A thesis submitted to the Department of Environmental Sciences and Policy of Central European University in part fulfilment of the Degree of Master of Science

Recycling Potential in Armenia

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ABSTRACT OF THESIS submitted by:

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This study focuses on recycling potential in Armenia as one form of misused resource. The international experience on recycling is described and municipal solid waste (MSW) composition is discussed. Situation in recycling sector of Armenia is given. In the country recycling is implemented in 3 ways: formal, semi-formal and informal. Up to 2008 the formal system of MSW collection and disposal does not imply separate collection, sorting, or any other type of waste treatment. If informal and semi formal recycling took place before, formal recycling activities started during past 3-4 years. The whole chain of recycling is absent in the country. There is no proper waste policy in place from governmental side. For having proper recycling system relevant infrastructure should be developed. One of the most important issues is awareness: public and business sector should understand recycling is profitable. In order to have used all the recycling potential 4 groups of issues were identified: waste policy and legislation, MSW overall chain, recycling infrastructure and awareness issues.

Keywords: recycling, Armenia, waste management, recycling potential, municipal solid waste

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Introduction

In Armenia there is very little waste segregation. Separate collection and recycling of municipal solid waste (MSW) if organized in a proper way can be a branch of economy that is profitable for enterprises, provides income to households and creates new job places. It is especially very important for a country such as Armenia where there is resource scarcity and due to closed borders with two neighbours Turkey and Azerbaijan importation of goods is costly. Although there is a lack of data on the amount and composition of MSW, it is obvious that recycling has some potential in the country. Also environmental impacts from recycling can be greatly reduced if proper recycling infrastructure is in place.

Problem definition

Aim and objectives

<u>Aim</u>: To explore the key factors as well as potential opportunities influencing on recycling potential in Armenia.

Objectives:

- To identify obstacles in MSWM system;
- To identify measures to be taken in order to stimulate better approach for recycling practices;
- To identify main barriers to effective recycling.

Research question

The research aims at finding answers to the following question: what is the current situation in recycling sector in Armenia and what is the potential for recycling?

Methodology

For addressing research question there are chosen qualitative research methods. In the primary stage of research literature review have been undertaken. Number of publications has been reviewed and best international experience has been studied (experience of developed as well as developing countries which register success in the field). Afterwards, primary and secondary data have been collected. In the data analysis stage all the gathered data has been analyzed and interpreted to writing.

Research Design

The aim of the master thesis is to explore the key factors as well as potential opportunities for recycling in Armenia. In order to achieve the aim social science research methods will be used. In the research there will be an attempt to include all the chain of recycling starting from waste collection.

According to Punch (2006) research design is between research questions and the data; it aims at illustrating how research questions will be linked to the data and what kind of tools and procedures will be used in order to answer them.

The study uses social science methodology. According to Punch (1998) the term "social science" means scientific study of human behavior. "Social" refers to people and their behavior, and to the fact that behavior takes place in a social context. "Science" represents the way how people and their behavior are studied. Whereas

the goal of science is to construct explanatory theory about its data, the goal of social science is to construct explanatory theory about people and their behavior. That theory on human behavior should be based on, and be tested against, real-world data.

In quantitative research there are used numerical data, and, typically, structures and determined research questions, designs and conceptual frameworks. Qualitative research uses non-numerical and unstructured data as well as it includes research questions and methods which are more general in the beginning of the research, and get more focused as the study progresses (Punch 1998).

The aim of scientific inquiry is to construct explanatory theory based on the data. The objective is to explain the data, not only use the data for description. Description tries to answer to *what* question, whereas explanation aims to answer *why* or *how* questions. Science as a method of building knowledge has an objective of explanation, not only description. However, descriptive knowledge is also important, since explanation needs description. Description is supposed to be an initial step towards explanation. "If we want to know why something happens, it is important to have a good description of exactly what happens" (Punch 1998, Miles and Huberman 1994).

The abovementioned approach is used in this research. First of all as a descriptive data all historical background and current situation will be given. Afterwards, it will be explained the ongoing developments. In this master thesis I will try to answer "why" or "how" about things being studied.

In the current work qualitative research methods will be used.

In order to illustrate to the reader the full picture, main steps of the research are drawn in the Figure 1-1.



The first stage is literature review which allows understanding the overall picture of the subject. This stage aims at giving a good background for further research. As a source of literature review has served existing academic literature, journal articles, reports as well as online resources. The literature is about international practices of recycling both in developed and in developing countries. Mainly international experience is looked through in this stage. Based on findings in the international literature key challenges faced by other countries have been put in Armenian context.

In the second stage from primary and secondary sources data was gathered. First of all electronic communication with different stakeholders was established. Interviewees were divides into 2 categories: who are directly involved in MSWM (government, local companies, and households) and who are not directly involved (NGOs, professors, consultants). Afterwards personal interviews were conducted with key stakeholders (government, local authorities, NGOs). Random interviews with different households also were conducted.

As a source for secondary data country reports and data provided by stakeholders, national legislation, regulatory framework and concepts were reviewed.

In the next stage, analysis of collected data was implemented. The local experience was compared with relevant international ones.

In the final stage findings were reviewed from previous stages and recommendations were developed. The research aimed at description of the current situation in MSWM system, existing obstacles for recycling and ways of increasing recycling share in Armenia.

Data Collection

Data was collected from primary and secondary sources. As a primary source of data, interviews with key stakeholders such as decision-makers in government and local authorities, as well as NGOs involved in this sector were conducted. Initially electronic communication with stakeholders was established.

As a source for secondary data, country reports and data provided by stakeholders as well as legislative acts and information about regulatory framework were reviewed. In this study data collection can be classified as the following:

- By interviewing,
- By observation,
- By review of documents/literature.

According to Punch (1998) interview is an important data collection tool in qualitative research. In this study interviews were individual and face-to-face based on questionnaires. Interviews were semi-structured and open-ended. The interview core

questions were developed beforehand ("structure to interaction"). Interview questions were general questions and were developed in the process of interview (in-depth interview).

According to Seale *et al.* (2004) it is crucial get a range of views on the studied topic. Interviewees were chosen based on the principle to get whole picture of the MSWM system. Interviews with representatives of households, companies involved in MSWM, NGOs and public authorities were conducted. The approaches of government officials, representatives of NGOs and households differ. In order to have the full picture of the situation all the information from interviewees with various approaches was collected and later on analyzed in data analysis stage.

• During the research period (mainly in June) in Yerevan 7 interviews were conducted. The interviews were in Armenian.

Another techniques used is documentary data collection. According to Punch "documents are a rich source of data for social research". The range of documents may be very broad from letters to government pronouncements and proceedings (Punch 1998).

In the current research as documentary data country reports, data provided by stakeholders, legislative acts and information about regulatory framework as well as e-communication with stakeholders was used. Statistical data was taken from National Statistical Service of the Republic of Armenia. Abovementioned documents were obtained from libraries, online (in governmental agencies' official homepages) as well as were provided by stakeholders hand in/directly (in the form of hard copy publications or in electronic version).

Data analysis

CEU eTD Collection

Data analysis includes:

- analysis of current situation of recycling in Armenia;
- identification of problems, ways how to overcome problems, development of recommendations.

Limitations

The current study is concentrating on the whole country. The aim is to present to the readers current situation of recycling in Armenia. The research is intended to reveal challenges and barriers that are in the way to increase the share of recycling.

