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Measuring the level of Environmental Performance in Insular Areas, through Key Performed Indicators, in the Framework of Waste Strategy Development.

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Abstract

To measure "*something that is not there"*, is not easy and at the same time not fully understandable and perceived by the citizens. Several elements (such as, waste production, waste management cost, social attitude and behaviour, etc.) interrupt and disturb any strategy in the framework of waste management. Additionally, through the European Green Deal (EGD), Europe is trying to achieve climate neutrality by 2050, taking into account the Circular Economy Strategy (CES) and the United Nations Sustainable Development Goals (UNSDGs). A Driving Force-Pressure-State-Impact-Response (DPSIR) breakdown was applied, to establish and organize key information's on the environmental performance (E.P) taking into consideration the existing pollution, reviewing the contemporary knowledge and existing implemented waste strategies on the driving forces, pressures, states and impacts. This paper includes several key performed indicators (KPIs), in order to evaluate the E.P of an area, through hybrid approach which cover among others, the waste compositional analysis, SWOT and PESTEL analysis, waste recycling and waste accumulation index, prevention activities, awareness activities etc. The results indicate that, the selected areas implement periodic measures, but they need to put more effort to boost their citizens to participate in any proposed waste strategy. Furthermore, the results are very valuable and helpful to policy makers, consultants, scientists, competent authorities, stakeholders etc., in order to design and promote synergies and activities (mainly in Local Authorities), to reach the proposed figures that EGD, proposed in relation with the CES as well as with the SDGs.

Key Words: circular economy, European Green Deal, waste strategy development, area metabolism, SWOT analysis, PESTEL analysis.

1. Introduction

According to several researchers (EllenMacArthurFoundation.org; Romere and Rossi 2017; Symeonides et al. 2019, Marrucci et al. 2019; Daddi et al. 2019; Zorpas, 2020) CES is consider mainly, as an industrial economy that indorses superior resource productivity, targeting to reduce waste and avoid pollution by design or to purpose new products. According to Ellen MacArthur Foundation, CES contain two categories: (i) the biological nutrients, designed to re-

enter the biosphere safely, and (ii) the technical nutrients, which are designed to circulate at high quality in the production system without entering the biosphere, as well as being restorative and regenerative by design. CES vision as indicated from Loizia et al. (2018a), Daddi et al. (2019) and Zorpas (2020) aim to increase the attention in Europe and around the world as a possible way, for our humanity to increase prosperity, while reducing dependence on primary materials (natural resources, fossil fuels) and energy. On the other hand, the EGD has a vibrant but not ambitious vision: to achieve climate neutrality by 2050 in the entire EU (Zorpas, 2020) through the adoption of the the 17th SDGs by 2030. Typically, those targets will be voted before the end of 2020 or beginning of 2021.

Comparing CES and EGD priorities, it can be said that CES emphasis to boost recycling of many material targeting at the beginning the critical mineral (rear earth element, Pt group etc), which are extremely crucial and important, for many innovative technologies and products such as robotics, smart equipment's, applicable in aviation industry and automotive industry and many other applications. Additionally, a target related with the recycling index of many materials i.e to reach 65% by 2035 and a particular indicator for packaging materials (PMD) to be recycled up to 70% before the end of 2030; separated recycling index for Al (60%), wood (30%), glass (75%), plastic (55%), ferrous metals (80%), papers and cardboard (85%) and furthermore a very strictly target related with landfilling are also being included in CES. Correspondingly, there is a clear target, to decrease landfilling to maximum 10% of municipal solid waste (MSW) by 2035. Shorting at source, as well as, prevention activities are very crucial for the success implementation of any waste strategy (Sharp et al. 2010a; Lasaridi et al. 2016). Emphasised is given to the bio-sector as bioeconomy encompasses the production of renewable biological resources and their conversion into food, feed, bio-based products and bioenergy through innovative and efficient technologies. At the same time, EGD priorities, include among others (a) a 90% reduction in transport emissions (b) GHGs reductions target for 2030 to at least 50% and towards 55% compared with 1990 levels (c) by 2030 to be achieved zero carbon in steel making process (d) promoting the circular bioeconomy (without limitation and a regulatory framework will be developed for biodegradable and bio-based plastics, and single use plastics measures will be applied), as well as, will support research and innovation on clean energy as well as, on the building environment (European Commission 2019; Zorpas 2020).

U.N Countries during 2015, adopted the 2030 Agenda for Sustainable development, encompassing of 17th SDGs and 169 targets, which can be monitored from 230 individual qualitative and quantitative indicators (Fuldauer et al, 2019, Vanham et al. 2019; Priyadarshini and Abhilash, 2020). Fuldauer et al, (2019) point out that, concerning the strategic planning of waste management for sustainable development, is an outstanding trial, predominantly for Insular Communities (Zorpas et al. 2013a; Zorpas et al. 2017a; Loizia et al. 2018b). It is more than truth that, nowadays, according to Agamuthu and Herat (2014), Dornan (2014), Zorpas et al. (2015a; 2017a), Fuldauer et al, (2019), Loizia et al. (2018a), Loizia et al. 2019, Vardopoulos et al, (2020), any infrastructure expansion in Insular Communities has unsuccessful to yield Sustainable development objectives and targets. It is also well known, according to Priyadarshini and Abhilash (2020) and Zorpas (2020), that, SDGs can provide a pathway, to world economies and sustainable development for harmonization with the encompasses of a number of measurable targets and goals, linked indirectly or directly with the principles and philosophy of CES. A well know and demanding goal is SDG-12, related with sustainable consumption and production. In particular SDG-12, its associated and related to the importance of productivity and efficiency in resource management, minimization in food losses (covering all the production steps, inclining the agri-sector and the trade market), as well as, generation

of waste reduction, through reuse and recycling as well as, to measure the progress of any implemented waste strategy (UN, nd; Vanham et al. 2019).
As mentioned from Zorpas (2020), in the outline of the development of any waste strategy, these can be clarified as a set of practices, process and activities that "*can reduce the impact of several processes on the environment through products and corporate policies such as (a) reducing of energy, (b) waste management and treatment (c) water consumption (including water footprint), (d) environmental footprint, and (e) changing the social attitude and behaviour, using green applicable sustainable resources and environmental management systems (such as ISO 14001, EMAS, Ecolabel etc) implementation and number of activities (related with prevention, reduced, reused, refurbished, remanufactured etc), measuring at the same time the impact on the society*". Reliable and moreover consistent data, concerning waste generation in any area taking into account population density, daily routines, existing waste strategies, incomes, infrastructures, policies, stakeholders etc., are based on evidences which can be only provided through detailed waste compositional analysis as well as micro compositional analysis (Messineo and Panno, 2008; Zorpas et al. 2013b, 2015b). According to Rong et al. (2017), and Baawain, et al. (2017), the characteristics and production of waste provide details to policy makers, how they will monitor, assess and re-scheduled their waste strategies in order to boost, through advertising (Wang et al. 2018a; Somplak et al. 2019; Yoo et al. 2019) and awareness activities (i.e prevention activities such as smart shopping list, food waste reduction, changing of books or clothes, used of refiling shopping bag, used of refiling coffee cup etc), as well as, motivation measures (i.e less waste taxes, free parking tickets, , tickets for theatre, discount vouchers etc.) to participate, in their waste management strategy (Zorpas et al. 2018; Zorpas 2020).

Indicators, in general, are mostly computational sets, seeking at simplifying, quantifying and transmitting assured and more solid evidences and/or information contributing towards identifying information, that are not simply observable (Gamberini et al. 2013; Vardopoulos, 2017, 2018; Vardopoulos et al. 2018, 2020). Additionally, are valuable tools to assess, determine and measure the progress and the improvement made in achieving a specific goal. Sustainability indicators are established to assess the E.P of actions and/or procedures and/or activities implemented in an area or by any organization (Mori and Christodoulou 2012; Ravets et al. 2018). While most of them, are used at national inventories (such as national greenhouse gas - GHGs emissions, gross domestic products-GDP, etc), there is a huge interest from corporations for the calculation and reporting of their E.P (Bossel, 1999; Vardopoulos et al. 2020). An environmental (which is a part of the sustainability) indicators structure, set up the framework for monitoring, observing and recording the environmental conditions, while at the same time, pays towards the compensation of established needs and requirements for assessing and comparing the situation of an area to another. Additionally, it pursues to support competent authorities in decision making process and developing action plans (Victor 1991; Inglezakis and Zorpas 2014; Zorpas et al. 2014a; Zorpas et al. 2017a).

Among the most applicable and suitable, as well as, well-known KPIs to assess the level of E.P (Sharp et al. 2010a; Sharp et al. 2010b; Mori and Christodoudou, 2012; Zorpas et al. 2015; Bartzas and Komnitsas, 2017; Kazuva et al. 2018; Fernandez-Aracil et. al. 2018; Fuldauer et al, 2019; Vanham et al. 2019; Tsangas et al. 2019; Urban Wins, 2019; Vardopoulos et al. 2020; Miranda et al. 2020; Zorpas 2020; Tsangas et al. 2020; Priyadarshini and Abhilash, 2020) are the: Life Cycle analysis (LCA), DPSIR), Municipal Solid Waste Production (MSW-P), Waste Composition (MSW-C), Municipal Solid Waste Recycling (MSW-R), the Increasing Waste Production Rate (IWPR); Waste Recovery Rate (WRR), Recycle Bins per Population (R.B.P), Total waste management cost per house (TWMC), the Clean Index (CI), Accumulation Rate

(AR) and waste Accumulation Index (AI), the Waste Generation Rate (WGR), the implemented Prevention Activities (IPA) including the awareness activities, SWOT and PESTEL analysis.

MCW-C, is a technique used to evaluate, in detail the nature, scale and origin of all kind of waste, while at the same time, can be compline with survey on household attitudes, (WRAP, 2008; Gomez et al. 2009; Zorpas et al. 2015b; Baawain et al. 2017; Tofalli et al. 2018). Additionally, can be applied to measure, if the proposed strategy (i.e prevention strategy) is appropriate and efficiently and at the same time, to provide information at the local level, to plan, organize, develop, implement, monitor and observe waste management schemes that will facilitate them to meet their contribution to the National targets (Voukkali et al. 2019), where those are applicable.

