THE ROLE OF ACCOUNTABILITY WITHIN A ZERO WASTE STRATEGY: EVIDENCES FROM A SICILIAN SMALL MUNICIPALITY

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Abstract: *Building a sustainable city model comprising an integrated waste management system has become an indispensable choice, also in the light of increasingly stringent regulatory constraints. The core point of the paper is the implementation of a zero waste strategy in a small municipality in Sicily. Given that only the unceasing participation of citizens may ensure the persistence over time of such a policy, accountability process works letting citizens approach directly the end-results of their ongoing good practices. By building up a SD model framed by a DPM chart, it is possible to figure out how disclosure of public saving resulting from the decreasing amount of waste piled up in the landfill, has boosted along the period 2011-2015, a virtuous cycle intended to cope with the citizens claims about environmental care and lower tax burden level.*
Keywords: *integrated waste management, zero waste strategy, dynamic performance management, saving, Public Governance, accountability.*

1. INTRODUCTION TO ZERO WASTE STRATEGY AS AN INTEGRATED WASTE MANAGEMENT SYSTEM

Sustainability might be seen as the most important challenge mankind is going to face in this millennium. Indeed, given the ongoing consumption rate, mankind ought to live at least in two planets assuming the European consumption model, whereas looking at the American one, mankind would need at least four planets (World Watch Institute, 2013). Zero waste strategy might be seen as a kind of Integrated Waste Management System (IWMS). More deeply, it requires to put together waste streams, waste collection, treatments and disposal methods, with the objective of achieving environmental benefits, economic optimization and social acceptability (McDougall et al., 2001; Thomas and McDougall, 2005; Marshall and Farahbakhsh, 2013).

Facing the need to slow down the ongoing consumption rates to deal with sustainability challenge, the main purpose of a zero waste strategy is not to find out more sophisticated methods to destroy waste. Vice versa, it aims to encourage production of products and packaging materials that will never be destroyed (Connett, 2007, 2013). The change in the paradigm this strategy is trying to foster, is essentially summed up in the 3-R scheme: reduction, at the source; recycling and reuse to extend the lifecycle of the products.

Generally speaking, the ambitious aim of Zero Waste requires to be grounded in two pillars:

- Engaging community, by undertaking public campaign just to make people receptive to this kind of matter and to invite them to adopt waste free practices;

- Industrial responsibility, as a guarantee of designing long-lasting, easily maintainable and repairable products, reducing packaging, reusing parts and material coming from discarded products and material in line with a circular economy (Simon, 2010; Connett, 2013).

2. APPLYING THE ZERO WASTE STRATEGY IN A SMALL MUNICIPALITY.

Nowadays, waste management is an integral part of a sustainable city model. In the last years, big cities like Stockholm and Adelaide have been experiencing significant improvements along "zero waste path". In all these particular cases, policies and regulations have been recognized as the overriding stimulus to foster the development of such innovative waste management systems causing citizens to take up the preset sustainable path (Uz Zaman and Lehmann, 2011). Moreover, it has been recorded empirically that operational efficiency of solid waste management depends on socio-cultural aspects including active participation of citizens for contributing in solutions (Guerrero et al., 2013; Bryson et al., 2014).

This conception is aligned with the idea of public governance as *«self-organizing networks covering non-State actors*» (Rhodes, 1996.); so that overall performance of economic and social system is the result of interactions involving further actors as well as the Public Body (Meneguzzo, 2005). Generally speaking, rate of municipal waste land filling for the 32 EEA member countries felt from 49 % in 2004 to 34 % in 2014. Specifically, while in Austria, Belgium, Denmark, Germany, Netherlands, Norway, Sweden and Switzerland, virtually no municipal waste is sent to landfill anymore; Cyprus, Croatia, Greece, Latvia, Malta and Turkey still landfill more than three quarters of their municipal waste (EEA, 2016).

Despite Italy reported between 2004 and 2014one of the highest increase (24 percentage points) in recycling rate in Europe (EEA, 2016); municipalities have been recently involved in the grip of the fiscal compact, in line with European diktats and the tough economic and financial situation (Creel et al., 2012; Warner and Clifton, 2014; Barbera et al., 2016). As a consequence, they have been approaching the need of a spending review aimed at squeezing the management costs as much as possible (OECD, 2015). Fiscal compact, as fiscal chapter of the Treaty on Stability, Coordination and Governance in the Economic and Monetary Union, signed on 2 march 2012 formalized the need for governments to keep as sustainable their public finances and to prevent a general government deficit, just to safeguard the stability of the Euro Area, as a whole. Accordingly, it also requires the introduction of specific rules, including a "balanced budget rule"[1] and an automatic mechanism to take corrective action. This rule has been cascaded on municipalities forcing them to hold down expenditures level just to stabilize their financial equilibrium.

