private as described in table 4.1.

Table 4.1: Tentative Sources of data collection

Data Source/ Item	National/ Local Government Agencies	Industry/ Trade/ Recyclers/ Waste Disposal Operator's Association/ NGO (Reports/ Published Data)	Market Research Agencies/ other published sources (Reports/ Published Data)
Saturation Level Household	√ (census data)		√
Saturation Level Industry/ commercial	√ (census data)	√	√
Number of Household	√ (census data)		
Export Data	Not available due to informal sector		
Import Data	√ (Cam Control/ Customs)	√	
Manufacturing/ Production	Not available due to absence of EEE manufacturing base in Cambodia		
Stock Data Private	Data not available		
Stock Data Industry/ commercial	Data not available		
Average Life Time		√	√
Storage Data	Data not available		
Reuse		√	√
Recycle		√	
Landfilled		√	

4.3 Application of Methodology

The application of any of the five methodologies on the basis of figure 4.1 and table 4.1, tentative sources of data collection have been assessed as per the constraint matrix given in table 4.2. The data required for applying each methodology has been described in table 4.2. The yellow mark indicates the availability of data for PPM. It can be concluded that Carnegie Mellon Method, a modified version of market supply method can be applied to carry out E-waste inventory assessment in PPM.

4.4 Conclusion

The application of Carnegie Mellon method requires data on imports, average lifetime, reuse and recycling. These data available from different agencies is supported by primary survey carried out through questionnaire survey and tracer technique described in chapter 5.

Table 4.2: Constraint Matrix

Methodology/ Data Requirement	Saturation Level		Number of Household	Calculated Sales			Stock Data		Average Lifetime	Storage data	Reuse	Recycle	Landfill
	Household	Industry		Export Data	Import Data	Manufacturing/ Production	Private	Industry					
Time Step Method	√	√	√	√	√	√	√	√					
Market Supply Method				√	√	√			√				
Carnegie Mellon Method				√	√	√			√	√	√	√	√
Approximation 1	√	√	√				√	√	√				
Approximation 2				√	√	√							

Chapter 5: E-waste Inventory

5.0 Introduction

A combination of two methods, “Carnegie Mellon Method” and “Tracer Technique” has been used to quantify E-waste inventory in PPM. These techniques are applied on respective parts of the E-waste trade value chain shown in figure 4.1 by using the data available from the source given in table 4.1. The following sections describe EEE items selected for quantifying E-waste inventory, conceptual approach, and application of methods to quantify the installed base of EEE, its projections, average lifetime, tracer technique and finally inventory.

5.1 Conceptual Approach

There are six items, which have been selected to quantify E-waste inventory. These include three items from ICT like TVs, PCs, mobile phones (MP) and three items from white goods like Refrigerator, Air Conditioner (AC) and washing machine (WM). These items have been selected considering their growth rate in PPM. There are four steps, which have been used to describe the conceptual approach.

Step 1: Establish the installed base of selected EEE items with future projections till 2020.

Step 2: Carry out the scenario analysis using assumed average life cycle of each EEE item.

Step 3: Confirm the average life cycle using “Tracer Technique”.

Step 4: Quantify E-waste inventory with projections.

The projections both for installed base and E-waste inventory have been considered till the year 2019 since master plan for PPM urban agglomeration is being prepared till this year. The major constraints experienced during implementation of these steps are given below.

1. Figures for EEE sales computed by using EEE import data from department of Kam Control are available only at country level and not at city level.

2. Figures related to obsolescence rate/ average life of an electrical and electronic item provided by secondary sources of data differ due to storage and reuse of E-waste.

The above constraints are overcome by demarcating the E-waste trade value chain into two parts at a point where E-waste arrives at repair shop. This point has been taken considering the mixed business/ functional profile of these shops including repair, reselling and part dismantling in PPM. Therefore, the point of entry before repairing and reselling step in E-waste trade value chain has been taken to demarcate the chain for application of two different approaches. This is described below and shown in figure 5.1. The four steps identified above have carried out and described in the following sections using this conceptual approach.

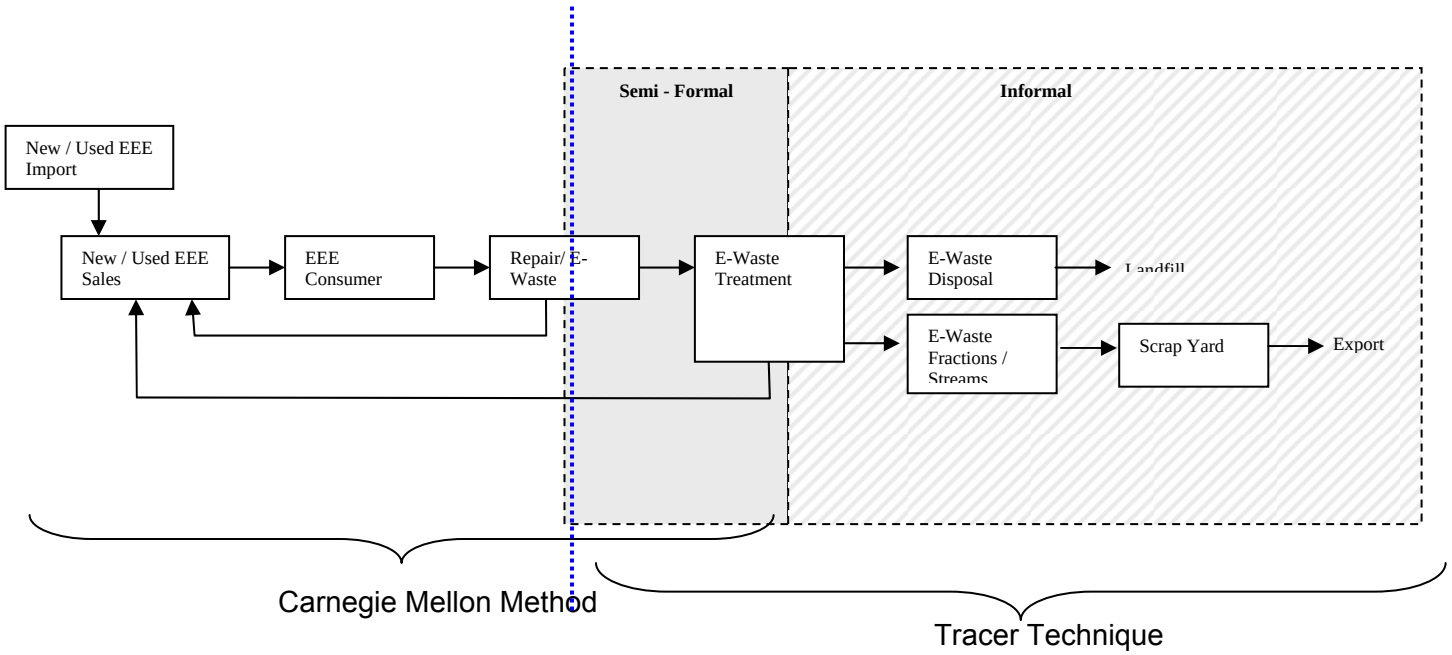


Figure 5.1: Application of two methodologies in the E-waste trade value chain

5.2 Establishment of installed base of selected EEE

Installed base of EEE in PPM has been established by using a number of inputs from diverse secondary data obtained from a number of sources/ agencies. Some of these sources include International Telecommunication Union (ITU), World Bank, ADB, UN-ESCAP, National Institute of Statistics of Cambodia, Municipality of Phnom Penh, Department of Kam Control, Academic institutions, CEA etc. Some of the major assumptions/ inputs used to estimate the installed base are given below.

1. EEE installed base is restricted to urban areas in Cambodia due to non-availability of electricity in rural areas in the country.

2. Census data of PPM from National Institute of Statistics of Cambodia has been used. The population growth rate has been assumed to be 2.5% per annum.

3. A uniform GDP growth rate of 5.5% every year has been assumed considering conservative growth estimates.

4. Installed EEE base projections have been made based on electrified household in low, medium and high income group in PPM considering 5.5% GDP growth rate. This data is described in table 5.1and table 5.2. Further, power supply planning is aiming for a 95% increase in the residential sector up to year the 2016 in Phnom Penh. This will translate into an annual growth rate of electrified households to be 2%. This data have been compiled from the report “Household Electricity Use Analysis and Forecasting: The case of Phnom Penh, Cambodia”, A thesis submitted by Mr. Nou Sovanndara”, Id: 0111090 as a part of the requirements for the degree of Master of Science, in Energy Technology, The Joint Graduate School of Energy and Environment,

at King Mongkut's University of Technology Thonburi, Thailand, 2nd semester 2002 ISBN 974-465-408-3 based on Statistical Data of Ministry of Planning of Government of Cambodia, Year Book 2001.

Table 5.1: GDP Projection in Combodia from 2002 to 2012, [Billion Riels]

Year	GDP at 3%	GDP at 5.5%	GDP at 8%
2002	10,476	10,730	10,985
2003	10,790	11,321	11,863
2004	11,114	11,934	12,813
2005	11,448	12,600	13,838
2006	11,791	13,293	14,945
2007	12,145	14,024	16,140
2008	12,509	14,796	17,431
2009	12,884	15,609	18,826
2010	13,271	16,468	20,332
2011	13,669	17,374	21,958
2012	14,079	18,329	23,715

Table 5.2: Percentage of Electrified Households in the Case of GDP at 5.5%

Year	Low Income	Medium Income	High Income
2002	39.44	41.17	19.39
2003	39.17	41.37	19.46
2004	38.88	41.59	19.53
2005	38.58	41.82	19.60
2006	38.26	42.06	19.68
2007	37.92	42.31	19.77
2008	37.57	42.57	19.86
2009	37.20	42.85	19.95
2010	36.80	43.15	20.05
2011	36.38	43.47	20.15
2012	35.94	43.80	20.26

5. Data on the number of hotels in PPM from 2003 to 2007 was obtained from statistical data of PPM municipality. This data was extrapolated till 2019 based on best fit polynomial curve with $R^2 = 0.97$ as shown in figure 5.2.

6. Data on number of companies/ offices in PPM from 2003-2007, obtained from statistical abstract of PPM was extrapolated till 2019 based on 5.5% GDP growth rate.

7. Percentage ownership of TVs, PCs, MPs, refrigerators and air-conditioners among households, hotels and offices have been taken from table 11, table 12, table 13, table 14 and table 15 of technical report on report "Technical Report on National Inventory of Used EEE in Cambodia" prepared by CEA and are summarized in appendix 4.

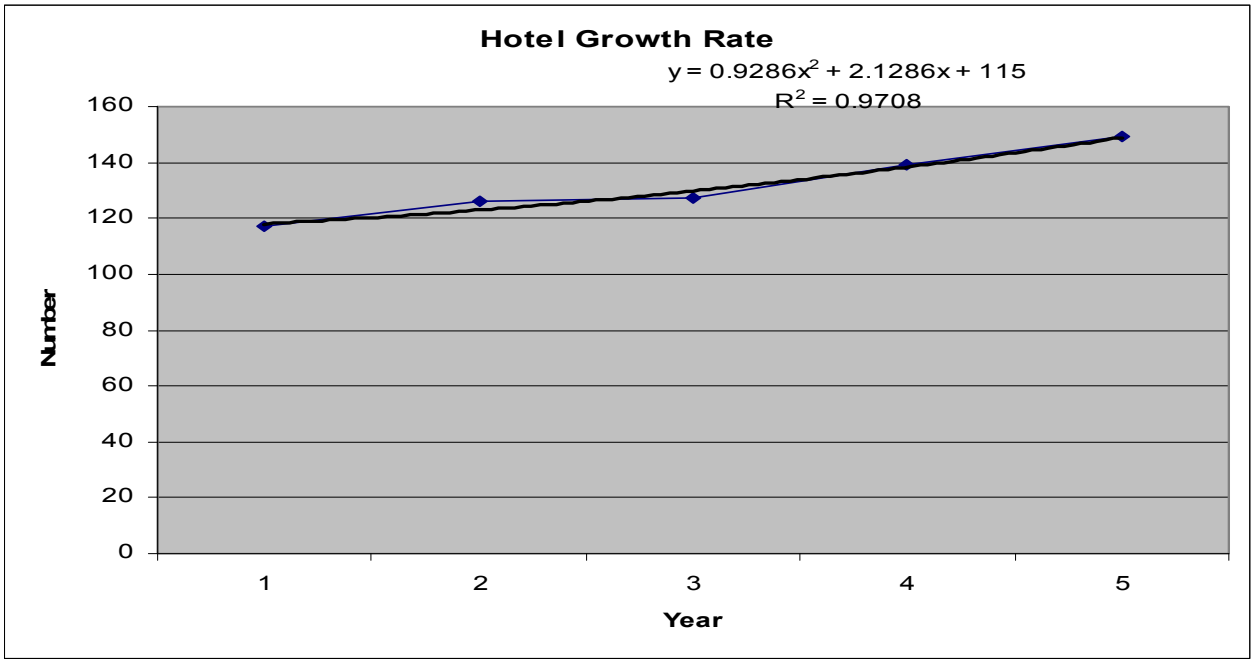


Figure 5.2: Projected number of hotels in PPM

8. Penetration rate of individual EEE for hotels and companies/offices have been estimated based on weighted average of their distribution given in table 11, table 12, table 13, table 14 and table 15 of technical report "Technical Report on National Inventory of Used EEE in Cambodia" prepared by CEA and are summarized in appendix 4. These penetration rates have been described in table 5.3 given below. It has been assumed that washing machines are used only in households in PPM.

Table 5.3: Penetration rates of different EEE items in hotels and offices/ companies in PPM

Item	Penetration Rate per Hotel (Weighted Average)	Penetration Rate per Company (Weighted Average)
TVs	21.268938	1.612342
PCs	0.584597	10.00849
Air conditioners	24.504802	4.219652
Refrigerators	18.809034	0.877216
MP	2.581659	2.884594

9. The import statistics for TVs and PCs from 2000 to 2008 from department of Kam Control for Cambodia have been compiled and shown in table 5.4.

Table 5.4: Import Statistics of different EEE items (numbers/units)

Year	TVs	PCs
2000	157,096	26,342
2001	162,557	1,863
2002	163,663	1,990
2003	114,390	1,852

Year	TVs	PCs
2004	126,755	1,514
2005	95,269	9,381
2006	86,438	3,115
2007	60,529	5288
2008	48,373	4654

Source: Department of Kam Control

10. As per CEA household survey carried out in 2006-07, penetration rate of TV at the household level in urban areas has been taken as 1.5 per household. This penetration rate in PPM is achieved if it is assumed that 22% of the imported TVs each year are added to the previous year's installed base of TV. Using this assumption, the installed base and penetration rate of TV in PPM from the year 2000 to 2008 has been calculated and summarized in appendix 5. Future penetration rate has been projected by extrapolating the penetration rate data till 2019 based on best fit polynomial curve with R^2 = 0.99. Using the projected penetration rate, the projected installed base of TV in PPM has been estimated and summarized in appendix 5.

11. As per CEA household survey carried out in 2006-07, penetration rate/ ownership ratio of PC in urban areas is 0.12/ person for a population above 13 years old (Approximately 74% of the total population as per PPM municipal data). This penetration rate in PPM is achieved if it is assumed that 32% of the imported PCs each year are added to the previous year's installed base of PC. Using this assumption, the installed base and penetration rate of PC in PPM from the year 2000 to 2008 has been calculated and summarized in appendix 5. Since no significant correlation was obtained for the penetration rate/ ownership ratio data starting from 2000 to 2008, a uniform penetration rate/ ownership ratio of 0.12 was adopted to project the future installed base and summarized in appendix 5. This penetration rate represents the most conservative scenario of business as usual considering that there will neither an increase nor decrease in penetration rate. The projected PC installed base till 2019 shows a significant correlation with R^2 = 0.99 for the best fit polynomial curve as shown in appendix 5.

