Towards a waste management plan for Smart cities

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Abstract

Today the theme of waste appears to be one of the priorities at the urban level. Every citizen produces about 1 kg of waste per-capita per day, and this value is expected to grow. To speak of sustainability for this field, it means to have a new approach to solve this emergency and make the waste a resource. The objective of this paper is to present the current situation regarding the EU and Italian legislation and the existing tools aimed at sustainable waste management. About laws, the Waste Directive (2008) is important because it introduces the concept of prevention in the production of waste as one of the primary objectives. In particular, the strategy of waste management should foresee the reduction of the quantity and the hazard level of waste in a perspective of sustainable development. This theme also appears transverse to other priority urban aspects such as tourism, energy, transport. Therefore, the developed analysis will be addressed not only to the specific topic of waste but also its possible interactions. Among the possible dedicated tools, the Environmental Action Plan (set specifically for the waste) and the plans/programs proposed by the EU can be very important. At the Italian level, there are few examples of these tools. In particular, in this paper, starting from ongoing research in the Mediterranean area, will propose an "Urban Waste Management Plan", as a reference tool for the waste management, where the management term considers different phases (collection, transportation, disposal and recovery/valorization). This plan should take into account the environmental, economic and social aspects and the characteristics of each city. Moreover, when fully operational, it will have to integrate with the other urban and regional planning tools towards a sustainable and participatory governance for cities that are really smart.

Keywords: legislation and tools waste management, governance, sustainability, urban waste management plan.

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1 Urban waste in the Smart cities logic

Against the background of economic and technological changes caused by the globalization and the integration process, cities in Europe face the challenge of combining competitiveness and sustainable urban development simultaneously [1].

The present society, based on consumptions and on "throwaway" politics, has the effect a higher consumption of energy and resources and increased of waste production. This contributes to increase in greenhouse gas emissions, and therefore atmospheric pollution, and acoustic pollution. At the urban level the role of territorial planning is strategic and the coordination of ongoing changes in terms of sustainability becomes a necessary approach to solve this emergency and make the waste a resource. Even from the legislative point of view, to deal with the environmental challenges it has become necessary to hire a strategic approach designed to analyze the issue of waste at every level of reference.

Focusing attention on the numbers one realizes the criticality of the situation. Every day, one kilogram of waste per person is produced, this means that Europe produces about 200 million tons of urban waste per year that have to be properly treated and disposed of. It is then noticeable because, from the 80s to today, the improvement of waste management has been at the center of EU environmental policy and it is considered, at the international level, one of the greatest environmental challenges. On the substance, early as the implementation plan adopted at the World Summit On Sustainable Development (Johannesburg, September 2002) resumes the themes of Agenda 21 and calls for action to "prevent and minimize waste and maximize reuse, recycling and use of environmentally friendly alternative materials, with the participation of government authorities and all stakeholders, in order to minimize adverse effects on the environment and improve resource efficiency..." (point 22) [2].

At the EU level, through the different Conferences that have taken place over the years, it has expressly outlined the prerogatives for the twenty-first century in reference to the "Waste" theme. In particular, early as 1992 the European Union has developed the Fifth Action Programme "Towards Sustainability" which had as objective to reduce the amount of waste per capita [3].

In the Sixth Environment Action Programme entitled "Environment 2010: Our Future, Our Choice" (revised in 2007), however, in addition to the specific objectives of reducing waste disposed of in landfills (less than 20% by 2010 compared to 2000, and less than 50% in 2050) were identified key priorities and main objectives of environmental policy in regard to "sustainable management of resources and wastes". In addition were explained in detail the measures to be taken in terms of possible remedies to reduce the impact: "decouple waste generation from economic activity, reduction in the volumes of waste and the volumes of hazardous waste, proximity of waste disposal to the place of waste generation, encourage re-use" (3.4.2.2 waste) [4].

With the passing of years the concept of "waste" is changed, on the basis that "the best waste is which is not produced" it is witnessing at the upsetting of the concept of waste, no considered an asset referred to discard but a resource to

recycle, reuse and recover raw materials and, at the same time, a valuable stock of resources that can be exploited.

The current EU policy on waste, as it is known is outlined in the context of Waste Framework Directive (2008/98/EC), which represents the last leg of a process that began the 1970s (Table 1).