Limitations could be grouped in the following way:

- Number of interviews were limited due to time constrains (also due to the aim and objectives of current research);
- Lack of statistical data which is a case for most developing countries.
- Language of communication will be Armenian and some information lost could happen during translation.

Chapter 1. Municipal Solid Waste

There are different definitions of MSW, varying across jurisdictions. According to Buenrostro *et al.* (2001), MSW is "all the solid waste generated within the administrative boundaries of a municipality, regardless of its physical and chemical characteristics and source of generation." MSW is defined by Wilson *et al.* (2001) as non-hazardous waste which is generated by households, commercial and business establishments, institutions as well as non-hazardous industrial process wastes, agricultural wastes and sewage sludge. During this research definition of MSW by Buenrostro *et al.* (2001) will be used.

Municipal solid waste (MSW) is the most complex type of solid waste stream compared with more homogeneous waste streams from agricultural or industrial activities (Troschinetz and Mihelcic 2009). Growing income can make changes in peoples' consumption patterns. Increasing waste types and quantities are a challenge for municipalities. At the same time, according to UNEP (2001), growing waste amounts generated will not be a problem if waste is viewed as a resource and managed in a proper way.

There are number of technological means to deal with waste, such as landfilling, incineration with energy production, composting of organic wastes, and material recovery through recycling. Landfilling is considered as a less sustainable method of MSW management compared with incineration. In case of developing countries, where waste streams are composed of 55% and more organic matter, composting can be an effective method for reduction of waste (mainly in tourist and agricultural sectors). On the other hand, incineration is considered as a costly capital investment for many developing countries and can cause societal and environmental health problems if misused (for instance, burning toxic wastes can result in significant air

pollution), and illustrates a less positive energy balance than transformation of material through recycling (Troschinetz and Mihelcic 2009). For developing countries such as Armenia incineration is not feasible mainly due to high cost.

In general, waste should be considered as misplaced resource (waste generation, recycling materials, recovery of nutrient, chemical and energy values of waste) (Kaseva and Gupta 1996). From that point of view possibilities of waste recovery should be discussed.

1.1 Aspects of MSW disposal and waste hierarchy

From 1970s approaches to MSW in the developed countries have changed vitally. It was realized that waste can also be considered as a valuable resource which can allow saving of raw materials. At the same time, it should be noticed that in the second half of past century waste volumes have increased due to population growth, economic development and increasing industrial activity and problems related to shortage of areas for landfills have emerged. The other problem related to landfills was the increasing toxicity of landfills due to technological development and consumption revolution (EPF 2007).

As a response to these emerging problems, some developed countries adapted new strategies on MSW aiming at reduction of waste amount and introduction of more environmentally friendly methods of their treatment. As a result, gradual transition from waste landfilling and incineration to MSW minimization and recycling was implemented. So called "waste hierarchy" was formed in this way and it became a basis for MSW strategies in developed states. In literature the waste hierarchy was called EU Hierarchy for MSW (EPF 2007) and it was first published in the EU Second Activity Program on Environment Protection (1977 – 1981). Nowadays, it is an

integrated part of all relevant EU directives and regulations in the MSW field (EPF 2007).



Figure 1-1. Waste management hierarchy *Source:* EPF 2007

Figure 1-1 illustrates waste management hierarchy. Landfilling which in the past was regarded as the cheapest way of waste treatment according to the waste hierarchy is the least preferable option in the waste hierarchy since currently disposal in landfills includes also high costs of conservation. MSW incineration is considered as harmful for the environment and human health. Only reuse and material recovery (recycling), energy recovery and minimization of MSW amount and avoidance are regarded environmentally and economically beneficial since mentioned activities use less energy and raw materials (EPF 2007).

European Union waste management approach is based on 3 principles:

 Waste prevention: a key point in waste management strategy. In case of reduced amount of waste generated, waste disposal automatically becomes simpler. Waste prevention is closely connected with improvement of manufacturing methods and influence of consumers who demand greener products and less packaging.

- Recycling and reuse: In case waste cannot be prevented, proper recycling should occur aiming at maximal possible recovering of the materials. The European Commission defined a number of specific "waste streams" for priority attention, which includes packaging waste, end-of-life vehicles, batteries, electrical and electronic waste (EC 2010). Nowadays, EU directives require Member States to introduce legislation on waste collection, reuse, recycling and disposal of the mentioned waste streams. Few EU countries have already brought recycling up to 50% of packaging waste (EC 2010).
- Improving final disposal and monitoring: If waste cannot be recycled or reused, it is safely incinerated, using landfill only as a last resort. Incinerating and landfilling require close monitoring since they have potential of causing severe environmental damage. There are specific guidelines for landfill management (included in EU directive on Landfill of Waste). Another directive limits emission levels from incinerators (EU directive on Waste incineration).

Craighill and Powell (1996) state that EU waste hierarchy does not reflect the real environmental impacts of waste management techniques and the ranking is based on intuition rather than on scientific approach. In "Life cycle assessment of recycling" section of the current thesis critics of that idea will be given.

In developed countries the government proposes a target of recycling as a percentage of recyclable components of MSW by a certain year (Bohm *et al.* 2010). For instance, according to EU Waste Framework Directive, by 2020 an overall minimum recycling target is set equal to 50% for glass, metal, paper and plastic waste for MSW (Waste Framework Directive). Already now as a result of the government policy in the United States percentage of MSW has grown from 6.4% (in 1960) to 32.5% (in 2006) (In this percentage are represented fractions recovered and

composted). (US EPA 2007). In EU share of recycled materials in MSW increased to 38 % in 2008 from 25 % in 2000 (EEA 2012).



Figure 1-2. Development of municipal waste management in the EU Source: Environmental indicator report 2012

Figure 1-2 illustrates the gradual development of MSW in the EU. If in 1995 only 20 million tonnes of waste was recycled, by 2010 this number reached 50-60 million tonnes (Environmental indicator report 2012).

In developed countries curbside programs are implemented. The expenses of implementation of recycling programmes depends on local economic conditions (labour, capital, fuel and disposal price) and programme attributes (who is implementing separation of waste prior to collection or later in a central facility, who implementing recycling programs: municipal government or private companies, from how many persons collection crews consist, how frequent is collection) (Bohm *et al.* 2010).

These factors determine the costs of recycling and that kind of estimation of costs and benefits could help policy makers to make decision on increase or reduce the amount of recycled materials: whether "benefits of increasing recycling include reductions in waste collection and disposal costs" (Bohm *et al.* 2010). Waste and recycling services are expensive and there is a need of financing from local taxpayers and/or state governments for operation. According to Bohm *et al.* (2010), the costs of collection, separation, processing, marketing and transportation of recyclable materials surpasses the costs of collection and disposal of the materials as waste (perhaps due to costs of additional economic resources needed for separation and processing of recyclable materials). The other aspects of recycling will be discussed in "Life cycle assessment of recycling" of the current thesis.

1.2 MSW composition in developing countries

MSW composition is defined by Wilson *et al.* (2001) as "a heterogeneous mixture of different types of discarded materials". The composition of MSW is greatly dependent on the conditions of area discussed. Generally, MSW consists of the following materials: paper, rubber, plastic, fabric, leather, vegetable/putrescible, wood, etc. (combustibles), coal ash, glass, metal, etc. (non-combustibles).