Sic stantibus rebus, adopting a zero waste strategy for a small municipality like Palazzo Adriano[2], made up of less than three thousands of inhabitants, might be seen as an unavoidable choice aimed at squeezing expenditure levels – given that transfer of waste in landfill implies an incurring cost, referred to the incineration system as last treatment stop – by encouraging a lower

[1]Constitutional Law n.1, 20 April 2012, and new article n. 81 of Italian Constitution. To read more, go to http://www.reuters.com/article/italy-budget-senate-idUSL5E8NKDKR20121220[2017].
[2]Palazzo Adriano is a small town belonging to the Metropolitan Area of Palermo.

waste production and by managing properly waste volumes still produced. Moreover, through this policy, municipality could also be able to cope with the intergenerational equity issue.

First of all, reducing the amount of waste in landfill by implementing a zero waste strategy, on the one hand turns into an economic benefit. Indeed, saving connected to the refusal of the incineration system will be converted into lower taxes, since, as it has been seen commonly, a so-called differentiated tariff system is used to distinguish the separated and non-separated waste by the tax which householders should pay (Bing et al., 2016).

Reduction of waste also turns into a driver simultaneously of direct and indirect benefits for society: on the one hand, it satisfies the collective interest in the environmental care; on the other hand, it creates the conditions to generate redundant positive externalities that are bound to strengthen the image and attractiveness of the reference area.

Recycling has always been a challenge for municipalities. In particular, reviewing the results attained throughout Italy, it is known that the main causes of the failure of such initiatives are:

- inability of municipality to raise awareness of the population, if the municipality either has not achieved satisfying fraction of waste recycled level or it has not been able to be accountable to the citizens for the results of such a policy (Heinrich, 2002; Behn, 2004; Bovens, 2007);
- lack of sufficiently strong control mechanisms (Frey et al., 2014), ready to ensure the continuation of a similar program, which of course, at least in the short term, encounters strong resistance, given that it threats a more convenient but also more polluting model of life.

Obviously, small municipalities are more likely to get a target fraction of waste recycled sooner respect to the larger ones. In particular, according to Ispra[3], recycling rate of over 60% is more likely in municipalities including both between 2,501 and 5,000 inhabitants and between 5001 and the 15,000 inhabitants (respectively 52,6% and 55,9% of the corresponding class of municipalities have reached the target fraction). Over 60% of recycling has been achieved also in the 33,3% of municipalities comprising between 100,001 and 200,000 inhabitants. Instead, there is no municipality with a population of more than 200,000 inhabitants that has been reaching such a threshold (Ispra, 2016).

In the last years, in accordance with the fiscal compact (Bel and Warner, 2015) and with a view of achieving scale economies – trying in the meanwhile to fix that historical local authorities budgetary and capacity shortfall, as mentioned before – it has been spread the idea of conferring waste management system to public consortia of services called ARO (Optimal Collection Area), whose costs will be split up among the different participating municipalities. In other words, waste management will be outsourced in favor of a public consortium that will take care of workforce management, devices and facilities, maintenance investments and processing waste in landfill. Generally speaking, such a choice has spread among small towns (Sorensen, 2007; Bel and Mur, 2009), since, by cooperating, they typically incur lower costs for their waste collection service. Inter-municipal cooperation in service delivery also may improve collection frequency and the quality of the service in small towns, lowering transactions costs (Bel and Mur, 2009; Bel and Fageda, 2010; Peters 2011; Gomez et al., 2013).

[3]Public Agency supervised by Ministry of the Environment, responsible for technical scientific activities connected to environmental care, protection of water and soil conservation.

Looking more closely at the municipality of Palazzo Adriano, the latter will be merged with the municipalities of Bisacquino, Prizzi, Chiusa Sclafani and Giuliana, in "Valle del Sosio ARO", assuming that they generally represent a rural and mountainous area with a low population density. This consortium has been introduced by Regional Law no.3/2013 but it has not begun to operate yet because of some bureaucratic quibbles about absorbing the employers referred to ATO PA 2, the former public company owned by municipalities, which was in charge for waste collection up to 2014, when it failed. In the meanwhile, waste disposal service has been contracted out to a private company, which is equipped with a transference station located in Cammarata (a municipality around 40 km far from Palazzo Adriano).

Decision about which waste management system to adopt is a clear demonstration of the role of Public Sector either as an acceleration factor or a constraint for the growth of the local area (Moore, 1995; Borgonovi, 2001; Meneguzzo, 2005; Flynn, 2007; Bryson et al., 2014; Bianchi, 2010, 2016). After all, empirical studies have shown that there is no "one size paradigm fitting all the urban realities", since there are different variables at stake impacting on the success of an ordinary waste reduction policy, like the necessity of good and reliable data or the importance of governance, as well as technology (Wilson et al.,2012).