DPSIR as a dynamic concept, according to Kazuva et al. (2018), is a tool that can be used to evaluate the environmental risk, and furthermore, to evaluate the features that subsidize to the E.P which proposed from UNSDGs and European Union on 1990 (Hambling et al. 2011; Kaur et al. 2020) including the targets set by CES and EGD (Zorpas, 2020). Although the DPSIR framework has been broadly used to analyze different environmental problems, (Jacob and Volkery 2004; Jagoon et al. 2009; Song and Frostel, 2012; Wang et al. 2018b; Miranda et al. 2020; Kaur et al. 2020), to the best of our knowledge there are limited studies focus on the evaluation of E.P in a specific area (Vardopoulos et. al., 2020). The application of the DPSIR model involves, information gathering to formulate indicators that can reflect the causal relationships between human activities, environmental consequences and responses to environmental modifications and changes. Common indicators for driving forces include economic, social and demographic changes in societies such as changes in production and consumption patterns and people's lifestyles (Jagoon et al. 2009). In the nutshell, DPSIR (Lewison et al. 2016; Kaur et al. 2020) is considered as a powerful tool, to address the consequences, the influences and the effects of several human activities and corresponding planning and policies for responses.

The paper is dealing with the application of hybrid approached through DPSIR, AHP, SWOT-PESTEL Analysis as well as on the application of several KPIs to assess the level of Environmental Performance in one area takin into account existing implemented strategies such as prevention, recycling, re used in insular communities etc. The outcomes are very imperative and helpful to policy makers especially in local level i.e Municipalities,, as well as in centralized level (ompetent authorities), consultants, scientist, stakeholders etc., in order to re-design and re-promote synergies and activities to reach the proposed targets that EGD proposed in relation with the CES and the UN-SDGs.

2. Material and Methods

An ambitious target needs significant effort either from politician and political parties, and either from local communities and citizens. The European Commission has adopted an ambitious new Circular Economy Package (CEP) to help European businesses and consumers to make the transition, to a stronger and more circular economy where resources are used, in a more sustainable way. Remain unclear, due to several reasons (such as limited available space, cost of living, seasonality, level of incomes, level of infrastructures, political decisions, other priorities, lack of waste strategy, lack of awareness activities etc.) how insular communities and/or small Municipalities can follow the proposed targets, in order to adopt to the concept of the EGD, CES and any of the SDGs in the nearest future.

2.1 Area Description

To assess the level of E.P. three selected areas were chosen from Cyprus. The main selected criteria were (i) the size of the Municipalities (less than 5000, between 35000-45000 and more than 60000 citizens), (ii) the activity of the Municipalities (tourist areas, agricultural areas, city activities), (iii) at least to implement recycling, (iv) to participate in EU projects related with waste management and/or other environmental projects.

2.1.1 Municipality of Paralimni (MoP)

Municipality of Paralimni is locked on the Eastern Region of Cyprus (Map 1) and according to the last inventory survey, which was carried out by the Cyprus Statistical Services on November 2011 the permanent living population, was 40000. However, as the Municipality consists, the main economical lungs of the island, because in this area there are the largest hotel resorts the living population rises up to 75000 (during the tourist period, which starts on April, and end on October). There are no any major waste consuming industries in the project area, and according to the available development plants the situation will remain the same in the future (Cyprus Statistics, 2011).

2.1.2 Municipality of Sotira (MoS)

Municipality of Sotira is also located in the Eastern Region of Cyprus and is approximately 3 Km from MoP, and has permanent population up to 5474 citizens (Cyprus Statistics, 2011). The area is characterised as Agricultural with the main product to be the potatoes and kolokasi which is protected product. In the entire area exist a small industrial zone which includes furniture's production, distribution of chemical clean products and trade mark.

2.1.3 Municipality of Larnaka (MoL)

Municipality of Larnaka is located in the South-East region of Cyprus with a permanent population of 51274 habitants and with equivalent population to be up to 115000 habitants. In the city of Larnaka exist hospitality industry, industrial zone, port and marina, more than 2000 restaurants, bars and, the main International Airport of the Country, STP, renewable energy parks, and several other services (Cyprus Statistics, 2011).

2.1.4 Waste Compositional Analysis

The waste compositional analysis has been done for all the examined areas with the same way, followed the approached that proposed by Zorpas et al. (2015b) and the methodology that is described with in the International standard EN 14899:2005 and ASTM D5231-92/2003 "*Standard test for determination of the composition of unprocessed solid waste*" by simulating the uniform of random sampling model. The methodology can be used to define and report the composition of MSW, through the selection and manual sorting of waste samples.

The wastes were collected from each area door to door for consistency. The total sampling lasted for 12 months as follow: 1st week sampling from MoP with daily analysis, 2nd week sampling from MoS with daily analysis, 3rd week sampling from MoL with daily analysis, 4th week brake. Then the analysis were continued taking into account the same rotation for the next 52 weeks. Each plastic bag was weight and then analysed immediately in 12 main categories: PMD (PMD includes all the packaging materials made from plastic, tetra pack, metal that are being used for recycling purposes in order to be able to reproduced new packaging items for, plastic bags, hazardous products etc), plastic film, plastics non-recyclable, aluminium packages, papers, glass, toilet papers (due to the fact that according to existing sewage treatment plants -

STP - is accepted to disposed of into sewer), edible food waste (EDF), inedible food waste (IFW), products that can be easily forward for home composting (i.e green waste) and others. (It is important to mention that, after the analysis the waste were collected again and disposed of, according to the policy of each Municipality for further treatment).

The equipment that were used includes fibber container adequate for storing and weighting each waste element, labelled accordingly, as well as, for traceability photos were taken. For waste categories which they had a considerable moisture content (such as EFW and IFW), were used plastic containers to avoid absorption of moisture. An electronic weigh calibrated scale was used, with a capacity of at least 100±0.025 kg. Additionally, several personal protected equipment was used such as safety glasses, elastic cloves one used, hard-had, first aid kit, uniform and leather protected boots.

2.2 KPIs to assess the level of Environmental Performance

The DPSIR (Fernandez-Aracil et. Al. 2018; Kazuva et al. 2018; Miranda et al. 2020) as presented in Fig. 1 describe, the breakdown that have been done, which and can be also used as a supporting approach to the discussion. The concept is based on the comparative actions taken, in order to evaluate the negative consequences arising from human activity, and is associated with the quantitative results of the MSW management procedures. Moreover, in order to highlight the most important aspects of sustainability, methodologically, an indicators system is proposed and applied. In general, DPSIR framework, analysis states that economic and social development, which are common Driving forces (**Df**) use Pressure (**P**) on the environment, and as a result, the State (**S**) of the environment changes, such as reduction of natural resources, decrease in biodiversity and deprivation of environmental quality. The changes, have Impacts (**I**) on the ecosystems, human health and other materials. Due to these impacts, society Responds (**R**) to the driving forces, or directly to the pressure, state or impacts through preventive, adaptive or curative solutions.

i. **Driving forces (Df)**: All kind of wastes will continue to increase without any doubt according to Inglezakis et al. 2012; Zorpas et al. 2012; Khan et al. 2016; Voukkali et al. 2017; Zorpas et al. 2017b; Economist, 2018; World Bank, 2018; Zorpas et al. 2018, Ttofalli et al. 2018; Eurostat, 2019. It is estimated that household and tourist activities will remain the main polluter worldwide (Zorpas et al. 2014b). At the same time according to Vardopoulos et al. (2020) social and economic development is considered the major source of pressure on the environment.

ii. **Pressure (P):** The quantity of MSW taking into consideration the rapid growth of population worldwide will continue to increase. According to WR0112, 2007; WARP, 2008; FAO, 2011; Zorpas et al. 2017c; Loizia et al. 2018a; Loizia et al. 2019, there are several clarifications why waste are being produced with the most important to be the (a) absence of awareness, educational and advertising activities; (b) the limited life of product; (c) consumer habits; (d) urbanization and level of incomes against the waste production (e) political issues etc., . At the same time waste (which before were products) consume natural resources, producing, during the production line (of the products) and during their end of life significant amount of GHGs emission (FAO, 2011), creating pollution also in coastal areas, underground and surface waters, as well as, on biodiversity (Inglezakis and Zorpas, 2012; Inglezakis et al. 2012; Symeonides et al. 2019). The existing applied strategy (which include door to door collection and some recycling) may be affected. Typically, in insular communities with limited available space the mots favour option (cheaper one) for the

298 waste management remains landfilling. However, according to Mazzanti and Zoboli,
299 (2008), there are differences in how dependent areas are on landfilling.
300 iii. **State (S):** The state of an infrastructure (Zorpas et al. 2015b; Kaur et al. 2020) typically
301 expresses the condition of an asset and service states to the Level of Service (LOS), with
302 respect to its capacity, functionality, physical condition, attractiveness, and ability to meet
303 the demand of given population. Zorpas et al. (2015b) and Zorpas et al. (2018) indicate
304 that, in most of the insular communities the MSW are being collected twice a week and
305 more often in the coastal areas (Voukkali et al. 2019). As a result of the LOS and waste
306 Accumulation Index (A.I) in relation with the Clean Index (C.I) can provide useful
307 information about the LOS in local level, in order to reschedule the whole implemented
308 strategy, including awareness activities and campaigns.
309 iv. **Impact (I):** In many areas, urban and peri urban, small Municipalities even though in Cities
310 and Megacities are facing noteworthy issues with the production of waste. According to
311 the World Bank Report (2018) the per capital waste production will increase in the nearest
312 future and will be varies from 0.77 kg/d (South Asia Region) to almost 2.1 kg/d (for EU
313 and North America). In small Island, such as Cyprus the waste production is closed to 420-
314 650 kg/citizen (Zorpas et al. 2015b; Zorpas 2020). Most of the competent authorities
315 (especial in insular communities) are desperate due to the fact, that, cannot implement
316 successfully any waste management strategy, while at the same time most of their citizens
317 are complained, because they don't have sufficient infrastructures to cover their needs (i.e
318 they don't find recycling bins, or the community is not participate in preventing activities
319 etc.) (Zorpas et al. 2016). Unsuccessfully waste management option, has direct affect in
320 society, economy and environment. For example, the presence of micropollutants, such as
321 microplastics in coastal areas, affect the tourist activities as well as the food chain
322 (Voukkali et al. 2019; Runko Luttenberger, 2020). Additionally, for several materials in
323 the household and business waste streams such as PMD, papers etc, the release of GHGs
324 emission from illegal waste burning, even though from waste incineration plans, for energy
325 recovery, is consider as more environmentally damaging than storing their carbon in
326 modern landfill (Kaur et al. 2020).
327 v. **Response (R):** In urban areas, municipalities are struggled to provide adequate waste
328 services. The main reason, is the limited available social and economic resources (Zorpas
329 et al. 2017c) and the absence of political visions and specific waste strategy (Zorpas, 2020).
330 Most of the Local Authorities face financial problems, due to the high gate fees from the
331 Mechanical Biological Treatment (MBT) facilities (Zorpas et al. 2015b). According to
332 Kaur et al. (2020) cities and local authorities (Zorpas et al. 2015a) are challenged by
333 providing these services mainly due to drivers and related pressures on waste management
334 infrastructures, which effects on the LOS. To train these competent authorities, are
335 mandatory to set specific (preferable quantitative than qualitative) target which must be in
336 line with SDGs, CES as well as GDS. Those targets may include waste reduction, waste
337 recycling index, prevention activities, educational material, cost-effective investments,
338 long-term integrated planning for waste strategy plan, financial and asset management
339 planning, motivation and/or regulatory relief measures (Loizia et al. 2018b), as well as, to
340 compliance with regulatory requirements, and moreover to consider a range of
341 infrastructure alternatives. Al the above can be achieved through best management
342 practices (i.e., Responses). It is expected that, some of those responses, could face doubt
343 and uncertainty, while assembling future policies.For instance, development of prevention
344 strategy, which mainly depends from social attitude and social behavior (Tonglet et al.
345 2004; Bars, 2007; WR0112, 2007; Sharp et al. 2010a; Abeliotis et al. 2015).
346
347 **[Figure 1]**