Waste streams vary among developed and developing countries. On average, waste streams in developing countries consist of half or more organic matter, that is two times greater than the portion of paper and cardboard, and glass and plastic have similar proportions. Waste composition also can be affected by seasonal effects, household income, domestic fuel supply, geography, living standards, and climate (Troschinetz and Mihelcic 2009).



Figure 1-3. Comparison of MSW composition of developed countries (United States and those in the European Union) against the average of 19 developing countries

Source: Troschinetz and Mihelcic (2009)

Vertical bars provide the range of composition of each material type for the developing countries.

On the Figure 1-3 one can notice that the greatest share in developing countries is for organic fractions, which is followed by paper and plastics. In the same time in the developed countries the greatest share is for paper which is followed by organic and plastic materials.

There is an opinion that high-income households produce more inorganic material as a result of packaging, when low-income households may generate more organic material for cooking (Troschinetz and Mihelcic 2009). Other experts claim that highincome households may produce the same quantity of organic fraction since they can prepare food from fresh, unpackaged food (Troschinetz and Mihelcic 2009).

It is important to state that during summer time organic fractions in MSW increases since fruit is "a bigger part of a person's diet in developing countries" (Troschinetz and Mihelcic 2009).

Chapter 2. Recycling

2.1 Definition of recycling

There are different interpretations of the recycling. The word is relatively new: for example, the word "Recycle" could not be found in the 1970 edition of *Webster's Collegiate Dictionary* (Robinson 1986).

Recycling can be defined as "reclamation of material and its reuse which could include repair, remanufacture and conversion of materials, parts and products" (Kaseva and Gupta 1996).

According Wilson *et al.* (2001), recycling is separation, physical or mechanical process through which secondary raw materials (glass, metals, paper, plastics/synthetics) are taken from MSW. Recycling can be implemented "manually, by simple and/or sophisticated mechanical equipment" (Wilson *et al.* 2001).

According to Robinson (1986), recycling is a closed-loop system which aims at optimization of resource utilization to the overall benefit of humankind while minimizing production of the waste. This definition is an alternative to the "Produce-Consume-Dispose" (P-C-D) system which was common principle in the world 2 decades ago and that principle used to regulate flow of materials. All activities in recycling both consume and produce. That's why each activity could be described as a "Consume-Produce" activity and viewed as a "recycling" activity and a part of recycling system.

EU Waste Framework Directive defines recycling as "any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes." According to this definition, recycling includes the reprocessing of organic fraction but energy recovery and the

reprocessing into materials which will be used as fuels or for backfilling operations are not part of recycling (Waste Framework Directive).

Definition made by Wilson *et al.* (2001) seems more complete and in this research that one will be used.

2.2 Advantages of recycling

Recycling is considered as an environmentally beneficial activity (which contributes to sustainable economic development) and collection, sorting and processing of recyclables into new materials causes environmental impacts (Craighill and Powell 1996). In recent years recycling is considered as sustainable approach to MSW management due to increasing collection, transportation and disposal costs (Kaseva and Gupta 1996). Recycling is regarded as an environmentally friendly activity because it decreases waste transportation expenses, extends the life period of the landfill (through reducing demand for landfill space) and lowers pollution caused by leachates (Kaseva and Gupta 1996). Recycling reduces also resource scarcity space and in general has energy savings (Craighill and Powell 1996).

Recycling has number of economic, environmental as well as social advantages (Kaseva and Gupta 1996).

The economic advantages are:

- Recovered materials require less energy in the production process in comparison with products made from virgin raw materials. In the result of recycling energy saving takes place in the form of electricity or fuel.
- Reuse of recovered material can decrease importation of number of goods in developing countries. Materials recovered from MSW, such as metals, papers,

glass, plastic and rubber can decrease foreign importation. For instance, usage of refuse from compost products can increase rice grain production significantly, in this way reducing dependence on chemical fertilizer.

The environmental advantages are:

- In the result of recycling activities the quantity of waste to be disposed is decreased and the overall space required for landfilling of waste is also reduced.
- Recycling may also protect soil: shredded paper wastes can be used as soil mulch. Soil mulching restricts "soil erosion, suppresses weed growth, buffers against temperature fluctuations and restricts evaporation of soil moisture" (Kaseva and Gupta 1996).

The social advantages are:

- Recycling can address unemployment to some extent: if organized in a proper way it can provide job places for unskilled workers in developing countries.
- Vegetables and food matter recovered from MSW after processing can be used as animal feed.

Collection of recyclables requires energy for collection and sorting and environmental impacts are rising while using recovered materials in new products (Craighill and Powell 1996).

2.3 Life cycle assessment of recycling

There are some critics of recycling: some researchers find that policy aimed at greater recycling may have little or no benefit to the environment. They suppose that more energy is used for getting materials to the recycling facility in comparison with energy savings by the recycling process (WRAP 2010).

According to ISO 14040 LCA is "compilation and evaluation of the inputs, outputs and potential environmental impacts of a product system throughout its life" (ISO 14040). Life cycle assessment (LCA) is a useful tool for assessment of the environmental performance of MSW management systems (Cleary 2009).

For comparison of environmental impacts of recycling with waste disposal system (when waste is going to landfill) lifecycle assessment can be used. Craighill and Powell (1996) used "lifecycle evaluation" which can be defined as lifecycle assessment and economic evaluation termed together (combination of LCA and economic evaluation). The case study was conducted for Milton Keynes in Central England and the results show that recycling system illustrates better performance from environmental point of view than the waste disposal system (global warming, acidification effects, nutrification of surface water) (Craighill and Powell 1996). Waste disposal system contributes to global warming more than the recycling system for materials studied (aluminum, glass, paper, steel, HDPE, PET, PVC). The reason is energy savings when secondary materials are used instead of primary ones. The greenhouse gas emissions which are generated during transportation of recovered materials to reprocessing facilities are significant, but they are compensated in the savings during the manufacturing stage. The results show that it is more environmentally beneficial to recycle aluminum, glass, paper and steel, but in the case of plastics recycling is optimal. (Craighill and Powell 1996).

There are social and environmental factors which are difficult to quantify, but which influence greatly on the level of success of the recycling scheme. For instance, while segregation, the household has to "clean, sort and store the materials" (Craighill and Powell 1996). There is a need for space to storage materials. Social costs appear in the form of noise from collection vehicles and from the materials reclamation facility, visual distortion from vehicles (Craighill and Powell 1996).

Recycling also has educational value: increasing environmental awareness. There is also "feel good" factor which appears when person understands that through participation of recycling process he contributes to environment (Craighill and Powell 1996).

Waste and Resources Action programme (WRAP 2010) conducted a comprehensive study on LCAs of 7 key material categories of key significance to recycling sector (paper/cardboard, plastics, aluminum, steel, glass, wood and aggregates). During the study 55 LCAs were reviewed. From 188 scenarios which included recycling the majority (83%) considered recycling preferable over landfilling or incineration. It was also concluded that for paper/cardboard, plastics, glass, steel, aluminum and aggregates there is a greenhouse gas emission saving from recycling comparing with landfilling or incineration (WRAP 2010).

In case of glass, type of recycling is also important factor which can determine relative advantage from landfilling or incineration. Closed loop glass recycling is considered preferable from both incineration and landfilling from environmental point of view. At the same time, open loop glass recycling was found disadvantageous (WRAP 2010).

