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Capacity development for plastic waste management

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submitted by
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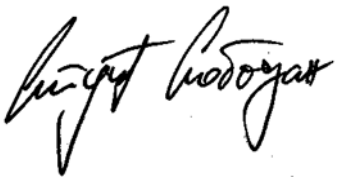
Statutory declaration

I hereby declare that I am sole author of this work. No assistance other than that which is permitted has been used. Ideas and quotes taken directly or indirectly from other sources are identified as such. This written work has not yet been submitted in any part.

This work has not been submitted in the same or similar form to any other examiners as a form of examination. I am aware that offenders may be punished (‘use of unauthorized assistance’) and that further legal action may ensue.



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Abstract

The emerging problems of plastic pollution and mismanagement of plastic waste have highlighted the need to find a solution that involves adopting a systematic perspective. Capacity development is recognized as an approach that can tackle these problems on a global scale and improve performances of the waste management system.

This master thesis focuses on the educational and training aspects of capacity development, pointing out different types of teaching materials and methods. Available publications were collected and evaluated to obtain overview in terms of their content and target groups.

Before the evaluation, stakeholders and their role in plastic waste management value chain were defined. This was made to determine the training needs of the different actors involved in the plastic waste management.

Since different stakeholders in plastic waste management have different interests, it was necessary to appropriately prioritize parameters (criteria) for evaluating them. The prioritization was conducted based on the roles and training needs of each stakeholders. For this purpose, weighting score method was used. The method was designed to include nine criteria for the evaluation (eight training topics and one graphical presentation of the content), three weights of criteria (1, 3 and 5, depending on the importance of the training topic) and three scores (0, 1 and 2, according to the presence of the training topic in the material).

The outcome of the evaluation gives the possibility to easily access the materials depending on the interest in a certain training topic, target group, plastic waste management topic, type of content or teaching method. The results of the evaluation are presented in a ranking form for each stakeholder with the description of publication and the link to the source. Thus, the results of the evaluation can be used either directly in training processes or indirectly as a baseline for the preparation of new teaching materials.

Keywords

Capacity Development, teaching materials, waste management, teaching method, plastic litter, circular economy, eco-design, recycling, waste prevention

Kurzfassung

Die aufkommenden Probleme der Plastikverschmutzung und des Missmanagements von Plastikabfall haben die Notwendigkeit eine Lösung zu finden erhöht, die einen systematischen Ansatz des Abfalllmanagements beinhaltet. Kapazitätsentwicklung wird als eine Möglichkeit angesehen, diese Probleme auf globaler Ebene anzugehen um die Leistung des Abfallmanagementsystems zu verbessern.

Diese Masterarbeit konzentriert sich auf die Bildungs- und Ausbildungsaspekte der Kapazitätsentwicklung und erläutert verschiedene Arten von Unterrichtsmaterialien und -methoden. Verfügbare Unterrichtsmaterialien wurden gesammelt und ausgewertet, um einen Überblick in Bezug auf Inhalte und Zielgruppen zu erhalten.

Vor der eigentlichen Auswertung wurden die Stakeholder und ihre Rolle in der Wertschöpfungskette der Kunststoffabfallbewirtschaftung definiert. Dies wurde durchgeführt, um den Schulungsbedarf und/oder -themen der verschiedenen an der Entsorgung von Kunststoffabfällen beteiligten Akteure zu ermitteln

Da verschiedene Akteure in der Entsorgung von Kunststoffabfällen unterschiedliche Interessen haben (Schulungsbedarf), mussten Parameter (Kriterien) für ihre Bewertung angemessen priorisiert werden. Die Priorisierung wurde basierend auf den Rollen und dem Schulungsbedarf der jeweiligen Stakeholder durchgeführt. Zu diesem Zweck wurde ein Relativvergleich mit fachlicher Gewichtung durchgeführt. Für die Bewertung wurden verwendet: neun Bewertungskriterien (acht Schulungsthemen und eine grafische Darstellung des Inhalts), drei Kriteriumswerte (1, 3 und 5, je nach Wichtigkeit des Schulungsthemas) und drei Bewertungen (0, 1 und 2, abhängig vom Vorhandensein des Schulungsthemas im Material).

Das Ergebnis der Bewertung bietet die Möglichkeit, je nach Interesse an einem bestimmten Schulungsthema, einer Zielgruppe, einem Thema der Kunststoffabfallbewirtschaftung, einer Materialart oder einer Lehrmethode leicht auf die Lehrmittel zuzugreifen. Die Ergebnisse der Bewertung werden in einer Rangfolge für jeden Stakeholder mit der Beschreibung der Materialien und dem Link zur Quelle dargestellt. Somit können die Ergebnisse der Evaluierung entweder direkt in Schulungsprozessen oder indirekt als Ausgangsmaterial für die Erstellung neuer Unterrichtsmaterialien verwendet werden.

Schlüsselwörter

Kapazitätsentwicklung, Unterrichtsmaterialien, Abfallmanagement, Lehrmethoden, Kunststoffabfälle, Kreislaufwirtschaft, Ökodesign, Recycling, Abfallvermeidung.

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Abbreviations

ACRR	The Association of Cities and Regions for Recycling
CBO	Community Based Organization
CD	Capacity Development
CEFLEX	The Circular Economy for Flexible Packaging
CIDA	Canadian International Development Agency
EPR	Extended Producer Responsibility
EU	European Union
GIZ	German Corporation for International Cooperation
HDPE	High-density polyethylene
ILO	International Labor Organization
LDPE	Low-density polyethylene
NGO	Non-governmental organizations
OECD	Organization for Economic Co-operation and Development
OHAS	Occupational Health and Safety
PET	Polyethylene Terephthalate
PP	Polypropylene
PBL	Problem-based learning
PRO	Producer Responsibility Organization
PVC	Polyvinyl Chloride
PoTSs	Potentially Toxic substance
PWM	Plastic Waste Management
StEP	Solving the E-waste Problem
UNDP	United Nation Development Program
UNEP	United Nation Environmental Program
US	United State
WHO	World Health Organization
WRI	World Resources Institute
WSM	Weighting Score Method
WWF	World Wide Fund

1. Introduction

Plastic waste is an environmental problem that occurs on a global scale: all countries and regions are affected. Developing countries, in particular, are facing the leakage of plastic waste into the environment, including the marine environment. This issue, in combination with an underdeveloped waste management system – in terms of poor waste handling and segregation, absence of proper infrastructure and occupational and environmental health practices – represents a major challenge. (Godfrey, 2019).

The reasons for weak waste management system can be found in a precarious financial situation and lack of technical and organizational capacity to deal with this growing problem. Therefore, capacity building in waste management is area where a serious effort must be mobilized to tackle these problems. Furthermore, capacity development can play a key role for the improvement of poorly developed waste management systems due to the capability to recognize problems in the system and to address them in an effective way. Capacity development is crucial not only for public institutions but also for private organizations and nonprofit associations (OECD, 2006).

Training and education have high value as tools for improvement of capacity (Pearson, 2011). Therefore, in every process of capacity building there is a focus on training methods, strategies, and materials. In the last decades many teaching and training materials have been developed and they are still under development. This is the case of materials for plastic waste management, they are of great importance in addressing the problem of plastic waste leakage.

The aim of this study is to evaluate the available teaching materials for plastic waste management in term of their content and highlight the different teaching methods and strategies. Consequently, the results of the evaluation will provide a practical overview of teaching materials that can be easily accessed and used in training process or for the design of new materials.

2. Capacity development

2.1 Introduction

In the last 60 years there is a growing need for development that will provide better health, education and economical system. Development that will enhance the reduction of poverty and improvement of living conditions on the global scale (Sachs, 2005). These needs and many other are part of Sustainable Development Goals (SDG's) defined by United Nations (UN) in 2015. For achieving these goals and fulfilling development needs, development assistance is recognized as an important tool (UNDESA, 2015). Assistance is conducted through strengthening the capacities of a country or an organization by donors or similar organizations.

Capacity development can be conducted for many different purposes, from influencing social phenomena to improving system performances. The waste management system falls within this perspective. Nowadays waste management system plays crucial role in several areas, it supports health care system by improving hygiene, resources prevention by promoting recycling, the economy by providing workplaces and natural environment by preventing pollution. Plastic waste management (PWM) is a branch of the waste management system that deals with plastic pollution and management of plastic waste. Many countries are failing to establish an efficient PWM system, therefore, there is a need for development assistance in this area to tackle plastic pollution on a global level.

Different definitions of capacity development (CD) have been proposed, ''for some CD is approach or process of solving a certain problem (example poverty) while others see it as a development objective (example development of individual or organizational capacity)'' (Bolger, 2000). A lot of different definitions fall between these two perspectives. CD can be more widely seen as a group of strategies, approaches and methods used by developing countries or external stakeholders for the improvement of individual, sector, network and system performances. Moreover, it is also important to define the term ''capacity'' for a better understanding of the CD concept. Capacity has been defined as the ability of people, organizations and society as a whole to manage their activities successfully (Austrian Development Agency, 2011)

Since different countries or institutions require different development assistance, there is no unique set of rules or methods to address CD. However, CD requires a long-term involvement and in most cases the approach to capacity building depends on adapting to situations, which requires learning from experience and flexibility to design a suitable approach (UNDP, 2015).

2.2 Framework and Principles

CD framework varies from one case to another, therefore its exact definition of depends on the organization or the country which capacity is build and the context in which development occurs (Ubels et al., 2010). Different organizations such as UNDP, OECD or CIDA have different models of the framework, where the main difference is the number of suggested capacity levels. The partition of capacity into levels turns useful for conducting better analysis where assistance is needed. Some organizations include three or five levels, while on the other hand Canadian International Development Agency (CIDA) proposes a framework with four levels of

capacity, the enabling environment level, the network/sectoral level, the organizational level and the individual level. The levels of CD are presented in Fig. 1.

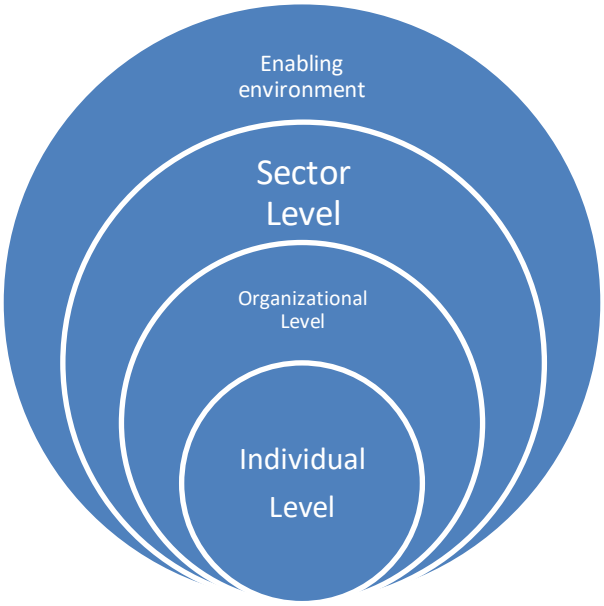


Fig. 1: CD framework

2.2.1 The enabling environment

At the enabling environment level development processes occur. The enabling environment level encompasses a wide range of activities that are tightly connected with other CD levels. It could be said that this final level of CD represents a system which consists of other levels of the framework. Enabling environment depending on social, legal, economic and political factors can be supportive or constraining (Bolger, 2000). Due to the fact that this level consists of other levels, changes at this level require longer period.

2.2.2 Network or Sectoral level

At the network or sectoral level focus is on set of policies and strategies (Austrian Development Agency, 2011). Moreover, this level is in the focus of investors and donors because initiatives at this level can accelerate CD and promote better sector and cross sector coordination.

2.2.3 Organizational level

At the organizational level, the CD focuses on organizational strengthening, addressing the management of processes and resources. This is the level where investors and donors enter CD with technical assistance or/and financial support (UNDP, 2015). Strong synergy exists between the organizational, sectoral, and enabling environment levels and they all affect the performance of the individual-level. The strong relationship between these levels provides either support or constrain to the development processes of organizational change (Lavergne and Saxby, 2001).

2.2.4 Individual level

The individual level of CD involves individual actors, smaller stakeholders such as collectors of secondary raw materials, waste managers experts and organizations providing scholarships and funding for research projects and students. At this level

the abilities of the stakeholders are strengthened through formal training and education or by learning through experience (UNDP, 2015). The development at this level should be part of a wider framework in which it will be synchronized with the other CD levels, if the investment is mainly focused on individual level there is a risk of limiting the development at the other levels (Alaerts et al., 2009).

The CD is based on principles and orientations that distinguish it from other approaches to development (Bolger, 2000). Moreover, these principles are essential for a successful development:

- Inclusion of all participants at broader scale with locally driven agenda.
- Development based on local capacities.
- Constant learning through experience and adaptation.
- Long term investments.
- Implementation of activities at different levels to address complex issues.

In light of these principles, it is worth underlining the importance of roles definition in context of a systematic perspective covering a long period of time, supported by strategic partnership. Moreover, learning and adapting is of crucial importance to obtain flexibility to adjust the approach depending on the case.

2.3 Objectives and approaches

Questions such as ‘’whose capacity is to be grown and for what purpose’’ defines the orientation and the objectives of CD. The CIDA underlines three CD objectives:

- Improvement or more effective utilization of skills, abilities and resources.
- Strengthening of understanding and relationships.
- Addressing issues of values, attitudes, motivations and conditions for sustainable development.

These objectives are adjusted to the context of development. For example, in the context of PWM objectives would be increasing collection and recycling rate, preventing plastic waste leakage into natural environment, reducing the use of single-use plastic, etc. Moreover, these objectives are interconnected in the way that achieving one of them often requires the achievement of one or more goals. For example, in the context of PWM, the aforementioned objectives can be achieved if efficiency of the stakeholders is previously improved through strengthening their relationships with other stakeholders by influencing their attitudes, values and motivations with proper training and education.

CD Approaches vary from case to case, the same approach can be valuable for some situations but irrelevant for others. Thus, it would be desirable to use a wide range of approaches and to combine them to cope with the complexity of CD. It is important that the CD approach is accepted by the one who leads the local processes of CD and that is broadly supported by stakeholders (Pearson, 2011).

CIDA defines seven essential approaches for CD which can be applied in many different situations:

1. Support with financial and physical resources.

This approach recognizes the lack of resources as the main cause of lack of capacity. Often recognized as a problem in CD, the solution is filling the gap by providing more financial funds, equipment, and other types of support that will

enhance the growth of capacity. The advantage of this approach lays in the fact that is relatively easy to implement.

2. Support to the improvement of the organizational and technical capabilities.

This approach addresses the lack of both technique and structural organization. The goal is to improve the existing technical and organizational abilities with activities, like technical assistance, training and improvement of working conditions. This is the most used CD approach because of the values of training, education and improvement of capabilities.

3. Helping to define clear strategic direction.

This approach turns out to be necessary when the organization is not able to define the direction of development due to some internal reasons or when it strives to tackle too many tasks due to overextension or stakeholder miscommunication. This approach should be applied also in case of lack of support to the organization by the political system, this often leads to the destabilization and inefficiency of the organizational system. The solution would be policy dialog that helps to establish the guideline of general direction that will lead activities and CD over a longer period.

4. Support to innovations and provision of opportunities for learning.

Often the main limitation to the development of the organization is represented by the lack of learning spaces and opportunities. Sometimes the problem is not a lack of technical abilities or policy direction, it is rather a lack of chance to experiment and learn without thoughts on failure, intervention, or negative reaction. Moreover, group and individual attitudes can play a key role in improving organizational performances. This means that strengthening social relationships, mutual trust, collaboration, loyalty, openness and generosity may have a positive impact the capacity growth of the organization. More complex organizational methods could be applied once when these factors are improved. Using this approach donors are trying to protect space for experiments without imposing technical methods.

5. Support for strengthening the complex organizational system.

This approach frames the capacity development issue in a systemic perspective. When the organization (or country) struggles to carry out important functions like national budgeting or data collection it may need the help of a group or external organization. This approach relies on two assumptions: first, performances and constraints equally derive from both the internal structure and the relationships with external groups and individuals. Second, to address complex public policy issues (e.g., waste management) a collaborative and synergistic action between various organizations is necessary.

6. Support to establishment of an enabling environment.

The context in which CD takes place can also play a crucial role in development. When enabling the environment is failing to support the development of sustainable capacity, donors can either help to establish a protected space (point 5) or the improvement of institutions and socio-political frameworks that can shape CD. It is worth mentioning that the establishment of a solid and secure enabling environment can be achieved through legislative and political actions.

7. Creation of performance initiatives and pressures

Inefficient sets of initiatives tend to create an environment where individuals and staff behave non-productively. Either the staff is not adequately paid or certain groups such as, public officials or commercial lobbies take advantage of the financial aid that organizations should benefit from. These groups reduce transparency, monitoring, and competition. In this situation the systemic improvement approach turns out to be useless. Therefore, it would be desirable to redesign the organization, break up public sector monopolies, enhance competition, adjust initiative structure and make information on performances more accessible to citizens. This might involve disrupting some of the existing capacities or changing the organization's aspects that prevent its improvement. Governance issues similar to the one just mentioned might be addressed by an external organization that that might aid improvement of overall democratization.