That being said, the aim of this research is to explain how the benefits for the citizens have sprung up from the start of this program (with its ten steps) since 2012 in Palazzo Adriano. Going in depth, Palazzo Adriano has been cutting down its expenditure levels pertaining the waste management system of almost 25% in four years by increasing at the opposite – thanks to the zero waste strategy – fraction of waste recycled from 4% in 2011 up to 65% in 2015. To find out the source of such spending review process naturally impacting on relationship between local government and citizens; it has been needed to integrate the 3-R scheme with the S of saving money just to highlight what has been strengthening this strategy over time, bringing out, within a tough regional situation, a virtuous waste management system. Indeed, implementation of a zero waste strategy in a small municipality like Palazzo Adriano should be weighted up in the light of the tough regional situation witnessed by the overall fraction of waste recycled. More precisely, in Sicily, in 2014 (Sicily Region, 2016), one third of all the municipalities did not go beyond the 5% and the regional recycling rate has not been recording so many improvements (Ispra, 2016), remaining almost constant until now (12,5% in 2014 and 12,8% in 2015).

Time horizon taken into account coincides with the lag of time whose data have been provided by municipality, namely a period of five years, including the year before the implementation of this strategy. This choice is justified by the desire of understanding the strength of that change the policy implementation has been unleashing over time.

To summarize, this paper is intended to answer the following research questions:

- How can a small municipality introduce a successful zero waste strategy?
- What are the main factors fostering or tackling a zero waste strategy?
- Which are the most important drivers explaining the behavior of waste cumulated in landfill?

3. METHODOLOGY

Assuming that unpredictability and dynamic complexity are the main enemies for the better understanding of a system and given that all is change, policy-maker ought to oversee

changes occurring within a certain system at many time scales (Sterman, 2000), and trying to keep track of interactions among these different scales. Therefore, a municipality should cater for performance, defined both as outputs – and mainly outcomes, as projections of the outputs in the outer local system (Ammons, 2001; Heinrich, 2002; Behn, 2003; Van Dooren et al., 2015, Bianchi, 2010, 2016)– it is supposed to get at the end of its policy, and the process that is in charge for those end-results. Besides, nowadays citizens are demanding better results from government at a time when resource constraints are increasing, and level of trust in government at all levels is at an historic low.Hence, rejecting black box concept and making all the process transparent as much as possible has become a priority (Sanger, 2013).

A Dynamic Performance Management Chart based on SD modelling techniques (Forrester, 1961; Sterman, 2000)might be seen as a useful planning and control panel based on an integrated and systemic view (Amigoni, 1978; Flamholtz, 1996; Otley, 1999, 2001; Bianchi, 2016). Aimed at keeping track of performance both as process and end-results,a DPM chart based on SD modelling might challenge mental models through simulation; so that modelling might be considered as a practical way to learn and test in a "protected" environment the consistency – in terms of robust trade-offs perception – of policy maker decisions (Morecroft, 1987, 2007).

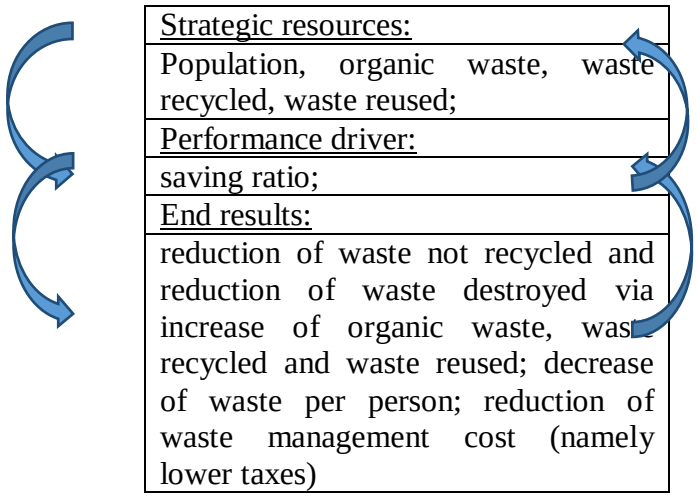
System Dynamics gives the possibility to build up an exploratory model looking into the dormant dynamics. To do this, it typically relies on reasoning in terms of stocks (states) and flows (changes) in accordance with the principle of accumulation (Forrester,1961; Sterman, 2000; Buede and Miller, 2016). Assuming that stocks have four important characteristics (they have memory; they change the time shape of flows; they decouple flows; they create delays), stock and flows structure (Booth Sweeney and Sterman,2000; Sterman, 2000) might be seen as a completion of another pillar of SD approach, the causal loops diagramming (Sterman, 2000), namely the possibility of mapping the system in terms of cause and effect relationships between individual system variables; the latter ones , when linked, form closed loops that feed back to the structure altering the relative importance of each of the variables listed in the system.

In order to provide decision-makers with proper lenses to interpret phenomena like unpredictability and dynamic complexity, SD modeling, within a DPM chart, has been used to support an understanding of:

- how end-results can be affected by performance drivers;
- how performance drivers can, in turn, be affected by the use of policy levers aimed to influence strategic resource accumulation and depletion processes;
- how the flows of strategic resources are affected by end-results (Bianchi, 2016).