12. Import statistics of MP obtained from department of Kam Control does not match the increase in installed base of MP in Cambodia for the year 2000 to 2005 as per MoPT data summarized in appendix 5. Therefore, the installed base of MP in PPM has been derived based on the CEA household survey and data from market research agencies. As per CEA household survey carried out in 2006-07, penetration rate/ ownership ratio of MP in urban areas is 0.53/ person for a population above 13 years old (Approximately 74% of the total population as per PPM municipal data). As per this penetration rate, the total installed base of MP in PPM has been estimated to be 412,976 units. As per market research agency quoting government sources, a growth rate of 15% has been recorded in MP sector during 2007-08. Assuming 15% growth during the lean period as conservative figure, installed base of MP in PPM from the year 2005 to 2009 has been estimated. This further extrapolated backward till the year 2000 based on percentage distribution of installed base of PPM with respect to Cambodia. Thereafter, the installed

base has been has been estimated till the year 2019 based on best curve fit with significant correlation of $R^2 = 0.99$.

13. According to Cambodia socio-economic survey 2004, the installed base of refrigerator in PPM is about 17.8 per 100 households. As per CEA household survey carried out in 2006-07, penetration rate/ ownership ratio of refrigerators in urban areas is 0.38 units per household, where 80 percent of the households are electrified. This penetration rate/ ownership ratio has been further divided as per low, medium and high income group households. Using the same penetration rate and the projected population with expected percentage of electrified households given in table 5.2, the installed base of refrigerators in PPM till 2012 has been estimated and summarized in appendix 5. This installed base of refrigerators in PPM from 2004 till 2012 has been further extrapolated till 2019 using best fit logarithmic curve with significant correlation $R^2 = 0.97$. Further, installed base estimation from 1993 till 2003 have been made using the penetration rate/ ownership ratio of 2004 with corresponding electrified household estimates. These estimates have been summarized in appendix 5.

14. According to Cambodia socio-economic survey 2004, the installed base of air conditioners in PPM is about 8 per 100 households. As per CEA household survey carried out in 2006-07, penetration rate/ ownership ratio of air conditioners in urban areas is 0.33 units per household, where 80 percent of the households are electrified. This penetration rate/ ownership ratio has been further divided as per low, medium and high income group households. Using the same penetration rate and the projected population with expected percentage of electrified households given in table 5.2, the installed base of air conditioners in PPM till 2012 has been estimated and summarized in appendix 5. This installed base of air conditioners in PPM from 2004 till 2012 has been further extrapolated till 2019 using best fit logarithmic curve with significant correlation $R^2 = 0.97$. Further, installed base estimation from 1993 till 2003 have been made using the penetration rate/ ownership ratio of 2004 with corresponding electrified household estimates. These estimates have been summarized in appendix 5.

15. The penetration/ ownership of any white good depend on the availability of electricity, income and consumer behavior. The electrified households in PPM as per low, medium and high income groups are summarized in table 5.2. Ownership ratio of washing machine with refrigerator has been identified as an indicator of consumer behavior for ownership of washing machine in PPM based on the field survey of electricity consumption in residential sector for low, medium and high income groups in the year 2002[2]. This ownership ratio has been applied to the refrigerator ownership in the low, medium and high income group as per CEA household survey in 2006. The tentative

[2] Table 4.10 in the report "Household Electricity Use Analysis and Forecasting: The case of Phnom Penh, Cambodia", A thesis submitted by Mr. Nou Sovanndara", Id: 0111090 as a part of the requirements for the degree of Master of Science, in Energy Technology, The Joint Graduate School of Energy and Environment, at King Mongkut's University of Technology Thonburi, Thailand, 2nd semester 2002 ISBN 974-465-408-3

washing machine ownership ratio in the year 2006 is summarized in table 5.5.

Table 5.5: Tentative ownership ratio of washing machine

Ratio	Low	Medium	High
Washing Machine / refrigerator (2002)	0.577778	0.923077	0.6054191
Washing Machine (2006)	0.028889	0.323077	0.5630398

Using the same penetration rate/ ownership ratio and the projected population with expected percentage of electrified households given in table 5.2, the installed base of washing machine in PPM from 2002 to 2012 has been estimated and summarized in appendix 5. This installed base of washing machine till 2012 has been further extrapolated from 1993 till 2019 using best fit exponential curve with significant correlation R^2 = 0.99. These estimates have been summarized in appendix 5.

16. The total installed base of EEE items in hotels and companies in PPM is summarized in appendix 5.

The total installed base of the six EEE items in household sector in PPM has been estimated and summarized in table 5.6. Therefore, the total installed base of EEE consisting of households, hotels and companies is summarized in table 5.7.

Table 5.6: Installed Base of EEE in households in PPN (number)

Year	Population	Installed Base (TV)	Installed Base (PC)	Installed Base (Mobile Phone)	Installed Base (Refrigerator)	Installed Base (Air Condition)	Installed Base (Washing Machine)
1993	717300	**26851**	77629.24		13789.38		24058.47
1994	793817	**37142**	78217.28		15825.53		25221.26
1995	814171	49505.10	78910.02		16811.00	7555.51	26440.24
1996	822993	63939.60	79707.46		17579.13	7900.73	27718.14
1997	822304	80445.90	80609.60		18149.89	8157.26	29057.81
1998	999804	99024.00	81616.45		22779.53	10237.99	30462.22
1999	936767	103052.00	82728.00		22010.28	9892.26	31934.51
2000	952429	137613.12	79762.65	83200.00	23056.40	10362.43	33477.96
2001	963165	172174.24	88192.09	138543.96	24002.07	10787.45	35096.00
2002	1005632	207936.78	88788.25	189756.39	25776.36	11584.88	36641.73
2003	1042108	243942.64	89425.05	269227.20	27453.29	12338.56	39244.08
2004	1050616	269108.44	90017.69	330980.65	28425.47	12775.49	40882.70
2005	1063856	296994.54	90502.17	380627.75	40325.61	34596.49	42764.64
2006	1052974	317953.72	93504.09	412976.40	58859.39	55597.03	43713.90
2007	1072258	336970.08	95196.25	474922.86	61706.93	62411.91	45971.00
2008	1080519	350286.46	96685.53	546161.29	63984.34	64742.04	47835.54
2009	1107532	443232.12	99102.67	628085.49	67456.36	68278.35	50630.73
2010	1135220	488596.25	101580.24	722298.31	71106.38	72002.48	53596.48
2011	1163601	535202.34	104119.74	775737.80	74925.88	75895.84	56736.49
2012	1192691	583143.96	106722.74	851637.30	78935.37	79992.70	60075.64

Year	Population	Installed Base (TV)	Installed Base (PC)	Installed Base (Mobile Phone)	Installed Base (Refrigerator)	Installed Base (Air Condition)	Installed Base (Washing Machine)
2013	1222508	632508.29	109390.80	929820.20	80412.60	83814.74	61836.09
2014	1253071	683378.03	112125.57	1010286.50	82547.46	86485.42	64824.73
2015	1284398	735832.90	114928.71	1093036.20	84496.42	88923.57	67957.82
2016	1316507	789950.63	117801.93	1178069.30	86289.30	91166.45	71242.33
2017	1349420	845807.74	120746.98	1265385.80	87949.25	93243.03	74685.59
2018	1383156	903480.20	123765.65	1354985.70	89494.62	95176.27	78295.27
2019	1417735	963043.88	126859.80	1446869.00	90940.21	96984.71	82079.41

Table 5.7: Total Installed Base of EEE (households, hotels, companies) in PPN (number)

Year	Population	Installed Base (TV)	Installed Base (PC)	Installed Base (Mobile Phone)	Installed Base (Refrigerator)	Installed Base (Air Condition)	Installed Base (Washing Machine)
1993	717300	**31183**	98755.68		16464.02	**16169.09**	24058.47
1994	793817	**41746**	100505.69		18676.82	**17670.87**	25221.26
1995	814171	54398.75	102424.34		19851.35	18736.18	26440.24
1996	822993	69142.10	104515.15		20821.86	19741.84	27718.14
1997	822304	85977.85	106781.85		21609.34	20699.28	29057.81
1998	999804	104907.47	109228.35		26471.10	23524.00	30462.22
1999	936767	109310.61	111858.79		25950.54	23968.12	31934.51
2000	952429	144272.21	110495.94	83200.00	27263.19	25276.98	33477.96
2001	963165	179260.95	120616.08	138543.96	28494.58	26592.70	35096.00
2002	1005632	215480.22	122996.01	189756.39	30575.25	28336.24	36641.73
2003	1042108	251974.02	125514.78	269227.20	32580.81	30095.06	39244.08
2004	1050616	277661.25	128093.01	330980.65	33905.56	31600.06	40882.70
2005	1063856	306104.71	130672.39	380627.75	46184.10	54556.21	42764.64
2006	**1052974**	**327659.82**	**135884.57**	**412976.40**	**65124.09**	**76763.43**	**43713.90**
2007	1072258	347328.58	139911.21	474922.86	68420.98	84878.56	45971.00
2008	1080519	361299.89	143862.16	546161.29	71143.02	88542.52	47835.54
2009	1107532	454964.75	148877.13	628085.49	75109.10	93518.57	50630.73
2010	**1135220**	**501110.51**	**154096.04**	**722298.31**	**79300.60**	**98788.01**	**53596.48**
2011	1163601	548561.95	159528.23	775737.80	83709.68	104335.52	56736.49
2012	1192691	597413.96	165183.52	851637.30	88357.57	110198.89	60075.64
2013	1222508	647755.11	171072.21	929820.20	90522.79	115903.45	61836.09
2014	1253071	699669.60	177205.12	1010286.50	93396.04	120576.56	64824.73
2015	1284398	753238.71	183593.63	1093036.20	96134.64	125141.12	67957.82
2016	1316507	808541.81	190249.69	1178069.30	98769.30	129638.71	71242.33
2017	1349420	865657.18	197185.84	1265385.80	101324.12	134102.87	74685.59
2018	1383156	924662.61	204415.29	1354985.70	103818.46	138561.36	78295.27
2019	1417735	985635.91	211951.88	1446869.00	106268.16	143037.77	82079.41

5.3 Scenario Analysis – E-waste Inventory

Average lifecycle of each of selected EEE item has been taken from the report "Technical Report on National Inventory of Used EEE in Cambodia" prepared by CEA based on survey carried out in 2006 and summarized in table 5.8. A range of average life of selected EEE items can be fixed with an "upper limit" and "lower limit" as summarized in table 5.8. Scenario analysis of E-waste inventory for the selected EEE has been carried out using "upper limit" and "lower limit" and summarized in table 5.9.

Table 5.8: Average Life time of EEE

No.	EEE Product	Use Period (Year)	Scenario 1: Lower Period (Year)	Scenario 2: Upper Period (Year)
1	TV	10	9	13
2	PC	9	8	13
3	Mobile Phone	7	7	10
4	Refrigerator	12	11	13
5	Air Conditioner	12	11	13
6	Washing Machine	12	11	13

Scenario analysis assists to assess the time between point of discard of EEE and its arrival at repair/ dismantling stage. This will help in assessment of life cycle of EEE before it arrives for dismantling in a geographical context.

5.4 Life Cycle Assessment through Tracer Technique

Life cycle assessment has been carried out through tracer technique from the point at which it enters repair shops. It is at this point that EEE item enters the E-waste trade value chain in PPM. Further, the nature of E-waste market in PPM indicates that all the three functions of repair, reselling and dismantling are occurring with majority of retailers under one roof in PPM. The following steps were followed to carry out tracer analysis for six items in PPM.

Step 1: Identify the tracer item in each EEE

Step 2: Follow the tracer item in the trade value chain

Table 5.9: Scenario Analysis – E-waste Inventory

Year	Scenario 1: Inventory (TV)	Scenario 2: Inventory (TV)	Scenario 1: Inventory (PC)	Scenario 2: Inventory (PC)	Scenario 1: Inventory (MP)	Scenario 2: Inventory (MP)	Scenario 1: Inventory (Ref)	Scenario 2: Inventory (Ref)	Scenario 1: Inventory (Air Con)	Scenario 2: Inventory (Air Con)	Scenario 1: Inventory (WM)	Scenario 2: Inventory (WM)
1993												
1994												
1995												
1996												
1997												
1998												
1999												
2000												
2001												
2002												
2003												
2004							16464.02				24058.47	
2005							18676.82				25221.26	
2006	**104907.47**	**31183**	**111858.79**	98755.68	**83200.00**		**19851.35**	16464.02	**18736.18**		**26440.24**	24058.47
2007	109310.61	**41746**	110495.94	100505.69	138543.96		20821.86	18676.82	19741.84		27718.14	25221.26
2008	144272.21	54398.75	120616.08	102424.34	189756.39	83200.00	21609.34	19851.35	20699.28	18736.18	29057.81	26440.24
2009	179260.95	69142.10	122996.01	104515.15	269227.20	138543.96	26471.10	20821.86	23524.00	19741.84	30462.22	27718.14
2010	**215480.22**	85977.85	**125514.78**	106781.85	**330980.65**	**189756.39**	**25950.54**	**21609.34**	**23968.12**	**20699.28**	**31934.51**	**29057.81**
2011	251974.02	104907.47	128093.01	109228.35	380627.75	269227.20	27263.19	26471.10	25276.98	23524.00	33477.96	30462.22
2012	277661.25	109310.61	130672.39	111858.79	412976.40	330980.65	28494.58	25950.54	26592.70	23968.12	35096.00	31934.51
2013	306104.71	144272.21	135884.57	110495.94	474922.86	380627.75	30575.25	27263.19	28336.24	25276.98	36641.73	33477.96
2014	327659.82	179260.95	139911.21	120616.08	546161.29	412976.40	32580.81	28494.58	30095.06	26592.70	39244.08	35096.00
2015	347328.58	215480.22	143862.16	122996.01	628085.49	474922.86	33905.56	30575.25	31600.06	28336.24	40882.70	36641.73
2016	361299.89	251974.02	148877.13	125514.78	722298.31	546161.29	46184.10	32580.81	54556.21	30095.06	42764.64	39244.08
2017	454964.75	277661.25	154096.04	128093.01	775737.80	628085.49	65124.09	33905.56	76763.43	31600.06	43713.90	40882.70
2018	501110.51	306104.71	159528.23	130672.39	851637.30	722298.31	68420.98	46184.10	84878.56	54556.21	45971.00	42764.64
2019	548561.95	327659	165183.52	**135884.57**	929820.20	775737.80	71143.02	65124.09	88542.52	76763.43	47835.54	43713.90

The tracer in each EEE item is described in table 5.1. Further, the tracer item has been tracked as shown in appendix 6 and amount calculated based on field survey carried out by project team on sample basis as summarized in appendix 7. An average amount for each item is calculated and correlated back to E-waste inventory summarized in table 5.9 to assess the average life cycle. This correlation for each item has been described below.

Table 5.10: Tracer Item

S. No.	Item	Tracer
1.	TV	CRT
2.	PC	CRT
3.	MP	LCD
4.	Refrigerator	Compressor
5.	Air Conditioner	Compressor
6.	Washing Machine	Motor

TV

Results of tracer analysis for TV are summarized below.

1. The survey of about 17 TV repair and dismantling shops carried out by project team shows that about 1152 units per month arrive for repair/ dismantling. This gives an average figure of about 68 units per month arriving at each shop.

2. There are about 40 repair and dismantling shops, which were surveyed by CEA during 2006. The total units expected to arrive at 40 shops per year are 32640.

3. On comparing the expected arrival of the TV sets at these shops with the figures for TV in table 5.9, the average life cycle of TV in PPM comes out to be about 13 to 14 years, which corresponds to figures in 2006-07. This also includes the storage period of the unit with different stakeholders.

PC

Results of tracer analysis for PC are summarized below.

1. The survey of 8 PC repair shops carried out by project team shows that about 525 units per month arrive for repair. This gives an average figure of about 66 units of PC per month arriving at each shop.

2. As per data of National ICT Development Authority, there were about 185 PC shops in Cambodia in 2006. PC shops surveyed in 2006 by CEA team in PPM constitute about 64 % of the total sample size. Using this percentage, the total PC shops in PPM have been estimated to be 118 in 2006. The units, which are expected to arrive at these shops for repair per year is about 93,456. As per CEA survey, the number of PCs arriving for repair constitutes about 89.85 percent (table 18 from CEA report), therefore, the total number of units expected to arrive at the se shops is about 102,941 units per annum in 2006.