The proposed KPIs that have been used (Loizia et al. 2018a; Urban Wins, 2019; Vardopoulos et al. 2020; Zorpas 2020; Runko Luttenberger, 2020) to assess the level of E.P were:

2.2.1 MSW-C: The indicator (Poulios and Papachristou 2005; Zorpas et al. 2015a; Loizia et al. 2018a; Vardopoulos et al. 2020; Runko Luttenberger, 2020) provides details related to the several wastes streams, that are produced in a specific period. The indicator (Eq. 1), provides information at local level to plan, organize, develop, implement and observe waste management schemes.

$$\boldsymbol{MSW - C} = \frac{Q_{Known\ MSW}t}{Q_{Total\ MSW}t} \quad (1)$$

2.2.2 MSW-P: The indicator (Vardopoulos et al. 2020) represent the ratio of the amount of MSW produced to the population at a given time. This indicator (Eq. 2) delivers a ration of the average waste quantity,

$$\boldsymbol{MSW - P} = \frac{Q_{Total\ MSW}t}{Q_{POP}\ t} \quad (2)$$

2.2.3 MSW-R: The indicator (Eq. 3), measures the recycled MSW compared with the total amount of MSW formed at a given time (Vardopoulos et al. 2020; Runko Luttenberger, 2020).

$$\boldsymbol{MSW - R} = \frac{Q_{Recycled\ MSW}t}{Q_{Total\ MSW}t} \quad (3)$$

2.2.4 C.I is estimated using Eq 4 (Zorpas, 2020).

$$\mathbf{C.I} = \frac{NIcol}{Sur}\ \mathrm{K} \quad (4)$$

Where, NIcol is the number of the items collected (i.e cigarettes buts, PMD, papers, other plastics, etc) from a specific area; *Sur.*: is the surface in m^2 of the specific selected area, while K is a constant that equals to 20. Table 1 is been used to categorize the level of the area.

[Table 1]

2.2.5 A.R and A.I is determined (Zorpas, 2020) using the Eq. 5 and Eq. 6 respectively and using the scale of Table 2, the selected area can be characterized.

$$\boldsymbol{A.R} = NIcol\ /\ S\ /\ T \quad (5)$$

$$\boldsymbol{A.I} = \log10\ (AR \times 1000000) \quad (6)$$

A.R is used to evaluate the accumulation of waste litter of a given item per unit of surface and per unit of time rate (items/m^2/day) (T is the time elapsed between the survey and the last cleaning activity in days). A.I takes into account the accumulation rates of the waste litter.

[Table 2]

C.I is being used to assess how clean is the area, which typically means that using this indicator we also assess the infrastructure of the area i.e waste collection period, cleaning department of the Municipality etc. (Voukkali et al. 2019). Hence using A.R and A.I index, we can evaluate the accumulation of waste litter of a given item per unit of surface and per unit of time rate i.e items/m^2/day.

2.2.6 WGR, WRR, IWPR: WGR index is estimated through Eq. 7 (Zorpas, 2020; Runko Luttenberger, 2020). MSW-C and MSW-R can be estimated throu WRR (waste recovery rate) index (Eq. 8) (Urban Wins, 2019).

WGR = (Waste Production in one area in kg) x Citizens (in the same area in one d) (7)

$$\boldsymbol{WRR} = \frac{Recoverd\ Waste}{MSW-P} \quad (8)$$

$$\mathbf{IWPR} = \frac{Qtotal\ waste\ production\ next\ year,t}{Qtotal\ waste\ production\ previous\ year,t} \quad (9)$$

WRR expresses the share of generated waste that is recovered in a specific period (i.e 1 month, 1-year etc). Waste recovery comprises recycling and other recovery options (i.e., waste reused, waste refurbish, waste to energy etc). This indicator includes (i) any recovery options (i.e. recycling, waste-to-energy, prevention etc); (ii) waste generation per sectors/sources (i.e households, trade, business etc.); (iii) significant waste streams such as plastic, paper, metal, glass etc.

2.2.7 Recycle Bins per Population (R.B.P)

The indicator (Eq. 10) estimates the number of recycle bins per population density. It is a very crucial indicator (Zorpas et al. 2015a; Zorpas et al. 2015b) as provide useful information to the policy makers, about the density of the population that can be served from the existing infrastructure.

$$\mathbf{R.B.P} = \frac{Number\ of\ Recycle\ Bins}{Population\ Density} \quad (10)$$

2.2.8 Total waste management cost per house (TWMC)

The TWMC per house can be expressed from the Eq. 11

$$\boldsymbol{TWMC_{per\ house}} = \frac{Total\ Gate\ Fee\ cost\ per\ year + \sum_{i=1}^{\infty} waste\ cost\ collection}{Number\ of\ houses} \quad (11)$$

Where, $\sum_{i=1}^{\infty} \boldsymbol{waste\ cost\ collection}$, include all the relevant cost of the cleaning department (or the waste collection department of each authority), such as, personnel cost working in the department, social insurances, maintenance and technical specification cost of the vehicles, vehicles insurances as well as other insurances related with the waste department, fuels, electricity amount related with the cleaning department, assets, etc (Zorpas et al. 2015a).

2.2.9 IPA: The indicator provides useful information in a specific area related with the awareness activities that are provided to the citizens in a specific time.

The awareness activities may include selected groups to assess any prevention activities i.e food waste reduction or participation in home composting, participation in web-platforms related with waste management in household level etc.

The area to be evaluated needs to subsidise to meet the targets set from the existing management strategy by e.g. preventing, reducing, reusing and recycling of waste, or by sorting packaging wastes, hazardous waste and food waste, biodegradable waste, participation in waste prevention

campaign etc (Cox et al. 2010; Sharp et al. 2010a; Sharp et al. 2010b; Zorpas et al. 2018; Marrucci et al. 2020).

2.2.10 Multicriteria analysis model - Analytic Hierarchy Process (AHP)

AHP analysis according to Zorpas and Saranti (2016) and Zorpas (2020), is based on the following philosophy: (i) breaking the problem into sub-categories (ii) for any proposed scenarios and or solution a pair wise assessment of the proposed criteria is been used and (iii) the preferences composition. The method is completed through specific steps which comprises: (a) the disunion of any issue in sub categories and the creation of an hierarchical structure, (b) the pair wise evaluation of decision elements used to derive normalized absolute scales of numbers, whose essentials are then used as significances, (c) significances are been set up, (d) the configuration of partialities are regulated in order to face out the specific issue.

The AHP is based on the following's steps:

Step 1: Specified i = 1,..., m objectives, determine their respective weights wi;
Step 2: For each objective i, link the j = 1,..., n alternatives and determine their weights W_i with respect to objective i; and
Step 3: Regulate the final (global) alternative weights (priorities) Wj with respect to all the objectives by $W_j = W_{1j}W_1 + W_{2j}W_2 + \ldots\ldots + W_{mj}W_m$. The alternatives are then descripted by the W_j, with the most preferred alternative having the largest W_j.

Moreover, to endorse consistency in the pair wise comparisons, during AHP analysis, the intention of the consistency ratio (CR) is necessary to take place, in order to assess any discrepancies in matrices of pair wise comparisons that should lead the decision makers to revise their initial estimates. Any pair wise comparison matrix is considered to be consistent and acceptable if CR is less than 10% (Ozdemir, 2005). In addition to that, a sensitivity analysis on the AHP weights is extended to demonstrate the impact of varying weights to the final outcome (Georgiou et al. 2012). The sensitive analysis were calculate using the makeitrational software Zorpas and Saranti (2016).

2.2.11 SWOT – PESTEL analysis

SWOT (Strengths -**S**, Weaknesses-**W**, Opportunities-**O** and Threats-**T**) according to many researchers (Fertel et al. 2013; Islam and Mamum, 2017, Symeonides et al. 2019; Tsangas et al. 2019) is a tool to be used for strategic assessment and has the ability to combine internal (**S** and **W**) as well as external (**O** and **T**) features of any organization (from public to private sector). The process is very operative and helpful, able to support policymakers in all levels. SWOT has also been used in combination with PESTLE (or PESTEL i.e. Political, Economic, Social, Technical, Environmental, Legal) analysis, to evaluate the potentials and the trials of implementing renewable energy (Islam and Mamun, 2017) as well as to assess the level of an existing tires waste management system in insular communities (Symeonides et al. 2019) and to evaluate the strategy of the exploitation of natural resources (Tangs et al. 2018). Additional, Fons et al. (2011) applied SWOT analysis for the assessment of the Sustainable Tourism Development in Spain, whereas Srdjevic et al. (2012) used PESTEL and SWOT, to notice which were the internal and external aspects that affect the water supply in Servia. PESTEL is been used also to evaluate, the effect of external aspects on a waste strategy (Zorpas 2020) or the situations on a project (Srdjevic, et.al., 2012).