The choice of the most appropriate approaches and measures depends on the particular situation in which they will be employed. This is the matter of CD assessment and questions that should be made, ''to what end we need to develop certain capacity, what will be the purpose, whose capacity needs to be developed, what kind of capacity needs to be developed to achieve wider CD objectives? '' (Wignaraja, 2009).

Approach to CD in the context of PWM where the focus is on teaching/training materials requires an assessment of stakeholders, their role in the PWM value chain, fields of education in PWM and teaching/training strategies. CD in this context engage approaches that give support with financial and technical resources, improvement of the organizational and technical capabilities, innovations and provision of opportunities for learning. Essential parts of CD, stakeholders, fields of educations, teaching/training materials and strategies are further discussed.

3. Stakeholders and their role in plastic waste management

To successfully develop capacity for PWM, it is necessary to determine stakeholders and to define their roles in the PWM value chain. This step gives an opportunity, in later phases, to find out appropriate teaching materials which will fulfill the needs of stakeholders based on their roles in the PWM stream.

3.1 Processes in plastic waste management

Before determining the stakeholders, it is necessary to establish and define processes in PWM, later this will be helpful to precisely define the positions of the stakeholders along the stream and to define their roles. A simplification of the processes involved in PWM stream are represented in Fig. 2.

3.1.1 Manufacturing

Plastic manufacturing is an interdisciplinary process that involves many fields of knowledge, including mechanical, chemical and electrical engineering. Plastic is made up of materials of organic origin like crude oil, natural gas, coal and cellulose that undergo polymerization. Except for these materials, secondary raw materials obtained from recycling processes can be also used.

Some of the most widely used methods for plastic manufacturing are Injection Molding, Extrusion Molding, Vacuum Forming, Blow Molding, Polymer Casting, and 3D Printing. The choice of one over the others depends on both the desired product and the properties of the material. There are methods that can make unique and creative products while some others make repetitive products. Nowadays the 3D printing technology has taken the role of the best technology that can maximize creative plastic production in a short time with minimum mistakes and waste (Kazmer et al., 2018). The types of plastic that are produced the most and that are predominantly found in the domestic waste stream are, Polyethylene terephthalate (PET), High-density polyethylene (HDPE), Polyvinyl Chloride (PVC), Low-density polyethylene (LDPE), Polypropylene (PP) and Polystyrene (PS) (RECOUP, 2020).

3.1.2 Waste generation

Plastic pollution is a global threat, it affects nearly every marine and freshwater ecosystem in the world. Many countries are struggling to handle the current volume of plastic waste and ongoing plastic pollution. Humanity produces nearly 300 million metric tons of plastic waste every year (Kaza et al., 2018). Waste management systems do not have enough capacity on the global scale for safe disposal or recycling of this amount of plastic waste. Previous studies estimated that nearly 8 million of metric tons of macroplastic and 1.5 million metric tons of microplastic end up in ocean every year (Lau et al., 2020). Moreover, it has been estimated that even with a strong commitment of the governments to reduce plastic emissions, it may reach 53 million metric tons per year by 2030 (Borrelle et al., 2020).

Some common plastic end-of-life products that end up in the environment are food wrappers and containers (PP and HDPE, respectively), plastic bags (LDPE), bottles and bottle caps (PET and PP, respectively), straws and stirrers (PP), takeout food containers (PS) and other.

3.1.3 Collection

For the further discussion it is important to notice that term ''collection'' in this case also includes process of waste separation (separation on the source). Collection or collection schemes represent an important part of any waste management scheme and it is recognized as an essential first step that plays a key role in a good performance of waste management in general. Collection schemes can help steering the waste stream composition which in further process can help pre-treatment, sorting, and recycling.

There are different collection schemes in use. Common collection schemes are *kerbside* and *bring system*. The first one is based on the principle that waste is collected from locations at residential buildings. The kerbside scheme has the advantage to be a good service for the citizens, but it requires higher costs and logistic efforts. The common waste fraction in kerbside scheme is lightweight packaging, organic waste, paper, and residual waste. Secondly, a bring system is based on the principle that household waste is collected at central collection points. The advantage of bring system represented by the fact that it requires less effort in logistic. However, the service offered to the community is not as convenient as kerbside collection. The waste fractions targeted by this scheme are textile, glass, paper and cardboard. Collection at the civic amenity site is also part of this system, which opens possibility to dispose batteries and WEEE (Plastic Edu, 2020). Plastic packaging waste can be collected separately (in EU plastic waste packaging from households falls under EPR) or with other waste, for example with metal packaging, paper and cardboard. Other plastic waste streams (non-packaging plastic) are usually collected with the mixed residual waste (Weissenbacher et al., 2015).

The organization of waste collection can be the responsibility of local governments or private companies, but the public-private partnership model is also present worldwide. OHAS is an important aspect of waste collection, especially from waste managers point of view. Applying safety measures significantly reduce chances for injures.

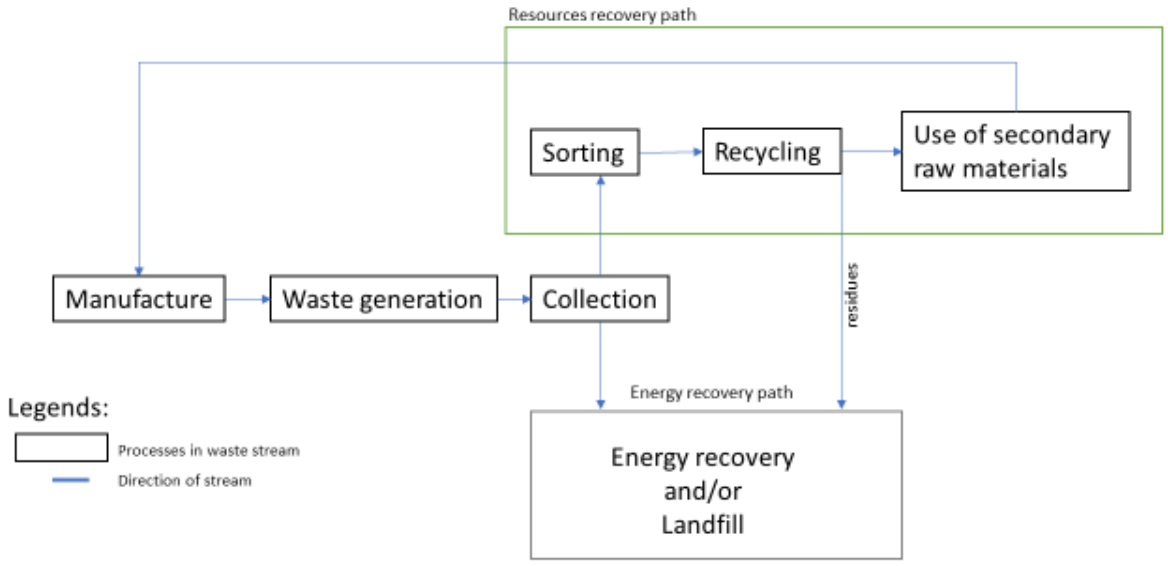


Fig. 2: Processes in plastic waste stream.

3.1.4 Sorting

Sorting operations derive materials which fulfil quality standards for recycling, in other words, a high degree of purity will make polymers re-usable. In this process, besides quality, the goal is to sort materials by polymer types (PP, HDPE, PET, etc.). The process of sorting takes place in treatment facilities and includes manual labor and automatized techniques. There are different techniques for pre-treatment and sorting. Mechanical sorting allows to separate plastic from other materials. However, often it is not enough to separate different types of plastics but is also necessary to sort them by color. Manual sorting is suitable in case of large amounts of plastic components, but it requires intensive labor employment. There are also new automated sorting techniques, such as Ultraviolet-visible spectroscopy (UV/VIS), Laser, Near Infrared (NIR), and others (Ruj et al., 2015). In modern sorting facilities, it is possible to find a combination of these technologies and methods adjusted to specific waste materials which provides optimization of the costs. One of the factors that can make plastic sorting easier and more efficient is reducing plastic waste variations. For example, the design of the plastic products can make sorting complex. Black plastic, plastic sleeves on bottles or products with multiple layers can significantly reduce the share of valuable materials. Besides the fact that multiple layers make separation expensive and difficult they contain ethylene vinyl alcohol or polyamides which can influence the change of color or in some materials physical, chemical and mechanical properties. Thus, eco-design can significantly help efficient sorting. The work in sorting facilities requires a sector in charge for OHAS that carries out risk assessment and provide recommendations for avoiding possible injuries.

3.1.5 Recycling

Recycling is an operation consisting in the conversion of waste into new materials or product. Moreover, energy recovery from waste materials is generally considered as a part of the recycling concept. Common outcomes of energy recovery can be electricity and/or thermal energy. In this way, energy that would otherwise be wasted is utilized (O'Rielly and Jeswiet, 2014). Materials and products that are difficult to mechanically recycle are often subjected to feedstock recycling. Compared to mechanical recycling, that recovers polymers from single-polymer waste streams, feedstock recycling (also known as chemical recycling) aims to convert waste polymers into the original monomers or into other valuable chemicals (crude oil or gas) (Garfoth et al., 2004). In mechanical recycling (the most widespread recycling approach) after the recyclable materials have been sorted, they are reduced in volume by shredding. Afterward, shredded materials are washed and dried to prevent contamination. During and after the process of drying, it is possible to identify and separate the remaining impurities. All these steps are essential for ensuring that the material purity is comparable to the purity of virgin plastic. During the final stage of melting, colorants and additives are added besides a certain percent of virgin plastic. Additives target specific properties that can be required by costumers and prevent degradation (Goodship, 2007). The materials are then cut into granules, dried, and stored ready to be used in the manufacturing of a new product.

Same as in sorting facility, OHAS has high value for the prevention of possible injuries and unwanted incidents in recycling facilities. Thus, it is necessary that recommendations made by an OHAS sector are followed during all the processes in facility.

3.1.6 Use of secondary raw materials

The way secondary raw materials will be used depends on the type of the recycling process. The two main types are the open-loop and the closed-loop recycling (Larrain et al., 2020). In the open-loop recycling process, recycled materials are converted into new raw materials and waste product.

Commonly, the materials recycled via the open-loop recycling are used for a different purpose than it was before recycling. Therefore, the recycled material will be used in another manufacturing process. Open-loop recycling usually involves degradation of recycled materials and removal of non-recyclable attached materials (labels and adhesives). This recycling type is also referred as *downcycling* or *reprocessing*. One typical example of one-loop recycling is the public recycling program. When a single-use product is purchased, the material it is made of goes out from the supply chain of the manufacturer company. When the same product is recycled, it is combined with similar products consisting of various materials other than desired recyclable materials, resulting in waste.

On the other hand, the closed-loop recycling process focuses on supply chain sustainability. The closed-loop system is developed so that the manufactured product can be recycled and used in the same type of products without significant degradation or waste. Thus, recycled materials can substitute original virgin materials. This is possible because in an early phase, during the product design, future recycling is considered (Huysman et al., 2015). Aluminum can recycle represents a valid example of closed-loop recycling because it is possible to recycle aluminum and produce a new can with negligeable levels of material degradation or waste production.

One major point in the use of raw materials is to avoid as much as possible the release of pollutants deriving from the plastic product into the environment or in the food supply chain. In developing countries, it often happens that there is not environmental legislation controlling recycling. Therefore, the chance of contaminating the environment where recycling materials are placed becomes much higher. Furthermore, this can also result in the transfer of potentially toxic substances (PoTSs, toxic metals, POPs, BFRs and PAHs) into plastic for sensitive use such as children's toys and food contact materials. Additives used in plastic material manufacturing with the scope of increasing the stability and durability of products can release PoTSs (for example, once exposed to high temperature). The migration potential of some PoTSs depends on the initial concentration in the plastic material. For this reason, it is important to have a regulatory control of manufactured plastic and its content (Hahladakis et al., 2018). . This is also important for aspects like OHAS and protection of people engaged in recycling and processing (manufacturing) of secondary raw materials.

3.2 Stakeholders

Six stakeholders involved in the PWM value chain, are recognized as essential factors for building a successful plastic waste management system. Each stakeholder has its own role and impact. Besides their contributions, important dynamics exist among stakeholders. This means that the efficiency or inefficiency of one of them can significantly influence not only the performance of the waste management system as a whole, but also the performance of other stakeholders. The Fig. 3 shows the stakeholder positions in the PWM chain.

3.2.1 Government

The role of the government is to define a legal framework for plastic waste management. This means that government has the responsibility of making a set of legal acts and regulations that will precisely define what are the rights and obligations of all other stakeholders participating in PWM. The various government levels can play different roles. The local government (municipality) is entrusted with the task of waste management services (collection and treatment). However, the responsibility in some cases can be shifted to other stakeholders such as PRO's or private waste management companies (local government can create competitive conditions) (Joseph, 2006). Furthermore, local governments have administrative duties such as decision on waste management tariffs and waste management approach (source reduction and reuse, recycling, incineration, composting, etc.). Municipalities can handle waste management services independently or in cooperation with private companies in the form of a public-private partnership (PPPs) (Massoud and El-Fadel, 2002). On the other hand, higher government levels, like the national or federal ones, are involved in producing strategies, targets, standards, laws, and in their implementation. Besides making laws and acts for environmental protection, the government has the duty of introducing penal measures against stakeholders who violate laws.

3.2.2 Manufacturers

Plastic product manufacturers mold, cast, and assemble products made of different types of polymers for various markets, from the car industry to food packaging. Manufacturers have the responsibility to follow standards and regulations to avoid environment pollution during production and later during the product usage. Thus, to achieve these goals, manufacturing industry has continued to develop tools and approaches that will lead to a sustainable product. Besides increasing the percentage of secondary raw materials (recycled plastic) in new products, an important approach is represented by eco-design. Eco-design has a significant influence on end-of-life product management and processing. For example, sorting can be much more efficient, and the quality of the recycling output can be significantly improved if the product is designed by eco-design standard. Moreover, applying eco-design manufacturers save resources and reduce costs of production.

3.2.3 Waste Managers / Recyclers

Crucial stakeholders in PWM are operators and managers responsible for overseeing and coordinating collection, sorting, and recycling of plastic waste. Waste managers carry out an office administrative work to maintain waste management as efficiently as possible. Thus, waste managers are involved in a broad set of activities, from technical duties (collection, sorting, recycling, monitoring, etc.) to the management work such as preparing, planning, implementing strategies, managing the budget, and ensuring that all activities comply with law and regulations. However, waste management practices are not the same in all countries and regions, even if they have common targets. This can be explained by the economic development because successful waste management requires investments (Davidson, 2011). Waste managers can be employed by waste management companies under the control of the local government or by private waste management companies.

3.2.4 Informal Sector

Informal waste pickers are collectors of secondary materials from different waste streams (mostly municipal and industrial waste streams) which are appropriate for re-use and recycling. Informal waste pickers are typical of developing and transitional countries and in most of these countries they are not legally recognized. Exceptions are some countries in South America, like Brazil, Colombia, Peru and Costa Rica. In Colombia, for example, the informal sector is recognized as a full-time recycler who is involved in recovery, collection, transport, and classification of waste (Bermudez et al., 2019). They are organized in associations that provide access to health and pension system, as well to other benefits which tend to help overcoming their conditions of poverty. Informal waste pickers are involved in activities such as collection, sorting, trading, sometimes even processing waste materials which can lead not just to increasing financial income but also to the recovery of up to 20% of municipal waste in these countries (Gerdes and Gunsilius, 2010). There are many ways for informal waste pickers to access the waste: from collecting recyclables from public bins to providing collection service to the household. In some countries waste pickers, separate and collect recyclables at open or controlled dumps. Waste pickers can be regarded as a sensitive social group because for many of the poorest people around the globe waste picking only represents a source of financial income and, at the same time, they are subjected to social stigma, they often face poor working conditions and they are frequently harassed (ILO and WIEGO, 2017).

3.2.5 Consumers

Consumers can be regarded as a stakeholder who generates plastic waste with a central role in the PWM chain. A responsible and educated consumer can significantly contribute to an efficient waste management. The starting point would be to prevent plastic waste, for example by avoiding using single-use plastics or buying such products, or by re-using plastics whenever it is possible. Besides prevention and re-use, separation at the source is something that can be legally binding, and it depends on the waste collection approach. Plastic materials can be separated at the source according to the plastic type (PET bottles, or rigid plastic such as pots, tubs and trays) or can be included as a part of multi waste stream collection together with metal and glass (Neidel and Jakobsen, 2013). By performing separation at the source, consumers contribute to a more efficient waste collection and processing. Non-Governmental Organizations (NGO's) and Community-Based Organizations (CBO's) are also recognized as consumers due to their social status and activities in the society. NGO's and CBO's can have an important role in communication between the community (consumers), authorities, and the market. Moreover, they can raise awareness in the society about the importance of plastic prevention, re-use, recycling, and promotion of zero waste agendas through education. They can enhance positive changes and support waste management development.