The study shows that that landfilling of paper and cardboard is an option inferior to the all the rest, especially while considering from energy demand and climate change potential perspective (WRAP 2010).

Jannick *et al.* (2007) claim that for Denmark also recycling in general is better option than incineration which again is better than landfilling. The results of research show that the waste hierarchy justifies itself: from environmental point of view recycling of paper is better than incineration or landfilling. For recycling the advantage is about saved wood resources which can be used for energy generation from wood (from renewable fuel not contributing to global warming) (Jannick *et al.* 2007).

Brisson (1997) states that from economic point of view it was concluded that recycling prioritization over incineration and then again from landfilling is a good idea. European Commission (1997) also found that recycling in general was the best alternative than incineration.

So, most studies illustrate that recycling provides more environmental benefits and less environmental impacts in comparison with other waste management options (WRAP 2010, Craighill and Powell 1996): recycling is environmentally friendly, saves energy, decreases raw material extraction and fights climate change (WRAP 2010).

2.4 MSW recovery (recycling) in developing countries and informal recycling

Developed countries typically implement recycling programs for collection and segregation of wastes for recycling purposes. In developing countries there is social sector known as scavengers who are dealing with such activities. Scavenger is citizen who has low- or no-income and collects materials either from the city or from landfills and dumpsites (Troschinetz and Mihetcic 2009). Another definition is given by Wilson *et al.* (2001): scavenger is "a person who takes away recyclables/reusable

materials from mixed MSW whenever it may be temporarily accessible or disposed of". Afterwards, collected materials are sold to recycling shops, secondhand dealers (middlemen), or exporters. Medina (2000) states that "when scavenging is supported – ending that exploitation and discrimination – it represents a perfect illustration of sustainable development that can be achieved in the Third World: jobs are created, poverty is reduced, raw material costs for industry are lowered (while improving competitiveness), resources are conserved, pollution is reduced, and the environment is protected." He supposes this kind of systems-wide perception has the potential of making considerable improvements in MSWM in developing countries.

Informal recycling takes place in developing countries due to low level of economic development. People are doing scavenging due to unemployment issues. Informal recycling has positive and negative impacts. Scavenging results in lower crime rates among unemployed (Kaseva and Gupta 1996). In parallel with health and social problems informal recycling provides considerable economic benefits. In developing countries some part of population is involved in informal recycling (up to 2% of the urban population in Asia and Latin America earn for living through waste picking) (Wilson *et al.* 2006).

There is a negative attitude to informal recycling is due to unhygienic and irrelevant to modern waste management system. According to Wilson *et al.* (2001), the informal sector is considered small-scale, labour-intensive, low-paid, mostly unregulated and unregistered activity with low-technology manufacturing and low-level provision of services (often completed by individuals or family groups). Informal sector participants are out of legal field, do not pay taxes, they have no trading license, are not included in social welfare or in government insurance systems.

Paper, cardboard, plastics, aluminum, steel, other materials, textiles and glass are collected during recycling (Haan *et al.*1998). Organic wastes also have monetary value since they can be used as livestock fodder, soil improvers and fuel (Dulac 2001).

Materials extracted through informal recycling are traded in local market. Possible end-users can be local industries. There is a chain between scavengers and endusers, and recycling network forms a hierarchy (Figure 2-1). The higher the level, the greater the added value of recyclables. Informal recyclers occupy the lowest level of the hierarchy.



Figure 2-1. Hierarchy of informal sector recycling *Source:* Wilson *et al.* (2006)

Individual scavengers/waste pickers are considered the most vulnerable social group due to lack of organized supportive network. Having restricted capacity for processing or storing materials, they can be easily exploited. Family-organised activities generally take place in dump scavenging and in cases when waste collection is implemented by the informal sector. Those activities usually involve vulnerable individuals (women, children and the elderly) increasing their health risks. In the same time family-organised activities decrease individual vulnerability through provision of a higher level of social and economic assistance (Wilson *et al.* 2001).

According to Wilson *et al.* (2006), formal recycling system should be established taking into consideration existing informal systems. The best option is integration of informal sector into waste management planning, using established practices and experience, trying to provide better working conditions and living standards to people involved in.

Organization and training of informal recyclers into micro and small enterprises (MSEs) is considered an effective way for increasing their ability "to add value to collected materials" (Haan *et al.*1998). Through having no intermediate dealers, their income will be considerably raised and recycling activities transform into legal field and become more socially acceptable. Establishment of scavengers' cooperatives and associations can also be a solution (Wilson *et al.* 2006).

Existing informal recycling sector in developing countries decreases the cost of formal waste management systems reducing amount of waste collected and transported. However, experience of developed countries shows that it is costly to create new formal recovery systems when existing informal ones are being eliminated. Developing countries should look at this challenge as an opportunity, adding on it new formal system (Wilson *et al.* 2006).

2.5 Factors influencing recycling of MSW in developing countries

Troschinetz and Mihetcic (2009), after making qualitative analysis of 23 case studies, found that the three main factors acting as a barrier to sustainable recycling in developing countries are MSWM personnel education, waste collection and segregation, and government finances.

Title	Description	Percent of case
		studies as a barrier
MSWM personnel education	Extent of trained laborers and skilled professionals in MSWM positions	83
Waste collection and segregation	Presence and efficiency of formal or informal collection and separation by scavengers, the municipality, or private contractors	79
Government finances	Cost of operations, budget allocation to MSWM, stability/reliability of funds	77
Household education	Extent of knowledge of waste management methods and understanding linkages between human behavior, waste handling, and health/sanitation/environment within households	69
Waste characterization	Assessment of generation and recovery rates, and composition of waste stream	67
Government policy	Presence of regulations, enforcement of laws, and use of incentive schemes	63
Technological and human resources	Availability and effective use of technology and/or human workforce and the safety considerations of each	58
MSWM plan	Presence and effectiveness of an integrative, comprehensive, long-term MSWM strategy	50
MSWM administration	Presence and effectiveness of private and/or public management of waste (collection, recovery, disposal)	44
Local recycled- material market	Existence and profitability of market systems relying on recycled-material throughput, involvement of small businesses, middlemen, and large industries/exporters	36
Household economics	Individuals' income influencing waste handling behavior (reuse, recycling, illegal dumping), presence of waste collection/ disposal fees, and willingness to pay by residents	22
Land availability	Land attributes such as terrain, ownership, and development dictating MSWM	0

Table 2-1. Summary of 12 factors influencing recycling as an element of sustainable municipalsolid waste management in developing countries

Source: Troschinetz and Mihetcic (2009)

Table 2-1 gives the name and description of each factor influencing on sustainable recycling, and the grade to which the factor is considered as a barrier to recycling in developing states. Household Economics is considered as one of the smallest barriers (22%) which shows that socio-economic conditions are not the restricting factors for recycling in developing countries. Land availability which is an issue for developed states also is not considered as a barrier.

Troschinetz and Mihetcic (2009) state that while identifying factors influencing recycling in developing countries **stakeholder involvement and collaboration** is considered as means for improvement of different aspects of MSWM. They state that collaboration accelerates increasing household awareness level on recycling, waste collection and disposal, influences on putting in place law enforcement, promotes provision of recommendations on policy initiatives, supports setting up integrated sustainable MSWM plans, and decreasing expenses via sharing of facilities and equipment between agencies.