3. On comparing 102,941 units per annum in 2006 with the figures for PC in table 5.9, the average life cycle of PC in PPM is estimated to be 11 years, which corresponds to an installed base of PC in 1995.

MP

Results of tracer analysis for MP are summarized below.

1. The survey of about 10 MP repair shops carried out by project team shows that an average of about 415 units per month arrive for repair at these shops.

2. There are about 32 MP repair shops, which were surveyed by CEA during 2006. The total units expected to arrive at these shops per year are 159,360 in PPM. These constitute about 89.85 percent (table 18 from CEA report), therefore, the total number of units expected to arrive at the se shops is about 170,515 units per annum in 2006.

3. On comparing 170,515 units per annum in 2006 with the figures for MP in table 5.9, the average life cycle of MP in PPM is estimated to be 5 to 6 years, which corresponds to an installed base of MP in 2001-02.

Refrigerator

Results of tracer analysis for refrigerator are summarized below.

1. The survey of about 19 refrigerators repair and dismantling shops carried out by project team shows that an average of about 33 units per month arrive for repair and dismantling at these shops.

2. There are about 43 refrigerator repair shops in PPM, which were surveyed by CEA during 2006. The total units expected to arrive at these shops per year are 17,028 in PPM.

3. On comparing 17028 units per annum in 2006 with the figures for refrigerator in table 5.9, the average life cycle of refrigerator in PPM is estimated to be 13 years, which corresponds to an installed base in 1993.

Air Conditioner

Results of tracer analysis for air conditioner are summarized below.

1. The survey of about 19 air conditioner repair and dismantling shops carried out by project team shows that an average of about 35 units per month arrive for repair and dismantling at these shops.

2. There are about 43 air conditioner repair shops in PPM, which were surveyed by CEA during 2006. The total units expected to arrive at these shops per year are 18060 in PPM.

3. On comparing 18060 units per annum in 2006 with the figures for air conditioner in table 5.9, the average life cycle of an air conditioner in PPM is estimated to be 12 to 13 years, which corresponds to an installed base in 1994.

Washing Machine

Results of tracer analysis for washing machine are summarized below.

1. Survey of about 9 washing machine repair and dismantling shops carried out by project team shows that an average of about 34 units per month arrive for repair and dismantling at these shops.

2. As per survey of such type of shops, it was informed that there are about 45 washing machine repair shops in PPM. Therefore, the total units expected to arrive at these shops per year are 18360 in PPM.

3. On comparing 18360 units per annum in 2006 with the figures for air washing machine in table 5.9, the average life cycle of washing machine in PPM is estimated to go beyond 13 years and is expected to be 18 years which corresponds to an installed base in 1987-88.

5.5 Projected E-waste Inventory

A conservative life cycle assessment of each of the EEE item has been fixed based on confirmation by "Tracer Technique" and summarized in table 5.11.

Table 5.11: Average Life Cycle of EEE item

S. No.	Item	Average Life Cycle (years)
1.	TV	14
2.	PC	11
3.	MP	6
4.	Refrigerator	13
5.	Air Conditioner	13
6.	Washing Machine	18

The projected E-waste inventory in terms of numbers and metric tons for the six EEE items starting from the year 2009 till 2019 has been estimated and summarized in table 5.12 and table 5.13.

Table 5.12: Projected E-waste Inventory (number)

Year	TV	PC	MP	Refrigerator	Air Conditioner	Washing Machine	Total
2008	41746.44	106781.85	189756.39	19851.35	18736.18	20881.99	**397754.20**
2009	54398.75	109228.35	269227.20	20821.86	19741.84	21891.25	**495309.25**
2010	69142.10	111858.79	330980.65	21609.34	20699.28	22949.29	**577239.44**
2011	85977.85	110495.94	380627.75	26471.10	23524.00	24058.47	**651155.11**
2012	104907.47	120616.08	412976.40	25950.54	23968.12	25221.26	**713639.87**
2013	109310.61	122996.01	474922.86	27263.19	25276.98	26440.24	**786209.90**
2014	144272.21	125514.78	546161.29	28494.58	26592.70	27718.14	**898753.71**
2015	179260.95	128093.01	628085.49	30575.25	28336.24	29057.81	**1023408.74**
2016	215480.22	130672.39	722298.31	32580.81	30095.06	30462.22	**1161589.01**
2017	251974.02	135884.57	775737.80	33905.56	31600.06	31934.51	**1261036.52**
2018	277661.25	139911.21	851637.30	46184.10	54556.21	33477.96	**1403428.03**
2019	306104.71	143862.16	929820.20	65124.09	76763.43	35096.00	**1556770.59**

The graphical representation of the inventory is shown in figure 5.3. The figure shows that the E-waste inventory in PPM is expected to grow exponentially with a significant correlation during the next decade. In terms of numbers, E-waste from mobile phones is expected to grow at a higher rate followed by TVs, PCs, refrigerator, air conditioners and washing machine.

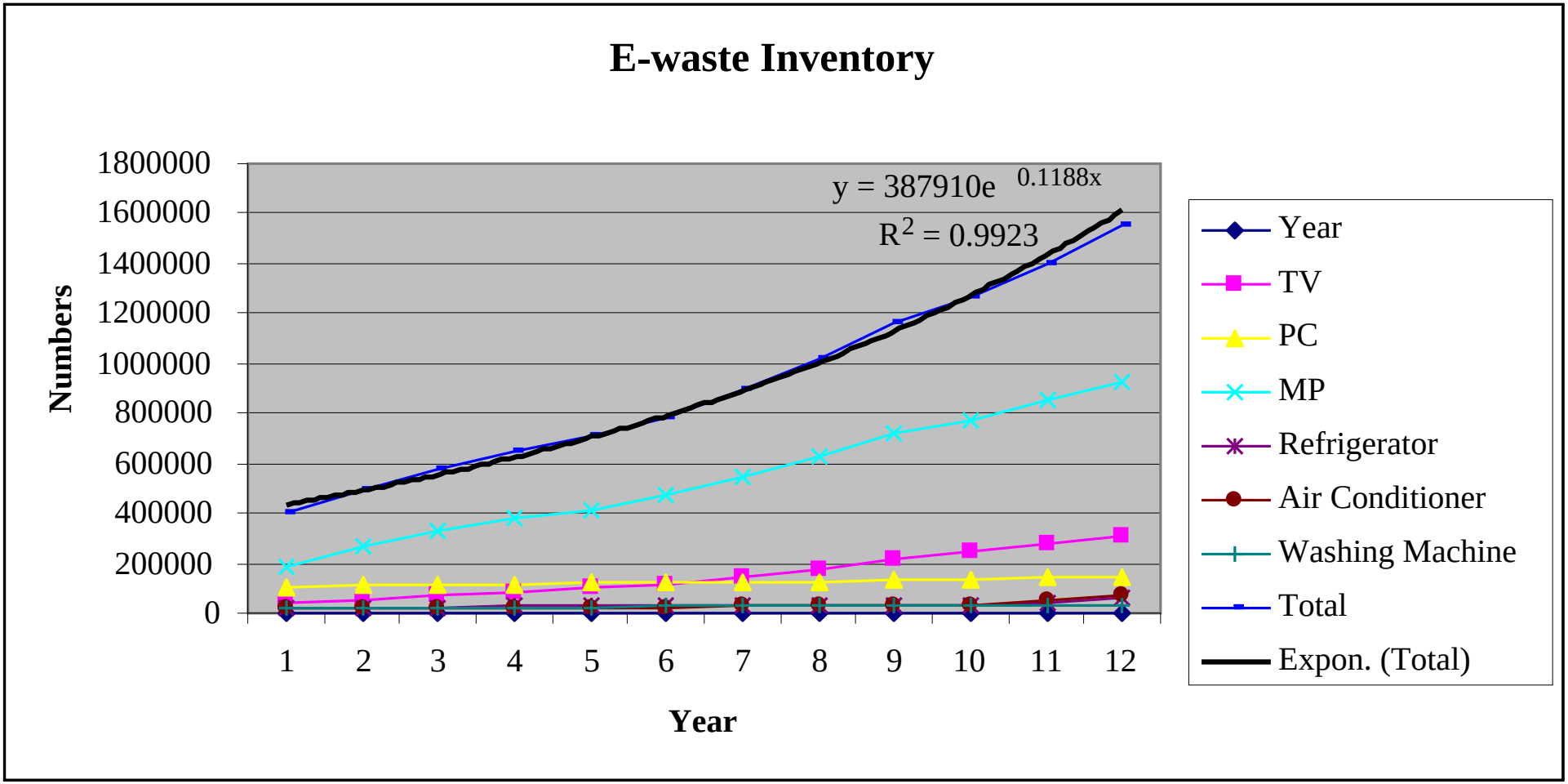


Figure 5.3: Projected E-waste inventory (numbers)

Table 5.13: Projected E-waste inventory (metric tons)

TV	PC	MP	Refrigerator	Air Conditioner	Washing Machine	Total
1461	2670	30	953	843	835	**6792**
1904	2731	43	999	888	876	**7441**
2420	2796	53	1037	931	918	**8156**
3009	2762	61	1271	1059	962	**9124**
3672	3015	66	1246	1079	1009	**10086**
3826	3075	76	1309	1137	1058	**10480**
5050	3138	87	1368	1197	1109	**11948**
6274	3202	100	1468	1275	1162	**13482**
7542	3267	116	1564	1354	1218	**15061**
8819	3397	124	1627	1422	1277	**16667**
9718	3498	136	2217	2455	1339	**19363**
10714	3597	149	3126	3454	1404	**22443**

The graphical representation of the inventory is shown in figure 5.4.

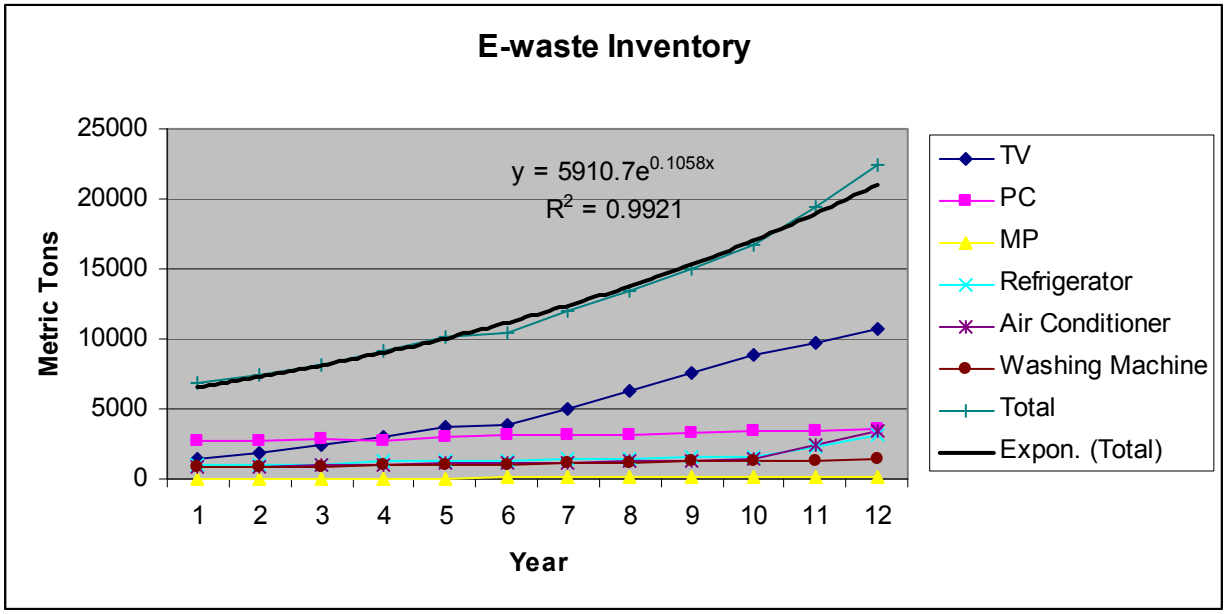


Figure 5.4: Projected E-waste Inventory (metric tons)

Figure 5.4 shows that the E-waste inventory in PPM is expected to grow exponentially with a significant correlation during the next decade. In terms of weight, E-waste from TV is expected to grow at a higher rate followed by PCs, refrigerator, air conditioners, washing machine and mobile phones.

5.6 Conclusion

The E-waste inventory projections in PPM provide the information on E-waste generation potential. Further, these projections both in numbers and weight show significant growth starting from the year 2012 onward. It gives policy planners,

implementers and other stakeholders three years to plan and implement future interventions. These interventions will form the basis of planning till 2019.

Chapter 6: Conclusions & Recommendations

6.0 Introduction

The objective of the proposed project is to formulate, design and implement an integrated E-waste management pilot project in PPM. After augmentation of local capacity, the level of effort could be scaled up to the national level and replicated in other countries. Specific objectives included building the national and local capacity in Cambodia on inventorization and management of E-waste by undertaking various activities, including the inventory of E-waste and a pilot project to process E-waste in and environmentally sound manner with optimum level of recovery for recycling. Other objective includes to bring out the guidelines and training materials for dissemination for other developing countries to replicate similar projects and capacity building process. The first out put of this project has come out in the form of E-waste inventory report, which is an indicator of the existing capacity of the stakeholders to prepare an E-waste inventory report for future planning. The major conclusions drawn from this report are described below.

6.1 Major Conclusions/ Recommendations

Major conclusions have been described below under each head.

<u>Regulatory Framework</u>

1. Definition of electrical and electronic equipment is not covered under the existing regulations. One of the major gaps, which have been identified, is the lack of clear definition of E-waste. There is very little difference between definition of used EEE and E-waste.

2. Since Cambodia is signatory to Basel Convention, it is assumed that all the definitions and items related to E-waste in the convention are covered in the existing regulations (article 20 and 21).

3. Words like “used goods/ scrap/ waste”, “discarded” and “disposal” are covered in existing regulations.

4. Reuse and recycling are defined in the draft strategy on 3R.

5. The sub decree on solid waste management defines the hazardous waste criteria. As per the criteria, some of the E-waste is listed in items 6, 11, 13, 14, and 21 of annexure of this sub decree.

6. Role of collector/ transporter is defined only in the context of hazardous waste and solid waste.

7. There is no specific definition of generator or producer of E-waste. However, definition of importer of Used EEE is mentioned in the existing regulation.

There is a need to cover E-waste either under existing regulations or a separate regulation depending on the time frame and capacity of regulatory agencies to

implement it. Since draft 3R strategy is being formulated in the country, E-waste can also be brought under its purview so that necessary regulatory interventions can be planned and implemented.

E-waste Market, Geographical Distribution and E-waste Trade Value Chain

EEE market is organized in three different types of market segments i.e. shops selling brand new EEE, shops selling brand new as well as second hand EEE and shops selling second hand EEE. The major findings of E-waste market are summarized below.

1. The majority of EEE market in PPM is organized in mixed market conditions with shops selling a combination of new and second hand items and shops selling second hand items.

2. The market share of second hand EEE is increasing every year, although, some of brand-new items are cheaper.

3. Consumers prefer branded EEE even when it is second hand.

4. Shops selling second hand EEE have multiple functions of selling, repairing, refurbishing and dismantling. Geographically, it is organized in different hubs catering to ICT and white goods sector. It is observed that the major hubs of AC refurbishing / dismantling also serve as major hubs for refrigerator refurbishing/ repair and dismantling. Major hubs for TV and PC are located at different places. However, hubs at Chamkamorn and Toul Kok serve as two major hubs for TV and PCs. Chamkamorn, Toulkok and Meanchay also serve as major repairing/ refurbishing centre for washing machine. Therefore, four functions can be geographically addressed at one place while considering future interventions.

5. There are twelve processes, which need to be considered for environmentally sound management while planning for future interventions since no chemical processing is occurring within municipal boundary of PPM.

6. The E-waste trade value chain consisting of stakeholders implementing twelve processes indicates that future interventions are required at level 1 and level 2 consisting of primary E-waste generators and secondary E-waste generator.