DPM chart, as structured below (see figure 2),acknowledging first the strategic role of population as the main factor that affects waste collection, emphasizes the importance of saving process, shown as a ratio between the actual waste management cost level and a target. This ratio might be seen as a performance driver that leads operationally, as end-results, to a reduction of waste not recycled and finally to a reduction of waste destroyed; this happens thanks to the concurrent increase of organic waste, waste recycled and waste reused that flow into the corresponding stocks, feeding strategic resources ready to be exploited or marketed. But saving process is also intended to decrease the amount of waste made by each person, diminishing as a consequence the total amount of waste produced each year. From an economic point of view, these end-results determine lower taxes motivating citizens to fuel this pattern persistently.

Figure 1 Dynamic Performance Management Chart applied to a zero waste strategy



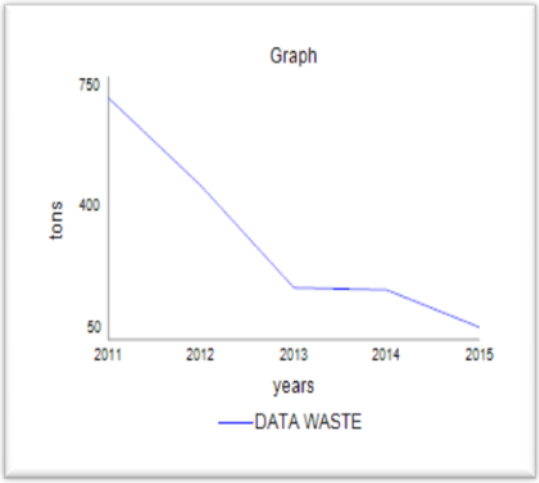
4. APPLYING THE DPM TO THE CASE STUDY.

Reason that pushed the municipality of Palazzo Adriano to increase the fraction of recycled waste lies in the alarming datum of the amount of waste piled up in the landfill for the year 2011, namely 693,84 tons.

To reverse this dangerous trend, the mayor of Palazzo Adriano, once elected, decided to adopt in 2012 a zero waste strategy; specifically, he pledged to reach at the end of the mandate the ambitious threshold of 65% of recycled waste, which represents tons of waste diverted away from landfill and incineration system as last treatment stop. Truly, threshold of 65 % was not accidental since it had been already listed in the Italian judicial system in art. 205 Legislative Decree no.152/06, as an objective to be pursued by 2012. Regional Law no.9/2010has put offits accomplishment by the end of 2015.In addition, European Directive n. 98/2008 has established that by 2020, preparing for re-use and recycling of waste such as at least paper, metal, plastic and glass from households and possibly from other origins as far as these waste streams are similar to household ones, shall be increased to at least 50% in terms of weight.

Once set the target, municipality has achieved the following decreasing pattern of behavior related to the amount of waste irreversibly conferred to landfill, getting to the level of 99 tons in 2015:

Figure 2 Reference behavior of waste piled up in the landfill observed in the model



At the same time it has been seen during the period 2011-2015 an increasing pattern of behavior of the fraction of waste recycled, up to the threshold of 65% that municipality set as target at the beginning.

Figure 3 Fraction of waste recycled along 2011-2015

Fraction recycled	
2011	4%
2012	24%
2013	62,77%
2014	63%
2015	65%

Source: municipality of Palazzo Adriano

Despite forecasting methods for solid waste generation frequently have been traditionally counting on a per-capita socio-economic and demographic analysis (Dyson and Chang, 2005);, by comparing the significance of data related to the decrease of waste in landfill with the decrease of population over time exposed below, it is easy to realize that surely there have been other aspects addressing significantly behavior observed during the period of simulation.

Figure 4 Population of Palazzo Adriano along 2011-2015

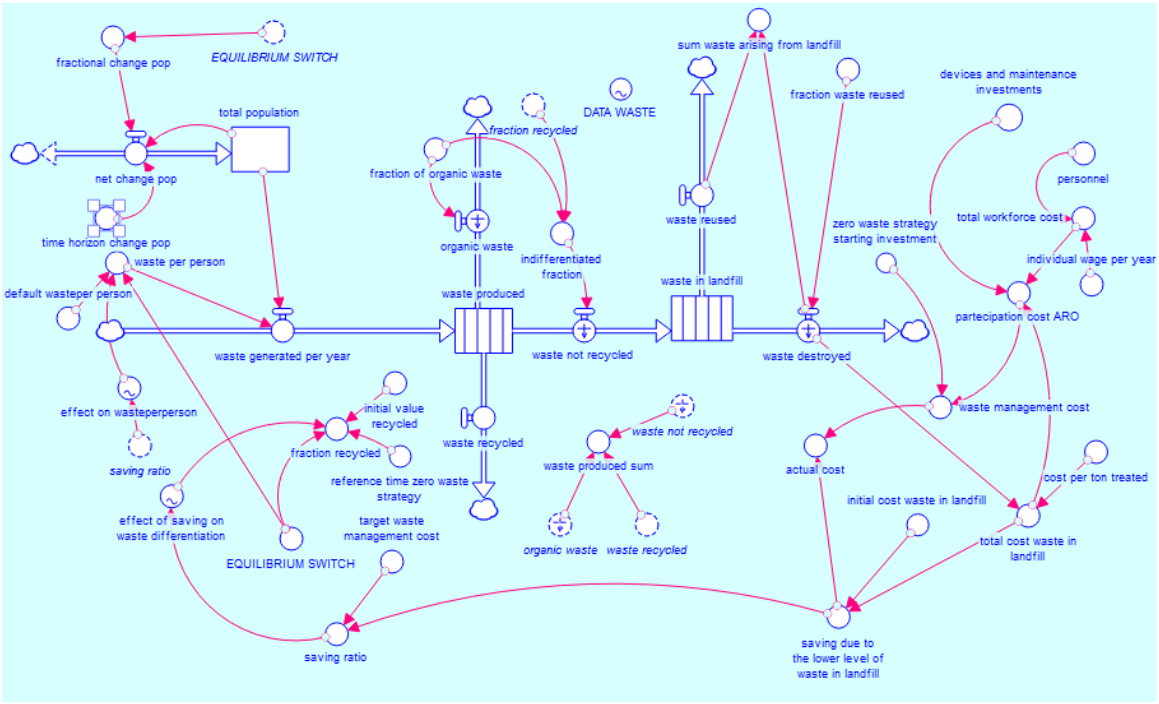
year	population
2011	2227
2012	2200
2013	2178

