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**CHAPTER ONE**

**INTRODUCTION**

**INTRODUCTION TO SWM**

1. All manufacturing activities and domestic practices generate some form of waste. The manufacturing processes and domestic practices do not consist of 100% conversion of material and energy inputs in to usable final products; some portion of the material and energy inputs inevitably end up as waste. When the waste generated exceeds the maximum assimilative capacity of the environment, it becomes a means of ‘pollution’.

2. Solid waste is described as non liquid waste material arising from domestic, trade, commercial, industrial and agricultural activities as well as waste arising from public sectors. Solid waste comprises of various different materials such as food waste, discarded clothing, garden waste, construction waste, factory off cuts and process waste and packaging in the form of paper, metals, plastic, or glass etc.

3. Solid waste is a growing problem in Sri Lanka aggravated in the absence of proper management systems. Deployment and implementation of a National strategy for solid waste management is essential in order to reduce environmental, social and economic problems associated with the present disposal practices. In the past, more attention had been given to waste disposal system with little or no attention to solid waste management<sup>1</sup>.

4. Over the past two decades there have been tremendous developments in the size of a number of cities in the developing world, many cities changing into sprawling urban development with little or no planning or legislative controls. This has been caused partly by a

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<sup>1</sup> National strategy for solid waste management page – 11.

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large influx of people of surrounding countryside. To utilize this potential work force many industries have grown up in the developing areas.

### **OBJECTIVES OF SOLID WASTE MANAGEMENT**

5. SWM may be broadly considered to have two main objectives:

- a. Sanitation.
- b. Environmental protection.

6. Good SWM is essential for protecting people's health and the sustainable development of the town/city. LAs are responsible for achieving these objectives at the minimum cost. Hence, through your work, you are contributing greatly to society.

7. **Sanitation.** Sanitation is the most fundamental SWM objective. It involves the following:

- a. Protecting human health.
- b. Protecting public places/private property from nuisance/danger (e.g. obstruction, vermin, fire).
- c. Keeping the town/city clean.

8. In achieving these objectives, the LA and/or their contractor must provide an effective/efficient garbage collection and disposal service for the minimum acceptable cost. Many people in developing countries have a low awareness of the health problems that can be caused by garbage. In fact, people are the dominant cause of garbage related problems. For example, in Sri Lanka, it is very common for people to discharge their garbage:

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- a. In any container or none.
  - b. At any time, even recently after a collection vehicle has passed.
  - c. At any place, including at the roadside, into drains, onto vacant land, or in water bodies.
9. The public seems to expect the LA to collect their garbage regardless of how or where or when they throw it. However, such practices and attitudes combined with the lack of a garbage collection service or infrequent/unreliable collection result in health and environmental problems and make the town/city look dirty. The main health/environmental risks associated with poor SWM are listed below:
- a. Organic waste rots quickly and smells. If it is thrown anywhere, flies, rats and other pests come. They spread diseases such as typhoid, cholera, and can also cause diarrhoea, eye problems, skin disease, etc.
  - b. Insects, especially mosquitoes, breed in the stagnant water. These cause disease, especially malaria and dengue.
  - c. Water gets trapped in tins, plastic bags and tyres that have been thrown away, and it will cause more mosquitoes, even more disease.
  - d. Water that touches garbage becomes polluted, including water in blocked drains, rain which passes through waste, any streams, rivers, lakes and wells with garbage thrown into them. Using such water can make you sick. It can also kill or poison fish.
  - e. Some waste is dangerous such as rusty tins, broken glass, hospital waste (syringes, needles, etc.).

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f. Other waste is hazardous. It may explode (e.g. aerosol cans), be poison or toxic (e.g. household cleaners), give off dangerous fumes if burned (e.g. tyres, PVC), or leach harmful chemicals into the environment (e.g. batteries).

10. **Environmental Protection.** Good sanitation should provide many benefits to many people within the city clean neighbour hoods, reduced disease, healthy life and beautiful environment. However, often the collected garbage is got rid of by dumping at one place, usually in the open with no soil cover being applied or any other environmental protection measures being taken (open dumping). This creates serious hardship for people living near the disposal site as society develops; more waste is generated, making the disposal problem worse. At the same time, the general public becomes more educated, aware and vocal, while national and state environmental legislation becomes increasingly strict. Together, these factors often lead to the LA taking or being forced to take action to “protect the environment”, particularly in relation to the negative environmental, social and health effects associated with poor land filling. This requires gradually improving land filling standards, as follows.

a. Discontinuing open dumping.

b. Implementing controlled tipping, this at the very least involves applying soil cover to the waste daily.

11. Progressing to sanitary land filling over a number of years, involving site security works, landfill gas management, storm water/groundwater management, etc. Better SWM for environmental protection requires significantly more money and resources than just for sanitation. In particular, sanitary land filling is expensive. At the same time, the general public are both willing and disciplined enough to cooperate with the LA in SWM. Hence, the LA should encourage public participation in SWM (e.g. discharging waste according to rules, using litter bins, sweeping the road outside their homes, etc.) as a means of reducing their SWM costs, whilst raising public awareness at the same time. Environmental protection also involves taking a broader perspective looking at how we can minimise waste by:

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- a. Reducing the amount of waste generated.
- b. Reusing waste materials as much as possible.
- c. Recycling waste materials into new useful items.
- d. Recovering energy from waste materials.

12. Waste minimisation requires public, LA, voluntary/non-governmental organisations and private sector cooperation in order to be successful. Examples of waste minimisation activities include the bottle deposit scheme currently operating in Sri Lanka, avoiding the use of polythene bags, source separation of garbage for subsequent recycling, home or centralised composting, etc.

### **DOMINANT SWM PROBLEMS**

13. The following problems are seen widely in Sri Lanka:

- a. Widespread scattering of waste in the towns.
- b. Terrible conditions of landfill sites.
- c. Huge SWM expenditure, approximately 20% to 30% of LA's total budget.
- d. Difficulty in controlling the many waste collection workers, which account for approximately 30% of all LA employees.
- e. Little remaining capacity of existing landfill sites.
- f. Many complaints from citizens.

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g. Lack of public cooperation.

14. Most of these are not technical issues but institutional ones. Technology alone cannot solve these problems. In other words, much improvement can be made through institutional and managerial capacity building, without spending much money. Good governance is the key.

15. **Causes of these problems.** The causes of these problems are as follows:

a. Insufficient understanding of the importance of SWM works and the low status of the section in charge of SWM works in Las.

b. Weak organisation due to lack of a cost control function, planning function, public affairs function, etc.

c. Insufficient utilization of existing materials and equipment.

d. Lack of waste discharge rules.

e. Lack of a future plan.

f. Lack of utilization of external resources. Most LGs deal with the majority of issues with their own resources such as staff and equipment, without considering the utilization of external resources such as the involvement of citizens. Therefore, they tend to solve problems by increasing the number of employees and/or making requests to donor agencies for equipment.

g. Insufficient knowledge of SWM works.

h. Insufficient knowledge of management.

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- i. Political intervention.
- j. Technology oriented approach with lack of consideration to important social and economic aspects.

16. Lack of financial sources. This implies the following. Concerning the solid waste problems in Sri Lanka, the institutional causes are much more important than the technical causes. Therefore, the SWM problems cannot be dealt with by technical improvements alone, institutional improvements must be executed as well. In other words, the governance quality of LAs is well reflected in the efficiency of SWM works. Consequently, the improvement of governance is very important for the improvement of SWM works.

17. The city of Colombo located in the western province of Sri Lanka. Northern boundary is Keleni River Eastern boundary is Anula College Nugegoda, Southern boundary is Wellawatta Bridge and Western boundary is coastal belt. Colombo consists of six Solid Waste management (SWM) divisions which consist of 47 area offices. The six solid waste management divisions have been named as 1, 2A, 2B, 3, 4, and 5.

18. The city of Colombo has been experiencing increase in population, technology development and changes in the lifestyle of the people. Therefore it is necessary to find out whether the existing solid waste management practices and their structure can support the process efficiently and effectively in order to function without any problem in the areas of health, sanitation and environmental degradation.

19. The reasons for selecting Colombo City for this study are that the Colombo City possesses the high population density, industries and Capital City of Sri Lanka.

20. Generation of solid waste has been on the increase for the past several decades in all parts of the world. The reason for this has been the increase in population, technology development and changes in the lifestyle of the people. These have taken place without any consideration for

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its impact and the environment. Hence solid waste is increasingly becoming a problem that governments need to find solution appropriate to their intensity and magnitude. In Sri Lanka as a whole the present mechanisms of waste disposal has not kept pace with the rate of generation of waste. The absence of appropriate management strategies with a political will within government has been a principal disconcerting factor.

21. The good governance at all levels is the key to secure such participation and partnerships. The process of solid waste management (SWM) from the source of generation up to the final disposal needs to follow a systems approach that would ensure its viability and sustainability throughout the country with special concerns on SWM both industrial and domestic. Good governance practice will need to share benefits of effective SWM, among all the stakeholders.

22. Mismanagement of solid waste and its improper disposal lead to health and environmental problems. Most obvious environmental problem that has more public concern is damages to aesthetic view. However more serious visible, invisible and sometimes irreversible environmental damages occur due to surface and ground water pollution by the leach ate from uncontrolled open dumping of solid waste. Air pollution can also be caused from the inefficient burning of the waste either in an open air or in plants with inadequate emission control systems. The haphazard disposal practices of solid waste also create a negative image to the country depriving industrial development opportunities including tourism.

23. SWM incorporates management activities associated with generation, storage, collection, transfer and transport, processing and disposal of solid waste in an environmentally sound manner.

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**CHAPTER TWO**

**METHODOLOGY**

**OBJECTIVES OF THE STUDY**

24. The overall objective of the study is to analyze the strengths, weaknesses, opportunities and threats (SWOT analysis) of the existing SWM in Colombo city and provide the mechanism to facilitate the planning and implementation of an appropriate strategy for SWM in Colombo city which will enhance the efficiency and effectiveness of the existing strategy.

25. To achieve the overall objectives it is obligatory requirement to achieve the following goals with regard to the SWM practices at Colombo Municipal Area.

a. To arrest the noticeable increase in waste generation in Colombo city and to implement waste reduction systems, thereby reducing the demand for collection and final disposal.

b. To establish feasible alternative treatment systems in order to divert as much waste as possible away from the point of final disposal, thereby also reducing the demand for final disposal capacity; and

c. To improve significantly the engineering and the operational standards and the standards of the final disposal of solid waste and waste residues, thereby mitigating the environmental impacts that arise currently from the disposal of solid waste.

**HYPOTHESIS**

26. Existing mechanism of solid waste disposal in Colombo City is not effective. However, some features of effective means of SWM such as public concerns and political will are evident

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in the CMC area. As such it is hypothesized that an effective mechanism can be identified for solid waste disposals through a SWOT analysis.

### **METHODS OF DATA COLLECTION**

26. The following methods were adopted to gather information with regard to the subject area.

- a. Literature review.
- b. Analysis of secondary data.
- c. SWOT analysis.

### **ORGANIZATION OF THE DISSERTATION**

27. The subject discussed in this dissertation has been covered in six chapters. This is the second chapter. Chapter three describes theoretical and conceptual base of waste management based on the literature review. Chapter four analyses the present strategies of SWM at Colombo Municipal Council, their strengths, weaknesses, opportunities and threats (SWOT Analysis). Chapter five contains the conclusion to the research paper. Chapter six devoted to present the recommendations based on SWOT analysis.

