ABSTRACT
The problem of waste is now a global one. Public and private sectors must cooperate to address the issue in order to solve the world’s limited resource and energy problem. Plastics are made from limited resource such as petroleum. Like other resources, therefore large advances could be made to recycle plastics wastes. The green and reverse logistics also provides business their bottom-line through good image as well as could reduce cost by using recyclable items form their own waste products. The study was undertaken with the objectives to: (1) study the present status of plastic waste management and the existing Phnom Penh household willingness and their influence factors to segregate plastics for recycling and reuse; (2) study how other cities encourage and obtained the participation of their population in plastics recycling and reuse and (3) recommend which policy the government should implement for plastic waste in Phnom Penh.

KEY WORDS
Green Logistics, Reverse Logistics, Recycling, Phnom Penh

1. Introduction
Logistics are important function of modern transport systems. Contemporary technological and spatial developments have improved the cost, efficiency and reliability of freight and passenger transport system. At the same time, the negative environmental impacts of transportation have gained wide recognition and are at the core of issues of sustainability, especially in urban areas [7].

Inserting the green and reverse logistics into the recycling and the disposal of waste materials of all kinds, including toxic and hazardous goods, has become a major new market. The problem caused by plastics is a world-wide phenomenon. Cambodia is no exception. It has become part of the daily life problems, for urban and also for countryside people alike. As disposal site in Stung Mean Chey (in Cambodia) could still have only limited life, waste has to be transported at greater distances to the new disposal site. A different approach is where reverse distribution is a continuous embedded process in which the organisation (manufacturer or distributor) takes responsibility for the delivery of new products as well as their take-back. This would mean environmental considerations through the whole life-cycle of a product (production, distribution, consumption and disposal). For example, BMW is designing a vehicle whose parts will be entirely recyclable [2].

The rising quality of life and high rates of resource consumption patterns have had an unintended and negative impact on Cambodian environment - where waste has been generated far beyond the handling capacities of the government and the company that collects waste. Cambodia is now confronting with the problems of high volumes of waste, the costs involved, the disposal technologies and methodologies, and the impact of wastes on the local and global environment.

But these problems have also provided a window of opportunity for Cambodia to find solutions involving the community and the private sector; innovative technologies and disposal methods; and behaviour changes and awareness rising. These issues have been amply demonstrated by good practices from many cities around the world.

There is a need for a complete rethinking of "waste" - to analyse if waste is indeed waste. A rethinking that calls for
- WASTE to become WEALTH
- REFUSE to become RESOURCE
- TRASH to become CASH

There is a clear need for Cambodia to research for the current approach of waste disposal that is focused on municipalities and uses high energy/high technology, to move more towards waste processing and waste recycling (that involves public-private partnerships, aiming for eventual waste minimization - driven at the community level, and using low energy/low technology resources. Some of the defining criteria for future waste minimization programs will include deeper community participation, understanding economic benefits/recovery of waste, focusing on life cycles (rather than end-of-pipe solutions), decentralized administration of waste, minimizing environmental impacts, reconciling investment costs with long-term goals. Cambodia should take into account the "3R" which refers to reduce consumption, reuse and recycle. The Royal government of Cambodia's intervention promoting greater environmental regulation appears inevitable. At the same time, individual logistics firms are finding a match between environmental considerations and profitability. It is becoming acceptable within the industry to adopt green measures. Sometimes they reduce costs, but more often than not they lead to more intangible benefits such as image and reputation enhancement. It is here that environmental management systems, such as International Standardization for Organization (ISO) 14000, may offer opportunities to green the logistics industry.

2. Literature Review

The amount of solid waste generated in Phnom Penh is 890.6 tons per day or an average of 320,616 tons per year. Medical waste accounts around 346.1 tons per year and Industrial waste accounts around 20,962.8 tons per year [4]. Plastic also take up a growing percentage of MSW stream and pose environmental challenges. Plastics wastes accounts for 15.5% of recyclable items which is 27% in total. Its low density, strength, user-friendly design and fabrication capabilities and low cost, are the drivers to such growth. From the view point of proper management of the final disposal site, plastic waste will be an obstacle. Therefore, countermeasures should be considered.