3.2.6 Producer responsibility organization

Extended Producer Responsibility (EPR) is an environmental policy approach in which the producer responsibility for a commercialized product is extended to the post-consumer stage of a product's life cycle (OCED, 2016). This helps to stimulate manufactures to design and produce more sustainable products and, at the same time, to increase the percentage of product recovery with the additional benefit of reducing the environmental impact of a product as waste. EPR scheme gives the opportunity to producers to shift their responsibility for collection and sorting to a third

party, a so-called Producer Responsibility Organization (PRO) which is paid by producers for end-of-life product management. Moreover, all the environmental costs of the product and the costs of end-of-life product management are added to the product market price. PRO's can operate in mandatory or voluntary EPR schemes. Many of them are mandatory, while the use of voluntary schemes remains limited to end-of-life products that are profitable to be collected (electronics, rechargeable batteries, etc.). Furthermore, PRO's can operate in a collective or individual EPR scheme. Collective schemes are more often used because they tend to reduce costs for participants and simplify operations. Targets for collection and recycling can be mandatory or voluntary. Mandatory targets are usually defined by authorities or, in another case, producers are allowed to define targets. Generally, there are two management models: in the single PRO model, owned by obligated producers, competition is organized through public calls (at operational level, for collection and disposal). The second model consists of several private PROs competing on market (UNEP, 2018).

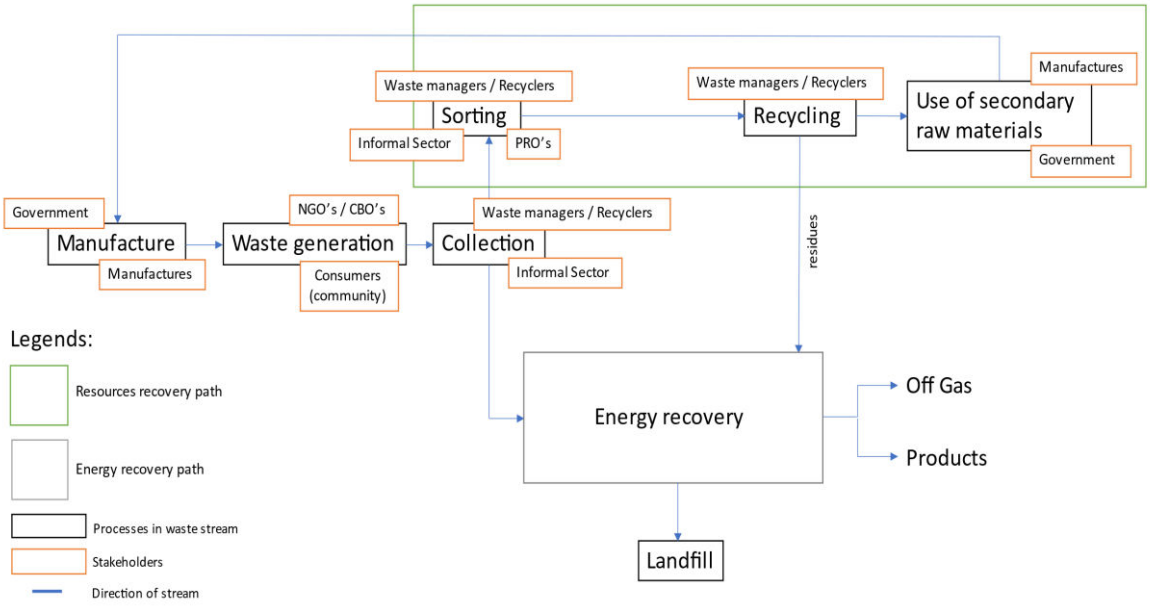


Fig. 3: Stakeholders and their roles in PWM.

4. Fields of education/training

Training and education play important roles in the development of individuals, organizations, regions, and society in general. Therefore, they are recognized as important elements of success for sustainable waste management. This can be explained by the fact that education, same as training, has the great potential to change people's attitude toward plastic waste problems by improving their knowledge. Thus, providing appropriate education and training fulfilling the educational needs of different stakeholders in the PWM value chain will not only develop skills and knowledge, but also it will enhance the development of the PWM system in general. Teaching and training strategies and different formats of teaching materials will be further discussed.

4.1 Teaching methods

To achieve development and training goals, it is necessary to use the right teaching strategy, or a combination of few different appropriate methods. The choice of the most suitable methods can play a crucial role for learning or teaching outcomes. Moreover, different strategies have different effects: this depends on the professional area and the stakeholder that are subject of training. The most common teaching methods are the direct, the hands-on, and the simulation-based ones (Yeunga et al., 2017). Each method has a certain level of effectiveness: the study carried out by Duerden and Witt (2010) showed that more traditional ways of teaching such as lectures are less effective due to lack of interactive components in teaching. On the other hand, other study (Sipos et al., 2008) showed that more experiential learning strategies can have a higher impact on learners. Moreover, some newly developed methods that are currently in use will be further discussed.

4.1.1 Direct teaching

The direct teaching method belongs to the group of basic and traditional methods. Using this teaching method means that a certain person (teacher) stands in front of a group of people (classroom) and gives information (knowledge) on relevant topics. Well-structured instructions and information, together with a teaching person who has authority are the key requirements for the successful outcome (Goodman, 1986). The efficiency of the direct teaching method depends on the skill or on the knowledge that has been chosen as a goal to achieve. For example, it is expected that the direct teaching method will be more successful in spreading awareness regarding the negative impact of plastic waste and less effective when the aim is to transfer practical working knowledge in a recycling facility. The direct method is based on two main principles: all participants can learn when they are properly taught, and all teachers can be good when effective materials and learning techniques are provided (Renard, 2019). Besides the spread of knowledge by the teacher, there are also other components in direct teaching. One of them is represented by the teaching materials that have been designed to support a better understanding of the presented knowledge (creative books and PowerPoint presentations, for example). A second one is the engagement of participants into groups to conduct a guided practice. Guided practice actively involves both the students and the teacher: it means that the teacher puts into practice the knowledge he presented while monitoring the work of groups of students. Feedbacks from students – that might find

some parts of the presented knowledge unclear – is also a component of direct teaching. These components together ensure effective direct teaching.

4.1.2 Hands-on teaching

The hands-on teaching method is a method that implies learning by doing. In this specific case, learners are included in activities through which they can develop skills and gain knowledge. In teaching sessions, tutors provide guidance to the participants on how to obtain knowledge more actively through interaction, experiments, and observations (Yeunga et al., 2017). Also in this case, the efficiency of the method depends on the field of training. For example, technical operations on machines in recycling facilities or the waste collection process are fields of training for which the hands-on teaching method seems more suitable. Moreover, all other situations where the knowledge can be better absorbed through a different set of activities – including active engagement of participants – are suitable for a hands-on teaching approach. The hands-on teaching method has the advantage of give access to materials and equipment which will be used on the workplace: this aspect can be extremely beneficial when it comes to health protection and safety at the workplace. This approach helps becoming familiar with tools and workplaces to the extent that health and safety risks are strongly reduced. Furthermore, more knowledge is retained when it is obtained through experience, rather than a lecture-style approach (Haury and Rillero, 1994). Along with the numerous benefits, some downsides also exist. The hands-on approach helps courses' and trainings' participants to get functional knowledge and a more general idea about how a certain process work, but put less focus on details. Therefore, in the case of plastic manufacturing, the hands-on teaching method will not have a high rate of success. A combination of the hands-on teaching approach with some other methods, such as the direct teaching method, can significantly impact the level of knowledge that can be achieved by the targeted group.

4.1.3 Simulation game-based teaching

The simulation game-based method is based on the principle that participants to courses or trainings are encouraged to simulate a real situation: in this case they must use a combination of skills and knowledge – deriving from different educational areas – to solve tasks or make decisions. In this way, participants have the possibility to witness the outcomes of their decisions and actions. Along with the gain of a specific knowledge in a certain professional area, this method can also help developing skills not strictly connected to that specific area. For example, if participants work in groups during the simulation process, th simulation game-based teaching approach can encourage communication and discussion between team members. This enhances not only professional skills but also social skills (Pivec and Dziabenko, 2004).

The concept of game-based approach is showed in Figure 4. This diagram allows to conclude that the game-based strategy tends to deliver an instructional content embraced in a game framework. The simulation (game) should be interesting, so participants are motivated to repeat the game in cycles. Repeating the simulation will help participants to gain knowledge from the interaction with participants and feedbacks from the simulation.

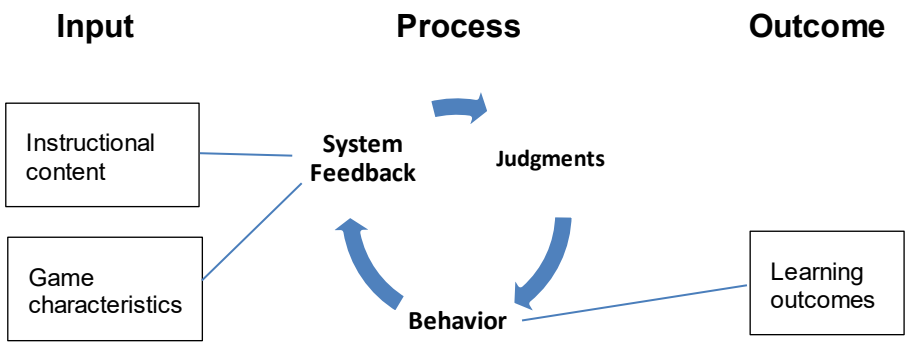


Fig. 4: Game-based learning model (Pivec and Dziabenko, 2004).

The impact of the game-based learning method depends on the training field. This concept is suitable for training fields in which critical thinking and communication in the group have high priority. In the context of PWM, the simulation-based method can have an important role in spreading awareness regarding plastic waste problems, especially among the younger population. This method is often used in the educational system (schools and universities), but it also can be engaged among consumers and communities as a part of the environmental campaign.

4.1.4 Other methods

Some of the methods which will be further discussed can be considered as newly developed since they took part in training and education in the few last decades. They have been used separately or in a combination whit one of the already mentioned methods and their efficiency depends on the training topic and educator.

The expeditionary learning method engages the idea of sending participants of course or training on an expedition where they will be able to see how certain issues can be solved in practice. Usually, this approach consists of preparation before the expedition and feedback in form of the report after the expedition (Klein and Riordan, 2011). A good example is a visit to a waste treatment plant by the local community or students where visitors can see and learn, from firsthand, how waste is processed and what are the consequences of bad waste management.

Personalized learning is a new method that is still evolving. It is based on the principle that training plans are adjusted to the learning possibilities and skills of participants. During the learning process, each participant can move to a new level or topic once when the current topic is mastered (Beghetto, 2019). This gives chance to each participant to progress beyond group level but also leaves space, for participants who need additional effort to master skills and knowledge, to have their own workload dynamic.

Flipped Classroom also is a relatively new method. The core of idea is that participants are supplied with teaching material (books and videos of lecture) which they should read and watch at home. Sessions and discussions with this approach give certain degree of freedom to participants in work with the hope that will have a positive influence on learning outcome (Herreid and Schiller, 2013).

Problem-based learning (PBL) is a teaching method which engage ‘’real-life’’ problems and promote approach different from direct teaching. PBL promote development of critical problem-solving abilities, critical thinking and communication skills (Bayat and Tarmizi, 2012). Lecturing is substituted with problem based on clear

learning goals, and problem is created by PBL instructors. Participants are guided through problem by instructor. This helps participants to learn key concepts, facts and processes which are related to core training content (Allen et al., 2018). Example of PBL could be found in urban planning where the students are challenged to observe and interview members of community and detect local issues. Therefore, to formulate practical solutions and implement them.

4.2 Types of teaching/training materials

Materials used in the training process have crucial importance for a positive outcome. Besides quality, the format of these materials is important when it comes to the impact on users (course or training participants). This can be explained by the fact that participants differ in several aspects, from age to teaching needs. The choice of a suitable material type for a certain group is of crucial importance for a positive outcome. Often, a combination of different types of materials can have a greater impact on the outcomes.

Two types of teaching materials are recognized as most common, written and multimedia materials. These materials and different variations inside these two groups will be further discussed and they are presented in Tab. 1.

Tab. 1: Types of teaching materials

Written	**Multimedia**
Textbooks	Videos / Movies
Guidelines / Manuals	Audio guidance
Magazines	Social Media
Brochures / Posters	Computer and Video games

4.2.1 Written materials

The most frequently used teaching materials come into the form of hard copy, but recently, with the development of technologies, a growing amount of these materials is becoming available in digital form. Written materials are suitable for almost all professional areas as a central teaching tool or as a supplementary material. Textbooks, that cover a central place among written materials, usually come together with support materials such as workbooks and exercises. These materials are often used in traditional teaching approaches, such as direct teaching, and they are suitable for the theoretical part of training programs.

Furthermore, guidelines and manuals have a high level of engagement not only in PWM but in any learning process. The reason for this is the possibility of these materials to give instructions and information without the support of a trainer or an educator. However, guidelines and manuals have their limitations when it comes to the impact and positive outcome. They are more suitable for non-complex processes in which users can understand what should be done without bigger problems. Most

frequently used materials for PWM training and education are guidelines and manuals for waste separation at source, health and safety at the workplace, guidelines for eco-design, etc.

Magazines and newspapers, either scientific or popular ones, also play a role in education. Scientific magazines can both be a source of knowledge and provide support for the further development of knowledge. Popular magazines and newspapers can also help spread awareness about plastic waste problems and shape people's attitudes towards environmental problems. The target group of these materials usually includes consumers and the community.

Brochures, posters, and similar materials can be helpful tools for the transmission of simpler information. These materials are mostly engaged in campaigns (brochures) and locations where it is necessary to give instructions regarding certain processes such as location for waste disposal (posters).

4.2.2 Multimedia materials

With the development of technologies, new teaching approaches are also emerging. Nowadays, knowledge and information are widely available in multimedia format, which offers contents in a more simplified and creative form (videos, pictures, etc.). The involvement of the internet in education and training processes has enhanced the development of multimedia materials. It has given participants the possibility to join courses and trainings even when they cannot be physical present (distance learning), and to adjust their personal schedule more easily.

Multimedia materials can be an efficient option when participants have different learning styles and background knowledge, since they allow to integrate different ways of information retrieval such as the visual, auditory, reading, and kinaesthetic one (Noordin et al., 2011).

Movies, and video content in general, can be a good teaching tool – especially when it is necessary to explain dynamic processes – because they allow to clearly represent visual clues and information. Moreover, video content can have a positive impact on participants when it comes to the level of attention directed to the presented knowledge. Video materials can be in long or short format, either movies or short training episodes. Multimedia materials are often used worldwide to spread awareness about problems like plastic pollution as a serious threat to the environment. Moreover, video materials are suitable when it is necessary to explain complex processes because learners can have access to abstract principles in an illustrated form (Bates, 2019).

Due to the development of the Internet, these materials today can be used individually or in a group, in a training (or education) center, at home, or anywhere else with electricity and a stable internet connection. In 2020, online lessons, in the frame of the so-called distance learning, gain great popularity due to the pandemic crisis caused by COVID-19. This situation has shown the enormous potential of video materials in the area of training and education, and this format is expected to develop more in the future.

The constant development of audio materials, from audiocassettes to podcasts, has made them powerful teaching materials, as long as they are used well (Bates, 2019). Audio materials can be used independently, but they can often be used in combination with other materials.

Audio materials like podcasts and interviews between researchers or experts can be used independently to spread awareness about environmental topics. The combination with other materials, like the visual ones (including figures, graphs, and tables) can be very useful. And the possibility to stop and restart recorded audio material has proved very useful when used in presentations. Moreover, in the last decade, the development of audiobooks has given audio materials the possibility to increase their share in educative materials even more. Audio materials like audio clips or podcasts have the advantage to be much easier to make than video, and it is easy to combine them with other materials. A drawback is represented by the fact that spoken language is less precise than text.

Since 2005, a wide range of web tools have started to be used in training and education. These tools can be defined as social media because they employ a different way of using the Internet than the previous "centre-to-periphery" use of institutional websites (Bates, 2019). Some of these tools are blogs, wikis, social networking (Facebook and LinkedIn), mobile applications, and multimedia archives such as YouTube or iTunes. The main characteristic of social media is that they encourage users to access, create, and share information in an easy and user-friendly way. As social media materials and tools are based on simple software, they are rapidly emerging in the form of new tools and applications (apps), especially because their use is free or low cost. In addition to providing access and sharing of training and teaching materials across networks, social media have the power to develop digital literacy and networking skills among users. However, besides the numerous positive aspects of social media as educational material, there is a problem related to the quality of the information, since the material is circulating freely. In other terms, the source is not always relevant and accurate.

Computer and video games have been ignored as possible teaching material for a long time. Since 2003, video games started to be included in training and education more and more. Educators started to take advantage of the fact that video games provoke emotions. Therefore, they adjusted the content of their knowledge to game designs and storylines, in order to effectively delivered it to their students. This approach has significantly impacted the participants of courses and trainings (Utoyo, 2019). These games usually involve the use of skills like critical thinking, logic, problem-solving, memory, and visualization. An example of educative video games is ‘Recycling City’ made by the U.S. Environmental Protection Agency, where gamers (learners) solve problems of waste management in imaginary towns combining knowledge from different sectors of waste management.