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**CHAPTER THREE**

**CONCEPTUAL AND THEORETICAL CONSIDERATION OF WASTE  
MANAGEMENT**

28. This chapter will describe the theoretical and conceptual base of waste management based on the literature review. However it is relevant here to understand the importance of studying the theories and concepts and its relevance to the practical situation of waste management in Colombo Municipal Area. Following a description of the evolutionary nature of these concepts and theories, this chapter will attempt to understand the relevance of these theories and concepts in the present context and its particular relevance to the Colombo Municipal Area.

**CONCEPTS OF WASTE MANAGEMENT**

29. The essence of waste management is encapsulated in the concept of waste management hierarchy, a symbol for the strategic options available for dealing with Solid Waste (SW). This conceptual framework introduced initially in the European Union's Second Environmental Action Program (1977 – 1981), embraces the least desirable to the most desirable options for SWM<sup>2</sup>. The option for the management of SW identified in the waste management hierarchy comprises the following (from the most to the least desirable):

30. **Avoid and Minimize.** The highest priority in making any waste management system more sustainable is to avoid generating waste altogether; thereby reducing overall quantity of waste to be collected treated and disposed. The next priority is to generate as little waste as possible by minimizing its generation at source.

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<sup>2</sup> European Union's Second Environmental Action Program (1977 – 81).

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31. **Recover (Recycle and Re use).** Recovery is a process that aims to remove the usable materials from the SW streams prior to their final disposal. It is relatively high up in the hierarchy as it can contribute significantly to reducing depletion of natural resources.

32. **Treat and Process.** SW treatment or processing is aimed at recovering material and or energy whilst minimizing the quantity of SW sent for final disposal.

33. **Controlled disposal.** The first step on the waste management hierarchy is the replacement of open dumps and disposal of SW in an engineered (sanitary) landfill, the most widely practised option for the management of SW.

34. The improvement and optimizing of any waste management system entails focusing on moving up the waste management hierarchy, away from disposal towards the direction of waste avoidance and waste minimization. This also require a fundamental shift in emphasis on where the management of SW is targeted away from dealing with waste following its collection towards a system whereby the primary target is the source of waste , the waste generator.

35. How far this change in emphasis can be achieved, in the short term, medium term and long term will determine how much progress is made in moving up the waste management hierarchy.

## **WASTE MINIMIZATION: EMERGENCE OF A NEW CONCEPT**

36. The concept of waste minimization differs radically from the ‘end of pipe’ approach to waste treatment<sup>3</sup>. Organizationally, there are no dividing lines here between who generates the waste (production personnel) and who treats the waste (environmental engineer). It is a team approach which attempts to simultaneously conserve the input resources by increasing the conversion efficiencies of production while meeting environmental expectations. Waste

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<sup>3</sup> Modak. Prasad – Waste minimization II – Environmental development series. Page 1 .

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minimization is thus an integrated approach and not an 'add on' as in the waste treatment approach.

37. Waste minimization can be done by auditing the manufacturing process with respect to optimal use (and reuse) of resources, improved housekeeping, more optimum process operation, etc. In some cases, even the basic manufacturing process may be examined in order to identify possibilities of substitution of raw material, equipment redesign, or even entirely new or different manufacturing processes.

38. In this preventive approach, the costs of waste treatment system get substantially reduced, and in some cases, even eliminated. Besides, since wasters are inherently reduced in this approach, the overall resource utilization factor improves, leading to improved profitability and competitiveness. In view of rising costs and procurement difficulties of resources such as water, chemicals and energy, these benefits are substantial, and in some cases even overshadow the benefits of the savings on waste treatment costs.

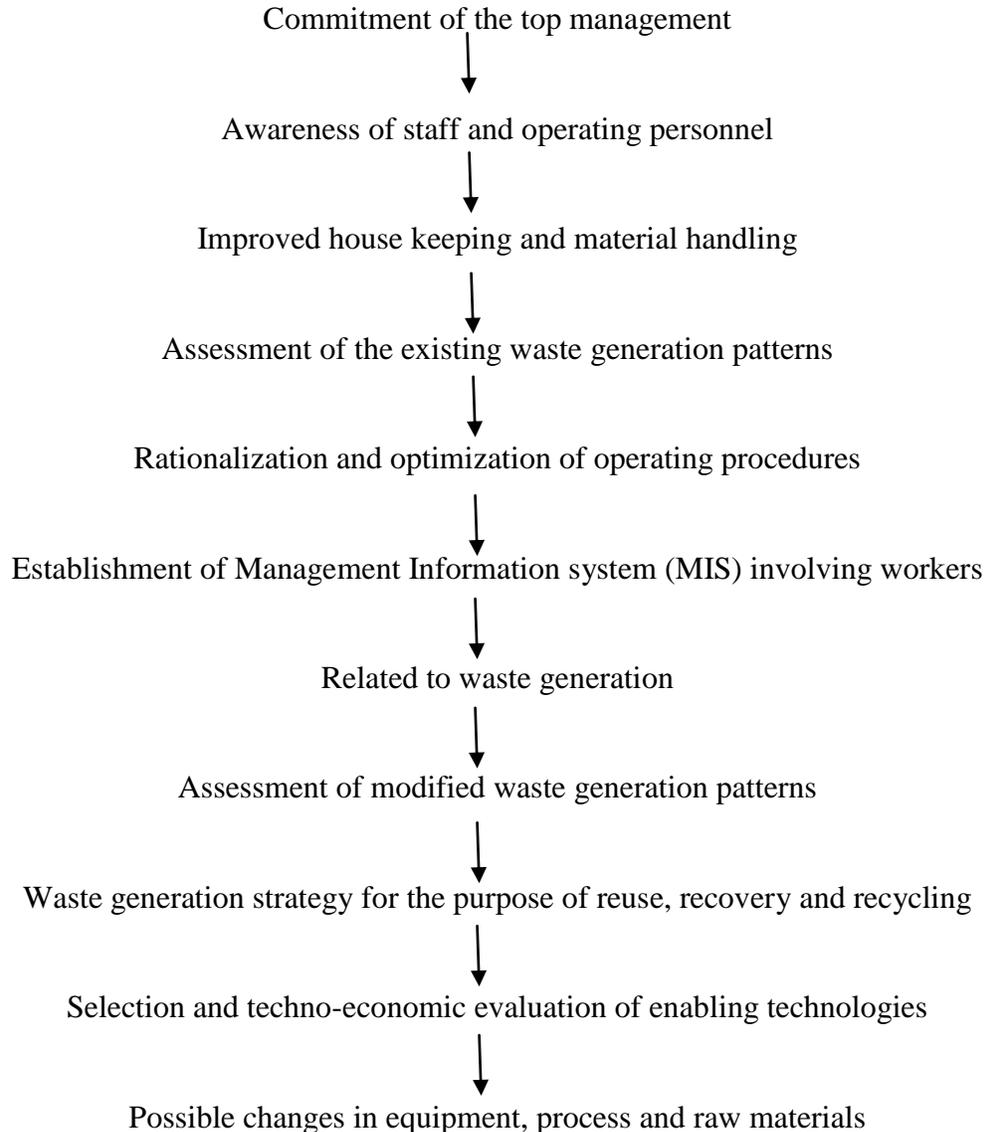
39. In the broad concept of waste minimization, the waste management system can also be viewed as a manufacturing process. Here the raw materials are the wasters from processes and products, which are seen as reusable, recoverable or recyclable fractions of the waste. In any of its forms, waste minimization requires management with a vision, and a willingness to look for win-win situations, or at least a break even situation.

40. Waste minimization is often hierarchical, in the sense that it need to begin at the top, and involves a strong interface between human and technological factors. The human factor consists of the commitment of the top management, dedication of the senior production and environment staff, and a willingness to change on the part of the shop floor workers. Changes are generally gradual and begin with marginal measures requiring little or no investment, slowly going on to more options requiring larger investment and a careful review and assessment of the costs and benefits.

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41. While the approach to waste minimization will be discussed in detail, it may be useful at this stage to briefly indicate the main components of a typical approach to waste minimization. The typical approach to waste minimization is shown in Figure 2.1.

**APPROACH TO WASTE MINIMIZATION**



**Fig 2.1**

**Source- Central pollution control board news letter 1998 Jan – New Delhi**

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42. A combination of ever more efficient resource use and tightening environmental regulation has significantly reduced waste generation in a variety of industrial sectors worldwide. The following review of international experience shows what has already been achieved elsewhere and provides the context for a detailed discussion of our own experience.

43. In West Germany, the chemical industry managed to cut emissions of heavy metals by 60-90% between 1970 and 1987 while boosting output by 50%. These improvements have been matched on an individual company level, as growing numbers of companies are regularly raising their 'environmental efficiency', the ratio of resource input and waste outputs to final products. At Nippon Steel Corporation, Japan, producing a metric ton of steel in 1987 emitted 75% less Sulphur Oxides and 90% less than in 1970. The 3M Companies in the United States has pioneered pollution prevention since 1973 with its pollution prevention pays program (3P)<sup>4</sup>.

## **ENVIRONMENT EDUCATION - A RELATIVELY NEW CONCEPT**

44. Environmental Education (EE) is a relatively new concept that was legitimate in the international forum by the Belgrade Charter of 1974. Since then its content, format, scope and legitimacy have been questioned and debated. This section aims to give an overview of what EE is, some of the main points of contention that have been debated, its relative success, how it has been implemented in different settings, and its relevance to the planned research.

45. A generally accepted definition of EE was published by UNESCO in 1977. There are three main principles:

- a. Foster a clear awareness of and concern about economic, social, political and ecological interdependence in urban and rural areas.

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<sup>4</sup> S Schmidheiny. – Changing course: Paper on 'Global Business Perspective on Development and the Environment 1992'.

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- b. To provide every person with opportunities to acquire the knowledge, values, attitudes, commitment and skills needed to protect and improve the environment.
- c. To create new patterns of behaviour of individuals, groups and society as a whole towards the environment.

46. A recurring theme through most EE literature is that there is no doubt that a close link exists between EE and a country's ability to reach the ultimate goal of waste management. The claim is that if the citizens of a country were more environmentally conscious, then resources would be more efficiently used and less would be wasted. If taken further, individuals and communities would become largely self reliant, relying upon the internal cycling of materials and placing minimal burdens on the local and outside environments. Filho of al<sup>5</sup>. asserts that to create local capacity is essentially to better be able to analyze and deal with resource use issues.

47. EE is not restricted to the classroom Elaine Swaith (1995) argues that the dominant force of modernism, which permeated into children's picture books, has encouraged fractured perceptions of nature, with the individual, the community, the city and humankind as separate from the natural processes of ecological systems<sup>6</sup>. To heal this fracture more holistic ecological children's books are needed. Kamanja Gathu (1997) discusses the use of the radio in NFE programs<sup>7</sup>. He argues that the goal of education should be to improve one's welfare, that education is not confined by the classroom, or by traditional teaching methods while formal education is constrained by high human resource requirements and is confined to the classroom.

48. Neither is EE restricted to the understanding of physical environmental problems. Sinha and Amin discuss the potential that the synthesis of the emerging philosophies of deep ecology, conservation biology, bioregionalism, and social critical analysis can have upon the theory and

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<sup>5</sup> W.L Filho et.al. 1996. book for Environmental Education.