The method (Figure 2a) used in this research was descripted from Tsangas et al. (2019) and Symeonides et al. (2019) to classify internal aspects **S** and **W**, as well as external aspects **O** and **T**. For any individual pillar of PESTEL (P-E-S-T-L- and E) we have recognized **S** and **W** of the internal environment as well as **O** and **T** for the external environment in order to acknowledge which of the proposed strategy (Figure 2b) must be followed.

[Figure 2]

During the 1st phase are being examined **S** and **W** of the internal environment while at the 2nd phase the **O** and **T** of the external environment are followed. The classification of the "positive" or "negative" aspects of the internal and external environment is based on the PESTLE. The process of encoding the PESTLE (Pol, Eco, Soc, Tec, Leg & Env), the external (ext) advantages and opportunities (+) and the internal (int), weaknesses and threats (-) and the significance coefficient (1 to 5) is analyzed in Table 3.

[Table 3]

The 3rd phase is the processing of coupling the main results and present them in a SWOT matrix (Figure 2b). The matrix is considering a vital tool of the SWOT analysis, in order to apply a decision-making option; which strategy must be followed. The Development Strategy is chosen when "**O-S**" overcomes, which means that **O** are too many while at the same time the organization has the potentials and the resources to exploit more. On the other hand, when "**W-T**" overcomes, means that the organization, does not have resources to overcome the **T**. Additionally, when the "**T-S**" appears is indicated that the organization face many external **T,** but at the same time has the capacities and the resources to address them. Finally, when the "**O-S**" exist the organization has several **O**, but at the same time there are several **W** and is not in a condition to face and exploit them. The sensitive analysis was then developed, using the maketirational (Zorpas and Saranti et al. 2016) software in order to be able to assess the chosen strategy.

3. Results and Discussions

The total quantity of MSW-P of MoP is continual increasing from year to year (Fig. 3) while for MoS and MoL remain constant. The differences, are due to the fact that, MoP present strong seasonality because of the hospitality industry (begging of April to the end of October). In the entire area of MoS there is almost zero tourist activity, as there is no any hotel or other major tourist movement (it is planned to open 2 hotels somewhere between 2021 and 2023) and in MoL the tourist activity compared with MoP is less (but does not present strong seasonality). As MoP can accommodate more than 20% of the total tourist, visiting the Island. This has a direct effect on the waste production from year to year. Seasonality, plays significant role in the waste production as according to Zorpas et al. (2015a) between May and September the waste production in a tourist area seems to increase, with the peak to be on July and August. Moreover, the waste production as well as the waste quality and quantity in a tourist area is strongly related also from the demands that tour operators asked from the hoteliers. Several tour operators asked from the hotels owners to provide all-inclusive services, meaning that variety of foods and fruits must be served at any time (direct effect on the production of FW although is too difficult to be measured). Also, tour operator, asked in their contracts especially from a 5 stars hotel, to offer to their visitor varieties of beauty, which most of them are in small plastics package of 10-50 ml (i.e premium shampoos, spa solutions, etc. This is also affecting the quantity of PMD production).

The average WGR the last 10 years (Fig. 4) was 0.0030±0.00071 kg/citizen/day for MoP, 0.0013±0.00021 kg/citizen/day form MoS and 0.0018±0.00015 kg/citizen/day for MoL. On 2011 for MoP the WGR was 0.0022±0.0009 while at the end of 2018 was 0.0039±0.0011 kg/citizen/day (almost 77% higher). The IWPR is presented in Fig. 5 with the MoP to have average 1.099±0.07, while MoS presented with 1.081±0.06 and MoL 1.023±0.08.

[Figure 3]
[Figure 4]
[Figure 5]

As indicated by Zorpas et al. (2012; 2015b) the existing waste management plan for MoP since the beginning of 2000 remain the same without any significant modifications, although MoP has participated in huge Life+ project under the acronym WASP Tool (*Project LIFE10 ENV/GR/000622, that was co funded from EU*) in order to develop its prevention waste strategy. The waste prevention actions were including Food Waste reduction, home composting, refiling shopping bags, etc. Until now, twice a week MSW are being collected door to door and those are transferred to the MBT unit (which was developed as BOT – Build Operation and Transferred- unit) approximately 65 km away from MoP. According to Zorpas et al. (2015b) the MBT unit was charged until the 2012, for the household wastes 54.8 €/t, for the biodegradable waste (greens) 46.8 €/t, for the recyclable waste 80.80 €/t and 100 €/t for the rest of the waste. Later on the specific policy was changed, due to the fact that those gate fees straggle the Local Authorities and a new gate fee policy was applied; 44€/t for the household waste, 12€/t for the biodegradable (green waste), 16€/t for the rest of the waste, will for any recyclable materials there was a zero policy fees.

The existing waste management system of MoS and MoL presents similarities. The MSW are been collected twice a week from all the areas, as well as, the recyclable materials are collected door to door from Green Dot Cyprus (GDC). GDC is responsible (Zorpas 2017b) for the 1st collective compliance system in the Island. GDC covers the gap among the production of packaging materials and Packaging Waste Law (L.32(I)/2002) (as was required from the 95/62/EC directive). The collection of recyclable waste from MoL starts on 2010 and for MoS on 2014. MoL, during 2014 starts a cooperation with a private company to collect certain quantities of biodegradable waste to produce compost (this has a direct effect on the reduction of the biodegradable waste from the household wastes). The private company charged 8€/t for the biodegradable waste and for any wooden materials such as pallets, 15€/t for any paint wooden item, 6€/t for the seaweed (from coastal areas), 5 €/t for the grass and 35 €/t for the mixed household waste.

Fig 6a presents the MSW-R regarding the PMD. MoP presented with average MSW-R_{PMD} equal with 1.09±0.26, MoS with 1.49±0.52 while MoL with 1.93±0.18. The average (Fig 6b) MSW-R_{paper} for MoP is 2.48±0.49, for MoS is 3.69±0.94 and for MoL is 2.71±0.54. What it is extremely important (from Fig 6a and 6b) is the fact that, the MSW-R_{PMD}, for MoP decreased from 2011 and after, while for MoS and MoL increased or remained stable. This can be explained by the fact that, MoP council didn't decide to continue the Life+ WASP tool project and to maintain any awareness activities that was developed through the 3-years project, to prevent and at the same time to boost recycling of waste materials. On the other hand, MoS and MoL through their continual (in a yearly base) awareness campaign that was developed, their citizens were continue to participate. At the beginning (Zorpas et al. 2015b; Zorpas et al. 2017c; Zorpas et al. 2018) MoP was developed an awareness campaign through advertising on social

media, numbers of abstracts in local magazines, organization of conferences for significant stakeholders (i.e hoteliers, restaurants, kids from schools etc.), announcement in social media (i.e Facebook, or Municipality webpage), spots in the local radio station, live links event in the central scare. Due to internal reasons and an improper waste policy, without specific vision and targets to be reached, didn't continue. In contrast, the same and similar awareness campaign was developed for the other Municipalities. Especially, for the MoS was added a door to door informative material to all the citizens on a monthly base and for a 12-month period). Also, a significant difference between MoP and MoS, MoL is the fact that on 2014 MoS and MoL turned into a door to door collection for all the recycling materials twice a week. This has a direct effect, on the citizens attitude and behaviour, as they learned how to sort their wastes efficiently and appropriate at source, resulting in an increasing MSW-R index for all the recyclable waste. As mentioned above, due to political issues GDC didn't continue to collect the recycling material from MoP and the responsibility was transferred unsuccessfully to MoP council.

[Figure 6]

It is remarkable (Fig. 7) that the three Local Authorities has significant amount of FW (EFW and IFW). The total FW production (including EFW and IFW) was 19.88% for MoP, 16.6% for MoS and 31.1% for MoL. There is no any specific FW strategy, beside the Governmental prevention strategy that has been applied in 2013 and other individual actions to sort FW and proceed for energy recovery since now (Zorpas et al. 2015a; Zorpas, et al. 2017a; Loizia et al. 2018a). Moreover, through the compositional analysis it was noticed that citizens do not applied any sorting activities at source, as they disposed-off (in the MSW) huge quantities of other recyclable materials such as PMDs (which were 8.69% for MoP, 7.7% for MoS and 10.75% for MoL), papers (which were 10.56% for MoP, 10.6% for MoS and 9.44% for MoL), glass (closed to 5% and for the three Municipalities). 27.41%, 30.6% and 21.15% for MoP, MoS and MoL respectively are the biodegradable waste (and consist a very interesting fraction as contain only green waste, fruits and vegetable) that can be easily composted (through home composting practices) (Zorpas et al, 2018; Agapiou et al. 2020). Toilet and kitchen papers is a fraction that attract further attention, as according to the existing policy of the STP units cannot be flashed into sewage. Mainly the Plastic Non-recyclable fraction which was 2.26% for MoP, 1.2% for MoS and 0.41% for MoL consist from elastic cloves and protected masks. A very interesting for further microanalysis research consist the Other fraction of wastes as in this category were included dusts, stones, pharmaceutical, stationeries, CDs, batteries, small toys, etc.

Taking into account other research's such as Baawain et al. (2017), that, took place in Muscat on 2014, it was found that FW was from 5.31% to 8.36%, green waste varies from 3.26-7.06%, paper and cardboard has a range from 17.09% to 20.70%, glass was from 3.12% to 5.31%. plastics bottles were 3.71-4.64%, plastic wraps were from 17.24% to 24.99% and other plastics varies from 2.92% to7.15%. Moreover, Gomez et al. (2009) indicated that, the organic fraction of MSW was nearly 45% of all MSW produced, followed by paper which was 17%, while Al-Khatib et al. (2010) stated that, the maximum recyclable and compostable waste was 65% and biodegradable wastes counts 62% in Nablus district of Palestine. A waste compositional analysis in Wales (Poll, 2003) indicate that FW was 16%, paper and cardboard was 21% and garden waste were 14% by weight of t MSW. Hence, Hui et al. (2006) specified that 59% of the MSW compositional analysis from Chongqing, in China was food waste. The composition of the MSW is of great importance, in order to be able to design, plan, establish and managing of future trends. Additionally, preventing of waste (Zorpas et al. 2017a; Elimelech et al. 2018; Voukkali et al. 2019) as well as, sorting of waste at source, is considering the first steps towards

more sustainable waste management strategies (Zorpas, 2020). It also benefits recycling and materials recovery, conserves resource and decreases environmental impacts of regular landfills. Even though this process increases the relative cost of the MSW collection, it reduced the volume of residual wastes, as well as, the management costs (Baawain et al. 2017).