Hannequart (2005) pointed out, in his guide for waste plastics recycling for local and regional authorities, the good and the bad sides of plastics. He said that history may view plastics as one of the most important technical developments of the 20th century. Plastics have opened the way for new inventions and have replaced other materials in existing products. They are light, durable and versatile, as well as resistant to moisture, chemicals and decay. Yet these properties can also bring challenges to waste managers in local and regional authorities. He continued that now people come to realize the need for waste plastics recycling. Policies have been introduced for recycling, diversion from landfill of untreated wastes and greater levels of resource conservation. Development of local, national and international strategies and new regulations setting targets and economic, market-based instruments and taxes have been adopted, and new technologies to collect, sort, treat and recycle waste plastics have been introduced. One of the challenges is that the more numerous, specialized, engineered and differentiated become plastics materials, the more difficult will be their recovery especially by material recycling which must be a first choice after reuse and prevention.

Pringle and Barker (2004) mentioned in their report prepared for Aberdeen Forward and Aberdeenshire Council, about starting a waste plastics recycling business. The report briefly charts what happened over the 16 months, from September 1999, when the company Scottish Recycling was set up to reprocess post consumer plastic waste into fence posts and street furniture to the time when the company went into voluntary liquidation. Their report provides a very interesting account for the general reader, policy maker and aspirant recycler. As new information on waste plastics recycling is being published at a rapid rate, this publication represents a snapshot of the situation today. It provides essential technical information; lessons learnt during the brief life of Scottish Recycling.

Lourenço and Soto (2002) studied the reverse logistics models and applications on the topic of a recoverable production planning model. The model takes into account the importance of developing new alternatives to improve the performance of the companies. This paper is to develop a medium term production planning model that deals with the concepts of Partnerships and Reverse Logistics. The model takes advantage of the synergies of integration; developing a model for global production planning that generates the optimal production and purchasing schedule for all the companies integrating a logistic chain.

Geroliminis and Daganzo (2005) in their study on “a review of green logistics schemes used in cities around the world” tried to see whether efficient and environmental friendly urban logistics systems can be created. The study is on Freight Carriers that strive to provide higher levels of transportation service with lower

1 Quote from V. Suresh, Managing Director of HUDCO, India
costs on the one hand. And on the other, the economic and environmental viability of cities are negatively affected by the present organization of urban goods distribution. They asked the relevant question whether these two competitive goals can be harmonized. Their paper presents several examples of “green logistics” schemes tried in a number of forward-looking cities around the world. The review highlights the basic qualitative ideas of these schemes and the results of field tests. Most of the ideas can be applied to other cities, but they are not a one-fit-all solution to every city. There is a need to analyze each location and find out which combination of schemes is best for that particular location. This should be an item of some further research priority.

Singapore Green Plan in 2012 provides 8 key measures: (1) Averting a Waste Land; (2) Living in Harmony with Nature; (3) Ensuring Clean Air; (4) Keeping the Water Flowing; (5) Improvement Public Health; (6) Forging Strategic Partnerships; (7) Enhancing External Collaboration; (8). Singapore’s have put efforts in getting residents to recycle have produce results – households participation rate in the National Recycling Program has increased from 15% in 2001 to 45% by end 2003. Industries have also explored more and newer ways to recycle waste, thus contributing to the increase in recycling rate from 40% in 2000 to 47% in 2003.

Established in July 2003 as an administrative unit and its Act proclaimed in May 2004, Zero Waste SA (ZWSA) [10] forms part of the South Australian Government’s Environment and Conservation Portfolio. ZWSA consults to the government and other stakeholders on environmental policy, and provides funding for programs that encourage waste reduction, recycling and ecological sustainability. ZWSA has developed South Australia’s first State-wide waste strategy. According to John Hill, Minister for Environment and Conservation, in his introduction of the Strategy, points out, “South Australia’s Waste Strategy 2005-2010 provides direction and is a call to action. Importantly it recognizes that changing people’s awareness, values, attitudes and behaviour to a sustainable course is critical for achieving many of its strategies, goals and targets. Changing the hearts and minds of businesses, industry, Governments, communities and individuals is a key feature of South Australia’s first Waste Strategy.”

3 Research Methodology

The survey was conducted by using questionnaire. The questionnaire is divided into two main sections: (1) general information and knowledge about plastic waste, (2) what factors would influence the household’s willingness to segregate their waste from plastics and non-plastics. The 429 questionnaires were randomly distributed door to door in the 7 districts in Phnom Penh. The data collected is analyzed using SPSS software.