Table 1: Main EU legislation on the waste management.

EU LEGISLATION	TOPIC
Directive 2008/98/EC on waste (Waste Framework Directive) of 19 November 2008, which repeals (December 2010) Directives 75/439/EEC, 2006/12/EC and 91/689/EEC	It defines: Art. 4: waste management hierarchy (priority order in waste management); plans and Programs; Art. 28: waste management plans; Art. 29: waste prevention programs – Annex IV examples of measures for waste prevention, Art. 30: Assessment and review of plans and programs.
Directive 2006/12/CE of 5 April 2006	It defines the concepts of waste, recovery and disposal; establishes the essential requirements for waste management; encourages to apply the waste hierarchy according to the principle "the polluter pays".
Directive 2004/35/CE of 21 April 2004	On environmental liability with regard to the prevention and remedying of environmental damage.
Directive 2004/12/CE of 11 February 2004	It amends the Directive 94/62/EC on packaging and packaging waste. It defines the essential requirements of the packaging, the composition must follow the reusability and recoverability criteria (in particular the recyclability).
Directive 2000/76/EC of the European Parliament and of the Council of 4 December 2000	On the incineration of waste.
Council Directive 91/689/EEC of 12 December 1991	On hazardous waste.
Council Directive 75/442/EEC of 15 July 1975	It defines: Art.1: "Waste" means any substance or object which the holder disposes of or is required to dispose of pursuant to the provisions of national law in force". Art.11: "Polluter pays" principle, the cost of disposing of waste, shall be borne by: the holder and/or the previous holders or the producer of the product from which the waste came".

This directive pays particular attention to the definition of the waste treatment hierarchy, especially in the prevention (precautionary principle), which is followed later in the order by, the reduction through the preparing for reuse, the recycling and other recovery actions (notably recover energy) and in final the disposal of waste (Art. 4). For some special waste streams (such as packaging, vehicles, electrical and electronic equipment) the principle of the hierarchy of interventions has been converted, for example, by the introduction of concrete

targets for recycling. In addition, in working out of strategies for waste management must taken into consideration the reduction both of quantity and of hazardous of waste produced in a perspective of the sustainable development. This is in order to make a valid management from the environmental, social and economic point of view and allow a dissociation between the environmental impacts, associated with the generation of waste, and the growth economic.

The directive does not only introduces the concept of waste prevention, but establishes other principles to follow: the strengthening of the responsibility for waste management (Art. 15 "extended producer responsibility") the "polluter-pays principle" and the "self-sufficiency and proximity principles"(Art. 16, to establish an integrated and adequate network of waste disposal installations and of installations for the recovery of mixed municipal waste collected, taking into account best available techniques). It also imposes for each Member States an obligation to adopt a waste prevention programme (where the waste prevention measures shall be clearly exposed; deadlines December 2013 – Art. 29) and a waste management plan (Art. 28). Those plans shall, alone or in combination, cover the entire geographical territory of the Member State concerned. The main purpose of these plans is to provide an overview of all waste generated (divided by type of waste streams) and related treatment options. The waste management plans shall contain at least the following (Art. 28):

a) The type, quantity and source of waste generated within the territory, and an evaluation of the development of waste streams in the future;
b) Existing waste collection schemes and major disposal and recovery installations, including any special arrangements for waste;
c) an assessment of the need for new collection schemes, the closure of existing waste installations, additional waste installation and, if necessary, the investments related thereto;
d) Sufficient information on the location criteria for site identification and on the capacity of future disposal or major recovery installations, if necessary;
e) General waste management policies, including planned waste management technologies and methods [5].

Given the importance of the issue of waste, in particular in urban areas, in addition to what has already been prepared, in terms of guidelines and documents processed as a result of specific conferences, the inclusion of this issue within the current European policies aimed at achieving of Smart cities would be desirable. Besides the importance to planning a smart and sustainable management of waste (the collection, transport, recovery and disposal), it is significant to consider this theme in a more comprehensive vision. The issue of waste is in fact transverse and closely connected to other priority urban issues such as tourism, energy and transport; intending with the term "transversality", the impact that these issues have in terms of resource consumption and waste production. For example, analyzing the main pressures related of tourism these are generally attributable to seasonality and/or to concentration of tourists in particular areas. These effects are expressed mainly through the increase of: water requirement, energy, mobility and production of waste [6].