<sup>6</sup> Elaine G Swaith,. Journal of Children's Literature Vol.21, No.1 Spring 1995.

<sup>7</sup> Gathu, Kamanja. "Adult Education and Development. No 51: 177-187.

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practice of EE<sup>8</sup>. Each philosophy brings richly texture insight into environmental issues and the role of the individual and society in creating and resolving them. Exposing students to this variety of thoughts will increase the likelihood that they will question their current values and supplement some with more environmentally sustainable ones. Similarly, Darlene Clover and Shirley Follen (1997) assert that new models of environmental adult education go beyond creating understanding and awareness<sup>9</sup>. Their aim is to build skills, a sense of commitment and responsibility, and ultimately to stimulate individual and collective action. Such programs link environmental concerns to other social issues and bring about social transformation.

49. In the 1990's educators began publishing articles questioning the goals of EE. Is it the goal to impart environmental information to a wider audience, or is it to bring about change. Most agreed that it was to bring about change. The question then become, is the dissemination of environmental information to people sufficient to bring about the desired changes towards a sustainable/ green society.

50. In a study on the effectiveness of EE for promoting responsible citizenship behaviour, Hungerford and Volk (1990) argue that the changing of environmental behaviour is much more complex than the traditional model of: knowledge acquisition, change in awareness, attitudes, and action<sup>10</sup>. There are many other factors that influence the degree to which environmental knowledge is translated into action. Two of the most crucial factors are an internal locus of control means being self reinforcing with respect to a goal such that you will continue to strive to achieve a distant goal. In brief, it is being an active optimist. Having action skills comes from involvement in previous action, often with the aid of a teacher or instructor. The authors make extensive use of previous studies and literature to substantiate these and other claims. They also draw attention to the fact that students in EE programs with a focus on a single and most often

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<sup>8</sup> A.H.M.M Sinha. and A.T.M.N. Amin. "Dhaka's Waste Recycling Economy in Regional Development Dialogue 16, pp.173 – 195.

<sup>9</sup> Clover, Darlene and Follen, Shirley. 1999 The Role of Education and Participatory Research in Community Self-Sufficiency and Sustainability: A Canadian Case Study.

<sup>10</sup> Hungerford et.al, "Journal of Environmental Education. pp. 8-21, 1990.

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local environmental issue do not learn to generalize their actions to other issues or the environmental in general.

51. An interesting observation they found from many studies was that one of the greatest predictors of environmental action is a feeling of empathy or environmental sensitivity rather than knowledge.

52. Closely related to the Hungerford and Volk<sup>10</sup> research is the Action competence Approach in Environmental Education by Jensen and Schnack (1997)<sup>11</sup>. They assert that environmental issues should be met with not only quantitative changes in uses of resources, but also qualitative changes regarding alternative visions of personal and societal development. The challenge for EE is not only to change specific behaviours such as littering, or not buying products with CFCs, but also to initiate a conscious change of an individual's values as recognized through the tension between past values and new environmental insights. Environmental action competence should not be the product of explicit behaviour modification; rather it should be the deeper questioning of an individual's relation to the environment and community. While this may sound true, it is also extremely difficult and perhaps too strong a reaction to EE programs which aim to change behaviours without properly conveying to the audience why they should change. There is a definite tension in EE between the relative importance of quickly changing behaviour and the tendency for people to learn about an environmental issue but never acting on it. However, it is clear that EE should be informing and interacting with individuals in order to improve their lives and not to achieve compliance to preset behaviours regardless of personal choice or local conditions. Environmental action competence should be based on a willing and able participant who is aware of the scientific, social and economic rationale for their actions.

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<sup>11</sup> Jensen, B. and Schnack, K. "Environmental Education Research Vol. 3, No. 2: 163-178, 1997.

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53. Kara Chan performed a study of recycling habits in Hong Kong (Chan, 1998)<sup>12</sup>. The results show that the attitude of an individual was the most significant factor in predicting their actual behavioural. Thus, the best predictor of a person recycling is their having a positive attitude towards the idea of recycling (being green). The second best predictor is the 'perceived behavioural control'. In other words, the perceived degree of difficulty in completing the behaviour, in this case separating recyclables and disposing of them in public receptacles. Third, the perceived level of 'subjective norm' felt from family, friends and neighbours as well as mass media. That is how strongly will a behaviour, such as putting recyclable tin cans, be punished by other social actors, or how strongly will proper recycling behaviour be rewarded by social actors (or indeed by your own self image and belief in being a good citizen).

54. The conclusion reached by Chan is that mass media campaigns appealing to citizens of Hong Kong to recycle are sound and have been shown to be effective in a sample group. Although not mentioned in her conclusion, Chan's results also suggest that mass media is not the most effective tool for changing behaviour. According to the results, the major factor in predicting behaviour is attitude. Thus, mass media is affecting the third most important predictor. What about the first two? Would it not be more opportune to tailor a program to these? The EE program for school children described in SWM in Vietnam section should be more effective because it aims to alter attitudes. Another option would be an information campaign explaining how easy and effortless using recycling bins is (if necessary the recycling program may have to be adjusted so as to make this true). Mass media campaigns that aim to increase social pressure to act in certain ways seem costly, not as pedagogically sound as EE as conceived by Hungerford and Volk, and seem doomed to be swamped by the torrent of consumerist mass media.

55. EE is gaining greater acceptance in the education and development community while there remains a definite need for better documentation of programs<sup>13</sup>. The proceedings of a recent conference discussing environmental management clearly show that there is very little

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<sup>12</sup> Chan, Kara. Journal of Environmental Management 52 1998.

<sup>13</sup> Apel, Heino and Camozzi, Anne. 1996. Adult Environmental Education: Development No. 47.

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documentation of environmental management projects that incorporate EE in the Asia Pacific region<sup>14</sup>.

### **CONSTRUCTING A THEORY OF WASTE MANAGEMENT (WMT)**

56. Constructing the theory of waste management is an effort towards signification of waste management. In order to effect such signification and to evolve any theory in waste management, an effective tool is needed that can be applied in encompassing schematic view. Given that waste is a human concept and dependent on the needs and values of humans, there should be a waste management theory explaining those concepts. Waste management theory draws facts from the existing waste management infrastructure and is restricted legislative constraints<sup>15</sup>.

57. The theory of waste management is based on the following considerations:

- a. Waste management is to prevent waste causing harm to human health and the environment.
- b. The primary aim of waste management is conservation of resources.
- c. By applying waste management, we shall avoid loss of resources.
- d. Prevent waste from being produced by creating useful products (non wastes) primarily.
- e. The role of waste management is to turn waste in to non waste.

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<sup>14</sup> Yasumasa Itakura. 1999. Integrated Environmental Management: Development, Information.

<sup>15</sup> Pongracz E (2002) Re-defining the Concepts of Waste and Waste Management: Evolving the theory of Waste Management. Doctoral Dissertation. University of Oulu, Department of Process and Environmental Engineering, Oulu, Finland. URL: <<http://herkules.oulu.fi/isbn9514268210/>> .

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58. It was proposed that the theory of waste management consists of the following hypotheses:

- a. Sustainable waste management depends greatly upon how waste is defined.
- b. Waste can be represented as an object without a purpose and or without an owner.
- c. Ownership over a thing is having the right and responsibility to act upon the thing. That is to manipulate the properties of things; and the role of waste management is to give a new purpose and every product is produced for an owner.
- d. Consumer awareness can be enhanced by educating consumers about their responsibilities as owners.

59. It is expected that the insight that the Theory of Waste management would give to the domain would greatly contribute to achieving the goals of waste management: resources conservation and environment protection. The practical values of such a theory would be;

- a. Giving answers to conceptual questions by explaining waste and concepts.
- b. Providing a guide for choosing waste management options.
- c. Providing a foundation for how and when to select and integrate waste management option.
- d. Predicting the outcome of the use of waste management actions.
- e. Aiding legislation in how to prescribe activity waste.

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60. Theoretical planning of waste management would then involve the methodological analysis of possible waste related activities, by the following principles;

- a. Define whether the thing is waste or non waste.
- b. Analyze why it become waste.
- c. Determine how it could have been avoided.
- d. Access the consequences of this waste amount be minimized.

## **RELEVANCE OF THE CONCEPTS AND THE THEORIES IN THE PRESENT CONTEXT**

61. The concepts and theories of several scholars are questionable at time in the practical scenario. However, it was evident that these concepts and theories are involved in SWM practices in Colombo Municipal area at certain levels. Waste avoidance, waste minimization and materials recovery have been embraced by many industrialized countries, particularly over the last decade or so, following growing awareness of the role of environmental issues as a potent consideration in policy formulation. The Colombo Municipal area is not an exemption for this global trend and it is been practiced with so many positive and negative remarks. In the quest for integrated and sustainable waste management, the focus of evolving waste management strategies in many of the most highly developed nations has shifted gradually and progressively up the waste management hierarchy (fig 2.1). These strategies not only encompass the safe treatment process, processing and disposal of waste material but also many policy measures encourage and/or enforce reductions in the qualities of waste generated and enhance the recovery of materials.

62. Waste avoidance and waste minimization comprise the adoption of measures or techniques that prevent or reduce the generation of waste materials. Waste avoidance and waste minimization measures are targeted at industrial production that is the immediate source of waste generation during raw material recovery or product manufacture, through the adoption of alternative, 'cleaner' technologies and production processes. Waste avoidance and minimization

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in industrial production, although of great significance and benefit to society as a whole, will not contribute directly to reducing the quantities of SW unless suitable incentive and economic benefits are introduced by government. At the level of 'individual' (importer, manufacturer, and distributor), the avoidance and minimization of SW is restricted principally to:

- a. The removal and / or reduction of packaging materials for consumer products;
- b. The clear labelling of packaging materials with regards to recycling destination; and/or
- c. The re use and recycling of recovered materials.

63. The recovery of materials from the waste stream of the domestic, industries and other institutions at Colombo Municipal Council area can be reused or recycled at a variety of points in the overall waste management system;

- a. At 'source' as individual, commercial, institutional and industrial premises.
- b. Informally during collection and transfer of SW by collection labourers.
- c. Formally at designated materials recovery facilities for SW.
- d. During pre processing of SW in preparation for waste treatment.
- e. During post processing of treated components of SW.
- f. At the point of final disposal of SW.

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64. The recovery of materials has already been done to a great extent by Colombo Municipal Council. Materials recovery is manifested in a number of ways, including, for example;

- a. The recycling of glass, metals, waste paper and card board and plastics.
- b. The home composting of kitchen and garden waste which is practising at Colombo City where this type of waste is being collected and composted in house hold and from the establishment directly by the outside sources.
- c. The reuse of glass and plastic containers through the implementation of refill schemes for certain products.

65. Every effort should be made to introduce measures and sustainable treatment schemes to divert waste materials away from final disposal, thereby reducing the demand for final disposal capacity. However it must be recognized that local experience with alternative waste treatment technologies is currently limited, with existing schemes treating only a fraction of SW generated in CMC. Inevitably, even with wholesale and intensive promotion through public and educational awareness campaigns it will take time to initiate, introduce and build up the capacity of:

- a. Alternative waste treatment technologies.
- b. Materials recovery system, and
- c. Measures to minimize and avoid waste generation.