While studying recycling behavior in China, Li (2003) stated that three **most influential factors to the activity of recycling are: gender, age and household income**. According to the study, elderly females of low-income families who are in charge of household activities are involved in recycling more actively.

Chapter 3. Municipal Solid Waste Management in Armenia

3.1 Current situation in MSWM sector in Armenia

For understanding the recycling potential in Armenia one should have overall picture of MSW. After collapse of Soviet Union Government of Armenia decided to involve private sector in municipal solid waste (MSW) management field. During past 20 years country succeeded in gaining larger share of private investment than in many other post-soviet countries. After independence in 1993, solid waste management (collection, transportation and disposal) was first implemented by state enterprises. Afterwards, in 1994 the Government initiated a reform programme in order to support private sector activities in MSW management system. The property belonging to municipal state enterprises was transferred to private companies. At the same time, landfills became owned by local authorities (Fichtner 2008).

According to Fichtner (2008), the current MSW management system of Yerevan supplies poor solid waste collection and disposal services. Insufficient funding is the main reason why the system currently does not provide appropriate services in all districts of the city. Very little investments has been made during the past 20 years.

Municipal government **contracts services** with private firms and pays them from local municipal budget. Contracted company is obliged to collect and transport MSW and to sign contracts with local commercial as well as government waste generators in the community and to collect proper fees for these services provided in accordance with the local government council's approved standards. The contracted company is responsible for street cleaning and snow removal as well. The contract is awarded on a yearly basis. The local government administration renews the contract annually with the same company and there is no competition for contract. The

company must submit a cost estimate for the services to the community council for contract approval (Arzumanyan 2004).

About 50% of the acting companies in Yerevan MSWM sector are privately owned. The other half are joint stock companies or limited liability companies owned totally by local government. It is difficult to state whether private or state-owned companies are working more effectively due to insufficient level of services provided. Differences from district to district in service provision are result of different management qualities rather than the form of ownership (Fichtner 2008).

MSW is collected weekly or once in every two weeks. There are containers only for mixed waste, and waste separation does not take place in formal way before or after collection. In general, there is no sorting of waste either before or after collection (UNECE 2000). **Collection and transportation of waste** is organized by the companies. According to Fichtner (2008) MSW collection and transportation system comprises of two interrelated components:

- Waste pre-collection scheme
 - "Horning" system¹;
 - Waste collection from garbage chutes;
 - Waste collection from pre-collection points;
- Waste transportation vehicles.

Local authorities are in charge of organization and control of MSWM activities which comprises waste collection, transportation, disposal and street cleaning. Service fees for waste collection are also set up by local authorities (Arzumanyan 2004).

¹ The "horning" system is used in areas where mainly private houses are located. In this case the waste truck arrives to the settlement and inhabitants put their waste into the waste collection truck (Fichtner 2008).

The state budget finances more than half of the cost of MSW treatment and landfill operation. The other part is covered by the population through monthly fees. The money formed in the result of monthly fees of city residents makes about 40-45% of Yerevan overall waste management costs (UNECE 2000). The waste collection fees range in regions (Marz). In the capital city the fee is 150-200 dram (AMD) (0,3-0,4 EUR) per person and in other regions (Marz) 80-120 AMD per person (Sergoyan *et al.* 2011).

MSW is collected by **dustcarts** and is transported to dumping sites. In Armenia there would be a need for 700 dustcarts, but there are only 540. The majority of them is worn-out and requires capital renovation or replacement. Of 540 around 380 are in exploitation. One third of dustcarts are in operation in Yerevan (UNECE 2000).

Nearly 900 villages are not covered by MSWM (UNECE 2000). In rural areas waste is often not taken to landfills or dumping sites, but rather burned or dumped arbitrarily near the roads (Sergoyan *et al.* 2011). Open incineration of waste is also rather common. (Arzumanyan 2004).

In Armenia no facilities for incineration or treatment of MSW at industrial installations exist (UNECE 2000).

About all MSW is disposed in landfills and **dumping sites**. The landfills occupy around 1 500 ha. There are 45 urban MSW landfills and 429 rural landfills in Armenia. Landfills are located 2-18 km far from from towns and sanitary requirements are not kept in those landfills (UNECE 2000). Most landfills in Armenia were constructed without special planning and proper environmental impact assessment procedure (Arzumanyan 2004).

There is no special equipment or preparation in landfills for prevention of leaching of hazardous waste. Usually landfills' staff aligns and covers the used territory with soil landfills. In case waste is not covered by soil due to lack of machinery, at the dumping sites incineration in the open air takes place. Sometimes various toxic pollutants evaporate from the landfills. Generally, landfills do not comply with hygiene standards and norms set by the Regulation on the Sanitary Norms and Standards for the Construction and Management of Landfills (UNECE 2000). There are no protective walls around landfills and no permanent monitoring for the emissions is in place. Only state sanitary-epidemological inspection conducts monitoring for water quality. (Arzumanyan 2004).

MSW from Yerevan is disposed at Noubarashen landfill which occupies 60 ha and has bottom lining, and two other dumps in the western part of Yerevan (UNECE 2000). The landfill is 22 km far from the city. Noubarashen landfill has handled the solid waste of Yerevan ever since the landfill's establishment in 1960. The amount of waste carried into Noubarashen landfill site is estimated as 420-450 tons per day (NSS 2007). Currently, 2 companies operate the landfill according to the rent agreement with the municipality. There are no legal requirements for licensing those companies for the landfill's maintenance (Arzumanyan 2004).

According to Arzumanyan (2004), there are 5-6 illegal dumping sites in Yerevan. There is no official data related to illegal dumping sites.

According to Advisory Study on the Municipal Solid Waste Management in Yerevan (2008), the following types of **municipal solid waste generators** may be distinguished:

family houses (mainly one- or two-storey detached houses);

- multi-apartment buildings (high- and low-rise);
- public institutions (schools, kindergartens, universities, hospitals and other);
- commercial organizations (restaurants, shops, hotels, offices and other);
- industrial sources.

In 2005 garbage gas processing was initiated in Noubareshen landfill by the Japanese enterprise "Shimitsu" (Sergoyan *et al.* 2011) and currently it is in exploitation (EPF 2007). Since 2006 research activities on potential of garbage gas accumulation and usage have been implemented at landfills in Vanadzor and Gyumri (EPF 2007).

According to MUD (2011), a new landfill will be set up in Kotayk region near the town Hrazdan. Establishment of a new landfill is a part of the national plan of MSW modernization. The landfill will be exploited by 8 municipalities: Hrazdan, Tsaghkadzor, Charentsavan, Yeghvard, Nor Hatchn, Byureghavan, Abovyan and Sevan. It will replace many existing dumpsites in the region and the new landfill will comply with EU standards. These authorities will create a joint-stock company for landfill management. The project will be financed by European Bank for Reconstruction and Development (EBRD) through provision of a loan and a grant. The investment will be repaid from fees collected in the result of the introduction of new tariffs for households and other users. It is envisaged that part of the loan may be paid back from the income generated from trading of collected recyclable materials (MUD 2011). The project includes procurement of bins and new dustcarts including compaction trucks. In the municipalities special containers will be introduced for collection of recyclable materials. Local authorities will be in charge of waste collection and transportation of all waste not suitable for recycling.