2014	2155
2015	2135

Source: Istat

To realize which causal loops are the most conducive to explain the dynamics underlying the implementation of such a policy, it is useful to take resort of the whole waste chain built up in the SD model[4]. Its development has been grounded in the idea of splitting up this chain in different steps just to figure out the destination of the waste produced each year.

Figure 5 SD model



In figure 5 it is possible to detect two key conveyor stocks that have been put in the foreground: on the one hand, waste produced that represents the amount of waste produced that is going to be subdivided, in accordance with its destination in three different outflows (organic waste, waste recycled, waste not recycled); on the other hand, waste in landfill expands upon one of the three possible destinations, and, in turn, is going to be depleted by two outflows, namely waste destroyed and waste reused which represent respectively the ultimate passage or a soft brake against the default scheme.

The conveyor stock waste in landfill accumulates the inflow waste not recycled, which comprises the amount of waste collected that has not been undergone by zero waste strategy. For this reason, leakage fraction referred to waste not recycled flowing out of the previous conveyor stock (waste produced) has been determined as completion of the sum of fraction recycled and

[4]The variable "Equilibrium Switch" warns that the model has been initialized in equilibrium.

fraction of organic waste, namely the leakage fractions respectively referred to the outflow waste recycled and organic waste (compost).

Waste not recycled passes through – in accordance with a First in First out scheme as a typical feature of the conveyor scheme (Ben Dor and Metcalf, 2005)– the stock to fuel the outflow waste destroyed. Leakage fraction referred to waste destroyed has been set as exponential just to sketch a nonlinear discharge. Transit time related to the conveyor stock waste in landfill embodies somehow the capacity constrain, since it takes time to treat waste not recycled and to destroy definitely what it has been not possible to recycle before.

Waste in landfill is depleted also by another outflow that takes into account one of the three pillars of the zero waste strategy, namely reuse. Reused waste comprises all that stuff like aluminum or steel that was not possible to recycle in the steps before. In this case the outflow waste reused is defined by selecting as leakage fraction of waste destroyed the completion of fraction waste reused. Therefore, waste reused has been represented by everything else is not going to flow out of the stock as waste destroyed. Positive correlation between the amount of waste in landfill and the amount of waste reused might be seen as a proof of the schedule, since what it has been impossible to recover in the steps before, it is going to be transferred to a provisional landfill just to undergo some interventions in order to refresh its usefulness.

On the other side of the waste chain, waste produced is boosted by an inflow that witnesses the role of population as the main responsible for waste production. Broadening the scope, waste produced is a conveyor stock depleted by three outflows. One is referred to the compost production loop; another one is referred to the recycling loop, while the last one is related to the transportation to the landfill.

Regarding compost, renowned as natural fertilizer locally used by farmers, it is useful to know that the corresponding outflow organic waste turns out to be related to fraction of organic waste, as leakage fraction. The latter has been kept constant (2,3% of total waste produced) during the period as well as the fraction of waste reused (3,6% of the amount of waste in landfill), because, by looking at the data gleaned from municipality, it has been seen a quasi-constant pattern of behavior. About reuse and recycled waste (which in turn comprises fractions of glass, paper and cartoon diverted from the transportation to the landfill), producers and users, joining CONAI system[5], are obliged to pay a contribution depending on the type of packaging waste brought out in the market(paper, plastic, cartoon, aluminum, steel or glass). CONAI withdraws a minimum fraction of this contribution for the fulfillment of its bureaucratic tasks, while the greater part of it is bound to be sent to the Consortia responsible for processing each type of packaging waste, in order to refresh their usefulness. These consortia, in turn, according to the ANCI[6]- CONAI framework agreement (Accordo quadro ANCI-CONAI), assign to municipalitiesa compensation to cover higher costs connected to the differentiated collection of waste. As said before, currently, municipality is contracting out waste management to a private company, but sooner, Palazzo Adriano together with the other municipalities, will manage this service by empowering a consortium of public services; so that, model has been completed by internalizing the ARO system.