66. In the mean time, SW continues to be generated at hire rate and requires to be disposed of securely. A significant and increasing demand for SW disposal capacity will remain in the foreseeable future in CMC.

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67. The changes that are taking place in economies, technology and advancement of human resources will hinder the application of these concepts and theories. Each and every concept or theory has its own pros and cons its application to the situation.

68. At present the 'Zero-waste' does not appear to be achievable, either technically or economically, in anything shorter than the very long term, that is a time period well beyond the consideration of this research.

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**CHAPTER FOUR**

**PRESENTATION OF DATA AND ANALYSIS**

**SOLID WASTE ACCUMULATION IN CMC AREA**

69. Amounts of Solid Waste accumulation in the six SWM divisions of CMC (Source: CMC) are shown in Table 2. 1. This indicates that in divisions 3, Solid Waste accumulation is the greatest whereas the least amount of Solid Waste accumulation taken place in division 5.

70. Number of workers of all categories and number of labourers in the six divisions who are directly involved in Solid Waste removal are given in Table 2.2.

| <b>Division</b> | <b>Solid waste accumulation (Kg)</b> |
|-----------------|--------------------------------------|
| 1               | 1,260,009.0                          |
| 2 A             | 1,723,930.0                          |
| 2 B             | 2,689,336.0                          |
| 3               | 3,536,970.0                          |
| 4               | 2,037,670.0                          |
| 5               | 728,165.9                            |

**Table 2. 1**

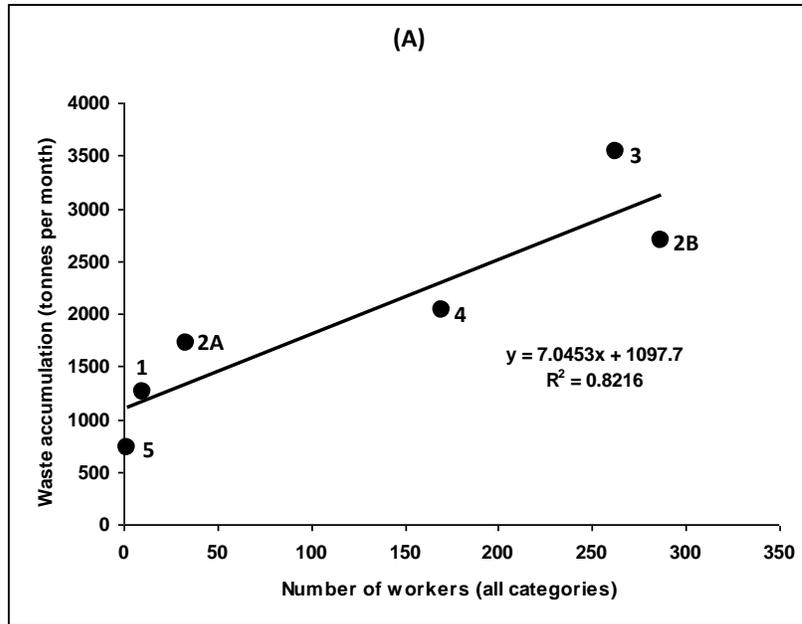
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**NUMBER OF WORKERS EMPLOYED IN CMC AREA (Source: CMC)**

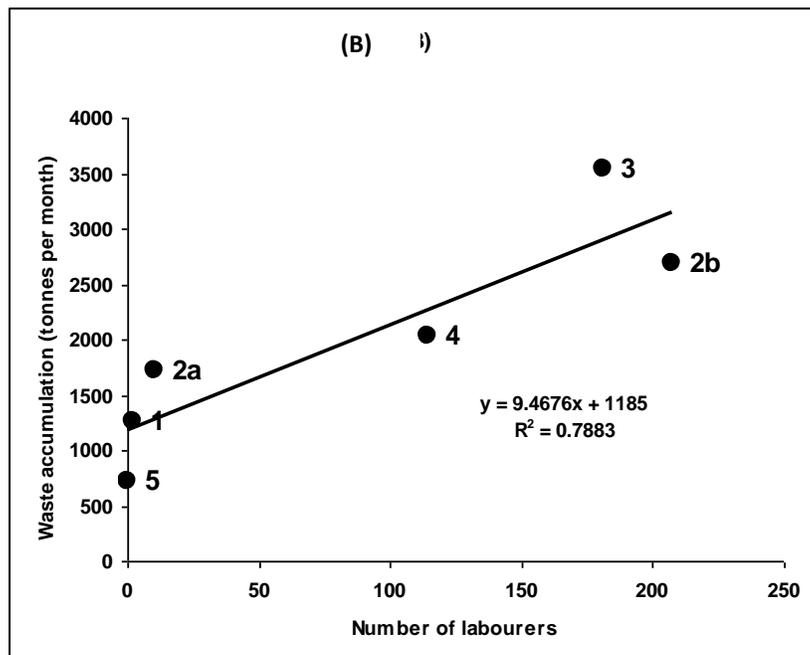
| <b>Division</b> | <b>No of workers<br/>(All categories)</b> | <b>No of labourers</b> |
|-----------------|---|------------------------|
| 1               | 10  | 2                      |
| 2A              | 33  | 10                     |
| 2B              | 287                                       | 207                    |
| 3               | 263                                       | 181                    |
| 4               | 170                                       | 114                    |
| 5               | 2   | 0                      |

**Table 2. 2**

71. There is a positive significant relationship between the number of workers of all categories and the Solid Waste accumulation ( $R^2 = 0.8216$ ,  $P < 0.001$ , Fig 2.2A). Similarly the relationship between number of labourers and waste accumulation in the six divisions is highly significant ( $R^2 = 0.7883$ ;  $P < 0.001$ ; Fig 2.2B).



**Fig – 2.2A**



**Fig – 2.2B**

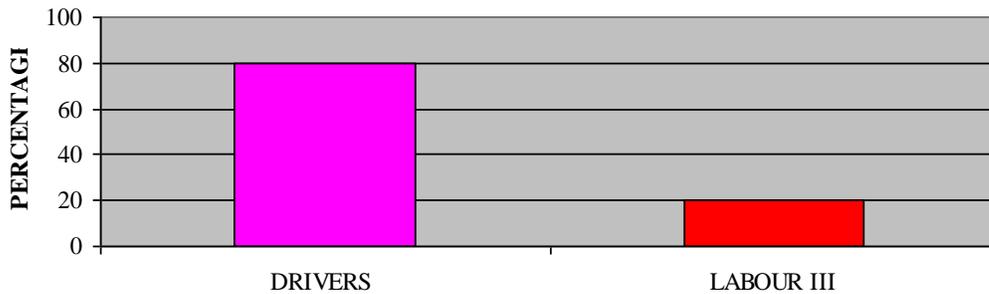
Figure 2. Relationship between (A) the number of workers of all categories, (B) number of labourers and waste accumulation in six SWM divisions of CMC.

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72. These indicate that generally numbers of workers assigned for waste removal are based on the amount of waste accumulation. However, in division 2b and 5 numbers of workers need to be increased whereas in division 2A and 3, number of workers can be slightly decreased.

73. Percentage of different categories of workers in the six SWM divisions of CMC are shown in figures 2.3A to 2.3F. Also the percentages of different categories of workers in the whole CMC area are shown in figure 2.3G. These indicate that labourers employed for SWM in CMC form the highest proportion.

**DETAILS OF WORKERS IN SWM SECTION IN DIVISION 1**

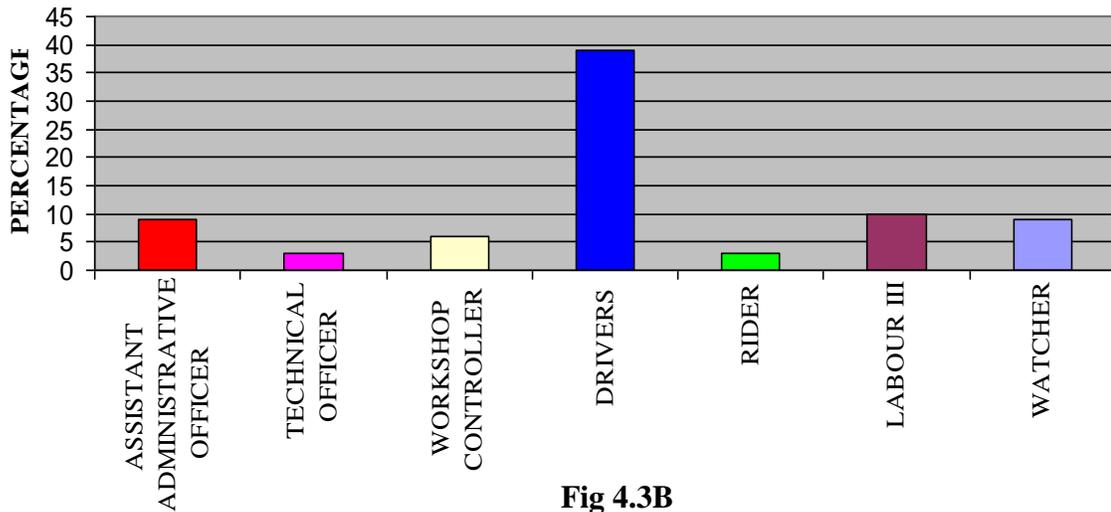


**Fig 4.3A**

74. Fig 4.3A shows the percentage of drivers 80% and labours III 20% work in division 1.

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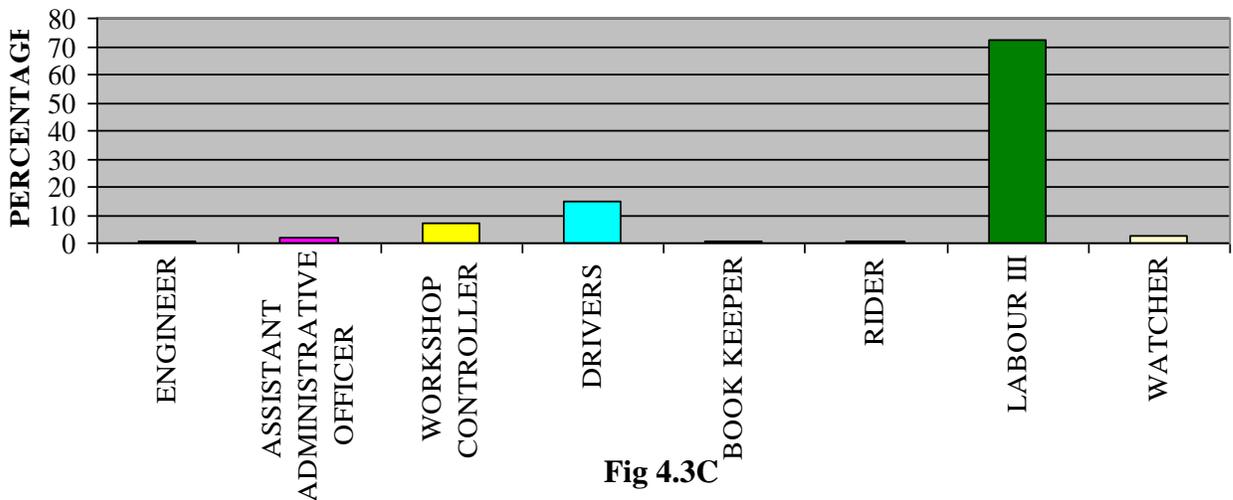
**DETAILS OF WORKERS IN SWM SECTION IN DIVISION 2A**



**Fig 4.3B**

75. Fig 4.3B shows the percentage of assistant administrative officers 9%, technical officers 2.5%, workshop controllers 6%, drivers 39%, riders 2.5%, labours III 10% and watchers 9% work in division 2A.