4.3 Training topics in plastic waste management

Each stakeholder in PWM has different needs in the context of teaching and training materials. To define these needs more easily it is necessary to map the relationship between stakeholders and training topics. Tab. 2 shows the mapping of stakeholders and training topics, based on roles of stakeholders in the PWM value chain (see chapter 2). As it can be seen in the table some stakeholders share the same training topics but in general, they diverse in common training fields. Since there is no teaching material that fits all stakeholders, it is necessary to define training priorities for each stakeholder. In Tab. 2 training topics that have high priority for certain stakeholder are marked with blue cross and the one that have medium priority are marked with red circle. This training topic classification is later used for the

prioritization (weighting of criteria) and evaluation of teaching materials (see chapter 5.2).

However, even if certain stakeholders have common training topics, the context can be quite different. For example, government, waste managers, and consumers have an interest in the waste collection but each of them in a different way. Government is interested in the organizational and financial aspects of waste collection, waste managers in technical, while consumers in informative aspect (waste separation at source). To understand better different contexts inside the training topics, they are further discussed and explained.

Tab. 2: Relationship of stakeholders and training process in PWM

	Regulations	Collection	Sorting	Recycling	Recyclability	OHAS	Products recyclability	Economic aspect
Manufacturers	✖				✖	○		○
Government	✖	✖		✖				○
Waste Managers	✖	✖	✖	✖		✖		✖
Consumers		✖					✖	○
Informal Sector		✖	✖			✖		○
PRO's	✖	✖	✖	✖				○

4.3.1 Regulations

Regulations are essential for the establishment of successful and efficient waste management because they give a legal framework for all other activities. Regulations define the roles, obligations, and responsibilities of different acters in PWM. Moreover, regulations influence other training topics in a direct or indirect way. In Tab. 3 training needs of different stakeholders in the context of establishing or following the legal requirements are presented.

Tab. 3: Specific training needs for different stakeholders in context of regulations

Manufacturers	- Instructions for fulfilling standards for plastic production and design of sustainable product.
Waste Managers	- Instructions for fulfilling the legal requirements for collection, sorting, and recycling of waste.
Government	- Guidance and support for decision makers, local and national authorities for: - Establishing the legal framework for PWM. - Defining duties and rights of stakeholders. - Monitoring. - Enforcement of legislation. - Measures recommendations for reduction of plastic pollution.
PRO's	- Instructions for fulfilling the legal requirements for establishment and management of infrastructure for collection, sorting and recycling of end-of-life products under EPR scheme. - Support and instructions for fulfilling required standards (mandatory collection and collection targets).

4.3.2 Collection

Waste collection is a multidimensional topic. It goes from management and operation to information delivery, depending on the stakeholder. In Tab. 4 training needs in the area of waste collection in the context of different stakeholders are presented. Important notice is that in this case into the collection is also included separation at source to simplify the classification of training topics.

Tab. 4: Specific training needs for different stakeholders in context of waste collection

Government	- Tools and guidance on how to establish different types of collection schemes (drop-off or kerbside, for example), choice of appropriate one and costs assessment.
Waste Managers	- Technical guidance on how to organize waste collection (collection-transfer-storage), from truck drivers to people who are manually collecting waste.
Consumers	- Instructions for disposal of waste and separation at source.
Informal Sector	- Technical guidance on collection, transport, and storage of waste in context of informal waste pickers and specific environment in which they operate.
PRO's	- Guidance on choosing appropriate EPR approach for collection of end-of-life products. - Guidance on organization and management of infrastructure for collection, transport and storage of end-of-life products under EPR scheme.

4.3.3 Sorting

Sorting is already mentioned as a process in PWM value chain as one of the most important phases in waste management. Due to its importance, it requires special focus in the context of training. In Tab. 5 training needs regarding sorting for waste managers, informal sector, and PRO's are shown.

Tab. 5: Specific training needs for different stakeholders in context of waste sorting

Waste Managers	- Technical guidance for waste sorting and sorting techniques in waste treatment facilities.
Informal Sector	- Technical guidance for waste sorting in context of informal waste pickers adjusted to surrounding environment in which they operate.
PRO's	- Technical guidance for sorting of plastic end-of-life products under EPR scheme.

4.3.4 Recycling

Same as sorting, recycling requires special focus when it comes to training and education. Recycling, similar to collection for different stakeholders, has different aspects. In Tab. 6 training needs for government, waste managers and PRO's are presented.

Tab. 6: Specific training needs for different stakeholders in context of recycling

Government	- Guidance for decision makers for establishing the legal framework for recycling, legislation enforcement and definition of responsibility.
Waste Managers	- Technical guidance for recycling operations in recycling facility. - Management and organization of recycling facility.
PRO's	- Technical guidance for recycling and recovery of end-of-life products under EPR scheme. - Management and organization of recycling and recovery.

4.3.5 Recyclability

Designing product for recyclability is driven by environmental and economic goals. Moreover, recyclability can be designed into products by choosing materials and modularity (Yadav et al., 2018). Therefore, eco-design can play a crucial role in manufacturing the product that will be easier to manage in post-treatment (sorting and recycling). Manufacturers are especially interested in this training topic because of their role in the PWM value chain. They require guidance on the design of plastic products which will increase the recyclability of the product and reduce negative impact on the environment. Guidance on eco-design includes chemical aspects of product composition and recommendations for different types of materials for various products. Moreover, this training topic should include recommendations and guidance for design of supplemental items of products such as plastic films for labels, closures, and other small parts.

4.3.6 Occupational Health and Safety (OHAS)

OHAS is a crucial training topic for the protection of human health and life. It includes a set of measures and recommendations which tend to keep participants in PWM out of risk that is present in their job. Besides recommendations, this training topic should provide information about risks, to locate and point out possible accident situations. OHAS training topic should cover training needs of workers involved in plastic manufacturing, waste management operators engaged on the field and at treatment facility, and informal waste pickers. By providing technical guidance and recommendations for activities in which they are involved. Also, this topic should cover the management aspect in such way that will give the tools to people who are in charge of OHAS management, to help them recognizing risk in their organization and facility.

Manufacturers, waste managers, and the informal sector are recognized as three stakeholders who have interested in this training topic and their needs are presented in Tab. 7.

Tab. 7: Specific training needs for different stakeholders in context of OHAS.

Manufacturers	- Technical guidance and recommendations for people engaged in use of secondary raw materials and plastic production. - Guidance on hazardous components of plastic materials.
Waste Managers	- Technical guidance and recommendation for people who are working on field and treatment facilities. - Recommendations and tools for determination of risk assessment. - Guidance on hazardous materials.
Informal Sector	- Technical guidance and safety recommendations for waste pickers that covers collection and sorting of waste. - Guidance on hazardous materials to which informal waste picker can be exposed.

4.3.7 Product recyclability

General knowledge and public awareness about the importance of recycling, avoiding single-use plastic products, and proper plastic waste management are important for achievement of environmental goals (no plastic leakage into marine environment, resource prevention, etc.). The consumers are targeted as stakeholder that should be educated about these topics, because, in case of knowledge and positive attitude, they can significantly contribute to sustainable waste management (Desa et al., 2012). Moreover, there are many materials which address this topic and point out importance of education in term of consumers and society in general. Therefore, this aspect PWM is included in analysis as a training (education) topic and consumers are recognized as stakeholder that has need for education in this topic.

4.3.8 Economic aspect

Economic aspect as training topic address financial aspect of waste management. Since many public and private waste management companies existences depend on their financial sustainability it is understandable why the economic aspect of waste management as a training topic is so important. Financial assessment of waste management operations (collection, sorting, and recycling), cost calculations, feasibility assessment, and tools for costs optimizations are some of the elements of economic aspect. These elements have significant value for waste managers, and they can help them to increase revenue and minimize costs. Furthermore, PRO's also have interest in this topic due to economic aspect of EPR scheme management. Government also, because of economic part of waste management organization (fees, taxes. etc.).

5. Analysis of teaching materials

In this chapter teaching materials and their availability are analysed, as well it is described the process of teaching materials collection. Additionally, the methodology of evaluation and constraints in methodology and process of collection are introduced.

The goal of the analysis is to identify the best available teaching and training materials for PWM in context of different stakeholders and training topics. The result of the analysis answer questions such as, what are the best teaching materials when final users are waste managers or which are the most suitable training materials in terms of waste collection or other training topics. Additionally, the results of the analysis should be able to highlight materials which address different topics of PWM for instance marine litter, circular economy or extended producer responsibility (EPR).

The analysis was conducted in five steps as is present in Fig. 5. The first step is the collection of teaching materials from different relevant sources, once when materials were obtained, they were grouped by targeted stakeholders. Preliminary evaluation was afterwards conducted to estimate whether the teaching material includes the required content. For example, some materials are not fully focused on PWM, but they can have a significant part dedicated to plastic waste. In this case, it is necessary to determine if the material includes relevant content to be considered as teaching material for PWM. In the 4th step the final evaluation was performed over teaching materials. The methodology that is used for evolution is the scoring method, the concept of the method will be later presented in detail. In final 5th step the final results are obtained, they are presented by each stakeholder in gradation format. This should provide an easier overview of materials depending on stakeholders or a training topic.

An additional goal of the analysis is to provide detailed information about teaching materials content. This brings the possibility of an easier combination of them depending on specific training requirements.

Fig. 5: Steps of analysis of aching materials.

5.1 Collection of materials

Teaching materials are created and published by relevant organizations with experience in the preparation of training and educational content for different target groups. Among these organizations are World Bank, United Nations (UN), International Labor Organization (ILO), Deustche Gesellschaft für internationale Zusammenarbeit (GIZ), World Health Organization (WHO), European Union, Organization for Economic Co-operation and Development (OECD), Plastic Zero Europe and many other organizations in a global or regional sale. For instance, 5 Gyres and Waste Management from United States (US), CONAI from Italy, Round Table and Green Dot from Germany, governments of Canada, India, South Africa, Peru, and educational institutions such as the Universities of Vienna and Las Vegas. Materials developed in a local scale also have an influence on different groups, addressing at the same time various topics of PWM.

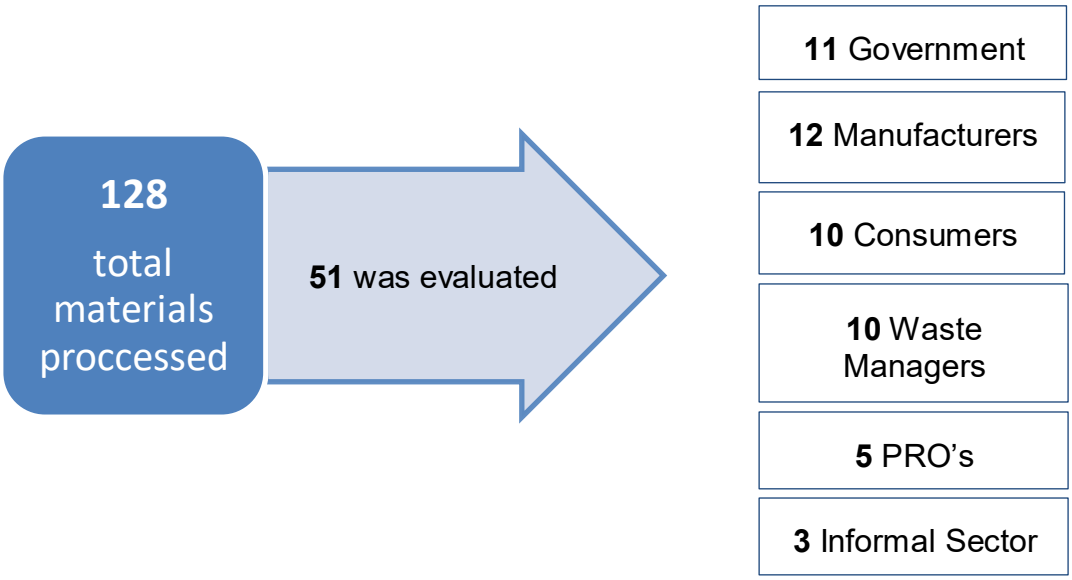


Fig. 6: Collection process of teaching materials.

In Fig. 6 is shown the process collection. From the 128 collected materials, only 51 qualified for final evaluation. More than half did not pass the preliminary evaluation, mostly due to insufficient content related to PWM. Out of these 51:

- 11 of them are targeting policy and decision-makers. In most of the cases these materials address regulations as a training topic and give support to establishment of legal frame for PWM. Therefore, they are classified as materials that targets government and policy makers in general.
- Additionally, 12 training materials address the production of plastic products and recognize regulations and recyclability as their main training priority. These are classified as teaching materials for manufacturers. Additionally, besides these two training topics (regulations and recyclability) in some cases they include an economic aspect of plastic production, which address questions about what should be done to reduce costs of production.
- Teaching materials for consumers aim to spread awareness regarding issues that arise from plastic waste mismanagement and give information for separation of waste at sources. In total, 10 of these are identified. They target almost all spheres of society, from large scale groups such as younger population and students to the specific groups such as communities in coastal

areas. Most of these materials have a local character and they have been developed for a specific region or a social group.

- Teaching materials that address the training of people and organizations in charge of managing waste are classified as materials for waste managers. 10 of these are identified. Collection, sorting, recycling and OHAS are the main topics of these publications. Additionally, the economic aspect of waste management and regulation guidance can be a significant part of the content.
- Five teaching materials discuss the extended producer responsibility (EPR) which makes them usable for PRO's. Their content gives guidance for the establishment the EPR scheme (collection, sorting, and recycling) and advices for fulfillment legal requirements. Furthermore, some materials have an economic aspect included, for example management costs. They include a global and international scope which gives the possibility to be useful for a wide range of users from almost all parts of the world, where the conditions can be replicable.
- Availability of materials that targets informal waste pickers was limited. Therefore, only three were evaluated in this research. Discussed topics int these publications are collection, sorting and OHAS.

The majority of materials are accessible in the PDF format. Many of them are supported with a graphical presentation of teaching content which significantly influences their efficiency when it comes to the transfer of knowledge. Beside written presentation, there are contents that are available in form of video guidance and lectures. Most of them aim to reach consumers and point out problems of plastic waste mismanagement. Almost all teaching materials under the scope of this research are written and presented in English (48), except a few of them which are in Spanish (two) and Italian (one). However, some of them are published by European Union (EU) and therefore are available in all official languages of the EU.

5.1.1 Data collection constraints

Two main constraints in the process of collection of teaching materials were,

- the narrow scope of research and
- the availability of ''free'' materials

These two constraints had a huge influence on the variation in numbers of evaluated documents between different stakeholders.

Although, there is a huge amount of teaching materials for general waste management. Most of them are made for industrial, medical or municipal solid waste (MSW). However, when the search focuses on PWM the number of publications designed for education and training rapidly decreases, creating narrow scope of research. It is not often the case that certain material focuses only on issues of PWM, this content is rather part of another topic. For instance, separation of waste at the source. In this case materials designed for MSW can be used as teaching material for PWM. However, the prerequisite to use these materials for education in PWM is that they fully cover one or more training topics for PWM.

The second constraint is the availability of ''free'' materials. Many private companies and organizations which are professionally involved in the design and creation of teaching content for PWM are not offering them for free. For example, a waste management company that develop training programs and materials for sorting, recycling and OHAS does not share work openly due to competitors on the market or

simply because of investment protection. This fact reduces dramatically the number of documents that could have been available for evaluation. Moreover, this fact turned the search for materials in direction towards relevant international and local organizations.

Despite of these constraints, sufficient quality amount of them was collected to apply evaluation and answer the questions, what is the best teaching materials in terms of content and different stakeholders.

5.2 Methodology of evaluation

Since different stakeholders have different training priorities it understandable that it is impossible to have a one-size-fits-all solution when it comes to teaching materials. To approach the evaluation of multidimensional features of teaching materials and to apply prioritization of them depending on stakeholders, weighting score method (WSM) was used in this study. WSM is a prioritization framework that allows to make decisions on how to arrange features in situations when there are several alternatives to evaluate. WSM is based on the principle that features are scored according to a set of criteria which is prioritized and then ranked by their final scores. The goal of WSM is to give objective and, quantitative value for each object of evaluation.

For the evaluation of teaching materials WSM were structured to answer the presence of training topics in teaching materials, see Tab. 8. Part of the structure are nine criteria introduced for estimation. Compound of all training topics and additional presence of supplementary illustrative content (multimedia content or PowerPoint presentation).

The weighting of criteria is based on the training priorities of each stakeholder. Weight 1 is given when the importance of certain criteria (training topic) for certain stakeholders is low. Weight 3 applies when criteria is not crucial for training interests of stakeholders, but it is beneficial for the learning experience. Finally, weight 5 is given for criteria that has essential importance for stakeholder. However, the weight is modified from one stakeholder to another one. For example, the criteria of ‘’collection’’ will have for two different stakeholders a different value.

It is as well the case for manufacturers of plastic products who do not have an interest in waste collection, and waste managers for whom waste collection is one of the essential topics. In this case weight of collection for manufacturers will be 1 and for waste managers 5.

Weights of criteria depending on each stakeholder are shown in Tab. 9. It is important to notice that graphical presentation has weight 5 regardless on the stakeholder, due to the positive impact on learning outcome.