[5]No-profit management system for packaging waste in Italy introduced by Legislative Decree no.22/97.
[6]Category association including all the municipalities in Italy.

Getting back to the end of the waste chain, amount of waste destroyed is bound to determine a total cost due to the treatment of waste in landfill required. This cost is equal to the tons of waste destroyed per year multiplied by the cost per ton treated. Precisely, it has been set equal to 102 euro per ton conferred, using an average value since cost per ton treated has been kept quasi stable over time. Consequently, the more waste municipality is carried to the landfill awaiting to be destroyed, the more cost it needs to bear. This cost determines participation cost ARO, together with devices and maintenance investments and workforce cost pertaining the employers appointed for waste collection within Consortium "Valle del Sosio ARO"[7]. Also, zero waste strategy starting investment represents a sort of sunk cost that municipality bore at the beginning just to let zero waste strategy program start out. Therefore, it is a sort of umbrella term including all the investments referred to public disclosure, building or purchase of treatment facilities and devices referred to this program (like the baskets related to each type of waste, to allow people to differentiate the waste). So, the whole waste management cost for municipality is equal to the cost of investments bore at the beginning just to make the program start out plus the participation cost ARO.

Every year municipality has gathered a saving due to the lower level of waste piled up in the landfill thanks to the implementation of this program, which is intended to hold the waste management cost down more and more. This value has been compared with the initial waste in landfill cost referred to 2011, namely the year before the start of the program. The underlying idea is that the less waste municipality is used to confer to the landfill the more saving respect to the year 2011 it is bound to get year by year and the lower taxes citizens are supposed to pay as a reflection of expenditures downsizing.

By comparing the saving achieved thanks to the implementation of a zero waste strategy with a target waste management system cost to be pursued during the mandate and defined as 25% less than the waste management cost referred to 2011 (almost 400,000 euro), it is possible to build up a ratio that symbolizes the attempt to get to the target as much as possible. *Sic stantibus rebus*, according to financial statements referred to 2015, waste management cost has diminished to 322,100 euro[8].Obviously once this virtuous cycle has started out, the more it lasts, the more difficult it will be to get a further improvement, both in terms of saving and increase of the fraction of waste recycled[9].

Saving ratio, in terms of policy, internalizes efforts of municipality to make citizens more and more aware of benefits emerging from such ongoing virtuous cycle, by periodically exposing – personally encountering citizens or resorting to social network – an in-depth analysis of the state of art. By way of example, two meetings have been mentioned: the meeting "zero"[10], where municipality for the first time explained the program with its ten steps to citizens on 10 July

[7] As said before, theoretically, they will be the same ones referred to the ATO PA2.

[8] Municipality of Palazzo Adriano, *"Financial statements of accounting period 2015*". Available on: http://www.comune.palazzoadriano.pa.it/it/DelibereConsiglio/2016/Luglio/CONTO%20DEL%20BILANCIO%202015%20-%20PARTE%20II%20SPESA.pdf [2017].

[9] This reasoning has been embodied in the decreasing decreasingly pattern of behavior of waste in landfill.

[10]Herewith the Decree through which zero waste strategy and the annexed door to door collection officially became compulsory. Municipality of Palazzo Adriano, *"Executive Decree n.3"*, 28 June of 2012. Available on: http://www.comune.palazzoadriano.pa.it [2017].

2012; the other one relating to the visit of Paul Connett, the guru of zero waste strategy in Palazzo Adriano on 26 September of 2012[11].

The above-mentioned ratio becomes the input of the graph function "effect of saving on waste differentiation" that embodies the idea that the more saving municipality gets the more citizens are inclined to recycle, looking at the benefits they might get thanks to recycling, This graph function, that is bound to spring up from 2012 in accordance with the beginning of the program, is going to influence the fraction recycled, since it is bound to be added to the initial value of fraction of waste recycled (referred to 2011), enhancing or diminishing it. Introducing the above mentioned graph function gives the possibility to show the first major causal loop (recycling loop) that may explain why there has been a decreasing pattern of behavior for the amount of waste discharged in the landfill.

Recycling loop is a reinforcing loop[12] which refers to the recovery of usefulness of the amount of waste that it has been already circulated.

Implementing such a program activates a key factor of a typical zero waste strategy, namely recycling, causing waste in landfill and waste destroyed to decrease; this means lower cost for municipality and conversely a higher level of saving respect to 2011. The more municipality is close to its target (25% less than the waste management cost referred to 2011), the more people feel themselves as encouraged to differentiate waste already brought out in the system as much as possible, causing waste piled up in the landfill to decrease further. Influence of saving process about boosting the differentiation of waste already circulated, might be seen as a remarkable impulse to make the three minor balancing loop[13] (composting, recycling, reuse[14]) persist over time (see figure 7).