3.1 Conceptual Framework

The main study on this research is how plastics collected could be recycle and re-use and whether the separation of these plastics should occur at the source or later in the value chain. A literature review and the case analysis identified a number of properties of reverse distribution channels that influence the performance. The willingness of household involvement of the plastics separation is most likely the root of waste behaviors. Thus we look into factors that be involved with households willingness to separate their waste from plastics and non-plastics.

From the objective of the study, we concluded our conceptual framework of this research as follows:

Figure 1: Reverse and Green Logistics
Conceptual Framework for Plastics recycling

3.2 Population and Sample

Sample size had been applied purposively to selected households, plastic collectors and wholesale buyers of recyclable plastics. The total household size was 173,678 (Ministry of Commerce, 1998). Given that it is not possible to survey the whole households, the author concentrated on some proportion of the households located in each district, believed to be able to represent each district.

Yamane (1973) recommended the formula for random sample as below:
Factors affecting the involvement of household to segregating plastics waste: study on the green and reverse logistics for plastic recycling and reuse in Phnom Penh illustrated in Figure 2

\[
n = \frac{N}{1 + N \, e^2}
\]

Where \( n \) is sample
\( N \) is population
\( e^2 \) is probability of error

The sample size can be calculated according to the recommendation as follow:

\[
\frac{173,678}{1 + 173,678 \times 0.05^2} = 399.99
\]

With \( N = 173,678 \), \( e = 5\% \) (95 percent confidence). Hence the sample size for conducting questionnaire should be 400 households.

4. Results

Households are aware that the city as a whole is polluted and solid waste is a major problem. They are aware that the use of plastics items or products will continue to grow, hence creating another environmental problem. This has made them to understand that there is a need to recycle or reuse plastics as much as possible. Out of 429 questionnaires distributed, 315 respondents agree that by recycling plastics will contribute to a clean city. This represents a 73.4% of the total respondents.

39.4% of total household respondents sometimes separate their waste. 13.3% often and 3% always separate their plastics waste. This makes up 55.7% of total households separates their waste. The 44.3% never or rarely separate their waste. But the good point is that 95.8% of the respondents are willing to separate if there are companies that collect their plastics by paying them the recyclables, even at cheap price. Also the level of agreement with the Municipal City to divide waste from plastics and non-plastics has a mean of 4.45 and S.D is 0.82. To sum up, households are willing to separate their waste if appropriate method is being developed, including incentive like paying the recyclables.

Almost all factors are highly important towards the involvement of households’ participation in the recycling process, including segregating their plastics wastes.
is a need for a complete rethinking of “waste” - to analyse if waste is indeed waste. A rethinking that calls for

Figure 3: Distribution of the Opinion on the Environmental in Phnom Penh

Figure 3 shows that more than half of the respondent opinion on the overall environment problem in Phnom Penh is polluted which represented 52% of total respondents and only 0.2% thinks that the environment in Phnom Penh is clean

Figure 4: Distribution of Respondents

Figure 4 shows the willing for households to segregate their waste if companies were collecting plastics products for recycling them. 95.8% are willing to do so and only 4.2 says they are not willing to do so as it is a waste of their time.

Table 2: Agreement Level with the Municipal City

<table>
<thead>
<tr>
<th>Description</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agreement level</td>
<td>4.45</td>
<td>0.82</td>
</tr>
</tbody>
</table>

Table 2 shows the level of agreement with the Municipal City if they require households to separate their waste from plastics and non-plastics products. Since the scale used is a 5-point scale, the Means between 2.61 and 3.40 represent the medium level of agreement with the Municipal City. The Mean score for the level of agreement to separate waste if required by the Municipal City is 4.45 and S.D is 0.82. This means that the majority says they will separate their plastics waste if it is required by the Municipal City.