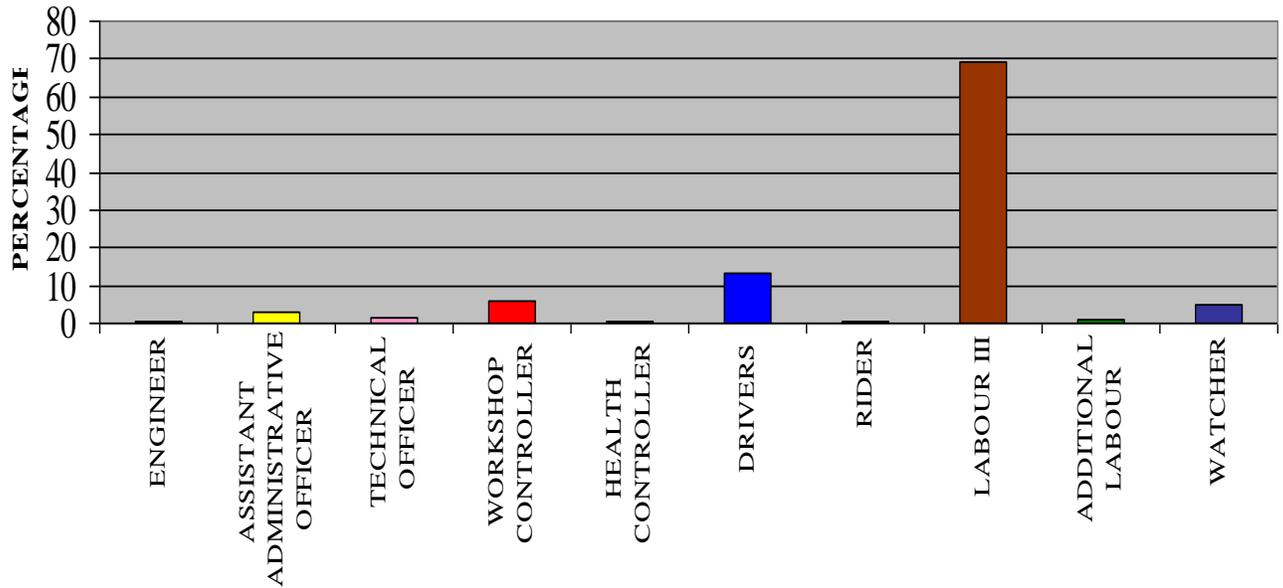
**DETAILS OF WORKERS IN SWM SECTION IN DIVISION 2B**



**Fig 4.3C**

76. Fig 4.3C shows the percentage engineers 1%, assistant administrative officers 2%, workshop controllers 8%, drivers 13%, book keepers 1%, riders 1%, labour III 72% and watchers 2% work in division 2B.

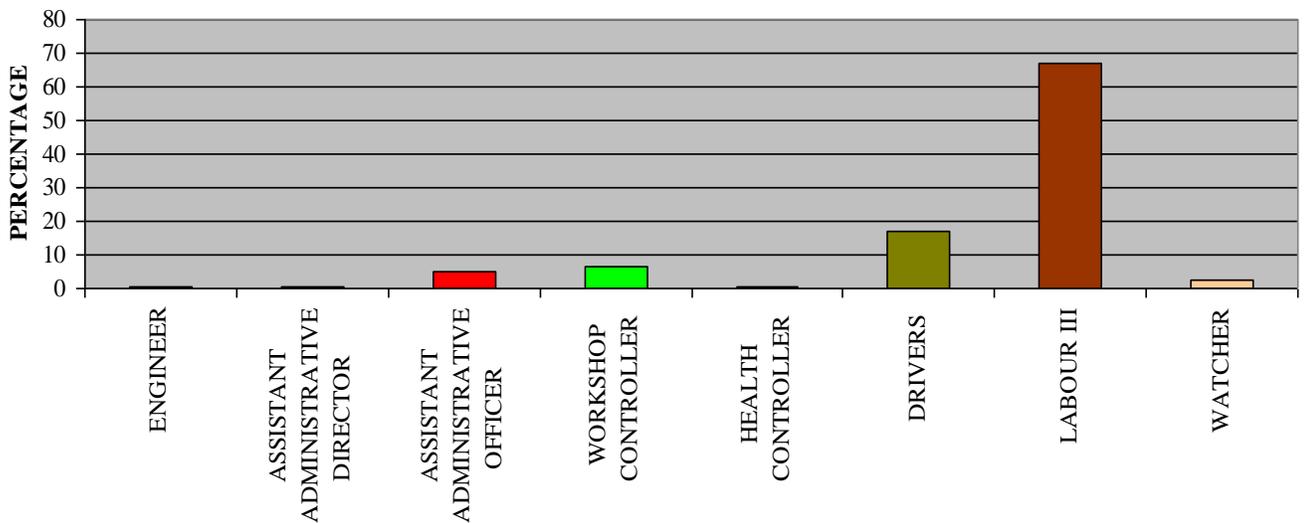
**DETAILS OF WORKERS IN SWM SECTION IN DIVISION 3**



**Fig 4.3D**

77. Fig 4.3D shows the percentage engineers 1%, assistant administrative officers 2%, technical officers 2%, workshop controllers 5%, health controller 1%, drivers 12%, riders 1%, labour III 69%, additional labour 2% and watchers 5% work in division 3.

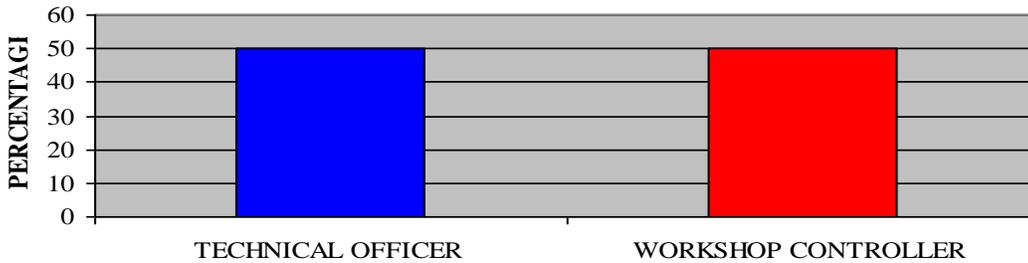
**DETAILS OF WORKERS IN SWM SECTION IN DIVISION 4**



**Fig 4.3E**

78. Fig 4.3E shows the percentage assistant administrative officers 5%, workshop controllers 7%, drivers 18%, riders 1%, labour III 67%, and watchers 2% work in division 4.

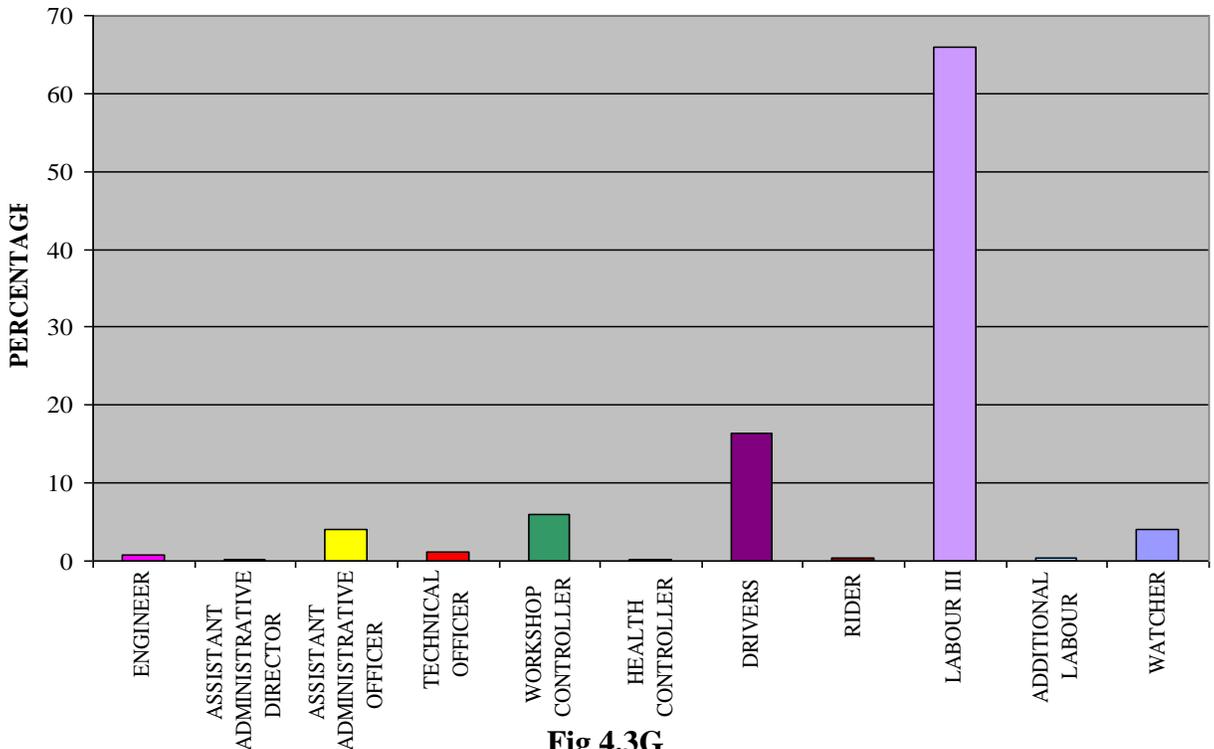
**DETAILS OF WORKERS IN SWM SECTION IN DIVISION 5**



**Fig 4.3F**

79. Fig 4.3F shows the technical officers 50% and workshop controllers 50 work in division 5.

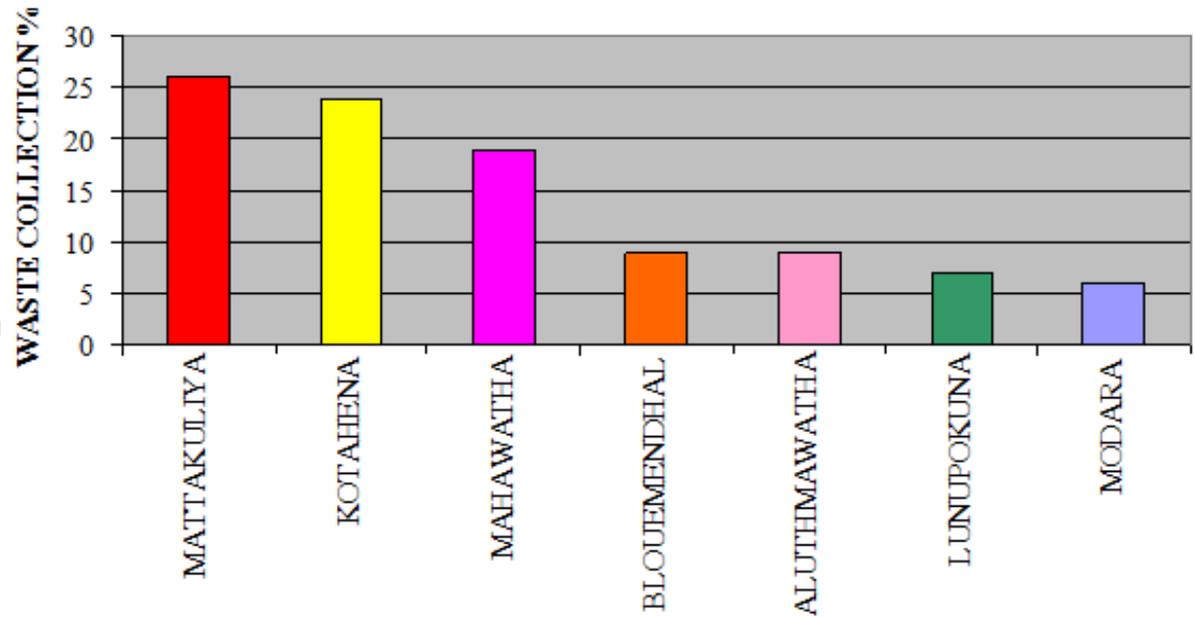
**TOTAL WORKERS IN SWM SECTION IN CMC**



**Fig 4.3G**

80. Fig 4.3G shows the percentage engineers 2%, assistant administrative director 1%, assistant administrative officers 4%, technical officers 2%, workshop controllers 5%, health controller 1%, drivers 16%, riders 2%, labour III 63%, additional labour 2% and watchers 4% work in CMC.