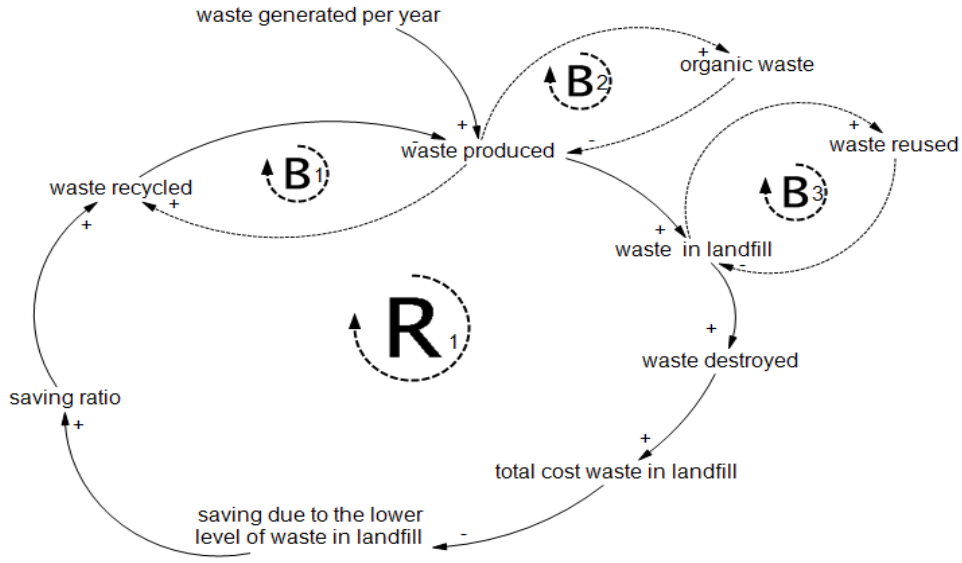
[11] Municipality of Palazzo Adriano, "*Press Review*", 2012. Available on: www.comune.palazzoadriano.pa.it/Rassegna Stampa [2017].

[12] Positive loop – as a result of the multiplication of all the polarity signs assigned to each causal relationship – is self-reinforcing (hence loop polarity identifier R). More deeply, the + signs at the arrowheads indicate that each effect is positively related to each cause, so that an increase in the cause allows the effect to rise above what it would have been (and vice-versa, a decrease in the first one causes the second one to fall below what it would have been).

[13] Negative loop, defined by an overall minus sign as a result of the multiplication of all the signs at the arrowheads, is balancing (hence loop polarity identifier B), so that it counteracts change. This means, for example, that the more waste produced the more organic waste it is possible to earn; but the more organic waste means the less waste produced ready to be sent to the landfill.

[14] Therefore, the more compost and the more recycling people are used to make, the less waste municipality is going to carry in the landfill, since citizens somehow succeed in retrieving the intrinsic value those products still embodied. The same is for waste reused, since the more waste they succeed in reusing the less waste piled up in the landfill is going to be destroyed.

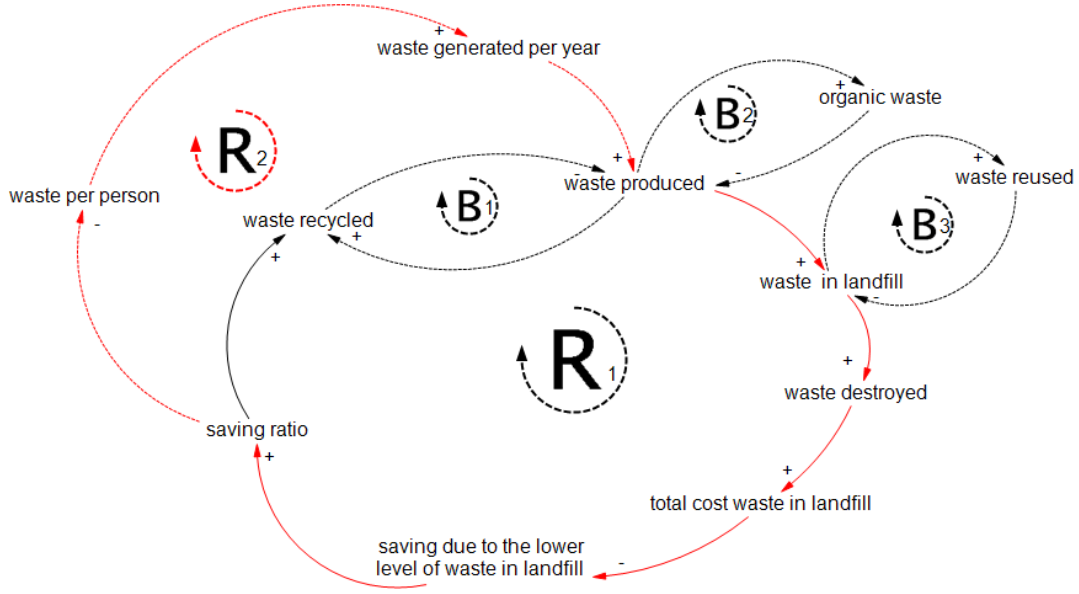
Figure 6 Recycling loop (R1)



Eventually, attitude of saving thanks to the development of such a policy over time is going to address also the habit of people to make waste at source, as witnessed by the graph function "effect on waste per person". More precisely, saving ratio acts also at the start of the waste management chain encouraging people to make waste as little as possible, whenever they see that their efforts are rewarded by a lower level of actual cost, namely taxes. Otherwise, if the level of saving were lower and lower, they would be less encouraged to produce less waste.