Table 3: Appropriate Method of Informing Recycling

<table>
<thead>
<tr>
<th>Description</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>TV advertisement</td>
<td>4.66</td>
<td>0.66</td>
<td>Most highly</td>
</tr>
<tr>
<td>Public discussions held in local communities</td>
<td>4.57</td>
<td>6.55</td>
<td>highly appropriate</td>
</tr>
<tr>
<td>Radio advertisement</td>
<td>4.44</td>
<td>0.83</td>
<td>highly appropriate</td>
</tr>
<tr>
<td>Newspaper</td>
<td>3.73</td>
<td>1.03</td>
<td>highly appropriate</td>
</tr>
<tr>
<td>Information leaflets delivered direct to households</td>
<td>3.67</td>
<td>1.28</td>
<td>highly appropriate</td>
</tr>
<tr>
<td>Billboards</td>
<td>3.52</td>
<td>1.24</td>
<td>highly appropriate</td>
</tr>
<tr>
<td>Municipal City website</td>
<td>2.45</td>
<td>4.83</td>
<td>less appropriate</td>
</tr>
</tbody>
</table>

Table 3 shows the appropriate method for the government to inform about recycling. Since the scale used is a 5-point scale, the Means between 2.61 and 3.40 represent the medium level of appropriate method for the government. The household respondents believe that T.V advertisement is the most highly appropriate (Mean=4.66, S.D=0.66) as well as Public discussions held in local communities and Radio advertisement (Mean=4.57, S.D=6.55 & Mean=4.44, S.D=0.83 respectively). Newspaper, Information leaflets delivered direct to households and Billboards were chosen as highly appropriate (Mean=3.73, S.D=1.03, Mean=3.52, S.D=1.24). Municipal City website comes last as less appropriate, giving a Mean of 2.45 and S.D equals to 4.83.

5. Discussion and Recommendation

From the analysis there are clear indications that the residents in Phnom Penh are aware that:

1. Phnom Penh is polluted;
2. The use of plastics is going to grow very much;
3. Plastics must be recycled;
4. They see that TV programs, newspaper ads and discussion among the communities are the best methods to inform about recycling;
5. They are also ready to participate in the separation of waste for recycle.
From the results, we wish to point out the following:

1. While 60.2% of the households finds that Phnom Penh is polluted or very polluted, still 39.6% find it normal and 0.2% find it clean. This is a good basis for tackling waste problems. But this calls for more awareness campaign about pollution created by waste.

2. They are clearly aware that the use of plastic is going to grow very much. This is indeed one of the major problems to be tackled, as the aim of waste management is to reduce it.

3. 73.4% of the households are of the view that plastics should be recycled. It is a very good basis. However, we should also take into account the benefits they gain from the recycled plastics: this means that they can sell them more.

4. A good percentage says that they separate waste: plastics and non-plastics. For this point, we know that they separate only those plastics they can sell, the remaining they put in the same bags of non-plastic waste.

**Short-Term Action Plan:**

As there is a need to cope with daily waste problems, the Phnom Penh Municipality will continue to do its work in cooperation with CINTRI. But it must also have a awareness campaign of the problems caused by wastes and the wealth produced by wastes.

**Proposed Action Plan for the current situation to reduce, recycle and incineration/landfilling, and composting:**

1. **Awareness Campaign:** through TV, Newspapers, and discussions among the communities (at Sangkat or district level). Here the TV ads, especially done by popular artists, have proved to be effective against litters on the streets or in public gardens/parks. They should be used to do the same for the reducing and recycling of wastes. The ways newspapers campaign against bird flu can be used as an example for the participation of citizens on waste management;

2. **Improving the collection and green logistics:** This is an important component of waste management. Here, importance must be given to collect the recyclables. As of now, people separate waste in a way as to put sellable items in one bag and the remaining in another bag (plastic bags!). Encouragement must be given to further separate recyclables and non-recyclables. This needs to come out with specific list for recyclables. The one given by the US EPA can be used as a basis for such a list. Besides, studies must be done on the frequency of collection, whether once a day or twice a day or other ways to improve the collection and the transport to landfills.

3. **Find partners that are willing to set up incinerators for energy.** This is very helpful to the city that has experienced electricity shortage, as it has been cut off once or several times per day that make people angry with the authority. Incineration must comply with environmental regulations in order to minimize the risk caused by gas emissions.

4. **Encouraging composting:** Composting is very important as Cambodia, an agricultural country, most needs it. And this is a problem that the Municipality can and must tackle as parks or gardens are public, while other wastes from back-yards will be encouraged to do composting as well.

**Long-Term Action Plan:**

The “Integrated Waste Management” calls for a long-term action plan, which needs to be reviewed from time to time in order to tackle the problems: How to transform Waste to Wealth, Refuse to Resources and Trash to Cash?