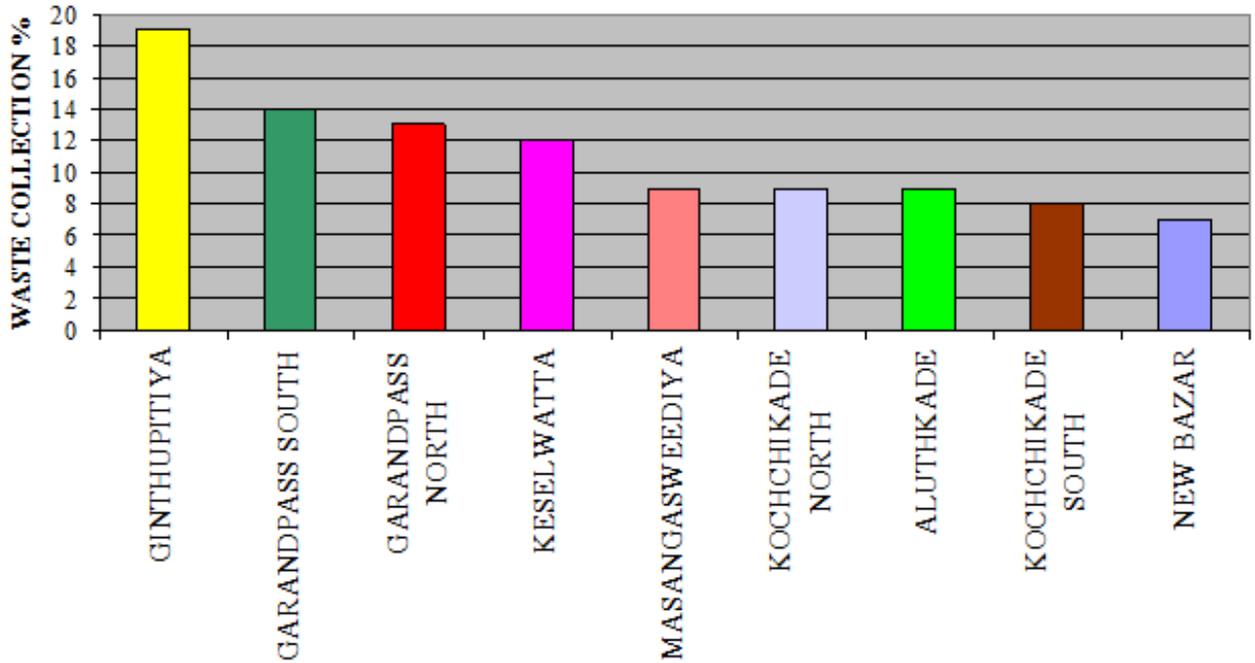
**QUANTITY OF WASTE COLLECTION OF DIVISION 01  
PER MONTH (JANUARY 2012)**



**Fig 4.4A**

81. Fig 4.4A shows the percentage of waste collection for the month of January in Mattakuliya 26%, Kotahena 24%, Mahawatha 19%, Blouemendhal 9%, Aluthmawatha 9%, Lunupokuna 7% and Modara 6% in SWM division 1.

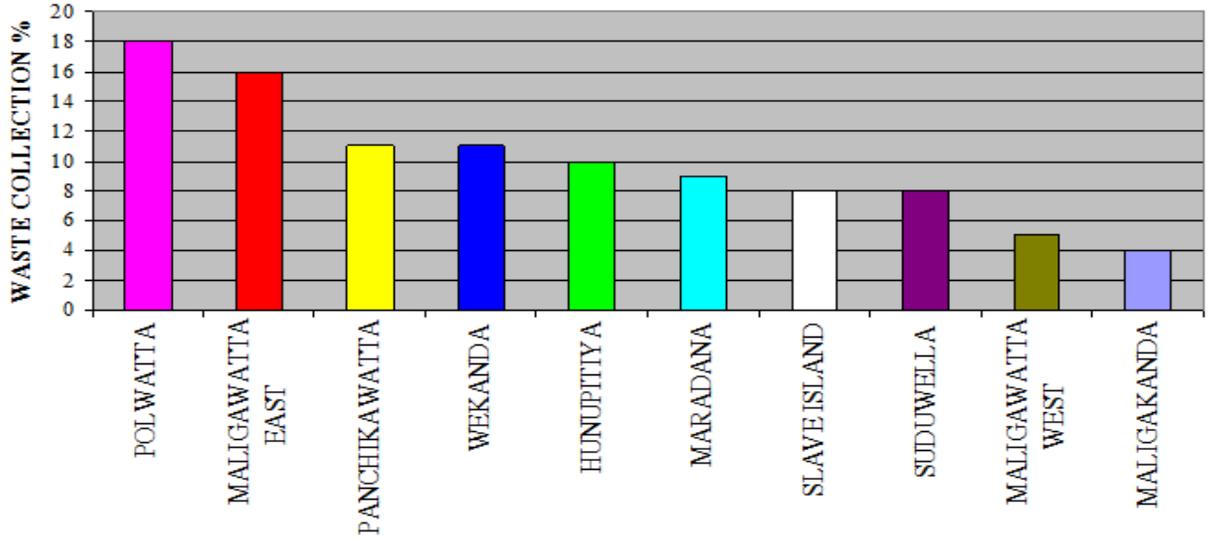
**QUANTITY OF WASTE COLLECTION OF DIVISION 2A**  
**PER MONTH (JANUARY 2012)**



**Fig 4.4B**

82. Fig 4.4B shows the percentage of waste collection for the month of January in Ginthupitiya 19%, Grandpass South 14%, Grandpass North 13%, Keselwatta 12%, Masangasweediya 9%, Kochchikade North 9%, Kochchikade South 8%, Aluthkade 9% and New Bazar 7% in SWM division 2A.

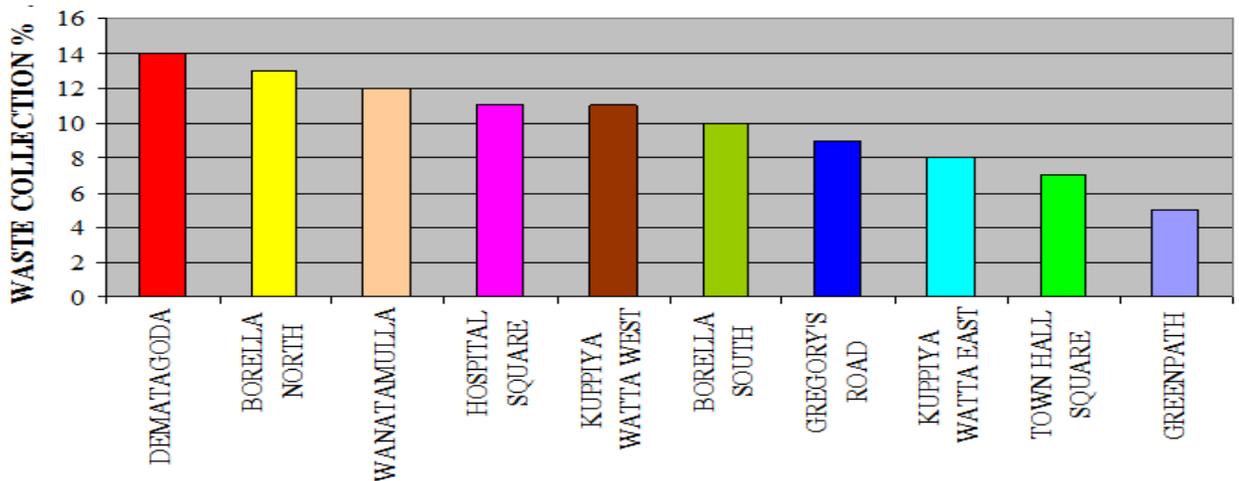
**QUANTITY OF WASTE COLLECTION OF DIVISION 2B**  
**PER MONTH (JANUARY 2012)**



**Fig 4.4C**

83. Fig 4.4C shows the percentage of waste collection for the month of January in Polwatta 18%, Maligawatta East 16%, Panchikawatta 11%, Wekanda 11%, Hunupitiya 10%, Maradana 9%, Slave Island 8%, Suduwella 8%, Maligawatta West 5% and Maligakanda 4% in SWM division 2B.