E-waste Inventory

A combination of two methods, “Carnegie Mellon Method” and “Tracer Technique” has been used to quantify E-waste inventory in PPM. These techniques are applied on respective parts of the E-waste trade value chain. There are four steps, which have been used to describe the conceptual approach to estimate E-waste inventory. These include establishing the installed base of selected EEE items with future projections till 2019, carrying out the scenario analysis using assumed average life cycle of each EEE item followed by confirming the average life cycle using “Tracer Technique” and quantification of E-waste inventory with projections. The major findings of tracer technique are given below.

1. Tracer technique confirmed the average life cycle for TV, PC, MP, refrigerator, air conditioner and washing machine to be 14, 11,6, 13, 13 and 18 years.

2. E-waste inventory in PPM is expected to grow exponentially with a significant correlation during the next decade both in terms of numbers and weight.

3. In terms of numbers E-waste from mobile phones is expected to grow at a higher rate followed by TVs, PCs, refrigerator, air conditioners and washing machine. This will form the basis of planning for product wise intervention.

4. E-waste inventory rages from 6792 metric tons in 2008 to 22,443 metric tons in 2019. In terms of weight, E-waste from TV is expected to grow at a higher rate followed by PCs, refrigerator, air conditioners, washing machine and mobile phones. This will form the basis of planning for any collection, transportation and recycling facility in future.

The E-waste inventory projections in PPM provide the information on E-waste generation potential. Further, these projections both in numbers and weight show significant growth starting from the year 2012 onward. It gives policy planners, implementers and other stakeholders three years to plan and implement future interventions starting from the year 2009.

Appendix 1

E-waste Management for Phnom Penh, Kingdom of Cambodia

Date: 10 February 2009
Place: Ministry of Environment, Cambodia (Phnom Penh)
Participants: Officials, Stakeholders, Project Team and UNEP-DTIE-IETC

Part 1: Launching Ceremony

9:30 – 10:00 Welcome Speeches and Need for ISWM Plan for Novo Hamburgo:

- **His Excellency Mr. Khieu Muth Ministry of Environment, Kingdom of Cambodia**
- **Mushtaq Ahmed Memon, Programme Officer, UNEP-DTIE-IETC**

10:00 – 10:30 Introduction of Project Team

- **Dr. Chrin Sokha, Deputy Director General, MOE Cambodia**

11:00 – 11:30 Introduction of the project on E-waste Manageement

- **Mushtaq Ahmed Memon, UNEP-DTIE-IETC**

11:30 – 12:00 Official Launching of the Project

- **Ministry of Environment & Project Team**
- **Local Stakeholders**
- **International Organizations and Bilateral Donors**

12:00 – 13:30 Lunch

Part 2: Awareness Raising Workshop on ISWM

13:30 – 14:30 E-waste Management – Learning from International Experiences

- **Mushtaq Ahmed Memon, UNEP-DTIE-IETC**

14:30 – 15:30 Capacity Building and Role of Project Team

- **Mr. Amit Jain, Consultant**

15:30 – 16:30 Coffee Break and Informal Discussions

16:30 – 17:00 Action Plan for UNEP Project on E-waste Management

- **Mushtaq Ahmed Memon , UNEP-DTIE-IETC**

E-waste Management for Phnom Penh, Kingdom of Cambodia

Date: **11-12 February 2009**
Place: **Ministry of Environment, Cambodia (Phnom Penh)**
Participants: Project Team and UNEP-DTIE-IETC

Training on E-waste Manual, Volume I
E-waste Inventory
Characterization & Quantification with Future Projections

First Day – 11 February 2009

9:00 – 10:00 **De-briefing on Roles and Responsibilities**

10:00 – 11:00 Outline of the Training on E-waste Manual
- **Mushtaq Ahmed Memon, UNEP-DTIE-IETC**

11:00 – 13:00 First Session
- **Defining E-waste / WEEE**

13:00 – 14:00 Lunch

14:00 – 15:30 Second Session
- **Setting boundaries for E-waste / WEEE assessment**

15:30 – 17:00 Third Session (with working coffee/tea)
- **Selection of Methodology for data collection & analysis**

Second Day – 12 February 2009

9:00 – 13:00 **Fourth Session**
- **Data review and assessment methodology**

13:00 – 14:00 Lunch

14:00 – 15:30 Second Session
- **Setting boundaries for E-waste / WEEE assessment**

15:30 – 17:00 Third Session (with working coffee/tea)
- **Case Study**

Appendix 2


Launching Ceremony
" Waste Electronic and Electric Equipment (WEEE)/ E-Waste Management for Phnom Penh City "
10 February 2009
Phnom Penh, Kingdom of Cambodia
Supported by : UNEP


Launching Ceremony
" Waste Electronic and Electric
Equipment (WEEE)/ E-Waste
Phnom Penh City "


Launching Ceremony
February 2009
Kingdom of Cambodia
UNEP


Launching Ceremony
" Waste Electronic and Electric
Equipment (WEEE)/ E-Waste
Management for Phnom Penh City "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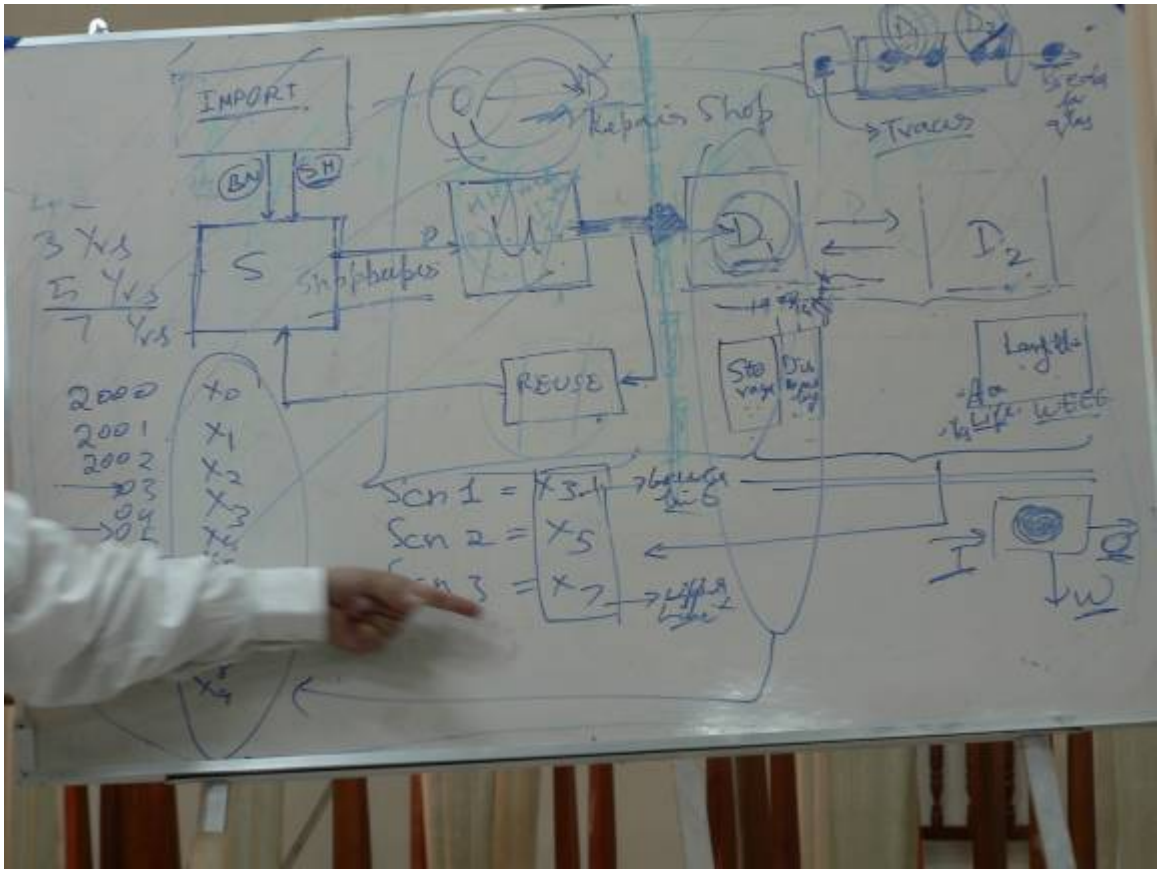

IMPORT
Repairs Shop
REUSE
Scn 1 =
Scn 2 =
Scn 3 =

Appendix 3

List of Stakeholders for Air conditioners

No	Survey date	Name of Interviewer	Position	Name of Source	Survey Type	Address	Telephone
9	28.Feb.2009	Mis. Na vy	manager	Hout Dara	Sell, Installation and Repairing	#384BEo, Mao Tse Tung Blvd, Boeung Salang, Toul Kok	012 246 266
1	26.Feb.2009	Sen Sovann	Owner shop	Sell of Air-Conditioner and refrigerator	Sell and Repair Shop	No.590Eo, St.217 Chhouk village, Tek Thla, Russey Keo	012 957 141/ 015 957 141/ 011 279 541/ 011 740 848
10	28.Feb.2009	Leng Chheang	Repairer	Long Ly Hak	Sell, Repair, Install and maintenance Air con	#64, St.271, Tropeang Samdach Monyreth Blvd, Phsar Doeum Kor, Toul Kok	012 389 745
2	26.Feb.2009	La Khav		Sell and Repair Air conditioning	Sell and Repair Shop	# 968Eo, 990Eo,Champuchea Kroum Blvd, Tpul Kok	012 33 00 53/ 016 58 58 28
3	26.Feb.2009	Prum Many	Owner shop	Mc Quay Air-conditioning	Sell and Repair	*#368Eo, Sihanouk Blvd, Sangkat Olumpic,Khan Chamkamorn*	016 890 288/ 012 818 928
4	26.Feb.2009	Pheakdey	Owner shop	Mekong Air conditioning Chhau Chhayheng	Sell, Repairing & Installing all Kind of old and New	#64, Samdech Monyreth, Toul Svay Prey, Chamkamorn	012 368 057/ 016 408 457
5	27.Feb.2009	Ouk	Mecaniscien	Nom Chhai Ya Rith	Sell, Repairing Air-conditioning	#430, Preah Sihanouk Blvd	012 910 860/ 092 343 729
6	27.Feb.2009	Tey Srorn	Mnager	Tey Srorn Buy & Sell Air-Conditioning		# 302, Preah Monyreth, Chamkamorn	012 92 32 01
7	27.Feb.2009	Heng Lim Hong	Owner	Heng LimHong Sell, Buy Repairing and Installation	Sell, Buy Repairing and Installation Air-conditioning	#63, St.271.Tek Lhla, Russey Keo	016 314 345
8	28.Feb.2009	Kim Long	owner shop	Kim Long Installation and Repair Air conditioner	Repairing and Install	#426 Eo Monivong Blvd,Sangkat Beung Keng Khang I, Chamkamorn	012 795022

List of Stakeholders for Washing Machine

No	Survey date	Name of Interviewer	Position	Name of Source	Survey Type	Address	Telephone
1	28-Feb-09	Mr. Eang	Seller	Used Items Yard	Dismentling and buying and selling	Road 1, Nirorth, ChbarAmbov, Meanchey	099 960044
2	26-Feb-09	Vy Pha	Shop owner	Vy Pha Shop	selling, repairing	No. 462, St. Kampuchea Krom, Mittapheap	012 648 977
3	27-Feb-09	Siv Hong	Shop owner	Eak Siv Hong Shop	selling, repairing	# 320Eo, St. 217, O Russey, 7Makara	012 900 528
4	26-Feb-09	Mr. Taing Saning Hak	Shop owner	Taing Saing Hak Shop	selling, repairing	# 747Eo, St. 128, Toeuk Laak I, Toul Kork	(011-012- 099) 918 518
5	26-Feb-09	Mr. Lim Cheng Hourt	Shop owner	Lim Cheng Hourt Shop	selling, repairing	# 569Eo, St. Kampuchea Crom, Phsar Depo 3, Toul Kork	015 924 373
6	26-Feb-09	Sun Yung	Shop owner	Mahamantry selling and repairing shop	selling, repairing	# 350Eo, St. Preah Sihanouk, Olympic, Chamkarmon	01 710 684
7	28-Feb-09	Mr. Chiv Vathana	Shop owner	Chive Vathan Shop	selling, repairing		012 897926
8	27-Feb-09	Chheuk Sung	son of shop owner	Kin Sung Shop	selling, repairing	# 799Eo, St. Kampuchea Krom, Teouk Laak 1, Toul Kork	012 826130
9	27-Feb-09	KY Chanthol	Shop owner	Ky Chantol Shop	selling, repairing	#301, St. Tep Phan, Toeuk Laak, Toul Kork	016 333 592

List of Stakeholders for Computers

No	Survey date	Name of Interviewer	Position	Name of Source	Survey Type	Address	Telephone
1	26, Feb, 2009		Owner Shop		Dismantling	# 13, St. 288, Sangkat Boeung Kenkung II, Chamkamon	011 890 348
2	28, Feb, 2009	Phanna	Owner Shop	High Tex Repairing Computer	Sell and Repairing	# 12, St. 488, Sangkat Phsar Doeum Thkov, Chamkamon	012 594 583
3	26, Feb, 2009	Kim Long	Owner Shop	Kim Long Computer		# 436 Eo, St.128, Sangkat Mittapheap, 7 Makara	012 881185
4	28,Feb, 2009	Heng Phally	Owner Shop	Krang Meas Computer	Selling Computer	# 11, St.2004, Sangkat Tek Thla, Russey Keo	012 911 780
5	28,Feb, 2009	Theara	Owner Shop	Thearun Computer		# 202, St. 143, Sangkat Boeung Kengkung III, Chamkamon	011 364 034
6	28, Feb, 2009	Theaneth	Retailer	Vuthy Computer		# 153, Boeung Kengkung III, Chamkamon	012 656262
7	26, Feb, 2009	Dala	Manager	Dala Computer	Selling and Repairing	# 1 A, St.105, sangkat Boeung Kengkung II, Chamkamon	012 337 769
8	26, Feb, 2009	Tula	Retailer	Thai San Computer	Selling, Repairing and Installation	# 416Eo, St. Kampuchea krom, Sangkat Mittapheap	012 488 827
9	26, Feb, 2009	Yu Dealong	Owner Shop	Junkshop	Dismentling	# 197, St.149, Sangkat tek luork II, Toul Kok	012 55 90 01

List of Stakeholders for Telephones

No	Name of Interviewer	Position	Name of Source	Survey Type	Address	Telephone
1	Phearvy	Shop Owner	Phearvy Shop	HP repair &seller's	106 Eo, St. Preah Sihanouk, Beoung Keng Kang 1, Chamkarmon.	017 312222
2	Chea Na	Owner Shop	Chea Na Phone Shop	Selling and Repairing	# 165 E1, St. 182, Phsar Depo 1, Toul Kork	012 603322
3	Tan Sophy	Owner Shop	Holiday II Selling & Repairing	Repairing & Selling	# 376, St. Kampuchea Krom, Depot 2, Toul Kork	012 99 55 88
4	Meng Theara	Seller	Leang Srim Phone Shop	Selling, Repairing	#428, St. 245, Boeung Salang, Toul Kork	012 22 57 22
5	Chhay Bunny	Owner Shop	Holiday Phone Shop	Selling, Repairing	# 510, St. Kampuchea Krom, Mithapheap, 7 Makara	012 387638
6	Sao Keary	Repairer	Kuntheary Phone Shop	Selling , Repairing	#21 Eo, St. 215, Phsar Depo 1, Toul Kork,	012 755 849
7	Long Ratha	Repairer	168 Repairing Shop	Repaing	# 166Eo, Preah Sihouk, Koeung Keng Kang 2, Chamkar Mon	016 299909
8	Heng Sophal	Shop Owner	Sophal Phone Shop	Selling and Repairing	#398, St. Mao Tse Tung, Phsar Keoum Kor,	012 333316
9	Chea Hong Ly	Shop Owner	Cheang Thy Selling and Repairing Shop	Selling and Repairing	#118, St. 230, Phsar Doeum Kor Market, Toul Kork	012 505 290
10	Bun Ly	Shop Owner	Bun Ly phone Shop	Selling and Repairing		012 305 011