According to Rong et al. (2017), World Bank (2018), The Economist (2018) and Voukkali et al. (2019) the volume and physical characteristic of the MSW varies from one place to another for several reasons. Those differences (Khan et al. 2016; Voukkali et al. 2019) are strongly corelate on the socioeconomics, lifestyle, incomes, standard of living, existing infrastructures, existing waste management strategy, consumption of products, educational level, attitude and behaviour of the citizens and many others.

From the results of the MSW-C it can be obtained what kind of strategy can be developed and in which waste stream we must emphasis as well as what kind of awareness activities must be realised to the citizens. The production of waste, has direct affect in the yearly budget of the Municipalities, as they affect the taxes that citizens must covered. For example, according to the data that have been collected (Table 4) the TWMC for MoL were 443.43€ for 2011, 347.99€ for 2014 and 359.43€ for 2017. MoP presented with TWMC 694.47 € for 2011, 686.34 € for 2012 and 767.01 € for 2015.

[Table 4]

To persuade and at the same time to influence citizens, to participate we must decode what they really produced for real money. For example, citizens of MoP (Table 5) disposed of EFW (valuable source for energy or to extract high added products participating in the bio-based sector) equal with 74410.91€ and citizens from MoL equal with 390278.32 €. Either FW prevention activities must be developed (such as preparation of other foods using leftovers i.e pizza, salads, soups, etc., or smart shopping list for the supermarket etc.) (Zorpas et al. 2015a) or either, those must be forward for energy production through anaerobic digestion (Loizia et al. 2018a). MoP disposed of recyclable materials (PMD, paper, glass, metal and Aluminium) that can be sorted at source in order to increase the recycling index (MSW-R), equal with 385932.77 € while MoL recyclable materials are equal with 604513.33 €. Moreover, the total cost of the biodegrade waste that are a valuable source for the production of high-quality compost (Agapiou et al. 2020) and it disposed of is equal with 404683.1 € for MoP and 277961 € for MoL. The implementation of prevention activities such as FW reduction (through the preparation of the correct portion of foods in the house), as well as, the adoption of composting at home (as attitude) and furthermore, sorting at source for at least the main recyclables materials (i.e PMD, papers, glass), could be useful to Local Authorities as can reduces to gate fees. Those amounts can be used in the concept of pay as you save, to improved other infrastructure (such as pedestrians, parks, tennis courts, bicycling roads etc), which aim to increase the quality of life.

[Table 5]
[Figure 7]

In the entire area of the MoP was until the end of 2015, 347 RBP. Those includes the blue bin for the collection of PMD, the brawn bin for the collection of paper and paperboard, a metallic bin for the collection of the glass. Those 96 points were spread in order to serve 53.6 citizens per RBP of the permanent population or 121.1 citizens per RBP of the equivalent population. However, due to several issues (i.e political struggles which is the major reason for the

repression of any waste management strategy) the program was suspended for a long period, jeopardizing the existing environmental program of the MoP. Thus, has a direct affect in the existing attitude and behaviour of the citizens who have already used to sort their waste and participate in the existing recycle program. It was estimated, that, more than 50% of the citizens did not continue to separate their wastes. During 2017 the Council of the MoP announced through SMS to all the citizens, that 85 new RBP were established again in the entire area and that the recycling program were start from the scratched. The new recycle strategy were includes 85 RBP, with 5 semi-submerged bins in different colour per point (light green for the organic, blue for PMD, brawn for paper and paperboard, green for the residual, and metallic for the glass collection). Remain unclear until today, how many of the previous RBP were exist, as according to the survey audit of the authors did, there was 46. However, until today there is no any specific awareness campaign or any motivations, to boost citizens to participate. The 85 new RBP can serve 226.8 citizens per RBP of the permanent population or 494.11 citizens per RBP of the equivalent population.

In the MoL even though the recyclable materials are collected door to door, there are also 400 blue bins for PMDs, 25 brawn bins for paper collections and 65 metallic bins for glass collection spread in entire city. This typical means that, in the MoL exist 400 recycling points with at least 25 of them include at least one blue, one brawn and one metallic bin. 40 of them includes at least one blue and one metallic bin as well as the rest 335 blue bins are spread in the entire city. This results in 128.03 citizens per RBP. There are also several recycle devices which received recyclable materials and give back voucher equal with 1 cent per item. However, there are no any records how many are participating and what is the percentage of the recyclable material that are being collected comparing with the total amount of waste.

In MoS there are 12 recycling points, with at least one blue and one brown bin and the metallic bin for the glass collection, even though MoS participate in a door to door collection, for the recyclable materials (PMD and paper). Each RBP can serve 456.2 citizens.

According to the MoL council it is expect that 19 new RBP that was established at the begging of 2018, covering all the categories of the recyclable materials, will also contribute to the MSW-R when those will be in operation. Moreover, MoL council intended to establish 64 more semi-submerged bin covering all the recyclable materials, in order to boost their citizens and enterprises to participate more in the sorting at source program.

Taking into account the results from Fig. 8 which presents the recovered waste (mainly PMD, paper and glass) and the WRR respectively it is obvious that the Local Authorities are far away from the targets set from SDG 12, CES and GDS (Table 6).

[Figure 8]
[Table 6]

According to the survey audit the waste infrastructure of MoP includes 4 waste disposal vehicles, MoS has only one and MoL 13. In MoP exist one Green Point (G.P) since 2017 (which may also serve MoS), as well as, one in MoL since 2014. In the G.P the citizens can disposed of WEEE, green waste, furniture, other recyclable materials (such as MPD, paper, glass), clothes, cooking oils, iron and batteries.

With the exception of dust, small stones, and leaves from the public areas and public roads the C.I index (Table 7) was tolerable for MoP, MoS and MoL in the case of the central roads, pacing

front town halls. What was remarkable, was the fact that, the main roads entering the Municipalities were characterized as moderate to dirty, as drivers use to throw from their windows PMDs, soft-drinks cans, cigarettes buts, kitchen papers and napkins, plastic bottles of water 500 ml, take away plastics etc. This shows the need for a further educational program for all the citizens, starting from the schools and then to other stakeholders. The central square was characterized from clean to moderate for the case of MoP and MoS, but for MoL was characterized from clean to dirty, due to the fact that it's also affected from the visitors entering to the beach. The waste that were found was mostly in all the squares: cigarettes buts, cigarettes box, bottles of beers, soft-drinks cans, plastic shopping bags, napkins, aluminium foil, EFW (i.e apples, orange leaves, etc), other PMDs etc. At the same time A.I and A.R remain from Very Low to Moderate for the studied areas.

It is remarkable, that, during the survey audit, one day after the sampling period and more specific between 8:00 and 12:00 a.m the C.I was almost zero, for the case of the roads pacing front of each Town-hall and the main plaza squares, resulting in a conclusion that the cleaning department of each Municipality is working efficiently.

[Table 7]

The SWOT analysis is presented in Table 8, while SWOT coupling matrix is presented in Table 9. In the SWOT matrix (Table 9), a coupling of findings is presented, concerning any opportunities with the related strengths (O-S), opportunities per weaknesses (O-W), threats with the related associate strengths (T-S) and threats with the related weaknesses (T-W). The numbering of the SWOT analysis as indicated in Table 8 links to the SWOT Correlated Matrix Table 9. According to the result of Table 9, there were 25 connections among O-W, 28 connections among O-S, 22 connections among T-S and T-W. Additionally, Table 9, indicates that, in order to improve, the E.P of the selected areas, the Municipalities has the option to select one of the followed Strategies in reverse series: O-S > O-W > T-S = T-W. All the Municipalities must choose between O-S or O-W, Development or Correctional Strategy, to improve their E.P. Starting with the development of educational materials and advertising activities, to increase citizens awareness regarding prevention activities, recycling, about the negative impact from illegal waste disposal etc. It is true, that traditional management practices from competence authorities may have negative impact on waste management practices.

Sensitive analysis (Figure 9) indicate that the system under study does not face significant problems and the O-S Development Strategy is the only option in order to optimize the E.P.

[Figure 9]

Even if SWOT analysis is well structured, it is often subjective and may be difficult to reach a consensus about its results (Fertel et al. 2013). This may be prevented, if the data used are extensive and accurate. In this research, accuracy was guarantee as we have visit, collect and evaluated the entire areas, as well as, the research team have done personal interviews from several employees from the Municipalities.

The presence of a strong environmental legislation in place, the existing environmental educational program from the Ministry of Education, Cultures and Youth promoted in each schools, the presence of so many Environmental NGOs that exist and acting, the current waste infrastructures and the proposed, that will be established in the nearest future, the tourists that

push for more quality of services etc., are some of the responses to the entire DPSIR system in relation with the chosen development strategy in order to optimize the existing E.P.

4. Conclusion

Local authorities from insular communities which their activities, mainly, focuses on hospitality industry and agricultural, without any holistic strategic waste management plan in place, beside typical recycling the lasted 10-15 years and landfilling for more than 30 years (as was and still the cheaper method worldwide), and without any measurable data regarding the impact of the existing environmental education program on the reduction of waste, or in the adoption of any proposed prevention activities, the main question remains: how any (small) local authority will be in a position to develop and at the same time to implement and monitor any waste strategy, in order to improve the existing Environmental Performance. From the results it is clear that the citizens are participating in the existing waste strategy that each local authority applies, but not effectively. Additionally, as there are no any motivation measures in place and moreover, the awareness activities are very limited and not within a specific time frame, they do not participate in any waste treatment scenario (recycling, prevention activities etc). However, the results also indicate that C.I, A.I and A.R, are in acceptance level, meaning that, the public space are in accepted cleaning level and the cleaning department of the Municipalities is appropriate. As SWOT analysis indicates, the only option to modify the E.P is to choose between development strategy and or correctional strategy, competent authorities must take into account any and all the opportunities and strength, that they have and to develop a holistic waste management plan, which must include prevention activities in specific waste streams, reused of materials, sorting at source, educational programs in monthly base (for defined stakeholders), as well as, strong awareness's activities in order to boost more citizens to interact and participate. At the same time, is true that without any motivation measures, citizens avoid to participate in any proposed strategy and for that reason local authorities, may take into account measures related with reduction of taxes or vouchers to be exchanged with free public parking, free tickets to theatre or cinema etc.