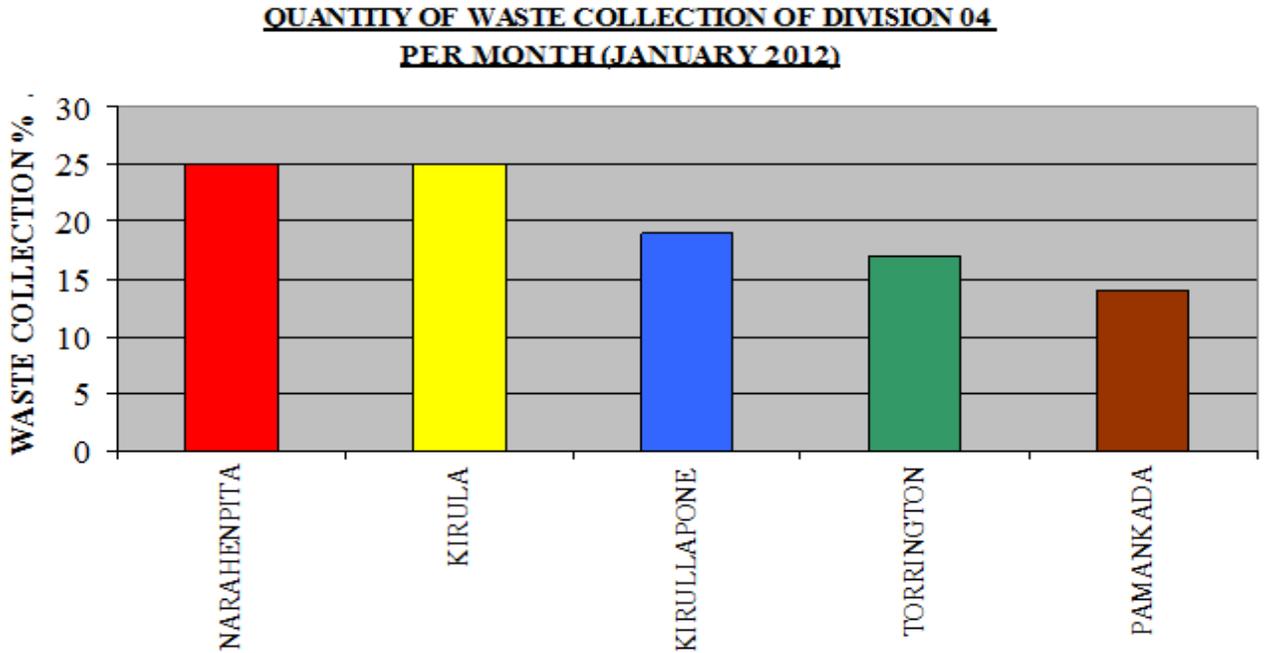
**QUANTITY OF WASTE COLLECTION OF DIVISION 3**  
**PER MONTH (JANUARY 2012)**



**Fig 4.4D**

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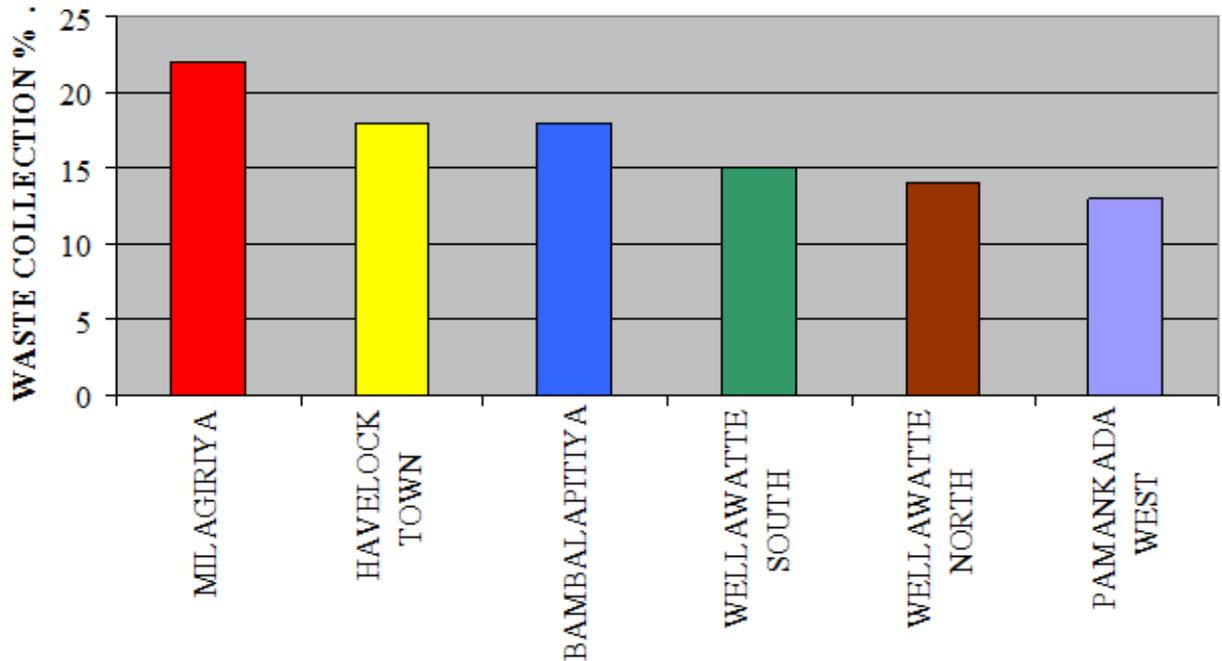
84. Fig 4.4D shows the percentage of waste collection for the month of January in Dematagoda 14%, Borella North 13%, Wanathamulla 12%, Hospital Square 11%, Kuppiya Watta West 11%, Borella South 10%, Gregroys Road 9%, Kuppiya Watta East 8%, Town Hall Square 7% and Greenpath 5% in SWM division 3.



**Fig 4.4E**

84. Fig 4.4E shows the percentage of waste collection for the month of January in Narahenpita 25%, Kirula 25%, Kirullapone 19%, Torrington 17%, and Pamankada 14% in SWM division 4.

**QUANTITY OF WASTE COLLECTION OF DIVISION 5  
PER MONTH (JANUARY 2012)**



**Fig 4.4G**

85. Fig 4.4E shows the percentage of waste collection for the month of January in Milagiriya 22%, Havelock Town 18%, Bambalapitiya 18%, Wellawatte South 15%, Wellawatte North 14% and Pamankada West 13% in SWM division 5.

**PRESENT STRATEGIES OF SWM AT COLOMBO MUNICIPAL COUNCIL,  
THEIR STRENGTHS, WEAKNESSES, OPPORTUNITIES AND THREATS**

**THE STRENGTHS OF SW PRACTICE AT CMC**

86. **Separation of Solid Waste.** Generally in Colombo city the composition of waste generation can be categorized as follows:

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|               |       |
|---------------|-------|
| Carbone waste | 83.5% |
| Polythine     | 5.6%  |
| Metal waste   | 2%    |
| Paper         | 7%    |
| Glass         | 0.6%  |
| Other         | 1.3%  |

By considering this CMC has introduced waste separation project for recycling at the place of waste generated. Therefore about 600 selected houses were given different colour polysac bags for paper, polythene, glasses. It was successful and eco friendly system so that people in the area were attracted to this strategy. Recently the compost project was introduced at Sedawatta which is handled by Burni Trading (PVT). Ltd.

87. Man Power and Infrastructure Facilities. The solid waste section in CMC has considerable strength of staff that is under Director solid waste. It is noted that the division office or the solid waste divisions also have the total of 66% of labourers. At the moment the sweeping and brushing of roads are done by using machines. Different types of vehicles are used to collect the solid waste in CMC area.

88. CMC has employed their workers (All categories) and laboures (Fig 2.2A, 2.2B) effectively by considering the waste accumulation in different divisions. Therefore they have managed to employ more worker/labourers where there is more waste accumulation. The relationship between number of labourers and the Solid Waste accumulation is shown in Fig 2.2B. This indicates that the area where there are more Solid Waste accumulation, high number of labourers have been employed for waste disposal.

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89. Awareness Programs. Once in three months, awareness programmes on solid waste are carried out on TV and Internet. Also seven street dramas per month are conducted to educate the people about the importance of solid waste management. In addition the importance of this activity is advertised in newspapers. The CMC conducts painting competitions in schools to educate people on solid waste management.

### **THE WEAKNESSES OF SW PRACTICE AT CMC**

90. Though CMC has taken steps to educate people on composting it is not adequate with compare to the population in the area according to the details found it is only about 0.1% people are practicing composting. In addition the awareness programme has not spread to whole area . CMC has only one vehicle for there propaganda purposes which is not enough. Compared to the largeness of the area.

91. Generally about half of Colombo's residents are estimated to be living in slums or shanty housing conditions. The slum and shanty areas do not have proper access for collection vehicles to enter or facilities to store the waste generated thus the provision of sustainable human settlement environment is far to reach. Therefore CMC have failed to have an effective propaganda and public information system to educate above mentioned people regarding the SWM.

92. Though CMC has employed its labourers effectively, they are not distributed proportionately. For example Fig 2.2B shows the division wise employment of labourers which indicates that in divisions 2b and 5 labour force is not adequate for removal of Solid Waste whereas divisions 2A and 3 has excess labour. Therefore some of labourers could be transferred to divisions 2b and 5 from divisions 2A and 3 to achieve higher effectiveness.

93. Disposing of solid waste in open dumps is the most common method in the CMC. Nearly or all of the waste generated is collected by the CMC and the remain is burnt or dumped in the backyard of the residents and the ashes are thrown to canals, lakes, rivers, bare lands etc. From

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the collected amount, most of the re-usable are collected in informal ways and the remainder is disposed at the open dumps.

94. The open dumping method is cheaper than other disposable methods. However, open dumps produce health and air pollution problems and is not an acceptable method of disposal. They can cause public health problems encouraging the growth of flies, rats and other pests.

95. Air pollution problems arise when the dumped waste is burned so as to reduce waste volume and conserve space. CMC have no regular disposal sites and depend on environmentally sensitive areas and natural habitats in which waste is disposed.

96. The selection of the best methods of waste disposal for a city is of utmost importance. It involves many factors; therefore, a careful consideration must be given to all factors before any decisions are made. Some of the main factors that requires due consideration to be given are the location considerations and the threshold limits. But the CMC due to the time and money involved in the process neglected the location considerations and threshold limits. Though undesirable implications due to the neglect of the location aspects are evident at every disposal site in CMC, non availability of a method to measure the implications directly is taken as an advantage.

97. The spatial planning techniques available for site selection were not used and arbitrary sites of unused or low lying lands sometimes hidden from the view are the more favoured disposal sites of the enlisting SWM methods in CMC.

98. The socioeconomic, physical and environmental considerations like cleanliness, health of the neighbourhood settlers, relative attraction of investments, and land value of the surrounding, coherence with the urban fabric environment pollution are totally neglected when it comes to the selection of sites for disposal purposes. No entry points are available for people's participation in existing SWM process.

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99. In addition, spontaneous combustion, outbreak of fires etc, were evident in the existing SW disposal practices in the CMC. Further, the total omission of land uses and zoning considerations are also evident when it comes to site selection for SW disposal and deposits are permitted to rise to heights to produce solid waste landscapes neglecting the urban form and urban fabric of the area. This leads to the urban blight with the mushrooming of low income settlements, development of socially unacceptable environment with the increase of drug peddling, crime, stealing etc.

100. Presently, the solid waste management in CMC addresses only the day's collection with no future plans hence the threshold levels have been completely neglected thus the crossing of thresholds will lead to a wastage of financial resources.

101. The prevailing laws related to SWM are very much old which cannot be implemented in today's context. In addition there are no specific laws with regarded to improper solid waste disposal.

## **OPPORTUNITIES**

102. The private sector involvement in SWM in CMC is very less. But there are private organizations that are willing to join with CMC to have an effective SWM. Therefore, opportunity should be given to private sector considerably to have an effective SWM.

103. Incentives can be given to households and industries by introducing waste reduction programmes. As an example: if households and industries are able to reduce SW a certain percentage of their taxes can be reduced.

104. The regulations can be introduced to include a garbage site in the new housing plans that are submitted for approval, especially when the land area is not limiting. In building blocks with limited land area, a mechanism for eco-friendly SWM should be incorporated. Laws can be enforced to punish people who do not practice sound SWM system in coordination with

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government. Research and development play a vital role in the success of the implementation of SWM strategy whereas CMC does not have such research and development section in their organization. Therefore opportunity should be created to establish a research and development section.

105. SW is generated by each and every individual. On the other hand the public displays strong emotions on the environmental and health impacts of mismanagement of solid waste. Therefore CMC should take initiative to encourage people for environmentally sound SW disposal through education and awareness creation as much as possible. Community involvement in the decision making process in developing solid SWM strategy should be encouraged. In Sri Lanka, major component of household waste (about 85% by weight) is known to be bio-degradable. Therefore, as a long run solution CMC should encourage public to practice home composting projects more effectively. As amounts of solid waste accumulation vary from area to area (Fig 2.2A, 2.2B) it might be possible that labour force can be assigned more effectively.