Tab. 8: Structure of WSM

Criteria	- Regulations - Collection - Sorting - Recycling - Recyclability - OHAS - Impact of product recyclability - Economic aspect - Graphical presentation
Weight	• 5 - High importance • 3 - Medium importance • 1 - Low importance
Score	• 0 - No content related to the topic • 1 - Content is present but does not include all relevant parts of the topic • 2 - Content is present, and it includes all relevant parts of the topic

Scoring is based on three points approach. A score of 0 is given when there is no content related to criteria (training topic) in the material. Score 1 is given when content related to training topic is present, but it does not include all relevant parts. For example, content in material related to OHAS for waste managers covers safety equipment which should be used during work but not the protocols for safety or the list of a hazardous substances. In this case score 1 is given. Furthermore, score 2 is given when content related to the training topic is present and includes all relevant parts.

For graphical presentation criteria similar concept is applied. Score 0 is given if the material consists only of text and it does not have illustrations or supplementary content (presentation or video). Score 1 is given when more than 50 % of the content in the material is covered with graphical presentation or illustration. Finally, score 2 is given when all content in teaching material is presented in illustrative or interactive form.

Tab. 9: Weights of criteria depending on stakeholders training priorities

	Regulations	Collection	Sorting	Recycling	Recyclability	OHAS	Product recyclability	Economic aspect	Graphical presentation
Manufacturers	5	1	1	1	5	3	1	3	5
Government	5	5	1	5	1	1	1	3	5
Waste Managers	5	5	5	5	1	5	1	5	5
Consumers	1	5	1	1	1	1	5	3	5
Informal Sector	1	5	5	1	1	5	1	3	5
PRO's	5	5	5	5	1	1	1	3	5

Once the weighting of criteria for each stakeholder was defined the teaching material was evaluated with WSM. During the process of evaluation, the score (depending on the presence of the topic in the material) is multiplied with the weight of the criteria, this is done for each criterion.

Finally, these values were added up and each training material obtained a quantitative value. Based on this result teaching materials were listed from the lower to the highest value. In Tab. 10 is presented an example of the evaluation process for one teaching material developed for manufacturers *(Eco Design of Plastic Packaging*). This process is conducted among all teaching materials for every stakeholder.

Tab. 10: Example of evaluation of teaching material with WSM

Criteria	**Weight**	*Eco Design of Plastic Packaging*
Regulations	5	0
Collection	1	0
Sorting	1	0
Recycling	1	0
Recyclability	5	2
OHAS	3	0
Product recyclability	1	1
Economic aspect	3	0
Presentation	5	2
∑Weight*Score		21

5.2.1 Methodology Constraints

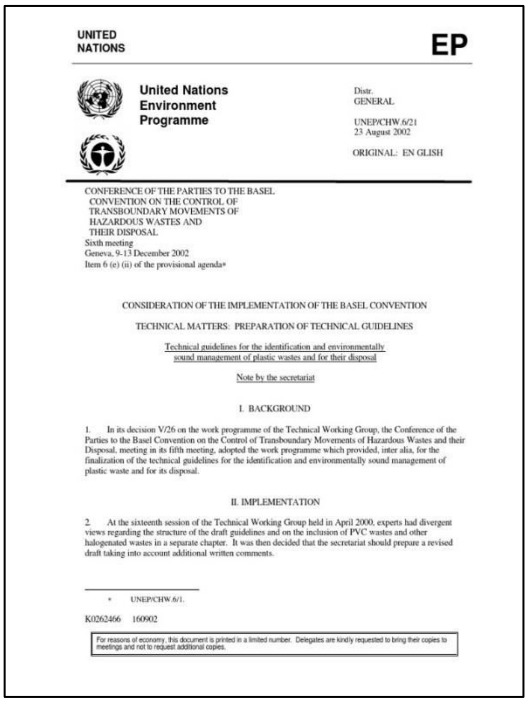
Constraints of methodology of evaluation are in the design of criteria, where the focus of analysis is on previously defined training topics and their presence in teaching materials. Therefore, presence of other content apart from defined criteria is not evaluated. This is noticeable mostly within final ranking of materials, where some materials received lower ranking only because their content is not perfectly matching the criteria of analysis. Such example are materials made by 5 Gyres which address plastic waste reduction in specific contexts (targets students in coastal areas and sailing community). Additionally, due to this constraint certain content is not pointed out in results, for instance, types of material analysis.

6. Results

In this chapter results of analysis are presented and grouped by stakeholders. Detail information regarding the content will be presented for 5 top ranked teaching materials for each stakeholder with links for easy access, as well. Presence of certain training topic is marked in tables with cross in criteria column. Other teaching materials can be found in tables while links for access in Appendix.

6.1 Government

Tab. 11: *Technical guidelines for the identification and environmentally sound management of plastic wastes and for their disposal*

<table>
<tr>
<td> 
UNITED NATIONS
EP
United Nations Environment Programme
Distr. GENERAL
UNEP/CHW.6/21
23 August 2002
ORIGINAL: EN GLISH
CONFERENCE OF THE PARTIES TO THE BASEL CONVENTION ON THE CONTROL OF TRANSBOUNDARY MOVEMENTS OF HAZARDOUS WASTES AND THEIR DISPOSAL
Sixth meeting
Geneva, 9-13 December 2002
Item 6 (e) (ii) of the provisional agenda*
CONSIDERATION OF THE IMPLEMENTATION OF THE BASEL CONVENTION
TECHNICAL MATTERS: PREPARATION OF TECHNICAL GUIDELINES
Technical guidelines for the identification and environmentally sound management of plastic wastes and for their disposal
Note by the secretariat
I. BACKGROUND
1. In its decision V/26 on the work programme of the Technical Working Group, the Conference of the Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, meeting in its fifth meeting, adopted the work programme which provided, inter alia, for the finalization of the technical guidelines for the identification and environmentally sound management of plastic waste and for its disposal.
II. IMPLEMENTATION
2. At the sixteenth session of the Technical Working Group held in April 2000, experts had divergent views regarding the structure of the draft guidelines and on the inclusion of PVC wastes and other halogenated wastes in a separate chapter. It was then decided that the secretariat should prepare a revised draft taking into account additional written comments.
* UNEP/CHW.6/1.
K0262466 160902
For reasons of economy, this document is printed in a limited number. Delegates are kindly requested to bring their copies to meetings and not to request additional copies.</td>
<td>1st place:
Technical guidelines for the identification and environmentally
sound management of plastic wastes and for their disposal

Created by:
United Nation Environment Program (UNEP)

Language and format: English, PDF.

Year: 2020

Description:
Technical guidelines for policymakers and assistance for development of strategies in PWM. Provide guidance on, prevention, identification, sampling and analysis, safe handling, separation, collection, storage, transport, shipping, recycling, energy recovery and final disposal.</td>
</tr>
</table>

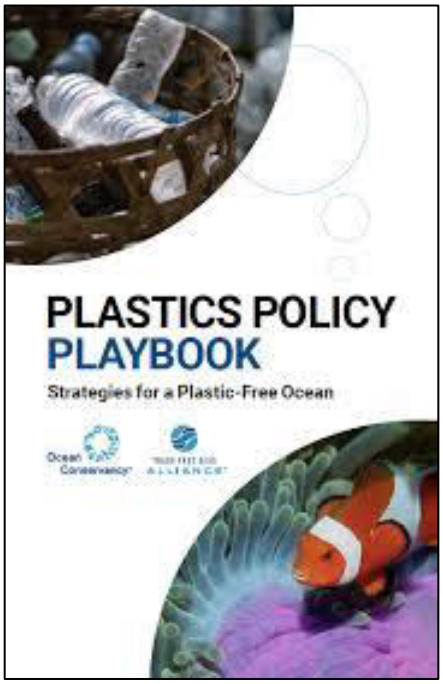
Regulations	Collection	Sorting	Recycling	Recyclability	OHAS	Product recyclability	Economic aspect
✕	✕	✕	✕		✕		

Link: http://www.basel.int/Implementation/Plasticwaste/Technicalguidelines/Overview/tabid/7992/Default.aspx

In Tab. 11 material with highest score among all teaching materials for government, *Technical guidelines for the identification and environmentally sound management of plastic wastes and for their disposal* by United Nation Environment Program is presented. This is updated version of publication from 2002.

In Tab. 12 *Plastic Policy A playbook: Strategies for a Plastic-Free Ocean* made by Trash Free Seas Alliance and Ocean Conservancy from US is presented. It had second highest score among all teaching materials which were targeting government and policy makers as stakeholder. Creators of publication are nonprofit organizations who address global problems of marine plastic litter.

Tab. 12: *Plastic Policy A playbook: Strategies for a Plastic-Free Ocean*

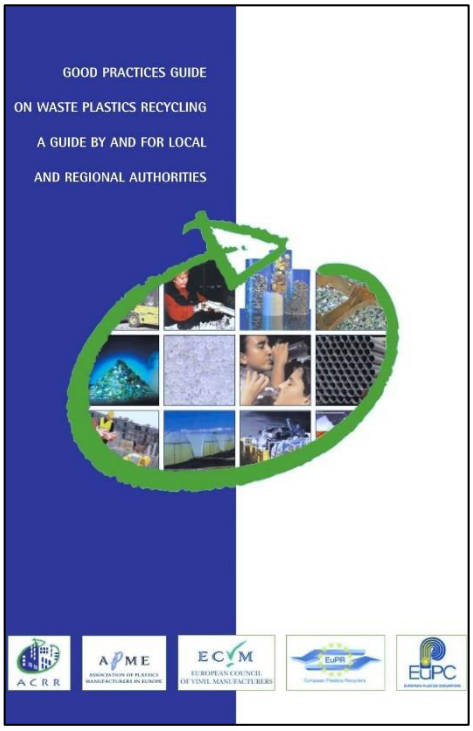
<table>
<tr><td rowspan="4"> 
</td><td>2nd place:
Plastic Policy A playbook: Strategies for a Plastic-Free Ocean</td></tr>
<tr><td>Language and format: English, PDF.</td></tr>
<tr><td>Created by:
Trash Free Seas Alliance and Ocean Conservancy</td></tr>
<tr><td>Year: 2019</td></tr>
<tr><td colspan="2">Description:
Provides a holistic framework of the most promising public and private sector measures across the value chain to improve the economics of collection. It targets national government, local government, corporates and non-governmental organizations (NGOs).</td></tr>
</table>

Regulations	Collection	Sorting	Recycling	Recyclability	OHAS	Product recyclability	Economic aspect
✕	✕		✕	✕			

Link: https://oceanconservancy.org/wp-content/uploads/2019/10/Plastics-Policy-Playbook-10.17.19.pdf

Teaching material which had third highest score is presented in Tab. 13. *Good practice guide on waste plastic recycling, a guide by and for local and regional authorities* prepared and published by The Association of Cities and Regions for Recycling (ACRR) with the support of European Plastics Industry Federations in 2004. The guide has a three-fold structure. The first element gives a general description of waste plastics management in Europe. The second develops more specific information focusing on specific flows or techniques. The third provides illustrations through descriptions of local experiences.

Tab. 13: *Good practice guide on waste plastic recycling, a guide by and for local and regional authorities*



3rd place:
Good practice guide on waste plastic recycling, a guide by and for local and regional authorities

Language and format: English, PDF

Created by:
The Association of Cities and Regions for Recycling (ACRR)

Year: 2004

Description:
The objective of this Guide is to offer local and regional authorities an insight into the socio-political, environmental, economic and technical aspects of waste plastics management, with reference to practical examples and case studies.

Regulations	Collection	Sorting	Recycling	Recyclability	OHAS	Product recyclability	Economic aspect
✕	✕		✕				✕

Link: http://www.seepvcforum.com/system/assets/000/000/136/original_ACRRReport.pdf

In Tab. 14 material which had fourth highest score, *TACKLING PLASTIC POLLUTION: Legislative Guide for the Regulation of Single-Use Plastic Products* by United Nation Environment Program and World Resources Institute (WRI) is presented. The guide draws upon a comprehensive global review of existing plastics legislation and derives recommendations for development of legislation on single-use plastic. It was published in 2020.

Tab. 14: *TACKLING PLASTIC POLLUTION: Legislative Guide for the Regulation of Single-Use Plastic Products*

4th place:
TACKLING PLASTIC POLLUTION: Legislative Guide for the Regulation of Single-Use Plastic Products

Language and format: English, PDF

Created by:
United Nation Environment Program (UNEP) and World Resources Institute (WRI)

Year: 2020

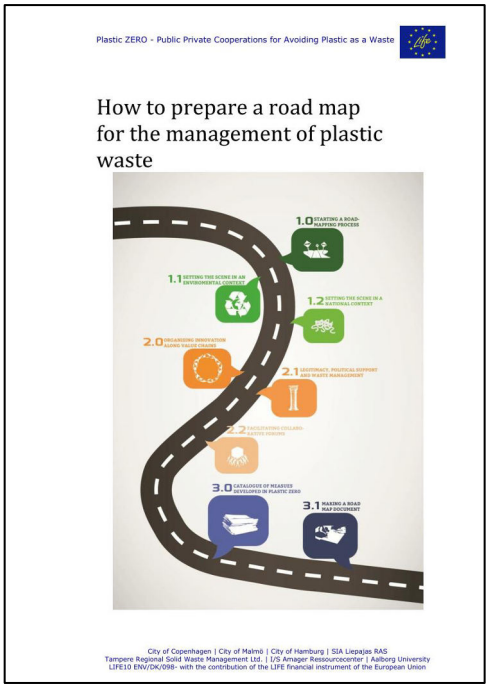
Description:
The guide is intended to be a practical tool for those working to develop laws and regulations to limit or manage single use plastic products. It provides guidance on how to develop legislation on single-use plastic products, outlines the main regulatory alternatives, and suggests the key elements that each should include.

Regulations	Collection	Sorting	Recycling	Recyclability	OHAS	Product recyclability	Economic aspect
✕	✕		✕	✕			

Link:
https://wedocs.unep.org/bitstream/handle/20.500.11822/34570/PlastPoll.pdf.pdf?sequence=3&isAllowed=y

How to Prepare a Road Map for the Management of Plastic Waste is material which had fifth highest score and it is presented in Tab. 15. The publication is prepared and published by Plastic ZERO from Europe and it is published in 2014. Guideline is highlighting design of road map in projects where focus is on enhancement of plastic resources-efficiency. The main target groups are local authorities, waste management companies and producer responsibility organizations.

Tab. 15*: How to Prepare a Road Map for the Management of Plastic Waste*



5th place:
How to Prepare a Road Map for the Management of Plastic Waste

Language and format: English, PDF

Created by:
Plastic ZERO

Year: 2014

Description:
Guideline on how to make a road map is meant to present possible solutions to the issue and to introduce a range of measures to enhance plastic resource-efficiency. Challenges and difficulties in that process are discussed with focus on local authorities, waste management companies and PRO's.

Regulations	Collection	Sorting	Recycling	Recyclability	OHAS	Product recyclability	Economic aspect
✕	✕		✕				

Link:
https://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=home.showFile&rep=file&fil=PLASTIC_ZERO_annex_d41b_action1.1_road_map_part_i_final.pdf

In Tab. 16 further evaluated materials for government and policy makers are presented.

Tab. 16: Rank list of further evaluated teaching materials for government

Rank	Title	Purpose	Created by	**Regulations**	**Collection**	**Sorting**	**Recycling**	**Recyclability**	**OHAS**	**Product recyclability**	**Economic aspect**
6	*Guidelines on Separation of Waste at Source*	Guidelines for organization of waste separation at source	Department of Environmental Affairs Republic of South Africa 2018	✕	✕						
7	*Single-Use Plastics: A Roadmap for Sustainability*	Measures for reduction of single-use plastic	UNEP 2018	✕							
8	*Marine Litter Legislation: A Toolkit for Policymakers*	Address approaches states can take to reduce and minimize marine litter	UNEP 2016	✕							
9	*Marine Plastic Debris & Microplastics: Global Lessons and Research to Inspire Action and Guide Policy Change*	Recommendations which guide decision makers to adapt to different local, national, regional and global contexts.	UNEP 2016	✕							
10	*Green Public Procurement Manual on Plastic Waste Prevention*	Targets environmental problems from post-consumer plastics	Plastic ZERO 2014	✕							
11	*Guidance for the Reduction of Plastic Waste in Meetings and Events*	Sorting at source and collection of plastic waste from meetings and events.	Government of Canada 2018		✕						

6.2 Manufacturers

Eco Design of Plastic Packaging had highest score among all teaching materials which target manufacturers of plastic products. Guidelines was made and published by German initiative of experts called Round Table in 2019. Beside detail guidelines on eco-design of different types of products and packaging, supplementary material is available such us, specific checklists for practical packaging development, illustrative examples and practical tools for assessing recyclability. Description of publication is presented in Tab. 17.