Concluding, transitioning towards a sustainable waste strategy to be in a position to adopt CES, EGD and SDGs, involves validation methods that can be functional at all level and moreover strong political decisions and commitment must be agree, even though success implementation of any waste strategy (i.e prevention, recycling, reuse etc.), their results does not have direct to the citizens.

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Figure Captions

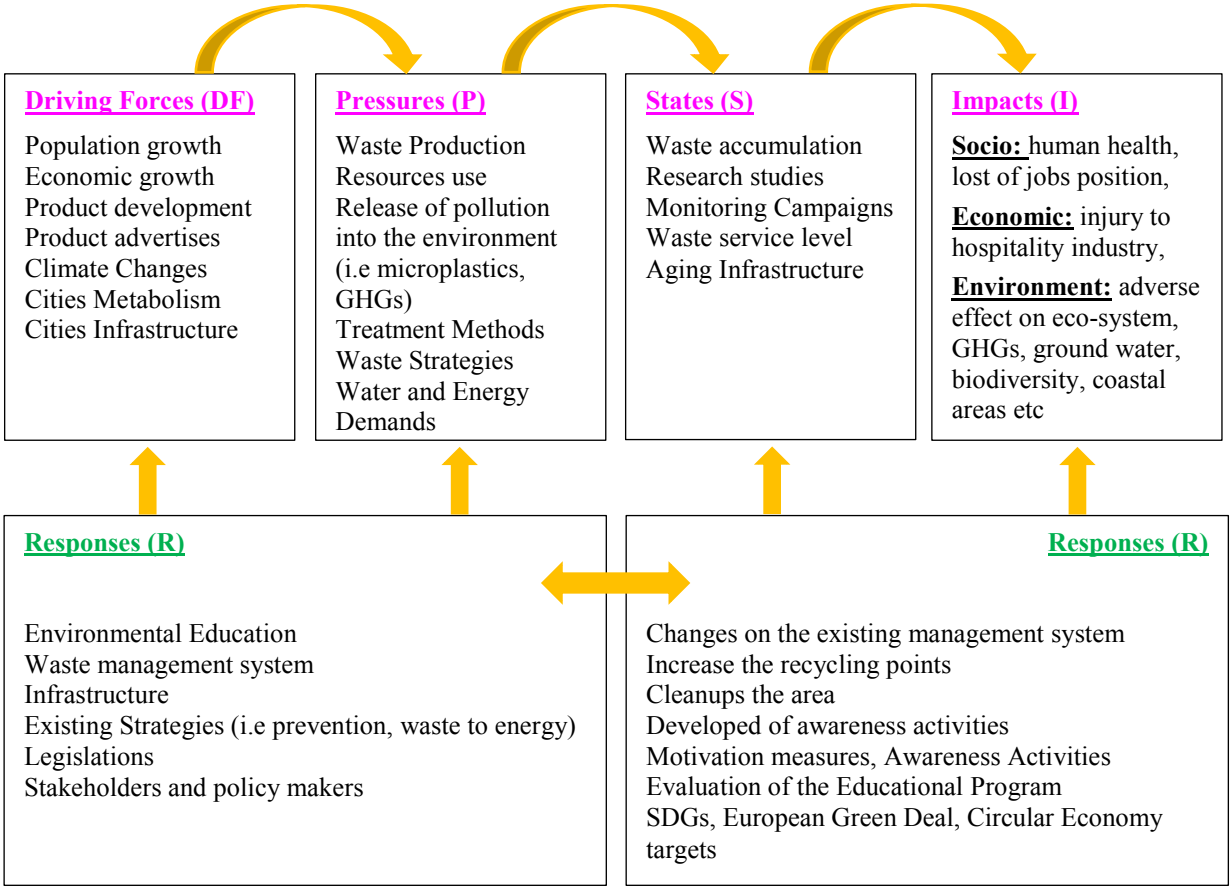

Figure 1. DPSIR concept approach to evaluate the Environmental Approach of the proposed areas