List of Stakeholders for Televisions and Videos

No	Survey date	Name of Interviewer	Position	Name of Source	Survey Type	Address	Telephone
1	25, Feb, 2009	Phorn Sopheap	Retailer	Tay Seng	TV, Cassette Player	St. Souk Hok, Sangkat Ourussey, 7 makara	012 65 10 71
2	25, Feb, 2009	Seov Chea	Owner Shop	Seov Chea TV Repair			
3	26, Feb, 2009	Sen Sophann	Owner Shop	Sen Sophann Shop	Reassembling of TV	# 590, St. 128, Sangkat Tekluork 1, Toul Kok	012 473 311
4	26, Feb, 2009	Ly Ye	Owner Shop	Ly Ye Sell, Repair	TV, Cassette Player, VCD	# 814B, St 128, Sangkat Tekluor1, Toul Kok	012 850 252
5	28,Feb, 2009	Hong Oun	Owner Shop	Hong Oun TV, VCD, CD	Repair Shop	# 554, St.163, Sangkat Toul Tompoung, Cahmkamon	012 999 766
6	26, Feb, 2009	Sok	Manager	Bun Sok Repaire TV, VCD&DVD	Repair Shop	# 952, St. 128,Sangkat Tek Luork, Toul Kok	012 849 068
7	26, Feb, 2010	Kim Hong	Owner Shop	Lay Bunleng	TV, VCD, CD, Studio	# 936, St.128, Sangkat Tek Luork, Toul Kok	092 614 099
8	28, Feb, 2009	Kim Vannak	Owner Shop	Kim Vannak Rpairing All electroic	Repairing	# 793Eo, Kampuchea Krom, Sangkat Tek Luork 1, Toul kok	
9	25, Feb, 2009	Kang Hai	Owner Shop	Kang Hai Sell and Repaire TV	Sell and repairing	# 360 Eo,kampuchea krom, Tek Luork 1< Toul Kok	011 940 152
10	28, Feb, 2009	Ngourn Limchhourk	Owner Shop	Ngourn Kinchhourk Sell & Repairing	Sell and repairing TV	# 144 Eo, St. 107, Sangkat Ourussey, 7 makara	012 506 793
11	28, Feb, 2009	Keo Seng	Owner Shop	Keo Seng	TV, VCD	# 938Eo, St. 128, Sangkat Tek Luork 1 Toul Kok	012 292 088

Purchase/Use pattern of TV in the Kingdom of Cambodia

User/ Item											Business Entry & Institution																
		Household (by income level)									Hotel (By # of rooms)									Office (By # of employees)							
		High			Middle			Low			Small			Medium			Large			Small			Medium			Large	
(1) Average #of EEE currently possessed (Q1-12)		2.33			1.44			1.11			10.50			22.06			43.55			1.20			1.17			1.90	
(2) Type of EEE currently possessed (Q1-1-2)		CRT	Mono	LCD	CRT	Mono	LCD	CRT	Mono	LCD	CRT	Mono	LCD	CRT	Mono	LCD	CRT	Mono	LCD	CRT	Mono	LCD	CRT	Mono	LCD	CRT	Mono	LCD
		98.44 %	0%	1.56%	95.26%	3.16%	1.58 %	96.70 %	3.30 %	0 %	100 %	0 %	0 %	100 %	0 %	0 %	99.37 %	0 %	0.63 %	97.54 %	0.82 %	1.64 %	100 %	0 %	0 %	100 %	0 %	0 %
(3) Ratio of imported EEE to total EEE currently possessed (Q1-2-2)		100 %			100 %			100 %			100 %			100 %			100 %			100 %			100 %			100 %		
(4) Average duration for used of discarded EEE (in year) (Q1-2-01) and (Q1-2-3)	Branch-New	4			6			6			6			6			6			7			6			5		
	Second-hand	3			4			-			4			3			4			-			-			4		
(5) Way to obtain EEE currently possessed (Q1-2-4)		B	G	O	B	G	O	B	G	O	B	G	O	B	G	O	B	G	O	B	G	O	B	G	O	B	G	O
		97.54%	2.46%	-	98.97%	1.03%	-	100%	-	-	100%	-	-	100%	-	-	100%	-	-	99.07%	-	0.93%	100%	-	-	100%	-	-
(6) Ratio of second- hand and branch-new EEE possessed (Q1-2-5) and		N	S		N	S		N	S		N	S		N	S		N	S		N	S		N	S		N	S	
		89.34%	10.96%		82.01%	17.98%		75.56%	24.44%		53.97%	46.03%		67.46%	32.54%		81.23%	18.77%		79.82%	20.18%		88.24%	11.76%		90%	10%	
(7) Disposal method (Q1-2-6)	Discarded	100%			91.58%			88.89%			89.47%			63.16%			97.66%			92.86%			50%			14.23%		
	Currently possessed	-			8.42%			11.11%			10.53%			36.84%			2.34%			7.14%			50%			85.71%		

Legend: B=Bought
G= given to someone
N= Brand-New
S= Second-hand
O= Others

Purchase/Use pattern of Computer in the Kingdom of Cambodia

User/ Item											Business Entry & Institution																	
		Household (by income level)									Hotel (By # of rooms)									Office (By # of employees)								
		High			Middle			Low			Small			Medium			Large			Small			Medium			Large		
(1) Average #of EEE currently possessed (Q1-12)		1.15			0.59			0.13			0.50			0.94			0.15			6.84			5.90			12.45		
(2) Type of EEE currently possessed (Q1-1-2)		CRT	Mono	LCD	CRT	Mono	LCD	CRT	Mono	LCD	CRT	Mono	LCD	CRT	Mono	LCD	CRT	Mono	LCD	CRT	Mono	LCD	CRT	Mono	LCD	CRT	Mono	LCD
		75 %	15.63%	9.37%	80.52%	7.14%	12.34 %	100 %	-	-	100 %	-	-	80 %	20 %	-	80 %	20 %	-	82.45 %	16.70 %	0.85 %	93.02 %	4.46%	2.23 %	76.94 %	7.25 %	15.81 %
(3) Ratio of imported EEE to total EEE currently possessed (Q1-2-2)		100 %			100 %			100 %			100 %			100 %			100 %			100 %			100 %			100 %		
(4) Average duration for used of discarded EEE (in year) (Q1-2-01) and (Q1-2-3)	Branch-New	5			5			-			-			3			5			5			3			4		
	Second-hand	3			2			-			-			3			-			3			2			2		
(5) Way to obtain EEE currently possessed (Q1-2-4)		B	L	O	B	L	O	B	L	O	B	L	O	B	L	O	B	L	O	B	L	O	B	L	O	B	L	O
		92.21%	7.79%	-	96.25%	3.75%	-	100%	-	-	100%	-	-	100%	-	-	100%	-	-	92.18%	0.16%	0.66%	93.36%	6.64%	-	91.01%	6.27%	2.72%
(6) Ratio of second-hand and branch-new EEE possessed (Q1-2-5) and		N	S		N	S		N	S		N	S		N	S		N	S		N	S		N	S		N	S	
		68.66%	31.34%		54.29%	45.71%		66.67%	33.33%		80%	20%		88.89%	11.11%		76.47%	23.53%		48.07%	51.93%		68.13%	31.87%		80.79%	19.21%	
(7) Disposal method (Q1-2-6)	Discarded	82.35%			94.12%			-			-			66.67%			40%			56%			79.31%			90.67%		
	Currently possessed	17.65%			5.88%			-			-			33.33%			60%			44%			2.69%			9.33%		

Purchase/Use pattern of Mobile phone in the Kingdom of Cambodia

User/ Item		Household (by income level)									Business Entry & Institution			Hotel (By # of rooms)						Office (By # of employees)								
		High			Middle			Low			Small			Medium			Large			Small			Medium			Large		
(1) Average #of EEE currently possessed (Q1-12)		3.97			2.63			1.3			0.75			1.13			4.33			0.84			1.83			3.84		
(2) Type of EEE currently possessed (Q1-1-2)																												
(3) Ratio of imported EEE to total EEE currently possessed (Q1-2-2)		100 %			100 %			100 %			100 %			100 %			100 %			100 %			100 %			100 %		
(4) Average duration for used of discarded EEE (in year) (Q1-2-01) and (Q1-2-3)	Branch-New	3			3			2			2			3			5			3			3			4		
	Second-hand	3			2			2			-			-			-			3			2			2		
(5) Way to obtain EEE currently possessed (Q1-2-4)		B	L	O	B	L	O	B	L	O	B	L	O	B	L	O	B	L	O	B	L	O	B	L	O	B	L	O
		98.45%	1.55%	-	98.61%	1.39%	-	100%	-	-	100%	-	-	100%	-	-	97.78%	-	-	98.85%	-	1.15%	96.23%	3.77%	-	97.56%	-	2.44
(6) Ratio of second-hand and branch-new EEE possessed (Q1-2-5) and		N	S		N	S		N	S		N	S		N	S		N	S		N	S		N	S		N	S	
		91.28%	8.72%		84.49%	15.01%		77.08%	22.92%		100%	-		94.73%	5.27%		94.87%	2.13%		92.05%	70.95%		98.11%	1.89%		91.80%	8.20%	
(7) Disposal method (Q1-2-6)	Discarded	93.40%			95.81%			96.97%			100%			100%			66.67%			100%			91.67%			86.67%		
	Currently possessed	6.60%			4.19%			3.03%			-			-			33.33%			-			8.33%			13.33%		

Purchase/Use pattern of Refrigerator in the Kingdom of Cambodia

User/ Item		Household (by income level)									Business Entry & Institution			Hotel (By # of rooms)						Office (By # of employees)								
		High			Middle			Low			Small			Medium			Large			Small			Medium			Large		
(1) Average #of EEE currently possessed (Q1-12)		0.93			0.35			0.05			0.83			9.38			35.89			0.520			0.79			1.03		
(2) Type of EEE currently possessed (Q1-1-2)																												
(3) Ratio of imported EEE to total EEE currently possessed (Q1-2-2)		100 %			100 %			100 %			100 %			100 %			100 %			100 %			100 %			100 %		
(4) Average duration for used of discarded EEE (in year) (Q1-2-01) and (Q1-2-3)	Branch-New	4			6			-			-			-			4			5			-			5		
	Second-hand	3			3			-			-			2			-			3			-			-		
(5) Way to obtain EEE currently possessed (Q1-2-4)		B	L	O	B	L	O	B	L	O	B	L	O	B	L	O	B	L	O	B	L	O	B	L	O	B	L	O
		98.21%	1.79%	-	94.85%	5.15%	-	100%	-	-	100%	-	-	100%	-	-	99.08%	-	0.92%	100%	-	-	100%	-	-	97.30%	2.70%	-
(6) Ratio of second-hand and branch-new EEE possessed (Q1-2-5) and		N	S		N	S		N	S		N	S		N	S		N	S		N	S		N	S		N	S	
		94.64%	5.36%		82.47%	17.53%		100%	-		70%	30%		79.49%	20.51%		93.20	6.80%		92%	8%		95.65%	4.35%		97.22%	2.78%	
(7) Disposal method (Q1-2-6)	Discarded	88.23%			57.14%			-			-			100%			92.69%			100%			-			100%		
	Currently possessed	11.77%			42.86%			-			-			-			7.31%			-			-			-		

Purchase/Use pattern of Air-Conditioner in the Kingdom of Cambodia

User/ Item		Household (by income level)									Business Entry & Institution			Hotel (By # of rooms)						Office (By # of employees)								
		High			Middle			Low			Small			Medium			Large			Small			Medium			Large		
(1) Average #of EEE currently possessed (Q1-12)		1.41			0.18			0			4			17.69			39.81			1.26			2.90			5.68		
(2) Type of EEE currently possessed (Q1-1-2)																												
(3) Ratio of imported EEE to total EEE currently possessed (Q1-2-2)		100 %			100 %			100 %			100 %			100 %			100 %			100 %			100 %			100 %		
(4) Average duration for used of discarded EEE (in year) (Q1-2-01) and (Q1-2-3)	Branch-New	5			-			-			3			4			8			7			4			4		
	Second-hand	3			2			-			-			3			4			-			2			4		
(5) Way to obtain EEE currently possessed (Q1-2-4)		B	L	O	B	L	O	B	L	O	B	L	O	B	L	O	B	L	O	B	L	O	B	L	O	B	L	O
		100%	-	-	97.96%	2.04%	-	-	-	-	100%	-	-	100%	-	-	100%	-	-	97.17%	2.83%	-	100%	-	-	83.52%	14.77%	1.71%
(6) Ratio of second-hand and branch-new EEE possessed (Q1-2-5) and		N	S		N	S		N	S		N	S		N	S		N	S		N	S		N	S		N	S	
		94.67%	5.53%		83.33%	16.67%		-	-		65.96%	34.04%		66.30%	33.70%		92.89%	7.11%		80.36%	19.64%		72.09%	27.91%		84.15%	15.85%	
(7) Disposal method (Q1-2-6)	Discarded	100%			-			-			100%			100%			94.97%			66.67%			86.67%			87.50%		
	Currently possessed	-			100%			-			-			-			5.03%			33.33%			13.33%			12.50%		