## **THREATS**

106. In the process of getting private sector involvement for SWM, CMC has to adopt certain procedures like Tender procedure which is time consuming and sometimes bound to lead to malpractices. The attitude of the public is very vital in the process of SW disposal. The people must have positive attitude towards SWM since it directly affects health, sanitation and environmentally sound life style. But it seems that people have negative attitude in this regard. CMC's main concern is removal of SW from the place where it generates whereas final disposal site is given less priority. The complex life style of the people forces them to have instant food items which are wrapped with polythine. The result is more SWs. Though some makes of the shopping bags are degradable they are not a solution for SW accumulation because the degraded shopping bags change soil texture.

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**CHAPTER FIVE**

**CONCLUSION**

107. Solid Waste is a growing problem in Sri Lanka aggravated in the absence of proper management systems. Deployment and implementation of a National strategy for Solid Waste management is essential in order to reduce environmental, social and economic problems associated with the present disposal practices.

108. In the present study attempts were made to identify the existing problems on SWM practices at CMC, the strengths, weaknesses, opportunities and threats of the existing SWM practices at CMC, based on the analysis of secondary data gathered with regard to the SWM at CMC, formulation of strategies to overcome the barriers and exploit the strengths of SWM practices and finally the recommendations for the implementation.

109. An attempt has been made to understand some concepts and theories on waste management such as the Concept of waste hierarchy, Emergence of the new concept of waste minimization, a relatively new concept of environmental education and the theory of waste management. It was revealed in this study that the concepts and theories, which were discussed, are difficult to be applied in many practical situations. Even though the CMC adopts the waste management hierarchy it is not streamlined to achieve the desired goals.

110. The generated SW is mainly managed through the strategies of recycle/reuse, material recovery, incineration and dumping. CMC has given more priority to open dumping and low priority for recycling and processing. The present strategies of SWM at CMC, their strengths, weaknesses, opportunities and threats analyzed on the basis of secondary data. The practical problems encountered by the CMC in SWM practices were identified. Strategy for SWM is to be based on the policy of waste management from generation to final disposal. Therefore the strategy should be formulated to encourage SWM practices through waste avoidance/reduction, reuse and recycling, and final disposal in an environmentally sound manner.

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111. However, for SWM to be effective, firm and undiluted commitment is required from all stakeholders to solve problems and issues inherent in the management of SW. The seriousness of the nature of the problem must be recognized and acknowledged by all parties of the system.

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**CHAPTER SIX**

**RECOMMENDATIONS**

112. Throughout the study, It has been continuously shown that the existing solid waste management methods used in CMC are not evolved in the spatial planning context considering the relationship between land uses and the solid waste generation nor the manage according to a spatial plan which consider the future population increase and the development in the economic activities hence the increase of the quantity of solid waste generated in the future. An appropriate solid waste management method can only be developed in the planning context with necessary measures to minimize or to eliminate the implications existing in the physical, socio- economic and environmental aspects in the provision of a sustainable human settlement environment.

113. One of the major element that due planning consideration is to be provided for a sustainable human settlements environment through the site selection for the solid waste disposal by sanitary land filling. In the previous chapter it has been shown that the sanitary land filling is the most feasible option for short-term consideration as well as long term considerations in the field of solid waste disposal. Therefore, based on the evaluation of waste disposal methods described in the previous chapter, the only feasible option for solid waste management in the CMC is sanitary land filling. But the practice of operating a sanitary landfill is yet to be introduced. Therefore, the development of a new sanitary land fill site is recommended.

114. However, composting has been identified as a potentially feasible option for long term development in this study. Composting is higher in the waste management hierarchy of the CMC than sanitary land filling. Therefore, a strategy of establishing economically viable, socially acceptable, technically feasible and environmentally sustainable method of composting the biodegraded waste is recommended. It should continue to reduce the volume disposed at the proposed landfill site and prolong its life thus delaying the crossing of threshold limits. It is also recommended that the proposed development of a new landfill site should not adversely affect the future practicability of composting, nor vice versa, and the removal of organic materials from

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the waste stream for composting will in fact benefit the landfill operation i.e. by reducing leach generation and extending the life of the landfill site. Nevertheless, a sanitary landfill is recommended because even with a fully developed composting scheme, the need for landfill remains for disposal of non-compostable material. Advantages of composting are as follows:

- a. No need to worry about the municipal waste collector to come and pick up your garbage.
- b. Contribution to protect the environment.
- c. Additional value for the recyclable item (i.e. paper, glass, plastics, polythene etc.).
- d. Free fertilizer for gardening.
- e. Generating environmentally friendly attitude among the family members.
- f. Can be proud of being a disciplined citizen who cares for his own environment.

115. Another advantage of recommending composting alongside with sanitary land filling is that it will lead to less moisture content in the solid waste stream. Thus it can be recommended a method of de-hydrating the waste received at the disposal site. The main feature of the waste received at the site will be the presence of low moisture content due to the non existence of organic waste with high moisture content.

116. A pilot project has been already carried out by the SEVENETHA, an NGO engaged in urban sector activities regarding composting of residential waste. A low-income settlement in the CMC area was selected to carry out the composting project and specially designed compost bins was given for the composting of their own solid waste to each residence. It was carried out successfully by them in the said location and therefore, it is recommended the expansion of composting of residential waste throughout the city with public participation and with a strong

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monitoring programme. Recycling of waste also helps to reduce and reuse the amount of waste at a considerable extent making final disposal manageable. Sustainable waste collection systems should be established in order to make recycling economically viable.

117. After removal of the recyclable components, there may be a considerable amount of garbage left behind which could be utilized for the generation of electrical and thermal energy. The utilization of combustible materials for energy recovery would be better option prior to land filling if economically feasible. Special attention should be paid to control air pollution when incineration is used as a strategy for waste disposal. Since our waste is largely organic, and everything that is organic is not compostable in a reasonable period of time large volumes of organic waste will continue to be deposited in landfills. A large sanitary landfill has the potential for landfill gas recovery as a source of energy. As the economic viability is the driving force for energy recovery from land fill gas, incentives should be given to develop infrastructure facilities for landfill gas recovery to control air emissions.

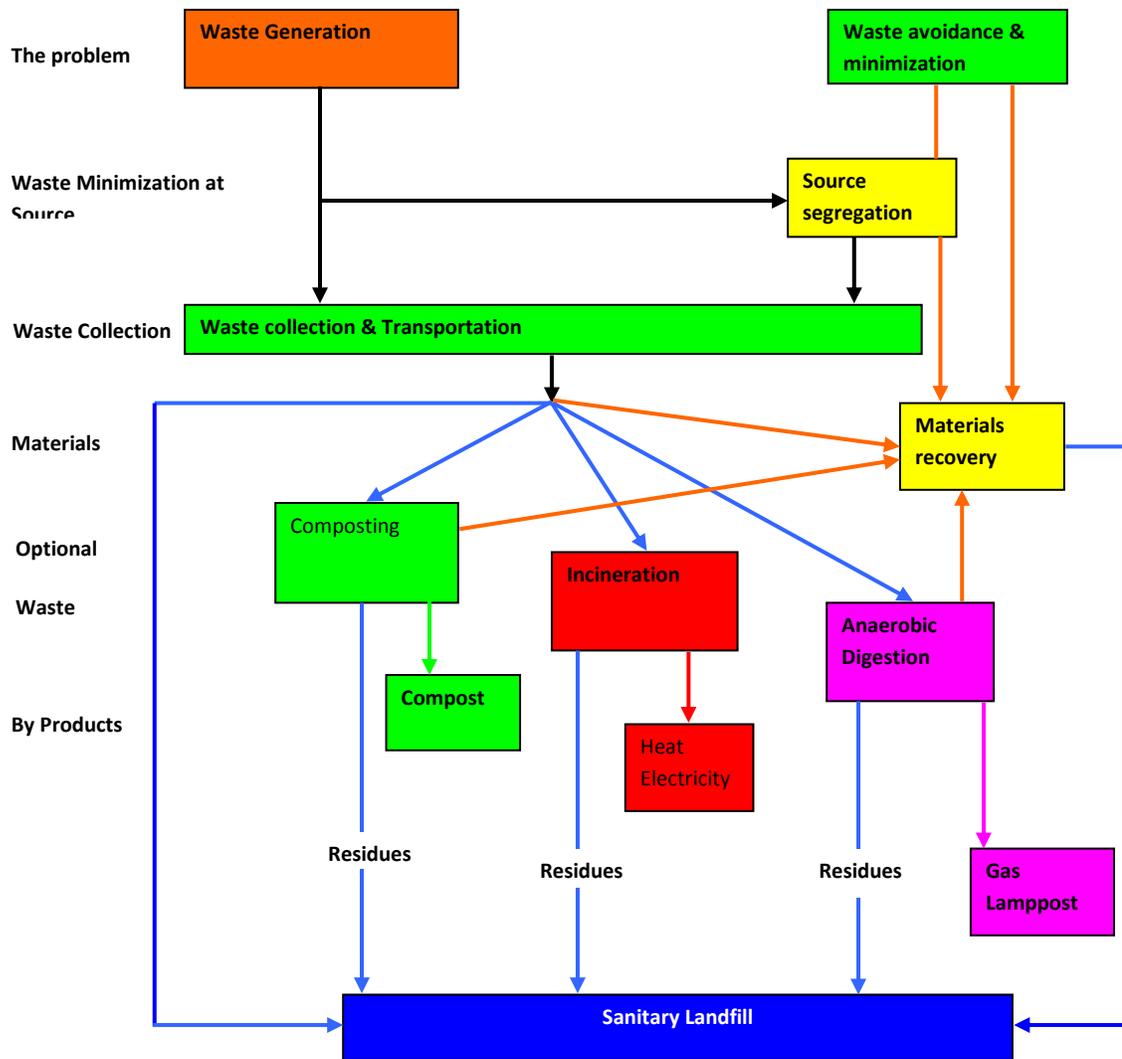
118. Private sector partnership in solid waste management is an essential component to be encouraged. The existing recycling industries should be encouraged to participate more in the development of infrastructure facilities in collection and transportation of waste. Recycling of glass, metal, and paper needs to be encouraged with viable small and medium scale industrial promotion strategy with adequate protection. Establishment of recycling plants at provincial/regional level can be promoted through such an attractive financial and technical support package. Such an environment would be a prerequisite for any meaningful participation of private sector in waste collection and disposal.

119. Private sector participation on composting of organic waste also shall be encouraged by providing more infrastructure facilities in collection and transportation of waste. A proper market also should be established by encouraging private sector involvement in recycling of waste considering waste as a resource.

120. Local authorities may seriously consider the possibility of privatization of solid waste collection and/or disposal systems which would result in more efficient collection and disposal of solid waste. Privatization would be more feasible in more urbanized areas in collection and disposal.

1121. The proposed strategy for effective SWM in CMC area as identified on the basis of SWOT analysis is diagrammatically shown in Fig 6.1.

**INTEGRATED SOLID WASTE MANAGEMENT (ISWM) PLAN**



**Fig 6.1**

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