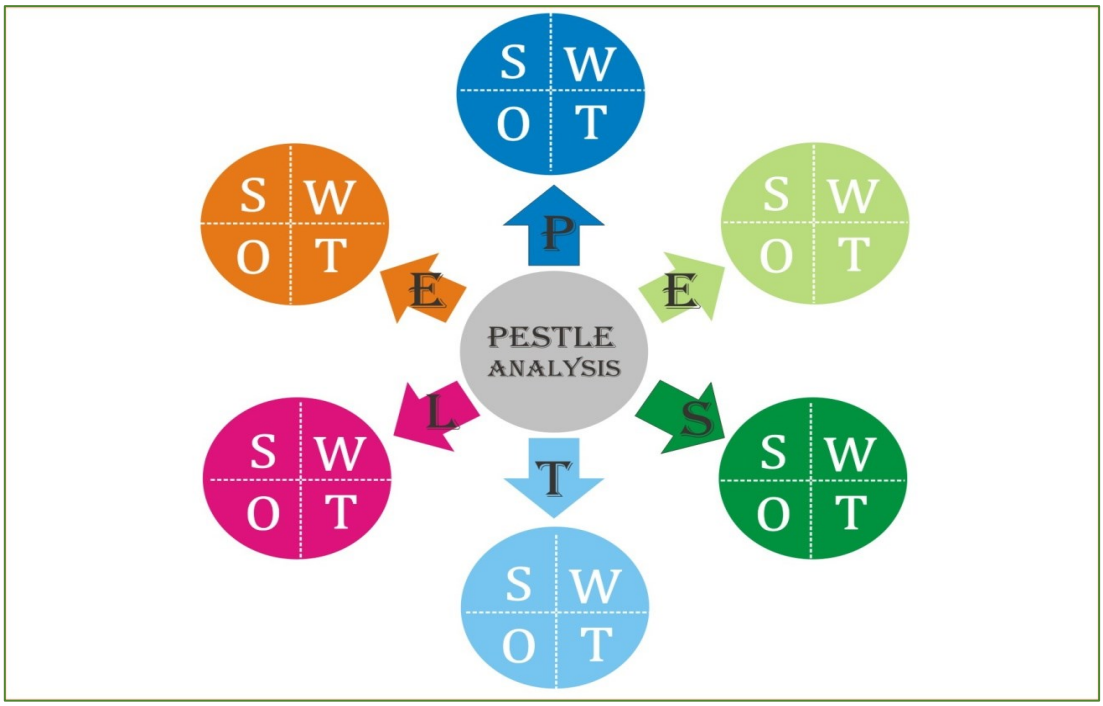

Figure 2a. SWOT & PESTLE analysis

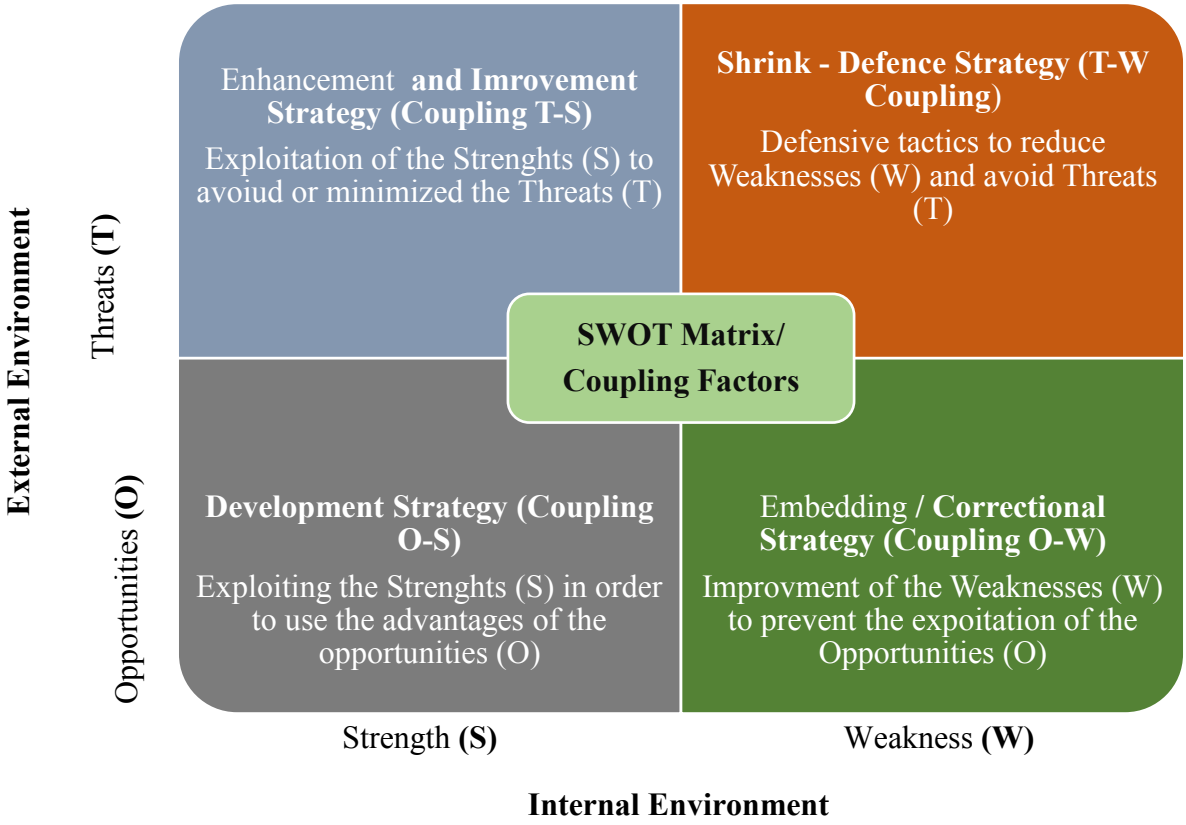

Figure 2b. SWOT Matrix

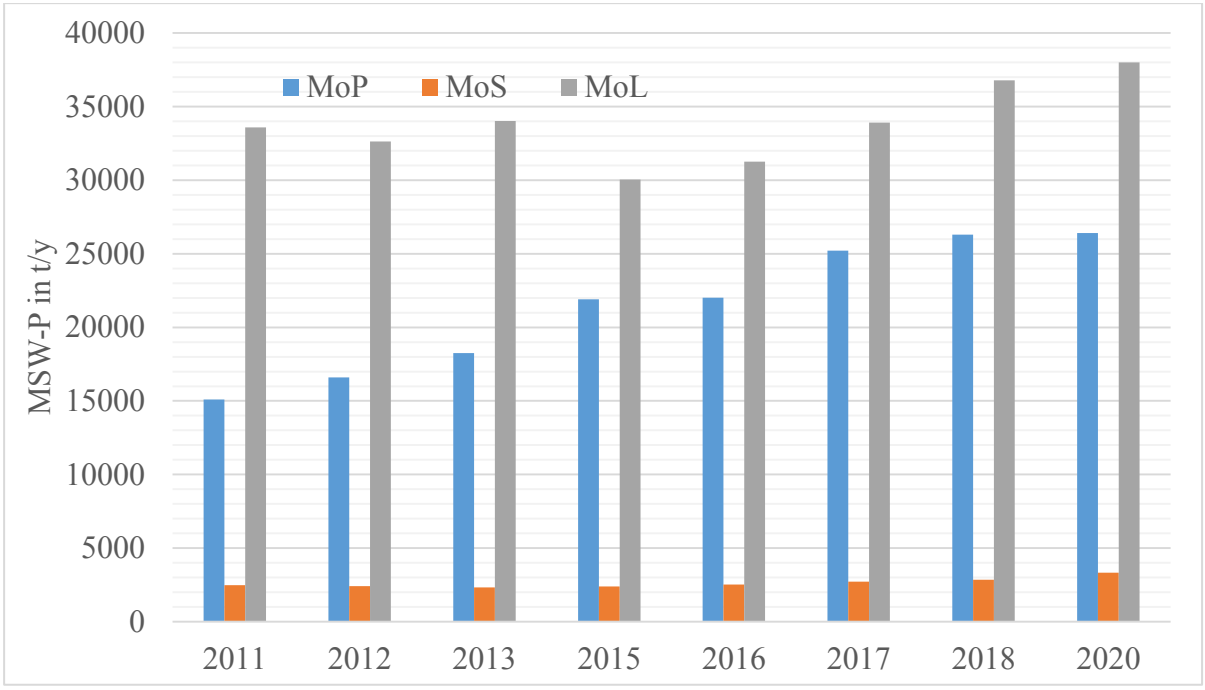

Figure 3. MSW-P for MoP, MoS and MoL from 2011since the projection of 2020

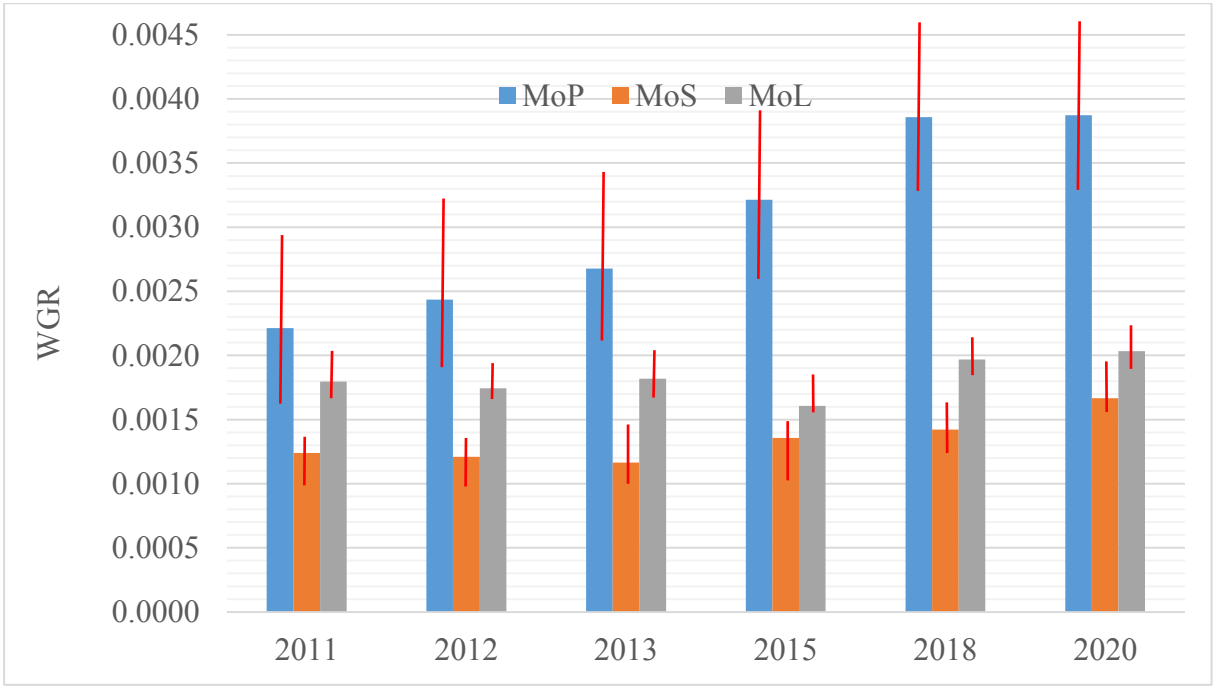

Figure 4. WGR of MoP, MoS and MoL in (kg/citizen/day)