To make the issue of waste "Smart" is necessary to reason about the latest technologies. In this context, the best good practice on waste, that is waste collection, in an efficient and integrated system, is emerging as one of the conditions to closing the life cycle of products (note that only 20% of our waste is made up of by non-recyclable waste) and therefore for sustainability. In fact, through the use of recyclable materials in production processes it is possible reduce the negative impacts associated with the disposal of waste and the soil, water, air pollution as well as having an economic sustainability in terms of reduced spending on disposal and production of new products. The recycling of waste, with the recovery of "secondary raw materials", allows to replace a portion of the raw materials in the cycles production (reducing the consumption and extraction of non-renewable raw materials and therefore savings energy) and subtract to the disposal a part of waste, thus avoiding the environmental impacts involved. These impacts are reduced in terms of greenhouse gas (air pollutants and greenhouse gases), contamination of water (leachate production), consumption and loss of value of the soil, reduction of the need for mobility.

In the context of waste management the use of modern technology makes it possible to reduce the impacts and therefore contributes to making this complex issue more sustainable. In particular, reasoning about the waste collection, e.g. the inserting of microchips into a bags for the collection allows to monitor the production of waste and to create a Tarifica that differ according to what is disposed as undifferentiated; the networking of the points of collection in the area through the creation of geo-referenced databases (using GIS "Geographical Information System") allows to reduce withdrawals from the responsible authority; the dryers for compost allow to reduce the wet component and therefore the possible "odors" at home; the compactors that reduce the volume of waste. These are just a few examples in which emerge the transversality and the impact of the issue of waste and also, such as integration with the technological component, inserted in the various phases of waste management in urban areas, can help to resolve many existing problems.

2 Sustainable waste management tools

Among the tools dedicated to the theme of urban waste can be mentioned the Environmental Action Plan and the waste plan/programs.

The Environmental Action Plan, a fundamental tool in the Agenda 21 process, is intended to highlight the priority issues in an urban context. For this reason also the issue of waste is analyzed within this plan, which by its nature is not a planning instrument, but that is definitely a document to keep in mind during the programming/choice of actions for a sustainable city. As is known, the Local Agenda 21 is the instrument to implement "sustainability actions" at the local level to which the Rio Declaration invited "...individual local communities to start up a process of consultation and consensus building among the social partners, in order to define and implement a Local Environmental Action Plan for urban sustainability addressed to the 21st century..." From Rio to today the Local

Agenda 21 has been, for many local communities, the means by which they have developed action programs for sustainable development [7].

The Environmental Action Plan, within the process of the Agenda 21, is the summary of cognitive and participatory phases. For the issue of waste, as for each topic considered as a priority, the plan identifies objectives, actions, actors to be involved, the timing of implementation of the interventions, dedicated funding...

There are also Environmental Action Plans specifics, namely that consider individual issues, such as the SEAP "Sustainable Energy Action Plan", which considers only the theme of energy. As is known, the SEAP is born within the 2020 European Policies, in which was signed the Covenant of Mayors (2008), which focuses on interventions at the local level. The SEAP identifies actions to reduce CO_2 emissions and the final consumption of energy by the different stakeholders involved. Purposes of this tool is to promote consumptions and services efficient and a cultural shift in energy and environmental awareness. Even the same SEAP could be therefore candidate as a tool that explores the relationship waste-energy (aspect that is not treated in the actual instruments and that its importance is relevance today); waste seen not as waste but as a resource from which to produce energy, such as biogas, or the choice of actions to reduce energy consumption, both for the disposal that for recovery of raw materials. Similarly, it is therefore possible to create Sustainable Waste Action Plans.

Another tool dedicated to the topic in question is the waste management plan.

In Italy, today, there isn't a municipal management plan, able to put in relationship all the actions foreseen within a waste management from collection, transport, disposal, recovery. In addition, the competence on waste in Italy, but also in other European and International territories, is not strictly of reference of the Municipality, although certainly this issue is a priority at the urban level.