Tab. 17: *Eco Design of Plastic Packaging*

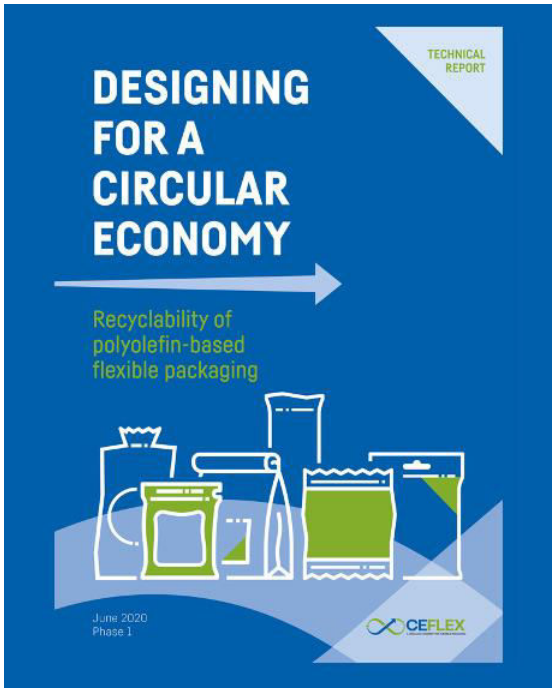
<table>
<tr><td rowspan="5"> 
</td><td>1st place:
Eco Design of Plastic Packaging</td></tr>
<tr><td>Created by:
Round Table</td></tr>
<tr><td>Language and format: English, PDF</td></tr>
<tr><td>Year: 2019</td></tr>
<tr><td>Description:
These Guidelines make an important contribution to a circular economy in the plastics packaging value chain. Describe how to implement eco-design effectively in the management of packaging projects and how to develop brand-specific environmental strategies for packaging design projects. Targets group are, Product managers, marketing directors and other decision-makers in packaging projects. Packaging developers and designers as well as specialist marketing and consulting agencies.</td></tr>
</table>

Regulations	Collection	Sorting	Recycling	Recyclability	OHAS	Product recyclability	Economic aspect
				✕		✕	

Link: https://ecodesign-packaging.org/wp-content/uploads/2019/10/ecodesign_core_guidelines_online.pdf

Second highest rank had *Designing for A Circular Economy: Recyclability of polyolefin-based flexible packaging* made and published by The Circular Economy for Flexible Packaging (CEFLEX) initiative from Europe. The guideline is highlighting polyolefin-based flexible packaging (PE, PP and mixed PE/PP) and gives practical advices on design of flexible packaging. Description of material is presented in Tab. 18.

Tab. 18: *Designing for A Circular Economy: Recyclability of polyolefin-based flexible packaging*

<table>
<tr><td rowspan="4"> 
</td><td>2nd place:
Designing for A Circular Economy: Recyclability of polyolefin-based flexible packaging</td></tr>
<tr><td>Created by:
CEFLEX</td></tr>
<tr><td>Language and format: English, PDF</td></tr>
<tr><td>Year: 2020</td></tr>
<tr><td colspan="2">Description:
Set of comprehensive guidelines to help anyone working in the flexible packaging value chain design packaging solutions which are recyclable. The guidelines have been developed by, and for, the whole value chain, from flexible packaging manufacturers to brand owners and retailers. In addition to offering practical advice on packaging design, the guidelines also offer detailed insight into current sorting and mechanical recycling processes for polyolefin-based flexible packaging.</td></tr>
</table>

Regulations	Collection	Sorting	Recycling	Recyclability	OHAS	Product recyclability	Economic aspect
✕		✕	✕	✕			

Link: https://guidelines.ceflex.eu/guidelines/

Third highest score had *Plastic Packaging: Recyclability by Design* made and published by RECOUP from United Kingdom in 2020. Guideline targets all those involved in the development and design of plastic packaging. Material consolidates and develops information from RECOUP members in both waste management and the packaging supply chain. Together with various sources in Europe and North America to provide a comprehensive guide on plastic packaging design. It is, therefore, particularly relevant to companies who are selling into the markets across Europe and the US. In Tab. 19 description of material is presented.

Tab. 19: *Plastic Packaging: Recyclability by Design*

<table>
<tr><td colspan="4" rowspan="4"> 
</td><td colspan="4">3rd place:
Plastic Packaging: Recyclability by Design</td></tr>
<tr><td colspan="4">Created by:
RECOUP</td></tr>
<tr><td colspan="4">Language and format: English, PDF</td></tr>
<tr><td colspan="4">Year: 2020</td></tr>
<tr><td colspan="8">Description:
Focus on design of more recyclable packaging and prevention packaging inadvertently interfering with existing plastic recycling streams. Help companies demonstrate compliance with the European recycling standard. Covers whole supply chain i.e. designers, packaging technologists, buyers, marketing and retailers but is primarily focused on those responsible for specifying the packaging being used</td></tr>
<tr><td>Regulations</td><td>Collection</td><td>Sorting</td><td>Recycling</td><td>Recyclability</td><td>OHAS</td><td>Product recyclability</td><td>Economic aspect</td></tr>
<tr><td>✕</td><td></td><td></td><td>✕</td><td>✕</td><td></td><td></td><td></td></tr>
<tr><td colspan="8">Link: https://www.recoup.org/p/130/recyclability-by-design</td></tr>
</table>

Fourth highest rank had *Guidelines to facilitate the recycling of plastic packaging* prepared by CONAI Italian private non-profit consortium. Guidelines is part of prevention strategy promoted by CONAI in support of its members and it is published in 2018. Description of material is presented in Tab. 20.

Tab. 20: *Guidelines to facilitate the recycling of plastic packaging*

<table>
<tr><td colspan="4" rowspan="4">x Guidelines to facilitate the recycling of plastic packaging</td><td colspan="4">4th place:
Guidelines to facilitate the recycling of plastic packaging</td></tr>
<tr><td colspan="4">Created by:
CONAI</td></tr>
<tr><td colspan="4">Language and format: English and Italian, PDF</td></tr>
<tr><td colspan="4">Year: 2018</td></tr>
<tr><td>Regulations</td><td>Collection</td><td>Sorting</td><td>Recycling</td><td>Recyclability</td><td>OHAS</td><td>Product recyclability</td><td>Economic aspect</td></tr>
<tr><td>×</td><td></td><td>×</td><td>×</td><td>×</td><td></td><td>×</td><td></td></tr>
<tr><td colspan="8">Link: http://www.progettarericiclo.com/en/docs/guidelines-facilitate-recycling-plastic-packaging</td></tr>
</table>

Considerations and Criteria for Sustainable Plastics from a Chemicals Perspective and Technical Tools and Approaches in Design of Sustainable Plastic had fifth highest score. Material is prepared by OCED and it was presented on OECD Global Forum on Environment in 2018 in Denmark. Material consists of two parts and 9 presentations. Description of material is presented in Tab. 21.

Tab. 21: *Considerations and Criteria for Sustainable Plastics from a Chemicals Perspective and Technical Tools and Approaches in Design of Sustainable Plastic*

5th place:
Considerations and Criteria for Sustainable Plastics from a Chemicals Perspective and Technical Tools and Approaches in Design of Sustainable Plastic

Created by:
OECD

Language and format: English, PDF

Year: 2018

Description:
This guideline was prepared with a broad audience in mind, but it is primarily focused on product designers who select plastics for use in products. Goal is to establish sustainable product design goals based on life cycle thinking to guide material selection.

Regulations	Collection	Sorting	Recycling	Recyclability	OHAS	Product recyclability	Economic aspect
				×			

Link: https://www.oecd.org/chemicalsafety/risk-management/considerations-and-criteria-for-sustainable-plastics-from-a-chemicals-perspective.pdf

The rest of evaluated teaching materials for plastic manufacturers are presented in Tab. 22.

Tab. 22: Rank list of further evaluated teaching materials for manufacturers

Rank	Title	Purpose	Created by	**Regulations**	**Collection**	**Sorting**	**Recycling**	**Recyclability**	**OHAS**	**Product recyclability**	**Economic aspect**
6	*Design for the Environment*	Guidelines for plastic from electronic	Plastics New Zealand 2018					✕			
7	*Sorting info Guide Making sorting simpler*	Guide on design of symbols for plastic sorting	CITEO 2019	✕		✕		✕			
8	*Recyclability of plastic packaging: Eco-Design for improved recycling*	Outlines the main principles of recyclability	COTREP 2019	✕							
9	*Circular Packaging Design Guideline Design Recommendations for Recyclable Packaging*	Recommendations for the recyclable design of packaging	FH CAMPUS WIEN 2020	✕				✕			
10	*Reuse and recycling of plastic packaging for private consumers*	Development of recycling and reuse practices	NCPP 2019					✕			
11	*Design of Rigid Plastic Packaging for Recycling Guidance*	Guidance for design of rigid plastic	WRAP 2013					✕			
12	*Design 4 recycling*	Recommendations for the recyclable design of packaging	Der Grüne Punkt 2019					✕			

6.3 Waste Managers

Highest rank among teaching materials for waste managers had *SEA-PLASTIC EDU.* It was prepared by three European universities (University of Natural Resources and Life Sciences Vienna, Dresden University of Technology and Aalborg University) and three Asian universities (National University of Laos, Dai Study Natural Science and University of Industry) for project of modernization of higher education in Laos and Vietnam. Description of material is presented in Tab. 23.

Tab. 23: *SEA-PLASTIC EDU*

	**1st place:** *SEA-PLASTIC EDU*
	Language and format: English, PDF
	Created by: SEA-PLASTIC-EDU Consortium
	Year: 2020
	Description: It is divided into three modules: - Technical Aspects (primary product of plastic, waste collection and sorting, thermal treatment and energy recovery) - Emissions and System Analysis (plastic waste generation, economic aspect, policy and legislation and impact of plastic waste) - Health and Safety (OHAS, hazardous waste management and toxicology and health issues)

Regulations	Collection	Sorting	Recycling	Recyclability	OHAS	Product recyclability	Economic aspect
✕	✕	✕			✕		✕

Link: http://plasticedueprints.io1cus.co.uk/

Second highest rank among teaching materials for waste managers had *A Guide to Separation of Waste at Source* made by Western Cape Government in 2019. The content addresses step-by-step implementation process of waste separation at source system. Description of manual is presented in Tab. 24.

Tab. 24: *A Guide to Separation of Waste at Source*

<table>
<tr>
<td rowspan="5"> 
</td>
<td colspan="8">2nd place:
A Guide to Separation of Waste at Source</td>
</tr>
<tr>
<td colspan="8">Language and format: English, PDF</td>
</tr>
<tr>
<td colspan="8">Created by:
Western Cape Government</td>
</tr>
<tr>
<td colspan="8">Year: 2019</td>
</tr>
<tr>
<td colspan="8">Description:
The guide is made to give municipalities, waste managers, contractors and others a comprehensive understanding of separation at source, including legal framework, where at how it is working, awareness and behavior change, risk management and more.</td>
</tr>
<tr>
<td>Regulations</td>
<td>Collection</td>
<td>Sorting</td>
<td>Recycling</td>
<td>Recyclability</td>
<td>OHAS</td>
<td>Product recyclability</td>
<td>Economic aspect</td>
</tr>
<tr>
<td>×</td>
<td>×</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>×</td>
</tr>
<tr>
<td colspan="9">Link:
https://www.westerncape.gov.za/eadp/files/atoms/files/WCape%20Govt%20Municipal%20S%40S%20E-Guide_%2010%20-9%20-19Final.pdf</td>
</tr>
</table>

Third highest score had *Work Adjustment for Recycling and Managing Waste* made and published by International Labor Organization and JICA in 2010. This training material focuses on waste collection and OHAS, with illustrations and many good examples that waste collectors, managers and the community can put to immediate use. Description of manual is presented in Tab. 25.

Tab. 25: *Work Adjustment for Recycling and Managing Waste*

3rd place:
Work Adjustment for Recycling and Managing Waste

Language and format: English, PDF

Created by:
International Labor Organization and JICA

Year: 2010

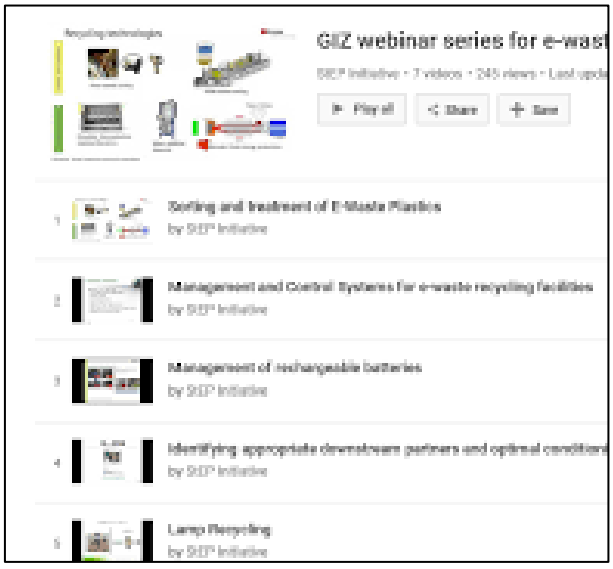
Description:
Action manual for waste collectors and communities to promote their joint actions in improving safety, health and efficiency in waste collection and management

Regulations	Collection	Sorting	Recycling	Recyclability	OHAS	Product recyclability	Economic aspect
	✕				✕		

Link: https://www.ilo.org/wcmsp5/groups/public/---asia/---ro-bangkok/---sro-bangkok/documents/publication/wcms_126981.pdf

Fourth highest score had *GIZ Webinar Series for E-Waste Plastic Recyclers* prepared by GIZ published in cooperation with StEP Initiative platform in 2019. This webinar consists of several online video lecture which address different problems of e-waste among them plastics from electronic end-of-life products. Description of webinar is presented in Tab. 26.

Tab. 26: *GIZ Webinar Series for E-Waste Plastic Recyclers*

<table>
<tr><td colspan="4" rowspan="2"> 
</td><td colspan="4">4th place:
GIZ Webinar Series for E-Waste Plastic Recyclers</td></tr>
<tr><td colspan="4">Language and format: English, online video lectures

Created by: GIZ Germany

Year: 2019

Description: Questions addressed:
- Implementation of a simple technique to separate plastics.
- Market for recycled plastic and potential customers.
- Shipment of plastics from e-waste.
- What to do with plastics which I can’t sell?
- Low-tech solutions for plastic recycling.
- Which plastics can usually be recycled nationally?</td></tr>
<tr><td>Regulations</td><td>Collection</td><td>Sorting</td><td>Recycling</td><td>Recyclability</td><td>OHAS</td><td>Product recyclability</td><td>Economic aspect</td></tr>
<tr><td></td><td>×</td><td>×</td><td>×</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="8">Link: https://www.youtube.com/watch?v=DoopWyYfZkM&list=PLE-AQTsQB0uMOrJadvRbCKpwvdAquE__e&index=2</td></tr>
</table>

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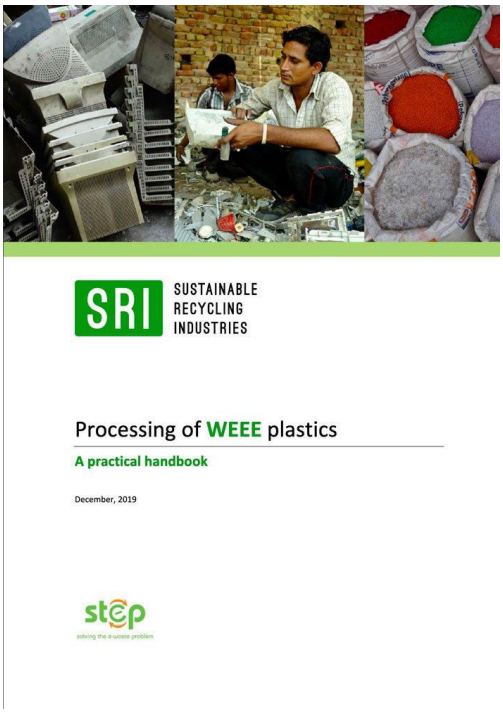
Fourth highest score had *Processing of WEEE plastics* made and published by StEP initiative and Sustainable Electronics Recycling International (SERI) organization in 2019. The guideline addresses the topic of plastic from e-waste. Description of teaching materials is given in Tab. 27.

Tab. 27: *Processing of WEEE plastics*

<table>
<tr>
<td rowspan="4"> 
</td>
<td colspan="8">5th place:
Processing of WEEE</td>
</tr>
<tr>
<td colspan="8">Language and format: English, PDF</td>
</tr>
<tr>
<td colspan="8">Created by:
StEP and SERI</td>
</tr>
<tr>
<td colspan="8">Year: 2019</td>
</tr>
<tr>
<td colspan="9">Description:
The purpose of this guideline is to provide practical information on how to recognize, process and market different WEEE plastics. It is specially oriented towards recycling companies in developing and emerging economies, where the potential for investments in advanced technologies is usually very limited.</td>
</tr>
<tr>
<td>Regulations</td>
<td>Collection</td>
<td>Sorting</td>
<td>Recycling</td>
<td>Recyclability</td>
<td>OHAS</td>
<td>Product recyclability</td>
<td>Economic aspect</td>
</tr>
<tr>
<td>×</td>
<td></td>
<td>×</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>×</td>
</tr>
<tr>
<td colspan="9">Link: https://www.sustainable-recycling.org/reports/processing-of-weee-plastics-a-practical-handbook/</td>
</tr>
</table>

In Tab. 28 further evaluated teaching materials for waste managers are presented.