The other donor, KfW will study MSWM issues in the Vanadzor town and surrounding areas. The research will be aimed at assessment of the quality of MSWM services and as an outcome a list of actions will be presented. New suggestions will be elaborated aimed at closing the existing landfill and construction of a new one in accordance with EU standards, recycling opportunities also will be taken into consideration (Waste governance 2011).

New landfills which will comply with EU standards will bring with them culture of recycling and will establish part of recycling infrastructure. Since the state does not have enough finances to change the system at once, those kinds of small steps will be quite useful.

3.2 Quantity and composition of MSW in Armenia

For putting in place proper recycling activities it is important to understand composition of waste generated. In case of Armenia there is a lack of data related to waste generation and composition. Collection of data on MSW is also difficult due to structure of settlements, seasonal differences, number and type of waste groups, percentages and composition of the groups (Sergoyan *et al.* 2011).

Different studies provide different information about MSW quantity and composition. According to EPF (2007), more than 1.0 mln. tons of waste is genereated in Armenia annually. According to UNECE (2000), during 1985-1990 around 1.3-1.5 million tonnes of MSW were generated annually (20% in rural areas and 80% in urban areas). The abovementioned quantity is equal to 370-430 kg per capita a year. For 1996-1997 amount of MSW was 247-285 kg per capita a year (UNECE 2000).

MSW varies in its composition and types. There are following materials in MSW: metal, wood, paper, glass, rubber, food leftovers, garden waste, and plastic products

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(disposable cups, bottles, toys, polyethylene packages, bits of linoleum, building materials etc). The disposal of these materials in the landfills can cause accidental combustion and hazardous substances such as nitroxides, sulphoroxides and carbondioxide can be released to the atmosphere. In the Noubarashen landfill waste consists of 10 % paper and cardboard, 25 % food waste, 3 % textiles, 3 % polyethylene, 5 % glass, 43 % - stones, sediments, mud etc. (Sergoyan *et al.* 2011).



Figure 3-1. Composition of MSW in Yerevan before and after 1990 *Source: UNECE (2000)*

MSW composition is given in percents. According to Figure 3-1, portion of paper has increased from 11.6% to 18%. Other major trend is that fraction of polymeric

substances has increased from 16.1% to 28% after independence. The relatively high difference in percentage of polymeric wastes is due to more usage of plastic bags and PET bottles for soft drinks. Another general trend is that fraction of food residues has decreased from 40.9% to 30%. Fraction of metals (both ferrous and non-ferrous) has reduced from 3.1% to 0.3%. These two numbers can be explained by decreasing standard of living after collapse of Soviet Union. Informal recycling is taking place. People are separating metals and sell them to collection points. In this case also probably informal recycling is taking place. The portion of food residues was reduced by 9% and portion of soil was raised by 12% since 1990.

The MSW consists of around 85% domestic waste and 15% of non-hazardous industrial waste. The comparison of MSW structure in Yerevan and Hrazdan towns is is given in Figure 3-2. In Figure 3-2 compares MSW structure of Yerevan and Hrazdan towns (UNECE 2000). Town Hrazdan was chosen since it is regarded to represent the average waste composition in urban areas. Here one can notice that there is not much difference between the MSW structures.



Figure 3-2. MSW composition in Yereva and Hrazdan *Source: UNECE (2000)*

Arzumanyan (2004) states that according other statistics provided, municipalities' composition of waste is quite different from official one. Quantity of organic waste and paper make about 40% each. However, this data does not fully reflect the reality since it is for a single community only (Arzumanyan 2004).

According to Butler (2011), in villages which do not have MSW disposal services organic wastes are re-used completely as a supplement to livestock feed and soil.

According to data provided by abovementioned studies it can be concluded that in urban areas of Armenia recycling activities are justified in Armenia, since organic fraction is less than 50% otherwise composting would be better alternative (Troschinetz and Mihelcic 2009).

Chapter 4. Recycling in Armenia

Up to 2008 the formal system of MSW collection and disposal does not imply separate collection, sorting, or any other type of waste treatment (Fichtner 2008). In Armenia recycling is implemented in 3 ways: formal, semi-formal and informal.

A. Informal recycling

Waste separation has been implemented in some different informal ways:

Waste collection from waste bins

The waste pickers are gathering useful materials from the waste bins. Following fractions are considered to be useful: paper, metals, glass bottles and plastic bottles. Sometimes food and textile also are being collected. Waste pickers use part of the collected materials for their own purposes: combustibles, clothes, and sometimes food. They wash and re-use plastic bottles for milk, kerosene and other liquids. However, a large portion of sorted out waste is sold (Arzumanyan 2004).

Waste collection in the landfills

A large portion of waste separation is being done by scavengers in the landfills. The waste pickers (scavengers) come to the landfill with their private cars and are waiting for waste trucks to come. In the landfill the scavengers separate paper, metals, food waste, plastics and combustibles. The separated useful fractions are being brought to the *buy-in centers*. Some of buy-in centers are located near Noubarashen landfill or other dumps. The other buy-in centers are located in private garages, backyards, etc. (Arzumanyan 2004). Informal recycling is implemented in terms of **paper and cardboard**. Paper and cardboard are collected in a few buy-back centers owned by a company in

Ararat region. Afterwards, collected substances are treated into egg boxes and other products.

"door-by-door" waste collection

In this case people involved in informal recycling are passing from house to house (or from apartment to apartment) and are collecting mainly glass bottles.

B. Semi-formal recycling

There exist few small-scale enterprises which are engaged in **plastic recycling** in Yerevan. According to Advisory Study on the Municipal Solid Waste Management in Yerevan (2008), this kind of firms arrange collection points themselves and treat the collected plastic waste into plastic basins, pipes for sewage system and shoe soles.

There are a number of small enterprises that **reuse paper** for production of toilet paper and packaging materials. Another case is recycling of paper. According to Arzumanyan (2004) there are 10 recycling companies in Yerevan. Main materials used for the recycling purposes of those companies are printing paper and newspapers.

Glass bottles are recycled (UNECE 2000). According to EPF (2007) some glass waste is also exported to Georgia to "Ksani Glass" company for production of bottles for soft drinks. In the past, recovery of organic waste was implemented. The food waste was collected for manufacturing animal feed (UNECE 2000).

In the end of 90s several companies established (mainly breweries, and "Coca-Cola, "Bjni Group") their own network of collection of the bottles in shops and restaurants. Price of bottle is included in the price of beverage and after drinking it can be

returned and bottle price will be refunded. The price of bottle makes about 10-15% of the initial price paid for the beverage when returning the empty bottle. The producers of the beverages want to reuse the bottles, since the price of a "second-hand" bottle is considerably less than for a new one (Arzumanyan 2004).

According to Arzumanyan (2004), there are following recycling enterprises in Yerevan:

- For waste paper: "Armbumprom" LLC, "Carton-tare" LLC and "50-50" LLC;
- For metal: "Europe" LLC;
- For plastics: "Yerevan Plus" LLC, "Gary Group", "Firm TNT" and "Grand Sun" LLC.

However, those recycling efforts initiated by small-scale private enterprises, are not sufficient for recovering of a reasonable portion of MSW and a number of issues arise in respect to health and safety aspects (EPF 2007).

C. Formal recycling

Plastic recycling is considered as a profitable business all over the world, but in Armenia there was no sufficient interest among the enterprises. Private sector was not interested in PET recycling since the market is small (5000-6000 tones is small volume). On the other hand, there were no relevant infrastructures and technical means in the towns for recycling.