In Italy there are guidelines or plans at regional and provincial level that usually frame the issue in general, but recent negative experiences in the Italian city show that it is necessary not only a waste management but that it is sustainable and that varies with the characteristics of the territory.

In Italy, Modena (which is among the top three Italian cities, with over 500,000 inhabitants, in the waste collection classification) seems the only municipality in which it is being adopted a waste management plan, properly understood. This plan aims to increase recycling, to discourage the use of landfills and disposal of the undifferentiated through an incinerator. Analyzing the values of the percentage of undifferentiated sent for disposal it has been reduced to 0.2% and the waste sent to landfills has dropped to 17%; purpose of the plan is to reduce this gave to 3%. Examining the remaining national territory, at the municipal level there are only partial local plans, namely that consider individual aspects of waste management, for example concerning the land-filling, plans for recycling, Programs related to good practices on waste, plans for hazardous waste.

Among the experiences analyzed, it should be recalled the municipal waste management and urban sanitation plan (2007–2011) of the Municipality of Ginosa (province of Taranto). This plan represents a good example of the implementation of the provision of the plan at the provincial level, in terms of planning and programming of waste management, for the phases of collection, transport,

recovery and disposal of waste. In the province of Taranto, the Municipality of Laterza has realized the waste collection municipal plan. That municipality, while considering only one aspect in the field of waste management, has adopted a policy aimed at "door to door" collection, it has developed communication and environmental education actions and it has introduced a new tariff system (by weight and volume).

In Trent there is a waste reduction plan for the City (2008) that has the aim to combine the choices made by the administration with the approval of the Project of reorganization of the municipal waste collection and the new challenges in terms of prevention and reduction. Among the objectives of this plan there are: the prevention and reduction of waste with the realization of actions to be implemented in a short time, the establishment of a collaborations network for the realization of sustainability initiatives, the transfer of knowledge and procedures to neighboring municipalities, the awareness of the population with incentives to those who implement good behavior in terms of waste reduction. In this instrument, the disposal aspect is to be analyzed in more detail.

Then, there are municipalities that have adopted a set of best practices on waste. In this regard it should be noted the municipality of Lodi, that among the different waste streams, considers a construction activities waste (asphalt, brick, concrete wired or unwired, etc.) and the sewage sludge urban. Interesting underline the different types of best practices existing for the subject in question; in this regard a study carried out in the province of Savona (Liguria region) is shown [8]. This area, in the southern part, is characterized by small different cities for population and tourist numbers. Some cities, according to the seasons, double or triple the number of people present. A first consideration is to enhance the best practices existing in virtue of demographic overload actually present (today the waste problem in this reality is underestimated). A second aspect is to introduce / update the existing good practice considering the vocation of each territory (in the case cited of tourist type) in addition to the population, resident and fluctuating. Considering the residents population, could be introduced and/or expanded good practices such as a door-to-door collection, actions of collection of waste depending on the components of a family, as well as prevention actions of waste production, as the inclusion in the municipality of distributors of bulk materials. Considering tourists, could be expanded and/or introduced best practices aimed at strengthening the collection by these users, or other services that improve urban hygiene such as the location of ashtrays on the beaches or actions aimed at the people involved in tourist facilities such as incentives for owners who implement virtuous policies on waste (Figure 1).

3 Towards an urban waste management plan

In order to define a waste management plan is necessary to analyze the documents present in the current scientific literature. Among the documents consulted, an important role is played by the "Preparing a Waste Management Plan – A methodological guidance note" (2012) document, proposed by the European