Tab. 28: Rank list of further evaluated teaching materials for waste managers

Rank	Title	Purpose	Created by	**Regulations**	**Collection**	**Sorting**	**Recycling**	**Recyclability**	**OHAS**	**Product recyclability**	**Economic aspect**
6	*Start Your Waste Collection Service*	step-by-step-guide of how to start a community-based waste collection service	ILO 2001	✕	✕				✕		
7	*Start Your Waste Recycling Business: Trainers Guide and Technical Handouts*	step-by-step-guide of how to start a community-based waste recycling business.	ILO 2007	✕			✕		✕		
8	*Manual handling in refuse collection*	OHAS in process of waste collection	Health & Safety Laboratory 2002		✕				✕		
9	*Recycling Training Manual*	Organizational aspect of recycling	Department of Environmental Affairs Republic of South Africa 2017	✕			✕				
10	*Strategy Guidance: Solid Waste Management Response to COVID-19*	OHAS during COVID-19 pandemic	UN Habitat 2020						✕		

6.4 Consumers

Highest score among teaching materials for consumers had *Mixed Curbside Residential Recycling Myths and Free Your Recyclables* prepared and published by Waste Management from US. Teaching materials include guidelines on separation of recyclables for households, working places and public institutions. It is published in 2018. Description of material is given in Tab. 29.

Tab. 29: *Mixed Curbside Residential Recycling Myths and Free Your Recyclables*

1st place:
Mixed Curbside Residential Recycling Myths and Free Your Recyclables

Language and format: English, PDF

Created by:
Waste Management

Year: 2018

Description:

Recycling rules for consumers, guidelines what is acceptable for recycling waste stream and what not. Includes parts for households, offices, and public institutions.

Regulations	Collection	Sorting	Recycling	Recyclability	OHAS	Product recyclability	Economic aspect
	×					×	

Link: https://www.wm.com/us/en/recycle-right/recycling-101

Second highest score had *Towards Responsible Use of Plastics: Reduce, Reuse, A Recycle Manual for Schools* prepared by UN Environment and Government of India published in 2018. Manual targets schools and give information on reduce, reuse and recycle of plastics. Description of manual is given in Tab. 30.

Tab. 30: *Towards Responsible Use of Plastics Reduce: Reuse. A Manual for Schools*

2nd place:
Towards Responsible Use of Plastics: Reduce, Reuse, Recycle. A Manual for Schools.

Language and format: English, PDF

Created by:
UN Environment and Government of India

Year: 2018

Description:
Education regarding recyclability of plastic waste and concepts of reduce, reuse and recycle of plastic waste. Manual targets students and schools.

Regulations	Collection	Sorting	Recycling	Recyclability	OHAS	Product recyclability	Economic aspect
	✕					✕	

Link: https://paryavaranmitra.in/Plastic%20Manual%20UN%20H.pdf

Third highest score had *Stop the flood of plastic Effective measures to avoid single use plastics and packaging in hotels,* materials prepared by WWF and published in 2019. This guideline targets hotel operators and guests providing them information on how to manage plastic waste in context of coastal areas. Description of materials is given in Table 31.

Tab. 31: *Stop the flood of plastic Effective measures to avoid single use plastics and packaging in hotels*

<table>
<tr><td colspan="4"> 
</td><td colspan="4">3rd place:
Stop the flood of plastic
Effective measures to avoid single use plastics and packaging in hotels

Language and format: English, PDF

Created by: WWF

Year: 2019

Description:
Measures and recommendations for reduction of single use plastic in hotels in costal areas. Recommendations are prepared for hotels, tour operators and tourists.</td></tr>
<tr><td>Regulations</td><td>Collection</td><td>Sorting</td><td>Recycling</td><td>Recyclability</td><td>OHAS</td><td>Product recyclability</td><td>Economic aspect</td></tr>
<tr><td>✕</td><td>✕</td><td></td><td></td><td></td><td></td><td>✕</td><td></td></tr>
<tr><td colspan="8">Link: https://www.wwf.de/fileadmin/user_upload/WWF_Plastikstudie_Hotelma%C3%9Fnahmen_eng.pdf</td></tr>
</table>

Fourth highest score had *Manual on plastic recycling* prepared by Association of Plastic Industrials from Columbia and published in 2000. Manual focuses on sorting of different types of plastic and give information about positive impact of recycling. Description of manual is given in Tab. 32.

Tab. 32: *Manual on plastic recycling*

<table>
<tr><td rowspan="4"> 
</td><td>4th place:
Manual on plastic recycling</td></tr>
<tr><td>Language and format: Spanish, PDF</td></tr>
<tr><td>Created by: Association of Plastic Industrials Columbia</td></tr>
<tr><td>Year: 2000</td></tr>
<tr><td colspan="2">Description:
Educative materials which targets consumers and give them information on sorting and separation of different types of plastic waste. Moreover, give information on importance and positive effect of recycling and economic aspect of it.</td></tr>
</table>

Regulations	Collection	Sorting	Recycling	Recyclability	OHAS	Product recyclability	Economic aspect
	×		×			×	

Link: https://www.acoplasticos.org/mdr2/pdf

.

Fifth best score had *Trash Academy* project conducted by 5GYRES from US in 2018 which is still ongoing. Material consists of written part and online video lectures which are published weekly in two languages. Educational project address problems of marine plastic litter and give information on how to reduce use of plastic and its leaking into nature. Description of material is given in Tab. 33.

Tab. 33: *Trash Academy*

	**5th place:** *Trash Academy*
	Language and format: English and Spanish, PDF and online video lectures
	Created by: 5GYRES
	Year: 2018
	Description: Targets problems of marine plastic litter and give information on how to reduce use of plastic and its leaking into ocean. Material comes in two forms as written material and online video lecture which are available and additionally weekly is published new one.

Regulations	Collection	Sorting	Recycling	Recyclability	OHAS	Product recyclability	Economic aspect
						×	

Link: https://www.5gyres.org/trash-academy

In Tab. 34 further evaluated teaching materials for consumers are presented.

Tab. 34: Rank list of further evaluated teaching materials for consumers

Rank	Title	Purpose	Created by	**Regulations**	**Collection**	**Sorting**	**Recycling**	**Recyclability)**	**OHAS**	**Product recyclability**	**Economic aspect**
6	*Tide Turners Plastic Challenge*	Reduction of marine plastic litter	UN Environment, Clean Seas and The Young Leaders Plastic Challenged 2018							✕	
7	*Recycling Resource*	Manual on which waste is for recycling	Waste Managers 2019		✕						
8	*The Plastic Journey A K-5 Plastic Pollution Curriculum*	Manual for good waste practice	5GYRES 2018							✕	
9	*The Back-to-School Plastic Challenge: Start the second school year by breaking up with single-use plastic*	Focus on rethink, reduce, reuse and recycling of plastic waste	UN Environment & Clean Seas 2018							✕	
10	*TrawlShare STEM to Stern Marine Plastic Pollution Educational Units for Students Learning at Sea*	Manual for good waste practice	5GYRES 2018							✕	

6.5 Producer Responsibility Organizations

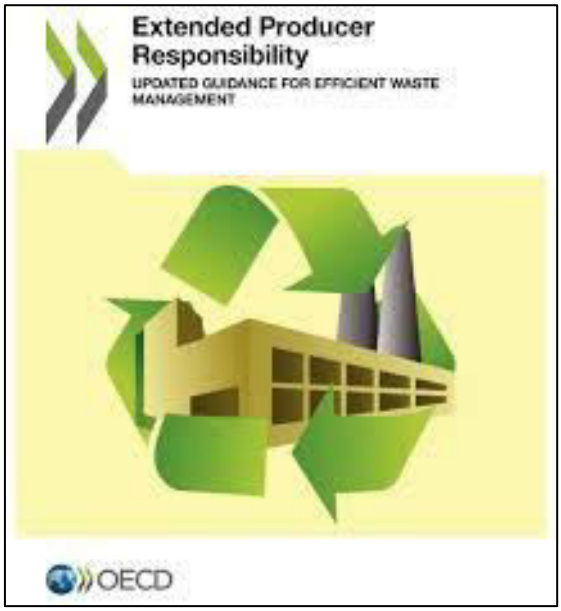
Highest score among teaching materials for PRO's had *EPR Toolbox: Know-how to enable Extended Producer Responsibility for packaging* made and published by PREVENT Waste Alliance in 2020. Focus is on question how to establish EPR scheme. Description of teaching material is given in Tab. 35.

Tab. 35: *EPR Toolbox: Know-how to enable Extended Producer Responsibility for packaging*

<table>
<tr><td rowspan="5">  </td><td>1st place:
EPR Toolbox: Know-how to enable Extended Producer Responsibility for packaging</td></tr>
<tr><td>Language and format: English, interactive PDF</td></tr>
<tr><td>Created by: PREVENT Waste Alliance</td></tr>
<tr><td>Year: 2020</td></tr>
<tr><td>Description:
Include 3 modules. First, general aspect of EPR scheme for packaging. Second, collection and sorting. Third, recycling. Moreover, include experience from Germany, Chile, South Africa, Republic of Korea and Tunisia.</td></tr>
<tr><td colspan="2">
<table>
<tr><th>Regulations</th><th>Collection</th><th>Sorting</th><th>Recycling</th><th>Recyclability</th><th>OHAS</th><th>Product recyclability</th><th>Economic aspect</th></tr>
<tr><td>✕</td><td>✕</td><td>✕</td><td>✕</td><td>✕</td><td></td><td></td><td>✕</td></tr>
</table>
</td></tr>
<tr><td colspan="2">Link: https://prevent-waste.net/wp-content/uploads/2020/11/PREVENT-Toolbox-interactivePDF_2020lowres.pdf</td></tr>
</table>

Second highest score had *Extended Producer Responsibility: Updated Guidance for Efficient Waste Management* made and published by OECD in 2016. This paper is one of the most used and quoted training material in area of EPR. It gives detail information about establishment and management of EPR scheme. Description of teaching materials is given in Tab. 36.

Tab. 36: of *Extended Producer Responsibility: Updated Guidance for Efficient Waste Management*

<table>
<tr><td colspan="4"> 
</td><td colspan="4">2nd place:
Extended Producer Responsibility: Updated Guidance for Efficient Waste Management

Language and format: English, PDF

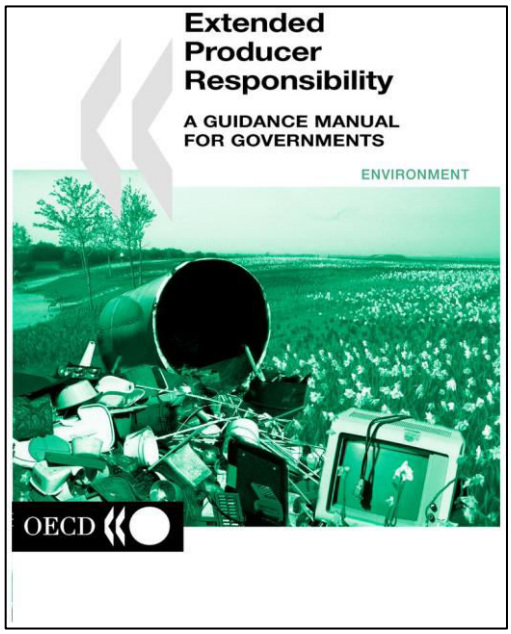
Created by: OECD

Year: 2016

Description:
Provide guidance on how to design and manage EPR scheme. The guidance is supported with advices and case studies from countries across the globe.</td></tr>
<tr><td>Regulations</td><td>Collection</td><td>Sorting</td><td>Recycling</td><td>Recyclability</td><td>OHAS</td><td>Product recyclability</td><td>Economic aspect</td></tr>
<tr><td>×</td><td>×</td><td>×</td><td>×</td><td>×</td><td></td><td></td><td>×</td></tr>
<tr><td colspan="8">Link: https://www.oecd.org/development/extended-producer-responsibility-9789264256385-en.htm</td></tr>
</table>

Third highest score had *Extended Producer Responsibility: A Guidance Manual for Governments* made and published by OECD in 2001. Material targets topic of creation and management of EPR scheme. Description of teaching material is given in Tab. 37.

Tab. 37: *Extended Producer Responsibility: A Guidance Manual for Governments*

<table>
<tr><td rowspan="5"> 
</td><td colspan="8">3rd place:
Extended Producer Responsibility: A Guidance Manual for Governments</td></tr>
<tr><td colspan="8">Language and format: English, PDF</td></tr>
<tr><td colspan="8">Created by: OECD</td></tr>
<tr><td colspan="8">Year: 2001</td></tr>
<tr><td colspan="8">Description:
Give guidance on establishment and management of EPR scheme. Moreover, address question of assigning of responsibility (physical or financial), collection and treatment.</td></tr>
<tr><td>Regulations</td><td>Collection</td><td>Sorting</td><td>Recycling</td><td>Recyclability</td><td>OHAS</td><td>Product recyclability</td><td>Economic aspect</td></tr>
<tr><td>×</td><td>×</td><td></td><td></td><td></td><td></td><td></td><td>×</td></tr>
<tr><td colspan="9">Link: https://www.oecd-ilibrary.org/environment/extended-producer-responsibility_9789264189867-en</td></tr>
</table>

Fourth highest score had *Development of Guidance on Extended Producer Responsibility (EPR)* made and published by European Commission in 2014. Focus of material is on legislative aspect of EPR scheme. Description of teaching material is given in Tab. 38.

Tab. 38: *Development of Guidance on Extended Producer Responsibility (EPR)*

4th place:
Development of Guidance on Extended Producer Responsibility (EPR)

Language and format: English, PDF

Created by: European Commission

Year: 2014

Description:
Guidance target legislation framework for establishment and management of EPR scheme. Moreover, give information about allocation of responsibility and economic part of EPR.

Regulations	Collection	Sorting	Recycling	Recyclability	OHAS	Product recyclability	Economic aspect
✕							✕

Link: https://ec.europa.eu/environment/archives/waste/eu_guidance/pdf/report.pdf

Fifth highest score had *How to implement extended producer responsibility (EPR)* made and published by Institute for European Environmental Policy and WWF in 2019. This teaching material is targeting government and small business in context of EPR scheme implementation. Description of teaching material is given in Tab. 39.

Tab. 39: *How to implement extended producer responsibility (EPR)*

<table>
<tr>
<td rowspan="4"> 
</td>
<td colspan="8">5th place:
How to implement extended producer responsibility (EPR)</td>
</tr>
<tr>
<td colspan="8">Language and format: English, PDF</td>
</tr>
<tr>
<td colspan="8">Created by: Institute for European Environmental Policy and WWF</td>
</tr>
<tr>
<td colspan="8">Year: 2019</td>
</tr>
<tr>
<td colspan="9">Description:
Guidance on identification of key stakeholders in EPR. Give support to implementation of EPR from aspect of government and small business.</td>
</tr>
<tr>
<td>Regulations</td>
<td>Collection</td>
<td>Sorting</td>
<td>Recycling</td>
<td>Recyclability</td>
<td>OHAS</td>
<td>Product recyclability</td>
<td>Economic aspect</td>
</tr>
<tr>
<td>×</td>
<td></td>
<td></td>
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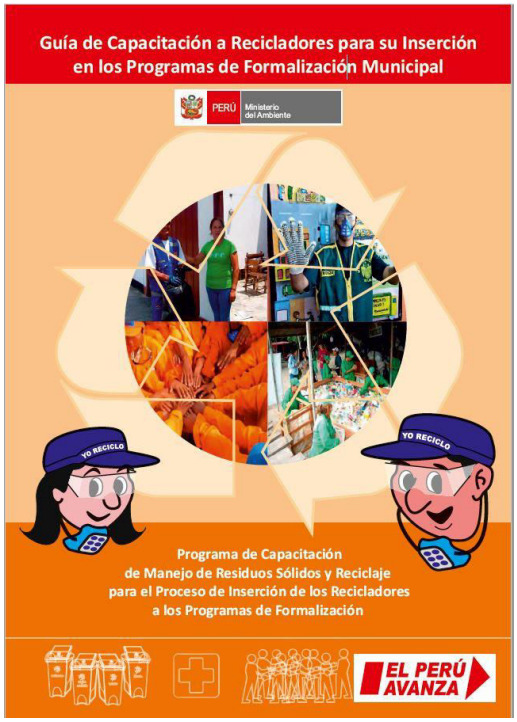
<td>×</td>
</tr>
<tr>
<td colspan="9">Link: https://d2ouvy59p0dg6k.cloudfront.net/downloads/wwf_germany_epr_briefing___final_230819_2.pdf</td>
</tr>
</table>

6.6 Informal Sector

Highest score among teaching materials that target informal sector had *Training Guide for Waste Pickers for their Inclusion Municipal Formalization Program* made and published by Ministry of the Environment of Peru. This teaching material focuses on process of formalization of informal sector. Description of teaching material is given in Tab. 40.