In 2011 a joint plastic recycling programme was launched by USAID, UNDP and "Eco-Engineering" company. It is a new public-private partnership initiative and is aimed at recycling of plastic containers, bottles and bags.

According to different estimations/ Per OSCE estimates (Eco-Engineering 2012) about 5,000-6000 tons of PET bottles per year are disposed of in Armenia.

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The project will be implemented in Yerevan and Gegharkunik, Lori, Armavir, Kotayk and Shirak regions. These areas were chosen since they are close to water basins where the highest concentration of PET waste occurs and are considered as one of the main water source pollutant. The project will be expanded in future to other regions (Eco-Engineering 2012).

The programme is a mediator between private companies and municipalities and aimed at establishment of such conditions that private companies will be interested in considerable investments in PET recycling sector.

UNDP and USAID will finance procurement of recycling bins to the municipalities and will provide technical support. The other partner, "Eco-Engineering" is supposed to sign contracts with small-scale processing companies in order to buy all the collected PET at a fixed price, as well as company should give support to processing enterprises in the technical terms. "Eco-Engineering" is obligated to invest 1.5 million USD if quantity of PET waste collected is about 3000 tones. Currently, the company processes about 1000-1500 tones of plastic waste (Eco-Engineering 2012).

In the result of programme number of jobs will be created for local people and implementation of programme will allow developing relevant micro- and small-scale enterprises.

The programme also envisages number of awareness raising activities through media, as well as spreading information via volunteers.

Starting from August 2011, in 8 towns (Alaverdi, Vanadzor, Sevan, Tsaghkadzor, Charentsavan, Ararat, Dilijan) special recycling bins were put. The towns were also provided with special equipment for compressing.



Figure 4-1. Recycling bin in Yerevan Source: photo by Davit Shindyan

Companies involved in waste collection in the mentioned towns are collecting preliminary sorted out waste and sell it to "Eco-Engineering", which is in charge of further treatment and exports it to Romania, Bulgaria and recently to Germany. Foreign companies are interested in procurement of raw materials from plastic waste since in developed countries according to legislation they should use in their production only processed material and local companies cannot provide necessary volumes of recycled plastic (Eco-Engineering 2012).

According Eco-Engineering (2012) PET bottle sorting and washing plant is situated in the capital and it can process about 2000 tons of plastics per year. The recycling process consists of the following actions:

- Pre washing;
- Sorting bottles by colors;
- PVC removal;
- Wet grinding;
- Hot washing with caustic solution;

- Rinsing;
- PE/PP removal by sink-float tanks;
- Drying;
- Packing into big bags and labeling.



Figure 4-2. PET flakes Source: Eco-Engineering (2012)

Figure 4-2 illustrates PET flakes that are produced by "Eco-Engineering" for products like polyester staple fiber or packing strap (Eco-Engineering 2012).

According to Cleanland (2012) there is also another company involved in recycling activities named "Cleanland". "Cleanland" was set up in 2009 As a Limited Liability Company and its activities cover several regions of Armenia. The company has **sorting factories** in Gyumri and Vanadzor (established in 2011). The company has agreements with municipalities of Vanadzor, Gyumri, Hrazdan, Dilijan and Sevan towns according to which it obtained the right for waste sorting for 25 years. The company pays 3 million AMD monthly to the municipality. Dustcarts in municipalities of Gyumri, Vanadzor bring collected waste to the sorting factories. The waste is put on the platform where separation to large-scale fractions takes place. Sorting is implemented by the workers. Paper, metal, wood, PET and other useful materials are separated. The sorted waste is collected into the bags. After sorting remaining waste

is taken to the city landfills. Waste sorting station is going to be established in Hrazdan (Cleanland 2012).

The company also has **recycling plant** in Yerevan (established in 2011). Here paper, plastic and PET are recycled.

According to Greenprint (2012) another company "Green Print" imports recycled paper and sells it to local enterprises for daily office activities. The Company also provides printing services on recycled paper (business cards, booklets, paper bags, etc.). "Green Print" mainly cooperates with environmental and international organizations. The business is not still profitable. Recycled paper is more expensive than ordinary one: 2400 AMD for a box of recycled paper vs 1800-1900 AMD for the same amount of ordinary paper (4.8 EUR vs 3.6-3.8 EUR).

Situation in recycling sector is gradually changing. If in past 20 years informal and semi-formal recycling was taking place, now formal recycling has started.

4.1 Role of non-governmental sector in recycling

According to Arzumanyan (2004) by 2004 about 80 environmental and ecological NGOs were registered in Armenia. Their **activities include** environmental education and training, participation in discussions, review of legislative initiatives and assessment of their environmental impact. From active 80 NGOs only a few are working on the waste management issues (Arzumanyan 2004).

Conclusions and Recommendations

During the research the influencing on recycling potential were grouped in 4 sections:

- waste policy & legislation,
- overall MSW chain,
- recycling infrastructure,
- lack of awareness.

One of the issues that hinder proper recycling in Armenia is a lack of legislation and regulations on waste management. There are number of problems which can be solved through strengthening state's role as a regulator. The Armenian legislation on waste does not comply with standards that are in place in the EU states. The definition of waste in Armenian legislation varies from the one defined by EU regulations. For putting in place a modern MSWM system in Armenia the relevant legal framework should be established. As a basis could be taken the EU waste framework directive and be modified according to Armenian reality taking into account economic and social conditions. Waste hierarchy system should be introduced. Relevant waste strategy and policy aimed at waste reduction also should be put in place. Waste reduction and recycling should be integral part of waste strategy. In the strategy the Government should propose a target of recycling as a percent of the recyclable component of MSW by some certain year. In every municipality waste management strategy should be developed and the design of it in small cities should take into consideration the composition of waste in that specific area.

Another issue in recycling is lack of data on MSW amount and composition. For making any estimation or programme one needs to have this information to see the

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clear picture. This information can be obtained if landfills have weighting mechanisms and properly provide information to National Statistic Service (NSS).

No proper monitoring and control in the whole waste management chain (or system), especially in landfills is implemented. For addressing this issue relevant reporting mechanisms should be developed.

No curbside programmes take place in municipalities. In Armenia certain types of recycling of materials that are profitable for business sector should be encouraged by the Government and municipalities.

Another problem in the recycling infrastructure is less participation from the local authorities' side. Overall there is a lack of communication between state government, municipalities, private companies and population.

Private sector should be more involved in provision of MSW services based on contracts between enterprises and municipalities. In towns mechanisms for management of waste service property should be developed (EPF 2007).

In the villages which are not covered by MSW services composting should be promoted. Here so called "decentralized community composting" can be implemented (Butler 2008). Advantage of this option is that it is a low-cost solution which requires only proper organization and public participation. Household composting also can take place.

From the recycling point of view there are number of problems in MSWM whole chain. First of all financing issues there exist: there is low level of fee collection from population for MSWM services and there is no penalty system for not paying collection fees (absence of compulsory mechanisms). To address this issue percentage of payment for services should be increased (EPF 2007) and adequate

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schemes for calculation of fees for waste collection and disposal should be developed. At the same time quality of services provided should be improved. Relevant mechanisms of fee collection should be introduced (for instance, punishments and penalties).