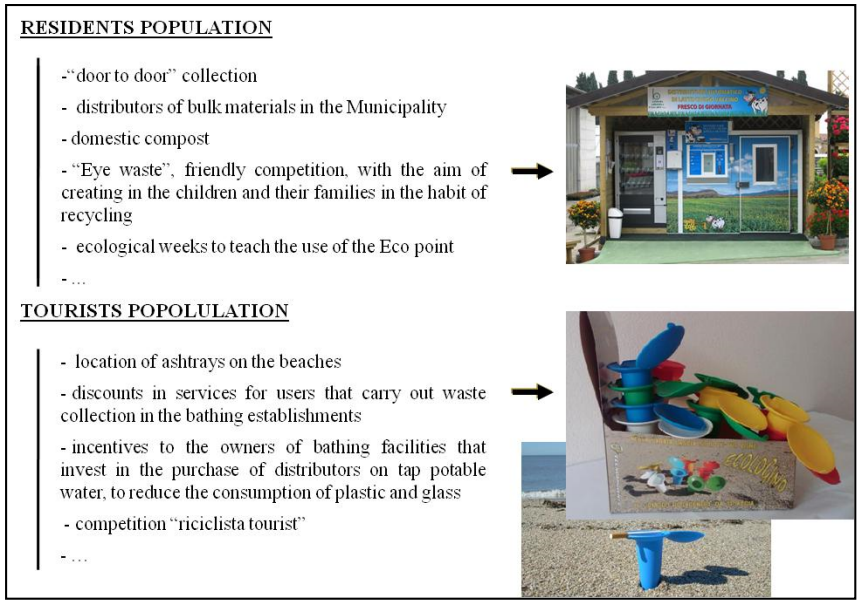

Figure 1: Development and introduction of good practices in small Ligurian coastal realities.

Commission, following the already described Waste Framework Directive (2008/98/EC). At European level, it requires that each Member State draw up a waste management plan [9].

The guidelines provide, besides an overview of the policies and principles established in the context of waste management, a possible structure of support for the definition of individual waste management plans. This guidance can be used in the definition both of national and local waste management plans (for a municipality or region). Of course, these analyzes turn out to be more detailed from the national to the local urban level. It is for the competent Authorities coordinate all aspects concerning the timing, the regional or local competencies, geographical coverage, the goals to be pursued, the phases of monitoring and the relationship with the other governance instruments.

Each Member State should establish a management plan that considers the entire national territory and national laws should define any additional levels of expertise for the management of waste. In Italy, for example, as described in paragraph 2, jurisdiction today is at the regional and provincial level and not municipal, where instead are concentrated the major criticalities. In this regard, a national plan has a strategic nature, as it identifies the objectives of general interest, a regional or local plans are instead operational real plans that include a detailed description of current systems for the collection, treatment plants, transportation, as well as future scenarios. The waste management plans (national/regional/municipal level), however, can contain more or less extensive

actions in accordance with national legislation and policy on waste adopted and promoted at the local level.

Although, in the Guidelines is not shown a rigid schedule to follow in preparing of the management plan, the plan is advisable that contains certain key items (Table 2).

Table 2: Key items "Preparing a Waste Management Plan", Eu. 2012.

EU LIGNES GUIDES		
PHASIS	**TOPIC**	**DESCRIPTION**
1. BACK GROUND	1 Overall waste problematic in a territory	In this phase the planning period is determined, and any other boundaries of the planning scope are clarified. Relationship with other plans, such as spatial and energy planning, is considered. It includes considerations regarding the EU principles as well as current and expected aspect of the EU directives on the waste management
	2 EU legislation	
	3 National legislation	
	4 Description of national waste policy and prevailing principles to address Point 1 above, in line with the waste hierarchy	
	5 Description of objectives set in specific areas 6 Inputs from the consultation process	
2. STATUS PART	1 Waste amounts, e.g.:	In this phase all data and information on the current situation in the waste management field are gathered and analyzed. Then the current waste management system and also the possible solutions to the real problems are identified
	a) waste streams	
	b) waste sources	
	c) waste management options	
	2 Waste collection and treatment for the above	
	3 Waste shipment	
	4 Organization and financing	
	5 Assessment of previous objectives	
3. PLANNING PART	1 Assumptions for planning	This part is prepared on the basis of EU and national legislation, the status part and relevant assumptions for projecting future developments. Central elements are: the determination of political objectives and the evaluation how these objectives may be met most effectively. For this purpose the choice of measures and instruments for the implementation of the plan or the strategy is relevant
	2 Forecast in terms of waste generation, total and per waste stream	
	3 Determination of objectives for forecasted:	
	a) waste streams	
	b) waste sources	
	c) waste management options	
	4 Plan of action, including measures for achieving objectives:	
	a) collection systems	
	b) waste management facilities	
	c) responsibilities	
	d) economy and financing	

As it can be seen the structure given to the plan provides three different consecutive phases, two of which are dedicated to the analysis and understanding of the state and the issues related of waste management, and a third which provides for its implementation.