1. **To emphasize on reducing the quantity of waste,** here we focus on plastics, and the hazard it poses;

2. **To improve the knowledge about pollutants;**

3. To Find easy ways for households to sort their wastes;

4. To look at the future

**Measures to achieve those objectives:**

1. **All the measures** of short-term plan are to continue;

2. **Awareness campaign** must be continued as long as the problem exists. The Royal Government of Cambodia should come out, through its highest authority, to lead this campaign. It is suggested to launch a Waste Reduction Day (WRD) or a Waste Reduction Week (WRW). This will certainly attract the attention of government officials, retailers, street markets, residents, especially youth (Cambodia is a country with 70% of the population are under 30).

3. **Legal instruments** must be adopted to cope with the problems. Cambodia has only one Anu-Kret (Sub-Decree) on this matter. It is not enough as problems compound and become more serious. It is to be recalled of the dumping of hazardous waste at Sihanoukville (a seaport) and was discovered and returned back to Taiwan, only after a long process.
4. **Help households to help recycling:** the authorities must do their utmost to help the residents to participate in reducing and recycling wastes. They must come up with concrete measures such as providing curbside or dropping-centers, or bags of different colors for different wastes. There is one example of a small park, near Wat Phnom in Phnom Penh, where it is financially managed by a hotel. The hotel provides two different colors of collection bags: yellow for dry waste like bottles, can, etc; and green for wet waste like fruits, perishable products. This is an example that must be encouraged and implemented further in Phnom Penh, and other cities.

To continue to encourage the selling of recyclables to small collectors (called Ed-Chai in Phnom Penh). This is a huge network of people buying recyclables for small companies, which in turn sell them to big companies or foreign companies. This has indeed generated jobs for quite a number of youngsters, even students who collect items on a part time job.

5. **Producers** are encouraged to cooperate in the waste management, especially to produce what can be recycled. Later on they will have to comply with legal regulations.

6. **Retailers** are encouraged:
   - to talk to their customers to reduce the use of single-use carrier bags;
   - to participate in reducing waste;
   - to increase the recycling of packaging and products on their own premises

7. **Residents** are encouraged:
   - to put pressure on retailers to minimize unnecessary packaging;
   - to reduce the use of single-use carrier bags;
   - to sort out household wastes into recyclables and non-recyclables;
   - to discuss in communities the problems and find adequate solutions;
   - to carry out concrete activities of waste management among the community’s members so as to foster a movement for a better living environment;
   - to educate their own children of the problems caused by wastes, especially plastics;

8. **Schools and Universities** are encouraged to come up with initiative for reducing and recycling wastes.

9. **Studies** of waste management and related measures or action plan in other countries or communities worldwide are to be encouraged.

Seminars, workshops and other forum must be organized in order to learn from the best practices.

10. **Future-oriented actions** must be adopted on the so-called e-waste and other hazardous wastes from electronic products. Cambodia is now a kind of dumping ground for used computers (second hand ones). This will create a lot of problems as it does not know how to handle the wastes from such materials.

11. **Other problems** facing the industrialized countries are also to be learned: many countries in the West now encourage the use of recyclable nappies. Cambodia’s middle class is growing. This will certainly have also a problem of waste from nappies.

12. **A Government Body or Committee** is to be set up to take charge of the waste management.

13. **Introduction to reverse logistics**

Cambodia is committed to sustainable development. Waste management is part of that sustainable development. Cambodia must come up with action plan on waste management. It cannot fail as this will affect its future generations.

Because Cambodia starts to tackle the problem caused by wastes, it has benefited from the worldwide benchmarks, either from government or authorities or from many articles in newspapers or magazines or TV/radio programs are abounded on the waste management. Cambodia has much to learn from them, and chose the ones that are fit for Cambodia, and transform our WASTE into WEALTH, REFUSE into RESOURCE and TRASH into CASH.

**References**


Aberdeen Forward and Aberdeenshire Council. Business Report Prepared For Waste Plastics Recycling to toxic and hazardous goods, has become a major new and the disposal of waste materials of all kinds, including transportation have gained wide recognition and are at the same time, the negative environmental impacts of developments have improved the cost, efficiency and reliability of freight and passenger transport system. At contemporary technological and spatial Logistics are important function of modern transport systems. Contemporary technological and spatial core of issues of sustainability, especially in urban areas

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