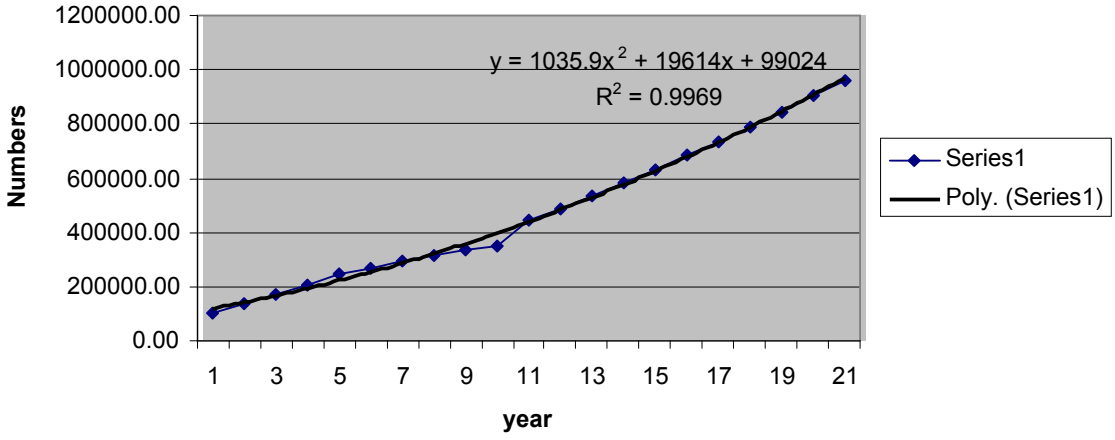
Appendix 5

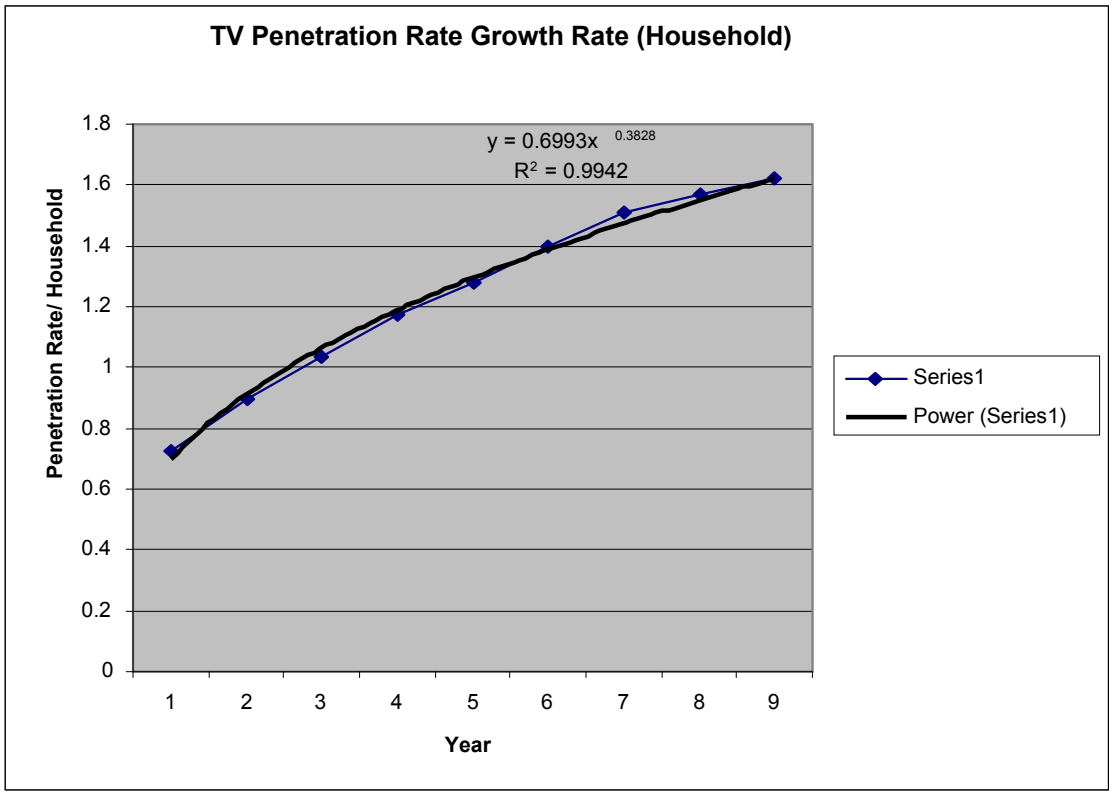
1.0 Television

Household Installed Base (numbers) and Penetration Rate of TV in PPM

Year	Population	TVs Added	Installed Base (TV)	Penetration Rate TV per Household
1995	814171		49505.10	0.304021514
1996	822993		63939.60	0.388457739
1997	822304		80445.90	0.48914939
1998	999804		99024.00	0.495217063
1999	936767		103052.00	0.550040725
2000	952429	157,096	137613.12	0.722432433
2001	963165	162,557	172174.24	0.893794106
2002	1005632	163,663	207936.78	1.033861194
2003	1042108	114,390	243942.64	1.170428785
2004	1050616	126,755	269108.44	1.280717408
2005	1063856	95,269	296994.54	1.395839945
2006	1052974	86,438	317953.72	1.509789036
2007	1072258	60,529	336970.08	1.571310636
2008	1080519	48,373	350286.46	1.620917633
2009	1107532		443232.12	2.000990189
2010	1135220		488596.25	2.151988746
2011	1163601		535202.34	2.299767882
2013	1192691		583143.96	2.444656924
2014	1222508		632508.29	2.586928878
2015	1253071		683378.03	2.726813386
2016	1284398		735832.90	2.864506038
2017	1316507		789950.63	3.000175229
2018	1349420		845807.74	3.133967313
2019	1383156		903480.20	3.266010547
2020	1417735		963043.88	3.396418165

Household Installed Base TV (Number)

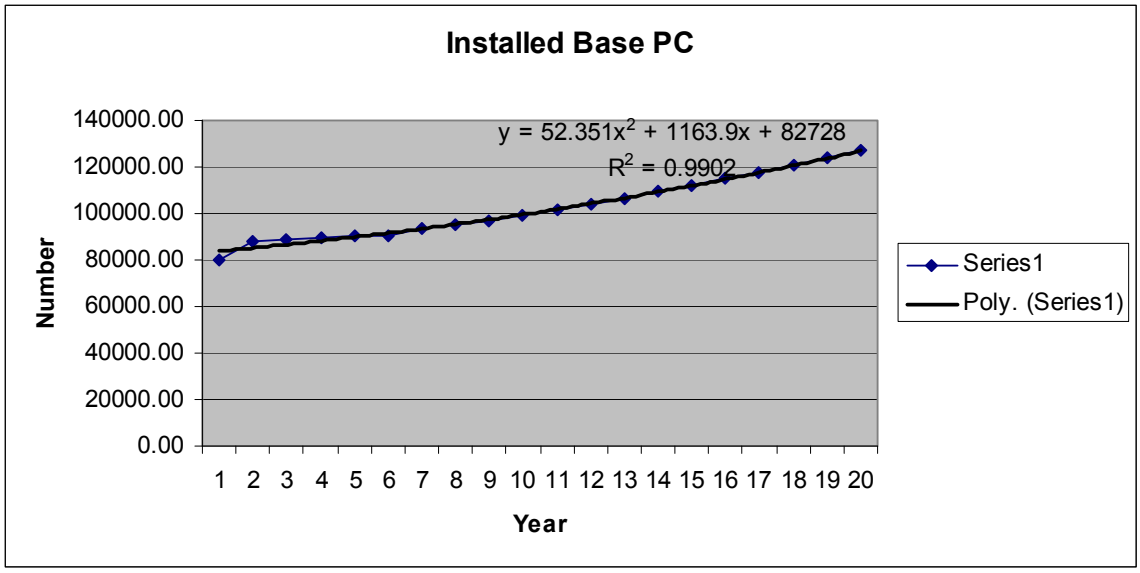



TV Penetration Rate Growth Rate (Household)
y = 0.6993x 0.3828
R² = 0.9942
Penetration Rate/ Household
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1
2
3
4
5
6
7
8
9
Year
Series1
Power (Series1)

2.0 Personal Computer

Household Installed Base (numbers) and Penetration Rate of PCs in PPM

Year	Population	TVs Added	PCs Added	Installed Base (PC)	Penetration Rate PCs per capita
1992					
1993	717300			77629.24	0.11
1994				78217.28	
1995	814171			78910.02	0.10
1996	822993			79707.46	0.10
1997	822304			80609.60	0.10
1998	999804			81616.45	0.08
1999	936767			82728.00	0.09
2000	952429		26,342	79762.65	0.08
2001	963165		1,863	88192.09	0.09
2002	1005632		1,990	88788.25	0.09
2003	1042108		1,852	89425.05	0.09
2004	1050616		1,514	90017.69	0.09
2005	1063856		9,381	90502.17	0.09
2006	1052974		3,115	93504.09	0.12
2007	1072258		5,288	95196.25	0.09
2008	1080519		4,654	96685.53	0.09
2009	1107532			99102.67	0.12
2010	1135220			101580.24	0.12
2011	1163601			104119.74	0.12
2013	1192691			106722.74	0.12
2014	1222508			109390.80	0.12
2015	1253071			112125.57	0.12
2016	1284398			114928.71	0.12
2017	1316507			117801.93	0.12
2018	1349420			120746.98	0.12
2019	1383156			123765.65	0.12
2020	1417735			126859.80	0.12


Installed Base PC
y = 52.351x2 + 1163.9x + 82728
R2 = 0.9902
140000.00
120000.00
100000.00
80000.00
60000.00
40000.00
20000.00
0.00
Number
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Year
Series1
Poly. (Series1)

3.0 Mobile Phones

Comparison of MP data

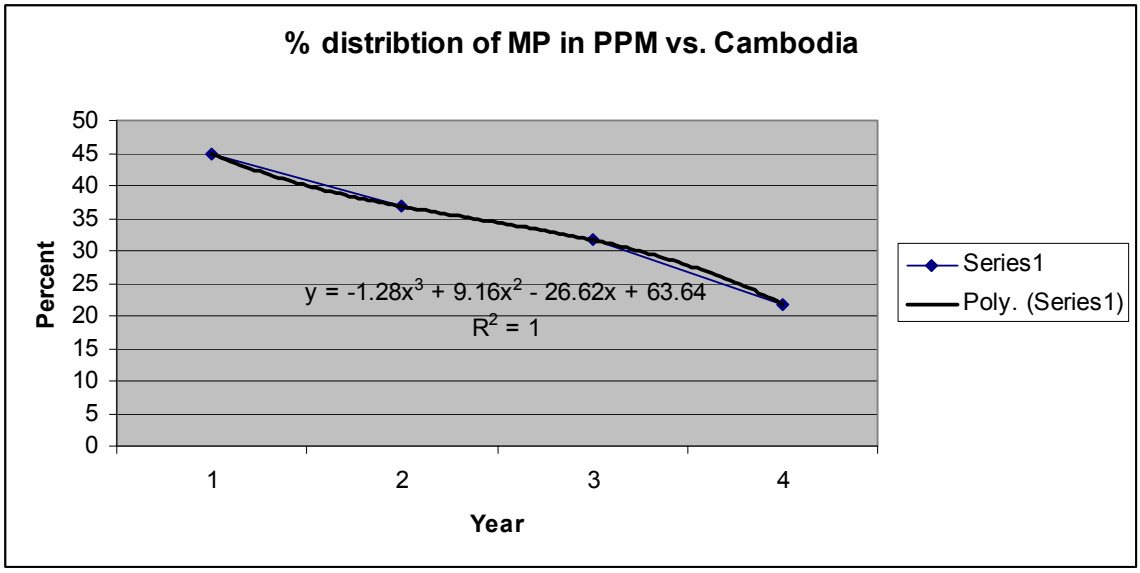
Year	MPs Added*	Installed Base of MP `in Cambodia+
1999		
2000	1,486	
2001	1,407	223458
2002	7,356	321621
2003	12,222	489504
2004	142,990	659324
2005	113,605	840916

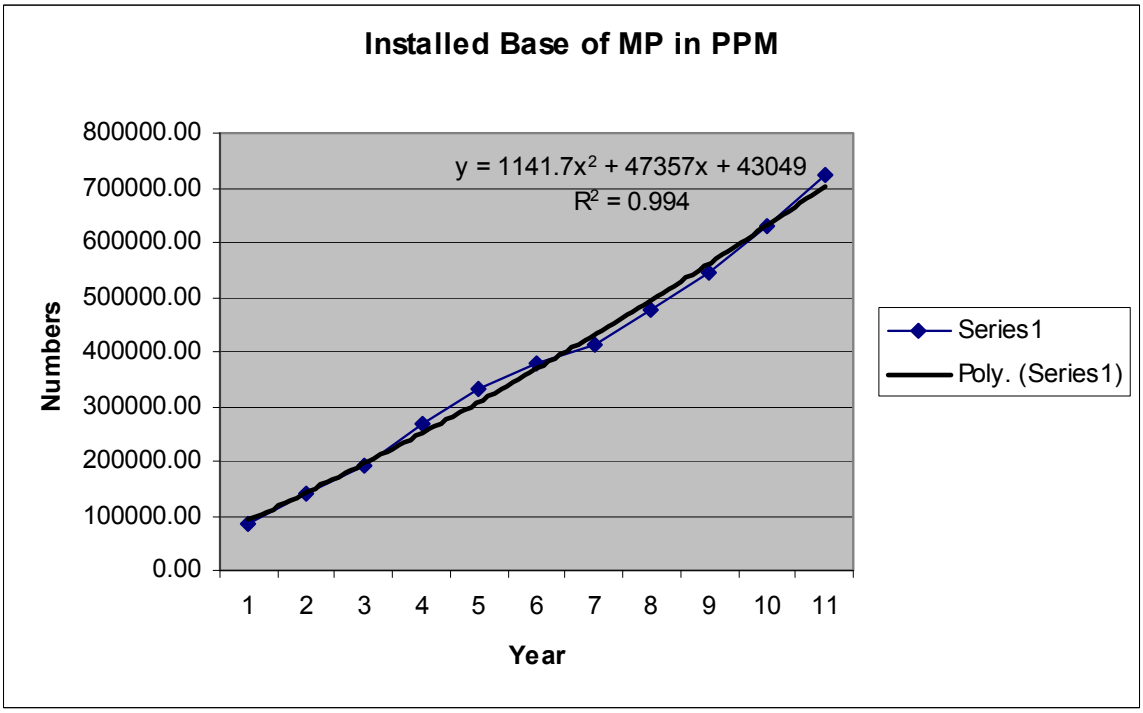
* Data from department of Kam Control

\+ Data from MoPT

Household Installed Base (numbers) and Penetration Rate of MPs in PPM

Year	Population	Installed Base (MP)	Penetration Rate MPs per capita
2000	952429	83200.00	0.0873556
2001	963165	138543.96	0.1438424
2002	1005632	189756.39	0.1886937
2003	1042108	269227.20	0.2583487
2004	1050616	330980.65	0.3150348
2005	1063856	380627.75	0.3577813
2006	1052974	412976.40	0.53
2007	1072258	474922.86	0.4429185
2008	1080519	546161.29	0.505462
2009	1107532	628085.49	0.5671037
2010	1135220	722298.31	0.6362627
2011	1163601	775737.80	0.6666701
2013	1192691	851637.30	0.714047
2014	1222508	929820.20	0.7605841
2015	1253071	1010286.50	0.8062486
2016	1284398	1093036.20	0.8510108
2017	1316507	1178069.30	0.8948444
2018	1349420	1265385.80	0.9377256
2019	1383156	1354985.70	0.9796335

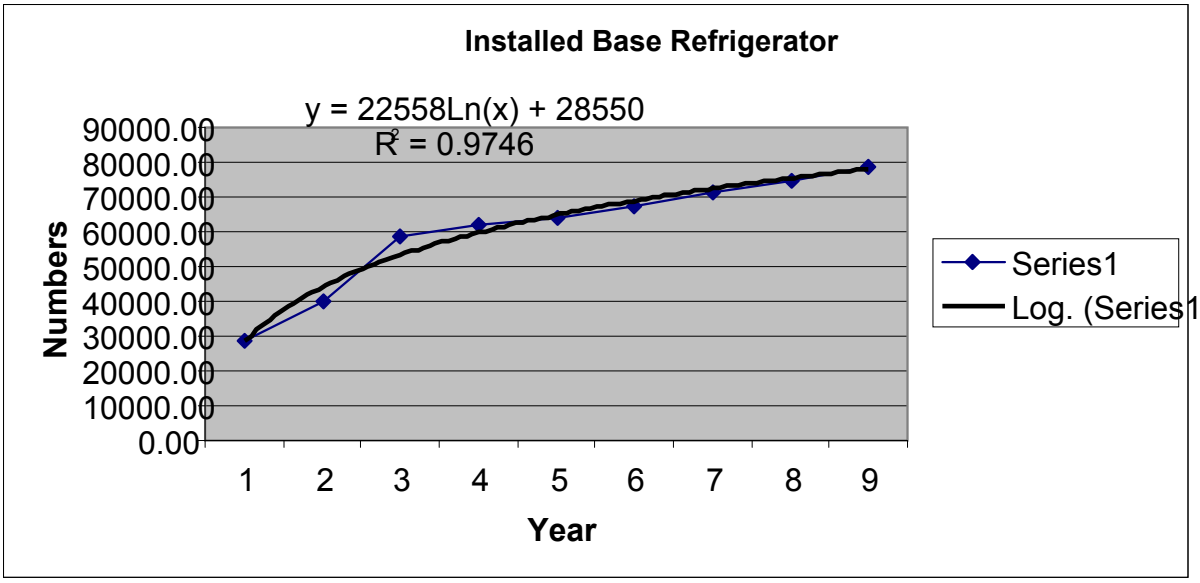

% distribtion of MP in PPM vs. Cambodia
Percent
50
45
40
35
30
25
20
15
10
5
0
1
2
3
4
Year
y = -1.28x3 + 9.16x2 - 26.62x + 63.64
R2 = 1
Series1
Poly. (Series1)