These guidelines identify some questions that are recommended, that each management plan should respond to:

- Why draw up a waste management plan? What is its purpose?
- What are the stakeholders involved?
- What is the time horizon of the plan?
- How does the plan fit in the governance instruments?

In addition, the guidelines specify that the targets identified in the plan must be specific, clearly defined and precise, measurable (so that it can be evaluated objectively), realistic and achievable in the time expected and related to deadlines within which it must be achieved.

The guidelines, in the final part of the document, provide a scheme of minimum and maximum criteria that allow you to assess the quality of waste management plans drawn up. Within this schematization are reported the entries to be insert in the document; the first column describes the Minimum Criteria (compliant with EU legislation and policy objectives), while in the other two columns are indicated the criteria that, if respected, allow to evaluate the plan, as a "good plan in the light of EU legislation and policy objectives" and an "ideal plan suitable to serve as an example of good practice for compliance with EU legislation and policy objectives".

4 Development perspectives

As regards the issue of waste, as territorial planning team, we have developed and we are carrying out various research today. Among those concluded the project ACTI-VE (Operational Programme Italy–France "Maritime" for 2007–2013 – April 2010–July 2012; cooperation area regions: Liguria, Tuscany and Corsica) is remembered. In this project the research goal is to define a cross border Agenda 21 as a tool for planning, development and sustainable management of the land in a transboundary level, to promote the best good practices for creating an Action Plan on Transboundary (PAT). Given the specific topic on the waste, the analysis are focused on the "transversality" of this topic with those related to the mobility and transport, energy and tourism thematic. Among the current researches is recalled MED-3R "Plateforme stratégique euro-méditerranéene pour une gestion adaptée des déchets" (Enpi CBCMED – December 2012–December 2015, cooperation area regions: 14 partner of the north and south coast of the Mediterranean basin) where 3R means "Rallonger la durée de vie des déchets, Réduire la production des déchets, Recycler les déchets en Méditerranée". This is a project whose main objective is to strengthen the coordination and cooperation between cities and several groups of actors in the Mediterranean involved in urban waste management (collection, sorting, and recovery) to develop effective, integrated, virtuous and adapted to the local contexts management systems. In this context, the European Guidelines are an important starting point to create a tool

dedicated to the sustainable management of waste, where this instrument contribute to sustainable planning of waste management by promoting the development of programming practices more consistent and adequate in the partner countries of the project.

The research in progress show that, in order that a waste management plan is sustainable and really applicable must include in it, as strategic and operational basis of the plan, the "participation". This type of approach enables us to valorize the contributions, in terms of experience and expertise, of all stakeholders (administrator, trade associations, population). In this regard, there are various possible initiatives to increase public awareness in the field of waste management. In the selection of the most appropriate methods of raising awareness is necessary to consider, for example, the target people (age, gender, etc.), the communicative content of the message (emotional, rational, ethical, alarming, etc.), the choice of the means (TV, radio, Internet, newspapers, etc.) and the allocated budget.

Participatory processes are not only an essential requirement for a plan, but also a guarantee for its validation. In fact, in order that a system of waste management is effective and feasible, the population is important that know, understand and realize the actions of this plan, given that the population is the actor more involved in the issue of waste as an actuator of what is provided in the local politics.

Only a plan able to take into account the characteristics of each city, including through active and responsible participation, and the environmental, economic and social aspects, will be able to blend with the other urban and regional planning instruments, towards sustainable governance and participate for a city that is really smart.

Annex

F. Pirlone. The author has deepened the tools dedicated to the sustainable waste management from the Environmental Action Plan, within the process of Agenda 21, to the plans/programs on waste at different scales of reference. In particular, the analysis was focused on urban waste management Plan and current best good practices, taking the example also some EU research completed or in progress.

I. Spadaro. The author has analyzed the issue of waste production at the urban level and deepened the existing regulatory framework and the EU policy on waste, and in particular, the Waste Framework Directive (2008/98/EC) and the document Preparing Waste Management Plan - a methodological guidance notes (2012). All this in order to insert the topic of sustainable waste management in the logic Smart cities.

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