The other problem is the fact that waste collection and transportation system is warnout: machinery and equipment are old. Dustcarts have been in exploitation from Soviet times and are outdated. Besides, those transportation means are not designed for collection of different recyclables. Those trucks do not have possibility to compress collected MSW. For bringing new investments for procurement of new machinery in the MSWM private companies should be involved. From the state side number of privileges should be provided to them (for instance, 3 year activities without taxes, right to sell recyclables). New trucks should have different sections for different waste type. Those trucks should also have waste compressing equipment (especially for plastics). Also required number of vehicles should be procured to meet real demand.

Non-compliance of existing landfills with existing sanitary norms and standards should be mentioned among the MSW chain problems. Also number of illegal landfills exists. In some areas open burning of waste is taking place. Illegal landfills should be closed. Since incineration is a costly option of waste disposal for developing countries, it cannot be considered feasible since in developing countries waste has low caloric value for incineration and more expensive fuel should be added (Sergoyan *et al.* 2011). However, existing landfills should be upgraded and new ones should be in line with EU standards and requirements. Financing of bringing in line with EU standards of landfills is also an issue. That's why landfill improvement can be implemented gradually. Firstly, leachate control, fire suppression and covering waste

with soil should take place (RTI, 2006). Around the perimeter of landfills trees and shrubs can be planted to decrease spreading the waste by wind (Butler 2011).

There are number of problems related to recycling infrastructure as a whole. First of all, it worth mentioning that there is a small market of recyclables due to country size (objective reason).

Secondly, no proper infrastructure is in place from technical and financial point of view. Few processing industrial facilities exist in the country. Overall in the country there is small amount of recycling bins. There is no market for recycled materials and no local production from recyclables. The chain is absent since recycled waste is exported abroad (mainly, plastics). Another issue is that there is a narrow network of collection points for recyclables and their geographical location is still not sufficient. Also knowledge of location of centers among households is an issue. Number of factors can affect costs of recycling: whether it is backdoor collection (curbside or alley service); whether municipal resources are used or private collector is in place; how frequent is the collection.

Another problem for recycling infrastructure is unstable supply and quality of waste (for instance, glass) for semi formal companies.

Existence of semi formal recycling proves that small scale recycling can be quite effective. If near markets, shops small collection points are organized also for plastics and people will get award for plastic waste, it can work.

Butler (2008) suggests an alternative of exportation plastics to crush plastic and add it to cement as aggregate. "Mortars and plasters made with recycled plastics result in low thermal conductivity, low bulk density, less wear and tear on mixing machinery

compared to mineral aggregates, and lower likelihood of cracking and crumbling" (Butler 2008).

Another issue in recycling infrastructure is the fact that in the country informal recycling takes place. As a solution to this problem informal recycling can be legalized. Some incentives should be established to involve informal recycling to legal field (soft force). Experience of developed countries shows that it is costly to establish a new formal recycling system and the best option is to integrate informal sector to formal one (Wilson *et al.* 2006).

According to Wilson *et al.* (2006) integration of informal to formal MSWM can take place through:

- Understanding economic, social and environmental benefits from informal recycling,
- Support in organization of themselves, so helping them to add value to recycled materials,
- Assistance waste pickers/scavengers to form MSEs which can be form of public-private partnership (PPP);
- Involvement of private sector, provision of incentives.

So, role of the state can is to promote cooperatives among informal recycling enterprises; try to make links between private companies and new cooperatives.

Forth group of problems relates to awareness issues. Social acceptance and participation from population side should be in place. There is low-level of awareness among population about recycling.

Here is quite important the role of NGOs. Although NGOs are still week, they can play very active role in changing pubic opinion about recycling. Different workshops

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can be implemented, media can be involved, in schools classes and field trips should be implemented, brochures about recycling should be elaborated, and compost training seminar can take place (Butler).

There is also low level of awareness among business sector. People do not understand yet that waste is money. Being informed population can have incentive to sort MSW.

Overall field	Problems	How to address	
Waste Policy &	Lack of relevant legislation and	Approximation to Armenian waste	
Legislation	regulations (waste hierarchy)	legislation to EU waste legislation	
	No waste strategy from governmental	Adoption of waste hierarchy Development and implementation of	
	side		
	No policy aimed at waste reduction	waste strategy and policy aimed at	
	Less participation from the local	waste reduction	
	authorities side		
	Lack of data on MSW amount and	Introduction of weighting and	
	composition	reporting mechanisms in landfills	
	No proper monitoring and control in the	Putting in place state and public	
	whole waste management chain (or	control mechanisms	
	system)		
	No municipal curbside programs	Implementation of municipal curbside	
		programs	
		More participation from the local	
		authorities' side.	
		Involvement of private sector in	
		provision of MSW services based on	

		contracts between enterprises and
		municipalities.
		In the villages that are not covered by
		MSW services, promotion of
		composting
MSW chain	Low level of fee collection from	Development of penalty system for
	population for MSWM services	not paying fee
	Absence of compulsory mechanisms for	Development of adequate schemes
	not paying collection fees	for calculation of fees for waste
		collection and disposal
	Waste collection and transportation	Involvement of private sector for new
	system is warn-out	investments
	transportation means are not designed	
	for different recyclables	
	MSW is not being compressed	
	Non-compliance of existing landfills to	Closure of illegal landfills
	international standards	Gradually upgrade existing landfills
	Existence of illegal landfills	and bringing in line with EU standards

Recycling	No proper infrastructure in place: few	Putting in place proper recycling
infrastructure	processing industrial facilities; small	infrastructure through more
	quantity of recycling bins;	involvement of private sector
	No local production from recyclables.	
	Lack of broad network of collection	
	points for recyclables	
	For semi formal companies unstable	
	supply and quality of waste (for glass)	
	Existence of informal recycling	Integration of informal to formal MSWM
		Promotion of cooperatives among informal recycling enterprises
Awareness	Low-level of awareness among	Social acceptance and participation in recycling from population side
	population	Involvement of NGOs in awareness raising
	Lack of motivation for recycling	Implementation of different
	NGOs that are not involved in recycling	worksnops, schools classes and field trips
	Low-level of awareness among	Elaboration of brochures about recycling
	business sector	

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Appendix 1

Armenia is a landlocked country in the South Caucasus. It is situated between the Black and Caspian Seas and is a mountainous country. Elevations vary from 400 to 4090, above sea level.



Рисунок 1 Administrative division of Armenia Source: <u>http://enrin.grida.no/htmls/armenia/soe2000/eng/maps/marz.htm</u>

Urban population is about 64% of total population. Armenia divided into 11 provinces (marz): Aragatsotn, Ararat, Armavir, Gegharkunik, Kotayq, Lori, Shirak, Syunik, Tavush, Vayots Dzor and Yerevan.

Before independence during Soviet era, Armenia developed industrial sector, providing machinery, textiles to other Soviet republics, getting raw materials and

energy instead of its production. Currently large industrial complexes of the Soviet era are not in exploitation (CIA 2012).

Before 2009 Armenia used to have double-digit economic growth (mainly due to development of construction sector). In 2009 Armenia's GDP declined by 14%. The economy started to recover in 2010 with 2.1% growth (CIA 2012).

Borders of Armenia are closed with Azerbaijan due to conflict with Azerbaijan over Nagorno-Karabakh region. Border with Turkey is also remains closed. The blockade initiated by Turkey and Azerbaijan limits Armenia's trade.