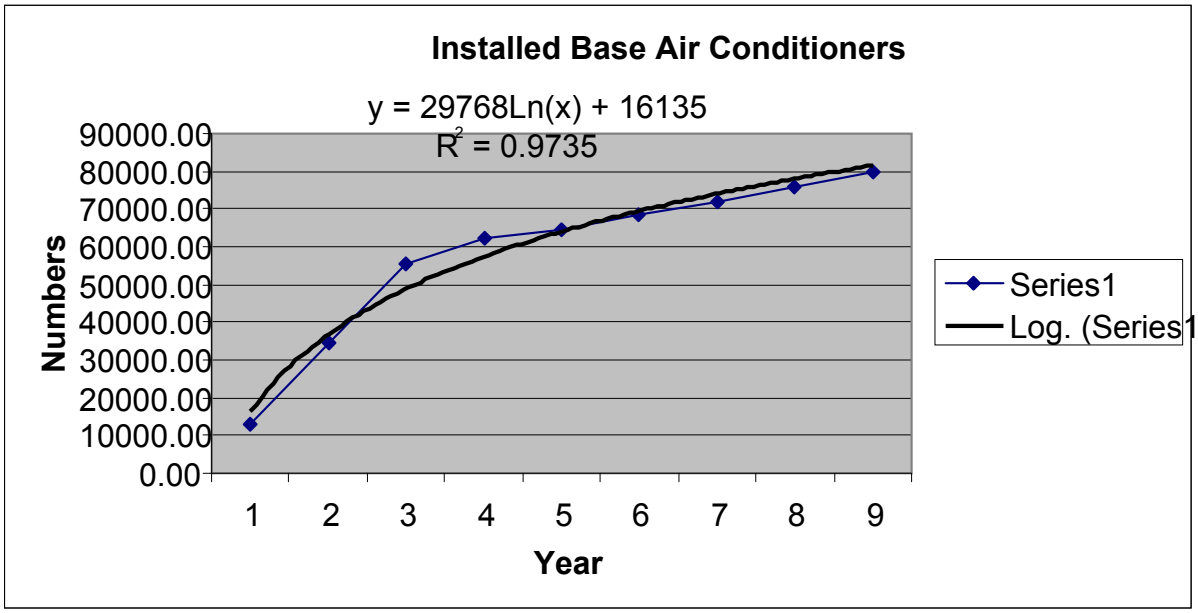

Installed Base of MP in PPM
Numbers
800000.00
700000.00
600000.00
500000.00
400000.00
300000.00
200000.00
100000.00
0.00
1
2
3
4
5
6
7
8
9
10
11
Year
y = 1141.7x2 + 47357x + 43049
R2 = 0.994
Series1
Poly. (Series1)

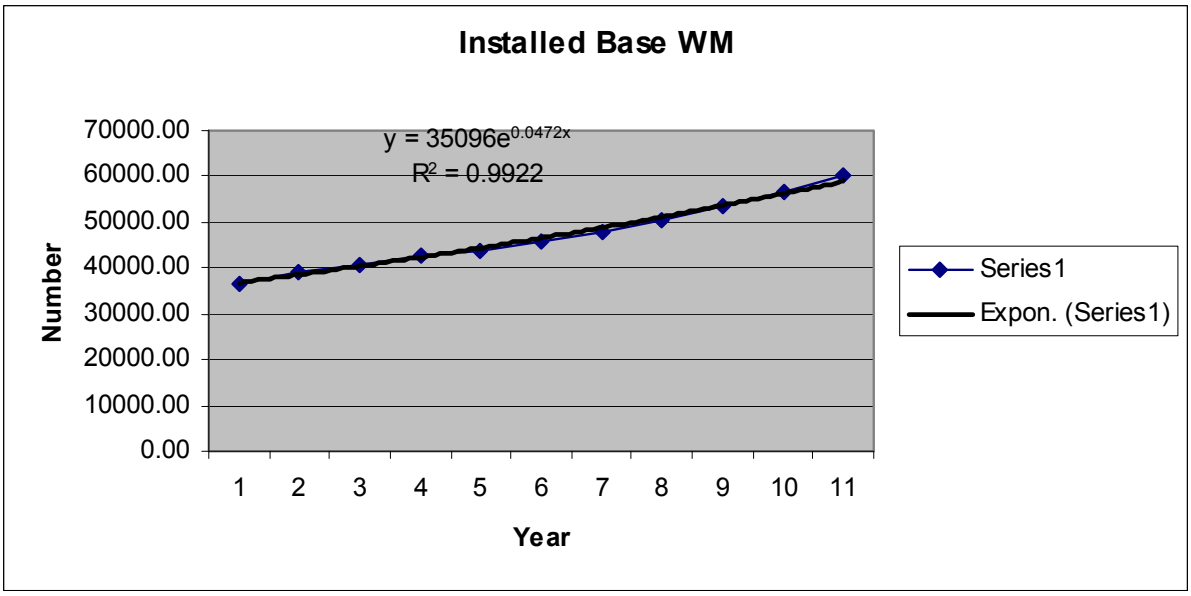
4.0 Refrigerators, Air Conditioners and Washing Machine

Year	Population	Ref Added	Installed Base (Ref)	Penetration Rate Ref (Household)	Air Con Added	Installed Base (Air Con)	Penetration Rate Air Con per capita	WM Added	Installed Base (WM)	Penetration Rate WMs per capita
1993	717300		13789.38						24058.47	
1994	793817		15825.53						25221.26	
1995	814171		16811.00			7555.51			26440.24	
1996	822993		17579.13			7900.73			27718.14	
1997	822304		18149.89			8157.26			29057.81	
1998	999804		22779.53			10237.99			30462.22	
1999	936767		22010.28			9892.26			31934.51	
2000	952429		23056.40		28,408	10362.43		529	33477.96	
2001	963165		24002.07		26,450	10787.45		5,697	35096.00	
2002	1005632		25776.36		44,920	11584.88		20,404	36641.73	
2003	1042108		27453.29		36,698	12338.56		11,554	39244.08	
2004	1050616		28425.47	0.178	15,070	12775.49	0.08	10,519	40882.70	0.19
2005	1063856		40325.61	0.242981634	19,331	34596.49	0.208460917	12,213	42764.64	0.2028
2006	1052974		58859.39	0.38	23,114	55597.03	0.33	8,209	43713.90	0.21
2007	1072258		61706.93		43,924	62411.91		8,714	45971.00	
2008	1080519		63984.34		22,443	64742.04		6,034	47835.54	
2009	1107532		67456.36			68278.35			50630.73	
2010	1135220		71106.38			72002.48			53596.48	
2011	1163601		74925.88			75895.84			56736.49	
2012	1192691		78935.37			79992.70			60075.64	
2013	1222508		80412.60			83814.74			61836.09	
2014	1253071		82547.46			86485.42			64824.73	
2015	1284398		84496.42			88923.57			67957.82	
2016	1316507		86289.30			91166.45			71242.33	
2017	1349420		87949.25			93243.03			74685.59	
2018	1383156		89494.62			95176.27			78295.27	
2019	1417735		90940.21			96984.71			82079.41	

Household Installed Base (numbers) and Penetration Rate of refrigerators, air conditioners and washing machine in PPM







Installed Base of EEE in Hotels in PPM

Year	TVs	PCs	Aircon	Ref	MP
1993		26		825	
1994		28		900	
1995	1110	31	1279	982	
1996	1211	33	1396	1071	
1997	1322	36	1523	1169	
1998	1442	40	1661	1275	
1999	1573	43	1812	1391	
2000	1716	47	1977	1517	
2001	1872	51	2156	1655	
2002	2042	56	2352	1806	
2003	2227	61	2566	1970	
2004	2430	67	2799	2149	
2005	2651	73	3054	2344	
2006	2892	79	3331	2557	
2007	3169	87	3651	2803	385
2008	3429	94	3950	3032	416
2009	3731	103	4298	3299	453
2010	4072	112	4692	3601	494
2011	4453	122	5131	3938	541
2012	4874	134	5615	4310	592
2013	5334	147	6145	4717	647
2014	5833	160	6721	5159	708
2015	6372	175	7342	5635	773
2016	6951	191	8008	6147	844
2017	7569	208	8720	6693	919
2018	8226	226	9478	7275	999
2019	8923	245	10281	7891	1083

Installed Base of EEE in Companies/ Offices in PPM

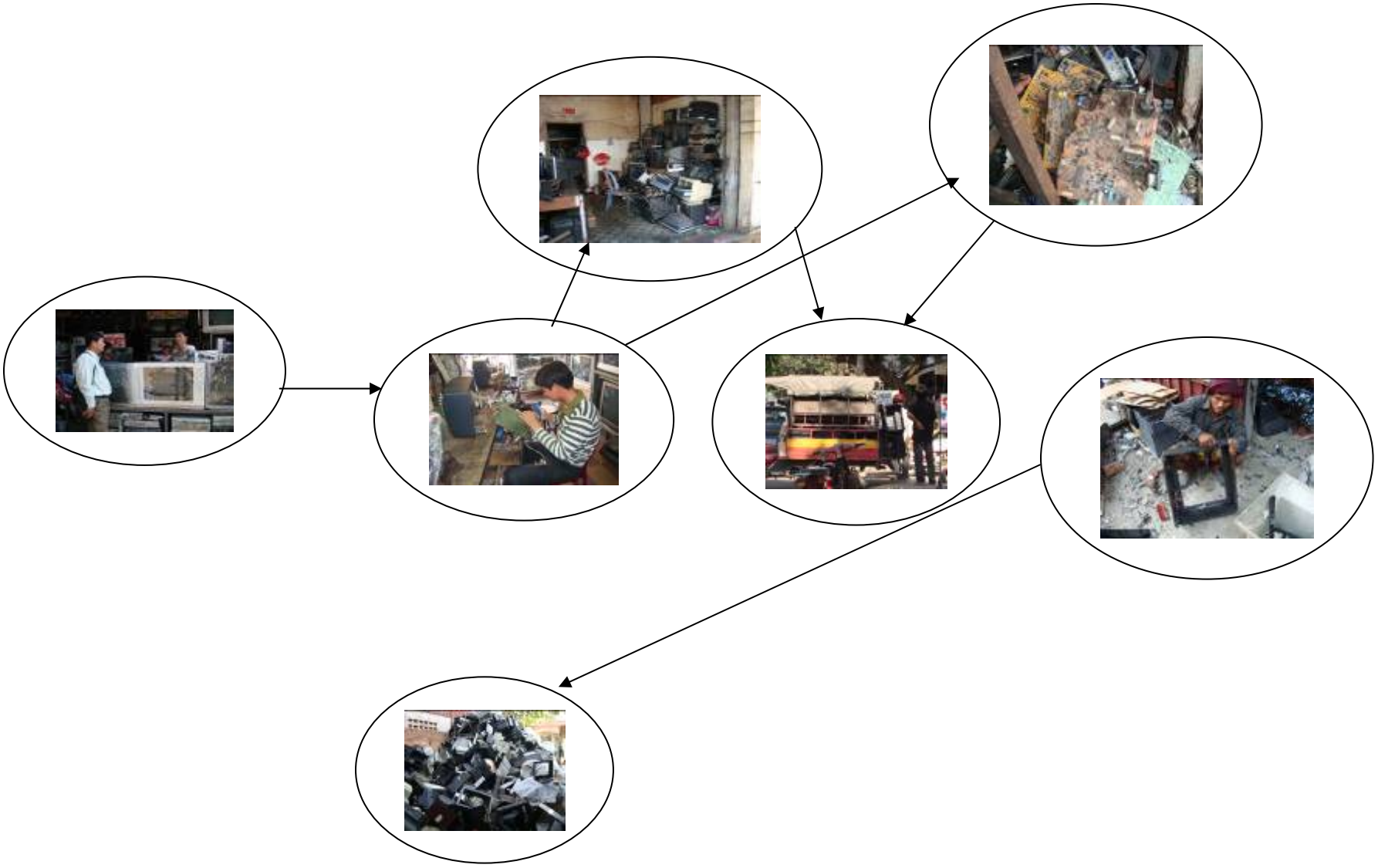
Year	TVs	PCs	Aircon	Ref	MP
1993		21100.80		1849.44	
1994		22260.43		1951.08	
1995	3783.19	23483.80	9901.27	2058.31	
1996	3991.10	24774.40	10445.41	2171.43	
1997	4210.44	26135.92	11019.46	2290.76	
1998	4441.83	27572.27	11625.06	2416.66	
1999	4685.94	29087.56	12263.93	2549.47	
2000	4943.47	30686.13	12937.92	2689.58	
2001	5215.15	32372.55	13648.95	2837.39	
2002	5501.76	34151.64	14399.06	2993.32	
2003	5804.12	36028.52	15190.39	3157.83	
2004	6123.09	38008.53	16025.21	3331.37	
2005	6459.60	40097.37	16905.90	3514.46	
2006	6814.60	42301.00	17835.00	3707.60	
2007	7189.43	44627.86	18815.43	3911.51	12862.40
2008	7584.85	47082.39	19850.28	4126.64	13569.84
2009	8002.02	49671.92	20942.04	4353.60	14316.18
2010	8442.13	52403.88	22093.85	4593.05	15103.57
2011	8906.45	55286.09	23309.02	4845.67	15934.26
2012	9396.30	58326.82	24591.01	5112.18	16810.65
2013	9913.10	61534.80	25943.52	5393.35	17735.23
2014	10458.32	64919.21	27370.41	5689.99	18710.67
2015	11033.53	68489.77	28875.78	6002.94	19739.76
2016	11640.37	72256.71	30463.95	6333.10	20825.45
2017	12280.59	76230.83	32139.47	6681.42	21970.85
2018	12956.02	80423.52	33907.14	7048.90	23179.24
2019	13668.60	84846.82	35772.03	7436.58	24454.10