So, waste per person has been modeled as a default value – a sort of estimation of how much waste a person is used to make on average by looking at the official data gleaned thanks to the municipality – multiplied by the effect that saving ratio can exert on the habit of recycling of each person. This explanation brings forward the introduction of the second major causal loop (waste production loop) that, as well as the recycling loop, make the three balancing loops– designated to squeeze the amount of waste irreversibly conferred to landfill – strengthen over time (see fig.8).

Figure7 Waste production loop (R2)



Therefore, by diminishing the amount of waste per person, saving process is intended to decrease consequently the whole amount of waste produced each year.

Figure 8 Waste generated per year during the period 2011-2015

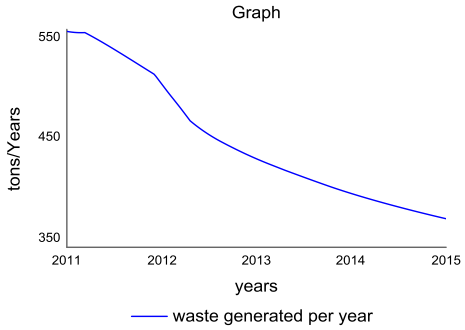
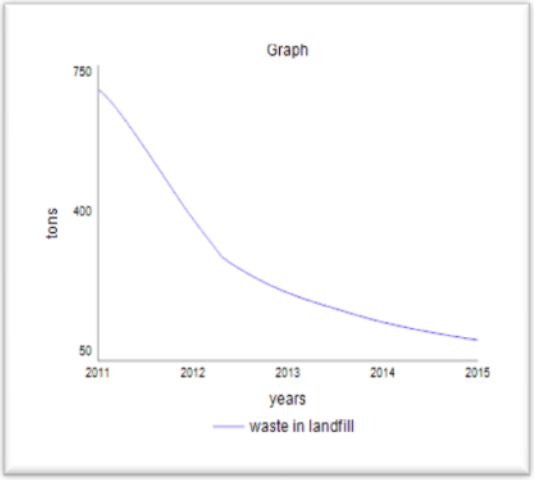


Figure 9 Behavior of waste piled up in landfill resulting from SD model.



4. CONCLUSIONS

Zero Waste Strategy has been a shift of paradigm that has required time to be understood and accepted by citizens. It might be seen as a double loop learning (Argyris and Schon, 1978) answer to the sustainability challenge, given that by implementing this strategy, municipality seems to be more willing to reveal an explicit mental model, to assess its consistency over time and to improve it (Forrester, 2009) by collecting all the weak signals of change arising from the outer systems. Recalling the democratic accountability paradigm (Behn, 2004), accountability process requires people to form expectations about performance; specifically, accountability process works letting citizens approach directly the end-results of their ongoing good practices. Actually, lower tax burden level has been crystallized as the reward of their effort to cause waste to decrease both at source and at the end of the waste chain depicted in the SD model.

That being said, given that the threshold of 65% of fraction of waste recycled might be considered as a national-regional diktat (art.205 Legislative Decree no.152/06 and art.9 Regional Law no.9/2010) framed within the boundaries of a preeminent European objective (Directive no. 98/2008), saving process might be seen as a facilitator, since its advertising allows to achieve this goal as soon as possible, encouraging people to still follow zero waste program.

The latter one has been becoming the input of a virtuous cycle fostered by saving process, witnessing that only higher levels of trust and good relationships with stakeholders and community may lead to a strategic approach to austerity management (Cepiku et al., 2015). Anyway, there is still room for fine tuning maneuvers, like reverse logistics initiatives (Govindan et al., 2015). These initiatives might engage community more and also they might fuel industrial responsibility, since on the one hand firms would be forced to think further about a sustainable production; on the other hand consumers will be more and more sensitive to the environmental care. In this perspective, consortium like "Valle del Sosio ARO" might be seen as a crucial bridge between community and industrial responsibility thanks to a door to door collection inspired by recycling criteria. It is important not to frustrate citizens commitment at source (by making waste as little as possible) and at the end (by differentiating waste as much as possible) avoiding to compact again waste and to send it indistinctly to landfill.

ARO together with consortia delegated for processing each type of packaging waste, might constitute the idealistic bond to let the two zero waste strategy feeders (engaging community and industrial responsibility) match. Specifically, ARO, as a form of inter-institutional cooperation, might increase further the yield of waste reduction policies implemented in each participating municipality, by exploiting scale economies and minimizing transactions costs; at that point citizens might become more aware of benefits arising from their ongoing good practices, stabilizing further a self-organizing network (Rhodes,1996; Meneguzzo, 2005). Within this frame, treatments carried out by consortia will enable industries to exploit the materials again capitalizing the citizen commitment.

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