Tab. 40: *Training Guide for Waste Pickers for their Inclusion Municipal Formalization Program*



1st place:
Training Guide for Waste Pickers for their Inclusion Municipal Formalization Program

Language and format: Spanish, PDF

Created by: Ministry of the Environment Peru

Year: 2010

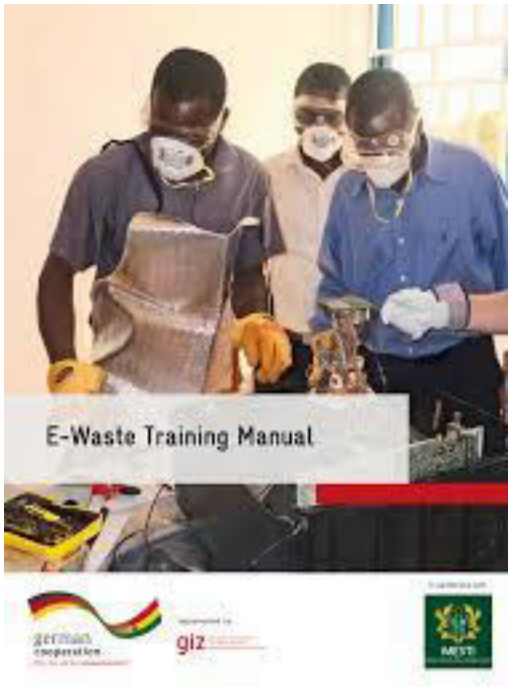
Description:
Guidance on formalization of informal sector, legal framework for activities and economic aspect of waste picking. Moreover, gives recommendation for OHAS and instruction for sorting and recycling.

Regulations	Collection	Sorting	Recycling	Recyclability	OHAS	Product recyclability	Economic aspect
×		×	×		×	×	×

Link: https://www.gob.pe/institucion/minam/informes-publicaciones/2768-guia-de-capacitacion-a-recicladores-para-su-insercion-en-los-programas-de-formalizacion-municipal

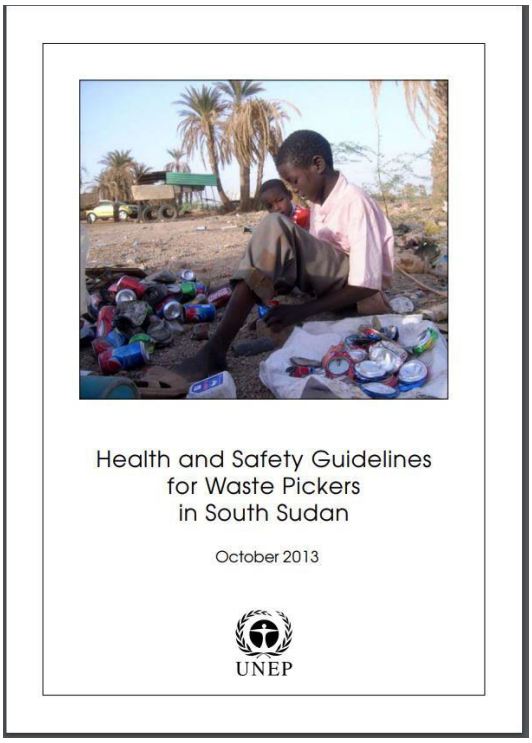
Second best score had *E-Waste Training Manual* made and published by GIZ Germany in 2019 in cooperation with StEP. This teaching materials generally focuses on e-waste and informal sector, but part dedicated to plastics from e-waste and OHAS for informal sector make this teaching material useful for education in PWM. Description of teaching material is given in Tab. 41.

Tab. 41: *E-Waste Training Manual*

<table>
<tr><td rowspan="5"> 
</td><td colspan="8">2nd place:
E-Waste Training Manual</td></tr>
<tr><td colspan="8">Language and format: English, PDF</td></tr>
<tr><td colspan="8">Created by: GIZ and StEP</td></tr>
<tr><td colspan="8">Year: 2019</td></tr>
<tr><td colspan="8">Description:
Guidance on dismantling electrical devices and sorting of different types of plastic from devices. Moreover, gives detail information regarding OHAS and risks which arise from these processes.</td></tr>
<tr><td></td><td>Regulations</td><td>Collection</td><td>Sorting</td><td>Recycling</td><td>Recyclability</td><td>OHAS</td><td>Product recyclability</td><td>Economic aspect</td></tr>
<tr><td></td><td></td><td></td><td>×</td><td></td><td></td><td>×</td><td></td><td>×</td></tr>
<tr><td colspan="9">Link: https://www.giz.de/en/downloads/giz2019-e-waste-management.pdf</td></tr>
</table>

Third highest ranked had *Health and Safety Guidelines for Waste Pickers in South Sudan* made and published by UNEP in 2013. Material focuses on OHAS in process of waste collection and transport of waste. Description of teaching material is given in Tab. 42.

Tab. 42: *Health and Safety Guidelines for Waste Pickers in South Sudan*

<table>
<tr>
<td> 
</td>
<td>3rd place:
Health and Safety Guidelines
for Waste Pickers in South Sudan

Language and format: English, PDF

Created by: UNEP

Year: 2013

Description:
Guidance on OHAS concerns for waste pickers, OHAS guidelines and recommendations for protection equipment.</td>
</tr>
</table>

Regulations	Collection	Sorting	Recycling	Recyclability	OHAS	Product recyclability	Economic aspect
					✕		

Link:
https://wedocs.unep.org/bitstream/handle/20.500.11822/19536/health_safety_guidelines_waste_SouthSudan.pdf?sequence=1&isAllowed=y

6.7 Teaching methods and material types

In this section compatibility of evaluated teaching materials with teaching methods (see chapter 4.1) and material type (see chapter 4.2) are discussed.

6.7.1 Teaching methods

Evaluated materials are dominantly suitable to be used in direct teaching. Certain materials are designed to be used in teaching seasons such as *TrawlShare STEM to Stern Marine Plastic Pollution Educational Units for Students Learning at Sea* made by 5GYRES. They offer educative content, timeline recommendations for lecture schedule, advices and hints for teachers. With it is shown how to effectively derive knowledge to students. Most of other materials are not particularly designed for lecture sessions, but they can be effectively used as supplemental material in direct teaching.

The materials designed to be used in hands-on teaching approach are present in Tab. 43. With their content encourage users to engage in independent activities through which they can learn more about topics such as environmental pollution caused by plastics or importance of recycling and proper waste management.

Tab. 43: Teaching materials suitable for hands-on teaching

Hands-on teaching	- *Trash Academy* by 5GYRES - *Tide Turners Plastic Challenge* by UN Environment, Clean Seas and The Young Leaders Plastic Challenged - *The Back-to-School Plastic Challenge: Start the second school year by breaking up with single-use plastic* by UN Environment & Clean Seas

Materials presented in Table 43 can also be used in other teaching approaches. Their content provides designed games and guidance for interactive activities. These materials can be used as a supplemental material in simulation-game based learning, expeditionary learning and flipped classroom teaching method.

6.7.2 Material types

The evaluated teaching materials are dominantly available in the written form (PDF format). However, many of them offer useful links to supplemental content to illustrate presented knowledge. Some of them are:

- *Tide Turners Plastic Challenge* made by UN Environment and Clean Seas and The Young Leaders Plastic Challenged,
- *EPR Toolbox: Know-how to enable Extended Producer Responsibility for packaging* made by PREVENT Waste Alliance
- *Eco Design of Plastic Packaging* made by Round Table.

On the other hand, there is *Trash Academy* made by 5GYRES that combine written and multimedia materials as two integral parts, combining the textbooks with video lectures. *GIZ Webinar Series for E-Waste Plastic Recyclers* made by GIZ Germany is only evaluated teaching material available in video format in form of online lecture.

7. Conclusion

This research reviewed available teaching materials for plastic waste management in in context of capacity development. Moreover, this thesis pointed out content of teaching materials by evaluating them in term of training needs of participants in plastic waste management value chain. Besides content of teaching materials, thesis identified common teaching methods in which evaluated material can be engaged.

The results of the research can be used as baseline for training and education activities because they provide easy access to training materials depending on interest in certain training topic or stakeholder. It can be used as a part of small-scale training project in waste management covering topics such as waste collection and sorting. On the other hand, results can be beneficial for large-scale project in term of development of capacity of developing country or organization. Furthermore, the training potential of materials is not only limited on training topic, but it also covers certain plastic waste management topics such as circular economy, plastics from e-waste, plastic marine debris, and extended producer responsibility.

Limitations of research are mainly the availability of materials and the methodology of evaluation. The results of the research were limited due to fact that that professional organizations who are designing training materials are not always willing to share their product. Therefore, the focus was only on free material made by relevant organizations involved in activities in waste management. Thus, potentially high-quality teaching materials could not be part of analysis.

The methodology of evaluation is designed to analyze teaching materials in terms of relevant training topics in plastic waste management. Consequently, materials that cover topics such as reduction of plastic consumption did not receive high scores and the topic was not pointed out in results of analysis. Is important to notice that the final ranking of teaching materials does not imply that certain material is the best for one or another stakeholder. It rather means that the material covers more defined training topic then other.

One topic that is not covered in this research is biodegradable plastic. As an alternative to single-use plastics and increased usage, teaching materials for biodegradable plastics can be object of further extension of the research. Moreover, e-waste today is fastest growing waste stream in the world with an annual growth rate of 3-4%, and a share of plastic in e-waste accounted for almost 20% (Sahajwalla and Gaikwad, 2018). The research included four of these materials (manufacturers, waste managers and informal sector), but due to emerging development of this topic further development of the research in term of plastics from e-waste is recommended.

It important to notice transition in usage of teaching methods from traditional face-to-face classroom approach where knowledge is presented by teacher to more creative approaches such as hands-on, simulation game based, flipped classroom and expeditionary teaching method. The reason for this can be found in development of new types of teaching material which include multimedia content and emerging development of online education. Consequently, this gives educators the opportunity to combine teaching methods and different material types to creatively present knowledge to the training participants. Moreover, COVID-19 pandemic enhanced usage of online education and training, and it is expected that further development of not only teaching methods but also the material types will go in this direction.

During the research similar evaluations of teaching materials were not found. This fact opens possibilities and makes baseline for further development of similar research which can include some other waste streams such as e-waste, metal, paper or glass. However, research in area of evaluation of teaching methods has been made (Yeunga et al., 2017) and this research is matching the findings of the master thesis in term of teaching methods and their usage nowadays.

Beside the inclusion of other plastic waste management topics (e-waste and biodegradable plastics) and other waste streams further research could address establishment of an online data base of evaluated materials and further development of evaluation methodology. Establishment of an online data base with user-friendly interface can significantly increase accessibility to teaching materials depending on filter of search (training topic, stakeholder, plastic waste management topic, teaching method and material type). This can be valuable not only for experts but also for users interested in waste management. Further development of the methodology and introduction of new criteria for evaluation will increase available information on material content. New criteria can address specific training topic or some other relevant parts of plastic waste management. Therefore, users will gain easier access to desired material content.

A final recommendation is regarding the use of materials in training activities. It is recommended in situations when there is interest in a specific training topic or stakeholder to go through all available materials that cover that topic and targeted stakeholder. This will provide wider range information. Moreover, materials are very suitable to be used for creation of new teaching materials because they summarize all relevant parts of plastic waste management.

8. Summary

Plastic waste mismanagement and plastic leakage into environment are environmental problems that affect all countries and regions in the world. Developing countries are more affected with these problems due to lack of capacity to tackle these issues. Capacity development is recognized as an approach that has potential to address these problems in systematic way. Education and training are central tools of capacity building because they strengthen skills and increase level of knowledge.

The main objective of this study was review of teaching materials for plastic waste management. This was conducted by applying a weighted score method to evaluate materials in term of their content and aimed stakeholder.

For the development of the methodology, it was necessary to define and map stakeholders along plastic waste management value chain. Additionally, defining their roles in plastic waste management helped to determine their training needs. Training needs of stakeholders were used for establishment of evaluation criteria and their prioritization.

The methodology comprises nine criteria for evaluation (8 training topics and graphical presentation of content), three weights of criteria (1, 3 and 5 depending on importance of training topic) and three points scores (0, 1 and 2 depending on presence of the training topic in material).

The teaching materials evaluated are grouped by targeted stakeholder. The summary and analysis of each material is provided to open the possibility of easy access to desired material depending on training topic. Moreover, besides common training topics the study covers different teaching methods and material types. Therefore, it provides access to the materials not only in term of training topics and stakeholder but also depending on training method and material type.

One of the findings of the research was the transition from traditional face-to-face classroom teaching methods to more interactive teaching approaches. Methods that include combination of few different teaching methods such as game-based simulation and hands-on teaching method. This transition is supported with development on different types of teaching materials. More and more new materials combine textbooks and multimedia content. COVID-19 pandemic reviled power of online education and point out in which direction the development of teaching methods and materials will go.

Recommendations for further development of research are the inclusion of biodegradable plastics, extension of research on plastics from e-waste and additional inclusion of other waste stream such as paper and metal.

Furthermore, the development of a data base for evaluated materials with user-friendly interface which will provide easy access to materials not only to experts but also to all other people who are interested in topic of waste management.

Further development of methodology and inclusion of new criteria will provide more detailed information about material content and cover topics which are not covered in this research.

Combined use of evaluated teaching materials is recommended.

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Appendix

Links to the teaching materials:

Government

6. Guidelines on Separation of Waste at Source*: http://sawic.environment.gov.za/documents/9390.pdf*
7. Single-Use Plastics: A Roadmap for Sustainability: *https://www.greengrowthknowledge.org/research/single-use-plastics-roadmap-sustainability*
8. Marine Litter Legislation: A Toolkit for Policymakers: *https://www.eli.org/sites/default/files/eli-pubs/marine-litter-legislation-toolkit-policymakers.pdf*
9. Marine Plastic Debris & Microplastics: Global Lessons and Research to Inspire Action and Guide Policy Change: *https://wedocs.unep.org/handle/20.500.11822/7720*
10. Green Public Procurement Manual on Plastic Waste Prevention: *http://www.plastic-zero.com/media/50849/green_public_procurement__manual_on_plastic_waste_prev preven__final_.pdf*
11. Guidance for the Reduction of Plastic Waste in Meetings and Events: *https://www.canada.ca/en/treasury-board-secretariat/services/innovation/greening-government/guidance-reduction-plastic-waste-meetings-events.html*

Manufacturers

6. Design for the Environment: *https://www.yumpu.com/en/document/read/36634318/design-for-the-environment-guidelines-2006-plastics-new-zealand*
7. Sorting info Guide Making sorting simple: *https://bo.citeo.com/sites/default/files/2019-09/20190927_Guide_Info-tri_Citeo_EN.pdf*
8. Recyclability of plastic packaging: Eco-Design for improved recycling: *https://www.cotrep.fr/content/uploads/sites/3/2019/02/cotrep-guidelines-recyclability.pdf*
9. Circular Packaging Design Guideline Design Recommendations for Recyclable Packaging*: https://www.ara.at/fileadmin/user_upload/Downloads/Guideline/FH-Campus-Wien_Circular-Packaging-Design-Guideline_FIN_ENG_Web.pdf*
10. Reuse and recycling of plastic packaging for private consumers: *https://plast.dk/wp-content/uploads/2019/12/Design-Guide-Reuse-and-recycling-of-plastic-packaging-for-private-consumers-english-version-1.pdf*

11. Design of Rigid Plastic Packaging for Recycling Guidance: *https://wrap.org.uk/resources/guide/design-tips-making-rigid-plastic-packaging-more-recyclable*
12. Design 4 recycling*: https://www.gruener-punkt.de/fileadmin/Dateien/Downloads/PDFs/1909_D4R_Guide_DE.pdf*

Waste Managers

6. Manual handling in refuse collection: *https://www.hse.gov.uk/research/hsl_pdf/2002/hsl02-21.pdf*
7. Recycling Training Manual: *https://www.environment.gov.za/sites/default/files/docs/publications/recycling_trainingmanual.pdf*
8. Strategy Guidance: Solid Waste Management Response to COVID-19: *https://unhabitat.org/sites/default/files/2020/05/un-habitat_strategy_guidance_swm_reponse_to_covid19.pdf*

Consumers

6. Tide Turners Plastic Challenge: *https://wedocs.unep.org/bitstream/handle/20.500.11822/28007/ChallengeBagdeTkt.pdf?sequence=1&isAllowed=y*
7. Recycling Resource: *https://www.wm.com/us/en/recycle-right/recycling-resources*
8. The Plastic Journey A K-5 Plastic Pollution Curriculum: *https://seagrant.psu.edu/sites/default/files/Lessons%20for%20NIE%202%20and%203%205GyresALLACTIVITIESPlasticPollutionCurriculum.pdf*
9. The Back-to-School Plastic Challenge: Start the second school year by breaking up with single-use plastic: *https://static1.squarespace.com/static/5b0b59598f51300662cb1bc8/t/5c7c63bf0d929729703fc120/1551655899953/CleanSeas-EDU-Pack-ENG-Temp_UN-3-EDITS.pdf*
10. TrawlShare STEM to Stern Marine Plastic Pollution Educational Units for Students Learning at Sea: *https://static1.squarespace.com/static/5522e85be4b0b65a7c78ac96/t/5e3329aef22b3a3761aba75f/1580411336474/5+Gyres+TrawlShare+STEM+to+Stern+Program+%28130pgs%29.pdf*