Appendix 6

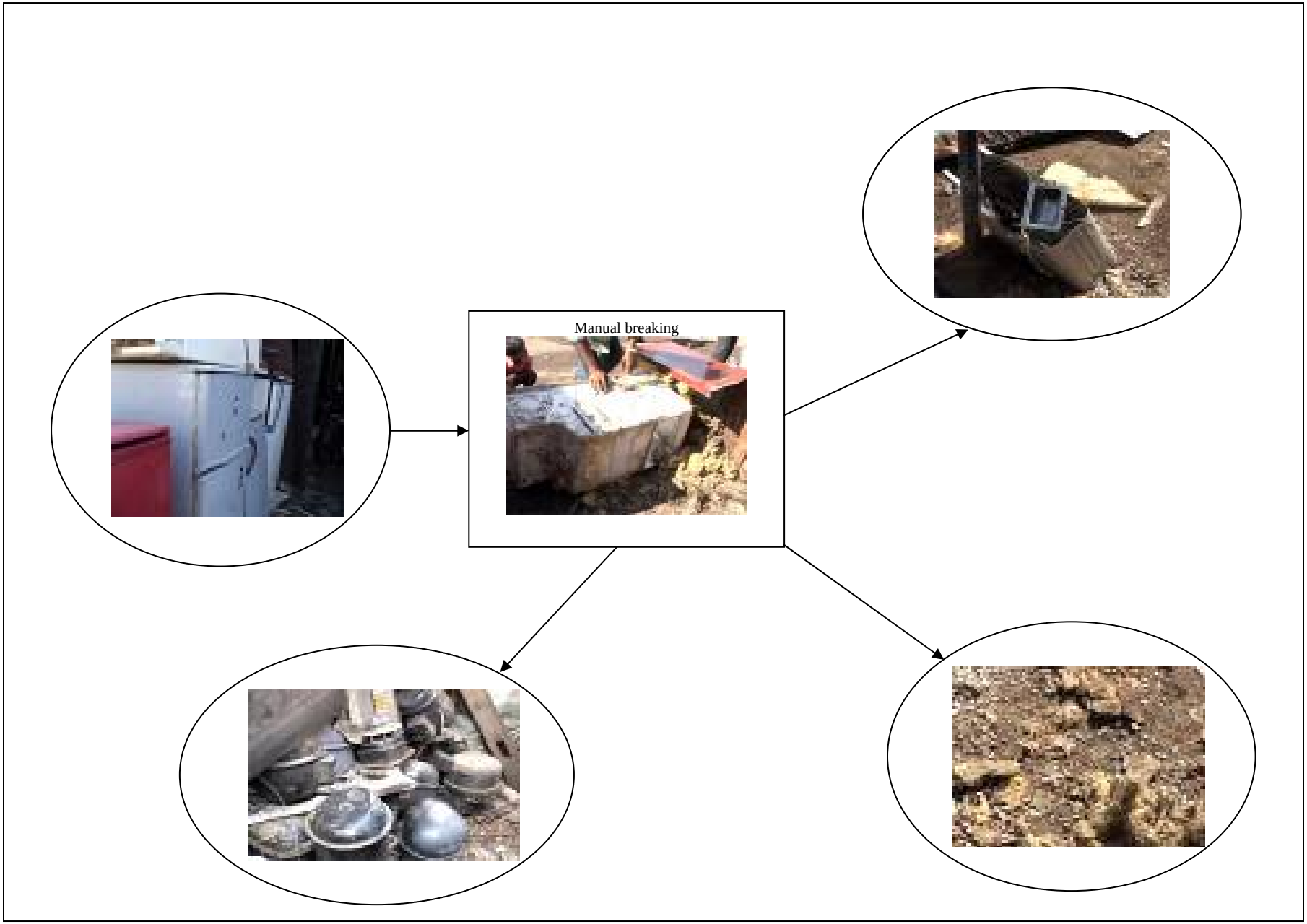
Tracer – Mobile Phones

Tracer – Washing Machines – Extraction of Motors

Tracer – Television / Personal Computer – Extraction of CRT



Tracer – Refrigerator / Air Conditioners– Extraction of Compressor



Appendix 7

Survey of TV Repair Centers

S. No	Name of Interviewer	Position	Name of Source	Survey Type	Address	Number of sets/ month
1	Phorn Sopheap	Retaller	Tay Seng	TV, Casset Player	St. Souk Hok, Sangkat Ourussey, 7 makara	30
2	Seov Chea	Owner Shop	Seov Chea TV Repair			60
3	Sen Sophann	Owner Shop	Sen Sophann Shop	Reassembling of TV	# 590, St. 128, Sangkat Tekluork 1, Toul Kok	90
4	Ly Ye	Owner Shop	Ly Ye Sell, Repair	TV, Casset Player, VCD	# 814B, St 128, Sangkat Tekluor1, Toul Kok	6
5	Hong Oun	Owner Shop	Hong Oun TV, VCD, CD	Repaire Shop	# 554, St.163, Sangkat Toul Tompoung, Cahmkamon	10
6	Sok	Manager	Bun Sok Repaire TV, VCD&DVD	Repaire Shop	# 952, St. 128,Sangkat Tek Luork, Toul Kok	300
7	Kim Hong	Owner Shop	Lay Bunleng	TV, VCD, CD, Stadio	# 936, St.128, Sangkat Tek Luork, Toul Kok	20
8	Kim Vannak	Owner Shop	Kim Vannak Rpairing All electroic	Repairing	# 793Eo, Kampuchea Krom, Sangkat Tek Luork 1, Toul kok	50
9	Kang Hai	Owner Shop	Kang Hai Sell and Repaire TV	Sell and repairing	# 360 Eo,kampuchea krom, Tek Luork 1< Toul Kok	30
10	Ngourn Limchhourk	Owner Shop	Ngourn Kinchhourk Sell & Repairing	Sell and repairing TV	# 144 Eo, St. 107, Sangkat Ourussey, 7 makara	45
11	Keo Seng	Owner Shop	Keo Seng	TV, VCD	# 938Eo, St. 128, Sangkat Tek Luork 1 Toul Kok	15

Survey of Computer Repair Centers

S. No.	Name of Interviewer	Position	Name of Source	Survey Type	Address	Quantity(Sets/month)
1.		Owner Shop		Dismentling	# 13, St. 288, Sangkat Boeung Kenkung II, Chamkamon	30
2.	Phanna	Owner Shop	High Tex Repairing Computer	Sell and Repairing	# 12, St. 488, Sangkat Phsar Doeum Thkov, Chamkamon	50
3.	Kim Long	Owner Shop	Kim Long Computor		# 436 Eo, St.128, Sangkat Mittapheap, 7 Makara	10
4.	Heng Phally	Owner Shop	Krang Meas Computer	Selling Computer	# 11, St.2004, Sangkat Tek Thla, Russey Keo	15
5.	Theara	Owner Shop	Thearun Computer		# 202, St. 143, Sangkat Boeung Kengkung III, Chamkamon	20
6.	Theaneth	Retaller	Vuthy Computer		# 153, Boeung Kengkung III, Chamkamon	240
7.	Tula	Retaller	Thai San Computer	Selling, Repairing and Installation	# 416Eo, St. Kampuchea krom, Sangkat Mittapheap	150
8.	Yu Dealong	Owner Shop	Junkshop	Dismentling	# 197, St.149, Sangkat tek luork II, Toul Kok	10

Survey of MP Repair Centers

S. No.	Name of Interviewer	Position	Name of Source	Survey Type	Address	Quantity (number)
1.	Phearvy	Shop Owner	Phearvy Shop	HP repair &seller's	106 Eo, St. Preah Sihanouk, Beoung Keng Kang 1, Chamkarmon.	4-10/day
2.	Chea Na	Owner Shop	Chea Na Phone Shop	Selling and Repairing	# 165 E1, St. 182, Phsar Depo 1, Toul Kork	5 /day
3.	Tan Sophy	Owner Shop	Holiday II Selling & Repairing	Repairing & Selling	# 376, St. Kampuchea Krom, Depot 2, Toul Kork	3-10 set /day
4.	Meng Theara	Seller	Leang Srim Phone Shop	Selling, Repairing	#428, St. 245, Boeung Salang, Toul Kork	10-15 set/day
5.	Chhay Bunny	Owner Shop	Holiday Phone Shop	Selling, Repairing	# 510, St. Kampuchea Krom, Mithapheap, 7 Makara	10 set /day
6.	Sao Keary	Repairer	Kuntheary Phone Shop	Selling , Repairing	#21 Eo, St. 215, Phsar Depo 1, Toul Kork,	30 Set /day
7.	Long Ratha	Repairer	168 Repairing Shop	Repaing	# 166Eo, Preah Sihouk, Koeung Keng Kang 2, Chamkar Mon	60 sets/month
8.	Heng Sophal	Shop Owner	Sophal Phone Shop	Selling and Repairing	#398, St. Mao Tse Tung, Phsar Keoum Kor,	30 sets/ month
9.	Chea Hong Ly	Shop Owner	Cheang Thy Selling and Repairing Shop	Selling and Repairing	#118, St. 230, Phsar Doeum Kor Market, Toul Kork	10 sets/month
10.	Bun Ly	Shop Owner	Bun Ly phone Shop	Selling and Repairing		120 sets/ month

Survey of Refrigerator Repair Centers

S. No.	Position	Name of Source	Survey Type	Address	Quantity/ month
1.	Owner shop	Sell of Air-Conditioner and refrigerator	Sell and Repair Shop	No.590Eo, St.217 Samdach Monyreth Blvd, Phsar Doeum Kor, Toul Kok	5
2.		Sell and Repaire Airconditioner	Sell and Repaire Shop	# 968Eo, 990Eo,Champuchea Kroum Blvd, Tpul Kok	0
3.	Owner shop	Mc Quay Airconditioning	Sell and Repaire	*#368Eo, Sihanouk Blvd, Sangkat Olumpic,Khan Chamkamorn*	0
4.	Owner shop	Mekong Airconditioning Chhau Chhayheng	Sell, Repairing & Installing all Kind of old and New	#64, Samdech Monyreth, Toul Svay Prey, Chamkamorn	0
5.	Mechanic	Nom Chhai Ya Rith	Sell, Repairing Ariconditioning	#430, Preah Sihanouk Blvd	0
6.	Manager	Tey Srorn Buy & Sell AriConditioning		# 302, Preah Monyreth, Chamkamorn	1
7.	Owner	Heng LimHong Sell, Buy Repairing and Instalation	Sell, Buy Repairing and Instalation Airconditioning	#63, St.271.Tek Lhla, Russey Keo	30
8.	Owner shop	Kim Long Insatllation and Repaire Air conditiooner	Repairing and Install	#426 Eo Monivong Blvd,Sangkat Beung Keng Khang I, Chamkamorn	2
9.	Manager	Hout Dara	Sell, Installation and Repairing	#384BEo, Mao Seng Tung Blvd, Boeung Salang, Toul Kok	30
12.	Repairer	Long Ly Hak	Sell, Repaire, install and maintennce Air con	#64, St.271, Tropeang Chhouk village, Tek Thla, Russey Keo	10

Survey of Air Conditioner Repair Centers

S. No.	Name of Interviewer	Position	Name of Source	Survey Type	Address	Quantity
1.	Sen Sovann	Owner shop	Sell of Air-Conditioner and refrigerator	Sell and Repair Shop	No.590Eo, St.217 Samdach Monyreth Blvd, Phsar Doeum Kor, Toul Kok	105
2.	La Khav		Sell and Repaire Airconditioner	Sell and Repaire Shop	# 968Eo, 990Eo,Champuchea Kroum Blvd, Tpul Kok	7
3.	Prum Many	Owner shop	Mc Quay Airconditioning	Sell and Repaire	*#368Eo, Sihanouk Blvd, Sangkat Olumpic,Khan Chamkamorn*	6
4.	Pheakdey	Owner shop	Mekong Airconditioning Chhau Chhayheng	Sell, Repairing & Installing all Kind of old and New	#64, Samdech Monyreth, Toul Svay Prey, Chamkamorn	15
5.	Ouk	Mecaniscien	Nom Chhai Ya Rith	Sell, Repairing Ariconditioning	#430, Preah Sihanouk Blvd	10
6.	Tey Srorn	Mnager	Tey Srorn Buy & Sell AriConditioning		# 302, Preah Monyreth, Chamkamorn	1
7.	Heng Lim Hong	Owner	Heng LimHong Sell, Buy Repairing and Instalation	Sell, Buy Repairing and Instalation Airconditioning	#63, St.271.Tek Lhla, Russey Keo	30
8.	Kim Long	owner shop	Kim Long Insatllation and Repaire Air conditiooner	Repairing and Install	#426 Eo Monivong Blvd,Sangkat Beung Keng Khang I, Chamkamorn	3
9.	Mis. Na vy	manager	Hout Dara	Sell, Installation and Repairing	#384BEo, Mao Seng Tung Blvd, Boeung Salang, Toul Kok	40
10.	Leng Chheang	Repairer	Long Ly Hak	Sell, Repaire, install and maintennce Air con	#64, St.271, Tropeang Chhouk village, Tek Thla, Russey Keo	1

Survey of Washing Machine Repair Centers

S. No.	Name of Interviewer	Position	Name of Source	Survey Type	Address	Quantity
1.	Mr. Eang	Seller	Used Items Yard	Dismentling and buying and selling	Road 1, Nirorth, ChbarAmbov, Meanchey	5-10 set /month
2.	Vy Pha	Shop owner	Vy Pha Shop	selling, repairing	No. 462, St. Kampuchea Krom, Mittapheap	5-10 sets/month
3.	Siv Hong	Shop owner	Eak Siv Hong Shop	selling, repairing	# 320Eo, St. 217, O Russey, 7Makara	5-10set/month
4.	Mr. Taing Saning Hak	Shop owner	Taing Saing Hak Shop	selling, repairing	# 747Eo, St. 128, Toeuk Laak I, Toul Kork	50 Set /month
5.	Mr. Lim Cheng Hourt	Shop owner	Lim Cheng Hourt Shop	selling, repairing	# 569Eo, St. Kampuchea Crom, Phsar Depo 3, Toul Kork	50 sets/month
6.	Sun Yung	Shop owner	Mahamantry selling and repairing shop	selling, repairing	# 350Eo, St. Preah Sihanouk, Olympic, Chamkarmon	30 sets /year
7.	Mr. Chiv Vathana	Shop owner	Chive Vathan Shop	selling, repairing		20 set /month
8.	Chheuk Sung	son of shop owner	Kin Sung Shop	selling, repairing	# 799Eo, St. Kampuchea Krom, Teouk Laak 1, Toul Kork	10-15Sets/month
9.	KY Chanthol	Shop owner	Ky Chantol Shop	selling, repairing	#301, St. Tep Phan, Toeuk Laak, Toul Kork	10 sets/month

Survey of TV Dismantling/ Junk Shops

S. No.	Name of Interviewer	Position	Name of Source	Survey Type	Address	Quantity(Set/month)
1.	Phorn Sopheap	Retaller	Tay Seng	TV, Casset Player	St. Souk Hok, Sangkat Ourussey, 7 makara	30
2.	Seov Chea	Owner Shop	Seov Chea TV Repair			60
3.	Sen Sophann	Owner Shop	Sen Sophann Shop	Reassembling of TV	# 590, St. 128, Sangkat Tekluork 1, Toul Kok	90
4.	Ly Ye	Owner Shop	Ly Ye Sell, Repair	TV, Casset Player, VCD	# 814B, St 128, Sangkat Tekluor1, Toul Kok	6
5.	Hong Oun	Owner Shop	Hong Oun TV, VCD, CD	Repaire Shop	# 554, St.163, Sangkat Toul Tompoung, Cahmkamon	10
6.	Sok	Manager	Bun Sok Repaire TV, VCD&DVD	Repaire Shop	# 952, St. 128,Sangkat Tek Luork, Toul Kok	300

Survey of Refrigerator Dismantling/ Junk Shops

S. No.	Name of Interviewer	Position	Name of Source	Survey Type	Address	Quantity/ Month
1.	Chan Deng	Boss		Junkshop	#284, St.146, Sang kat Tek Luork 2, Toul Kok	
2.	Ms. Sok Chou	Owner	Sell and Bough waste	Junkshop	#128, St.230, Sangkat Phsar Doeum Kor, Toul Kok, PP	2t/m
3.	Yang Vannak	manager			# 23B, St. 336, Sangkat Phsar Doeum Kor, Toul Kok, PP	15sets
4.	Namm Nam	Owner Shop	Sell, Buy,Set up, Repaire		# 70Eo, St.154, sangkat Phsar Thmey 3, Doun Penh	10sets
5.	Nong	Retaller	Kim Tay Reassemble and Retaller	Refrigerator	# 158B, St.150, Sangkat Tek Luork 1, Toul kok,	3ssets
6.	Try Leng	Owner Shop	Sell, Repaire Air-con Refrigerator		# 332, St.182, Sangkat Tek Luork 1, Toul Kok	
7.	Kem Savuth	Owner Shop	Sell and Retaller Air-Con		# 79DEo, St. 107, Sangkat Ourussey, 7 Makara	30sets
8.	Sor Sophearith	Manager	Yong kong installation and Repaire		# 12 Eo, St. 271, Sangkat Toul Svay Prey 2, Chamkamon	2.00
9.	Kim Chhiv	Owner Shop	Kim Heng Sell, Installation		# 1Eo, St. 39, Sangkat Phsar Doeum Kor, Toul Kok	3.00
10.	Srun Bunne	Owner Shop	Fujiaire(E.A.C) Galanz		# 44Eo, Monireth, Sangkat Toul Svayprey II, Chamkamon	
11.	Kak Srey Leap	Owner Shop	Kak Srey Leap		# 708, Kampuchea Krom Blvd, Sang kat Depo II, ToulmKork	5.00

Survey of Air Conditioner Dismantling/ Junk Shops

Name of Interviewer	Position	Name of Source	Survey Type	Address	Quantity per month
Chan Deng	Boss		Junkshop	#284, St.146, Sang kat Tek Luork 2, Toul Kok	
Ms. Sok Chou	Owner	Sell and Bough waste	Junkshop	#128, St.230, Sangkat Phsar Doeum Kor, Toul Kok, PP	2tons
Yang Vannak	manager			# 23B, St. 336, Sangkat Phsar Doeum Kor, Toul Kok, PP	15sets
Namm Nam	Owner Shop	Sell, Buy,Set up, Repaire	Air-con shop	# 70Eo, St.154, sangkat Phsar Thmey 3, Doun Penh	10sets
Nong	Retaller	Kim Tay Reassemble and Retaller	Air-con shop	# 158B, St.150, Sangkat Tek Luork 1, Toul kok,	3sets
Try Leng	Owner Shop	Sell, Repaire Air-con Refrigerator		# 332, St.182, Sangkat Tek Luork 1, Toul Kok	
Kem Savuth	Owner Shop	Sell and Retaller Air-Con		# 79DEo, St. 107, Sangkat Ourussey, 7 Makara	30sets
Sor Sophearith	Manager	Yong kong installation and Repaire		# 12 Eo, St. 271, Sangkat Toul Svay Prey 2, Chamkamon	2 sets
Kim Chhiv	Owner Shop	Kim Heng Sell, Installation		# 1Eo, St. 39, Sangkat Phsar Doeum Kor, Toul Kok	3 sets
Srun Bunne	Owner Shop	Fujiaire(E.A.C) Galanz		# 44Eo, Monireth, Sangkat Toul Svayprey II, Chamkamon	
Kak Srey Leap	Owner Shop	Kak Srey Leap		# 708, Kampuchea Krom Blvd, Sang kat Depo II, ToulmKork	5 sets