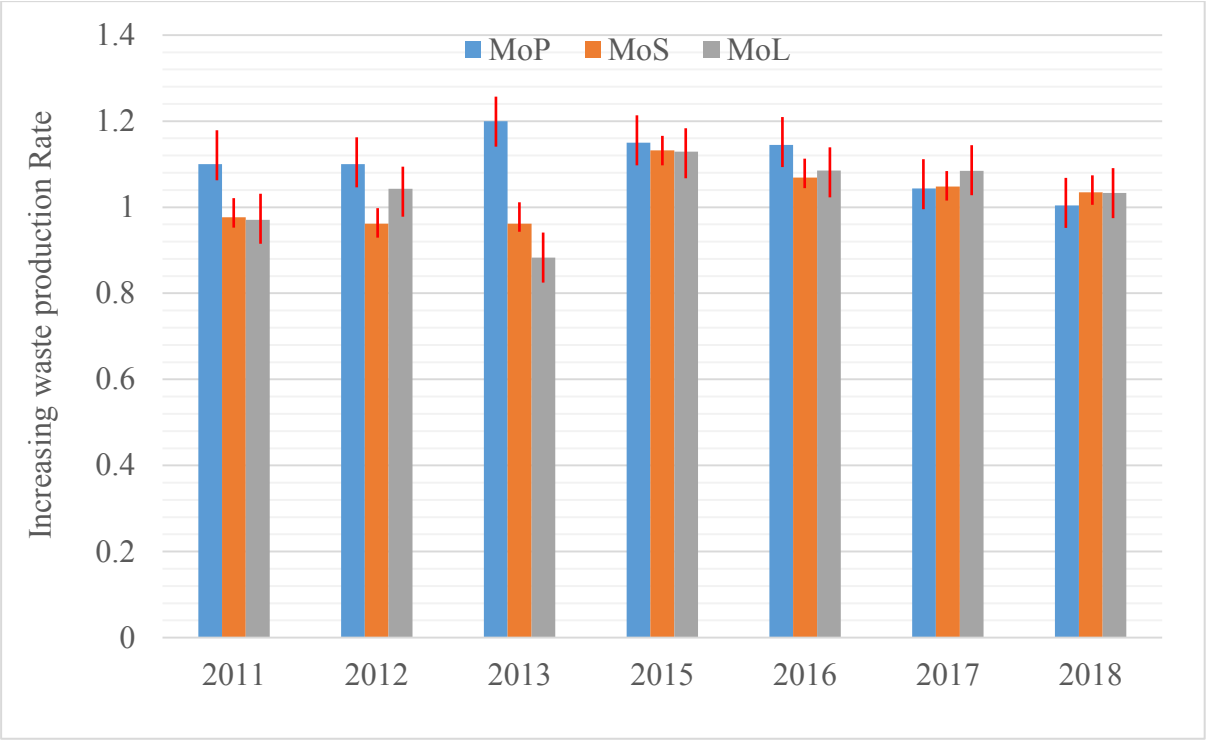

Figure 5. IWPR per year for MoP, MoS and MoL

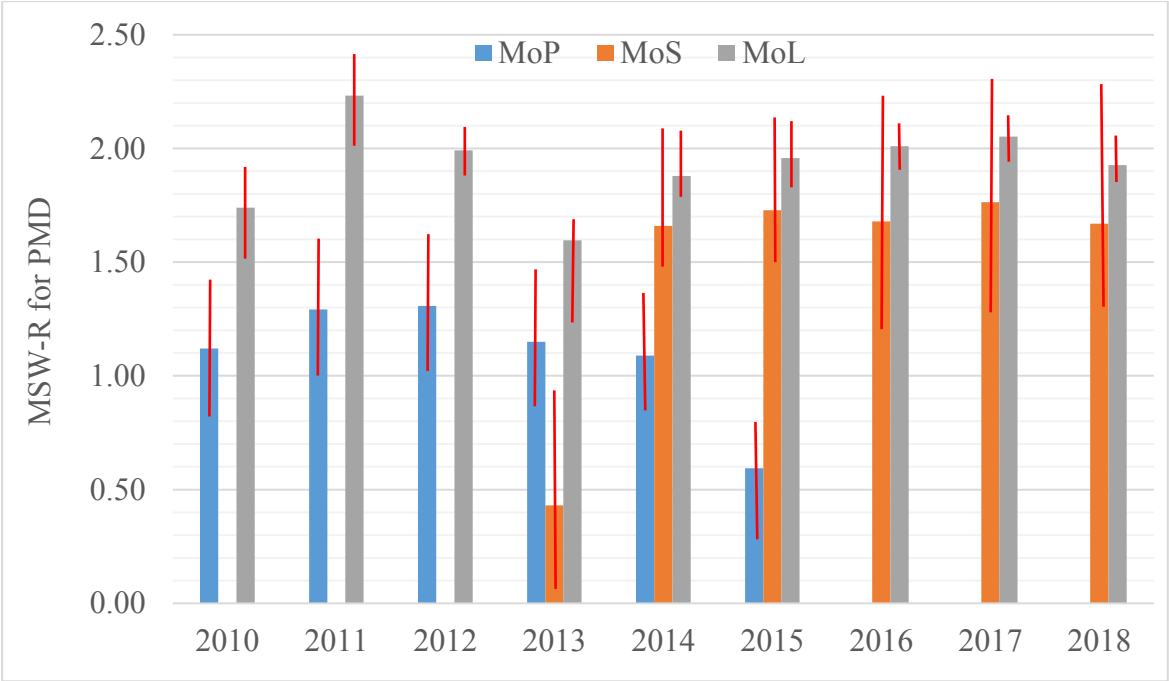

Figure 6a. MSW-R for PMD for MoP, MoS and MoL

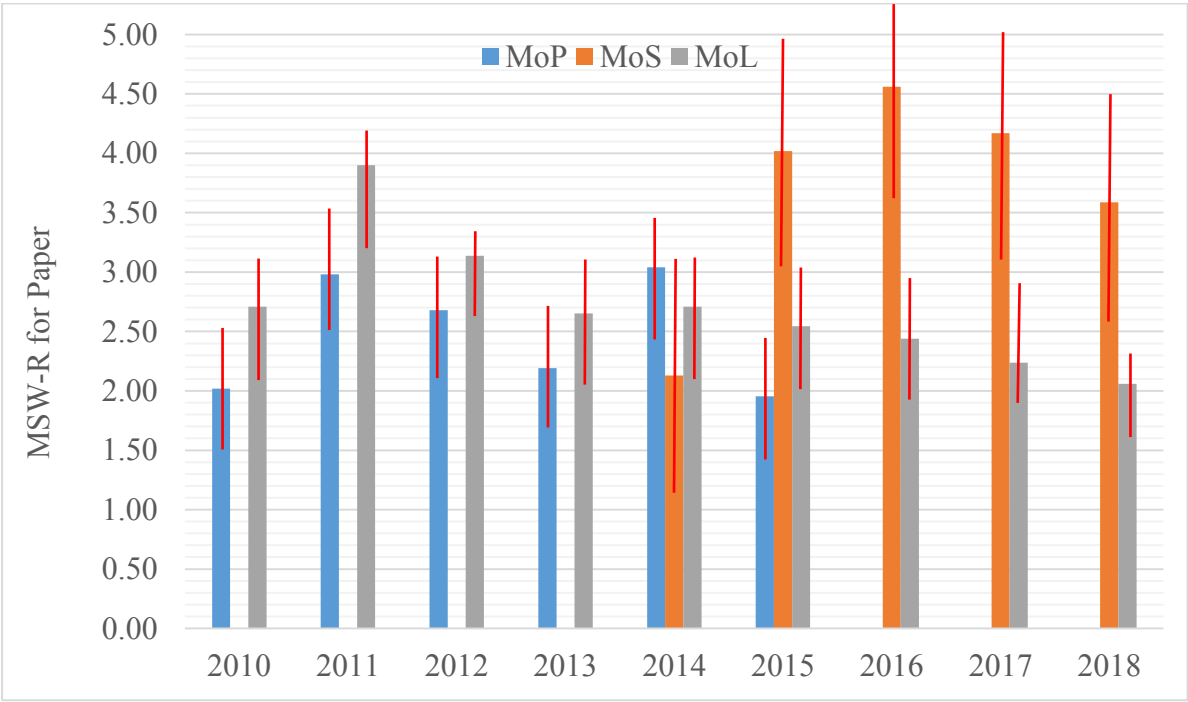

Figure 6b. MSW-R for Paper for MoP, MoS and MoL

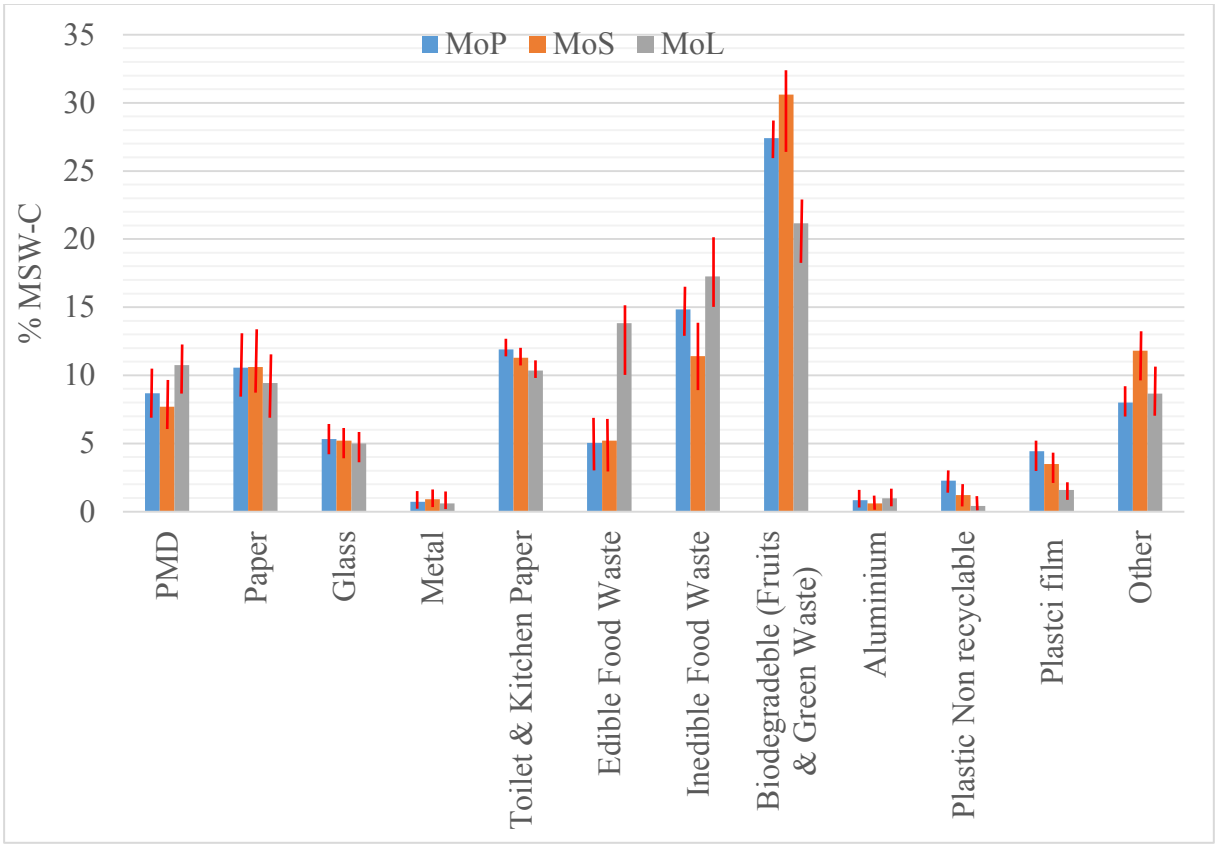

Figure 7. MSW-C for MoP, MoS, MoL

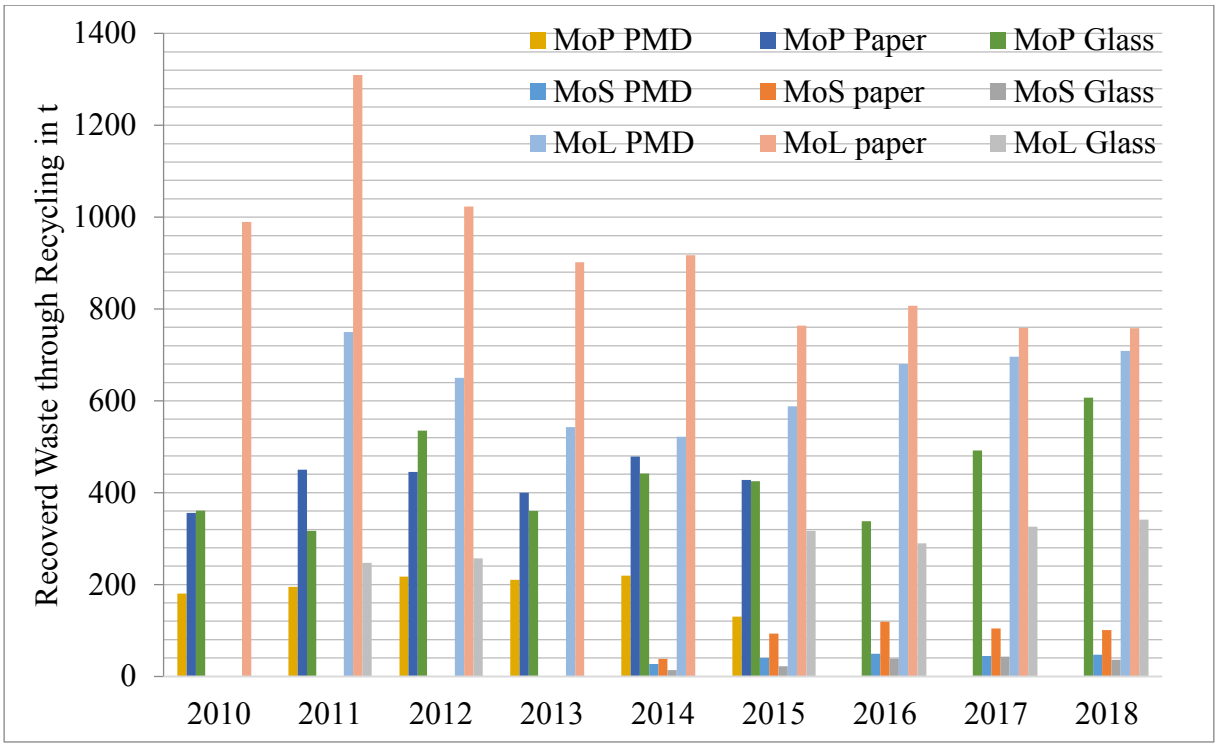

Figure 8a. Recovered waste through recycling

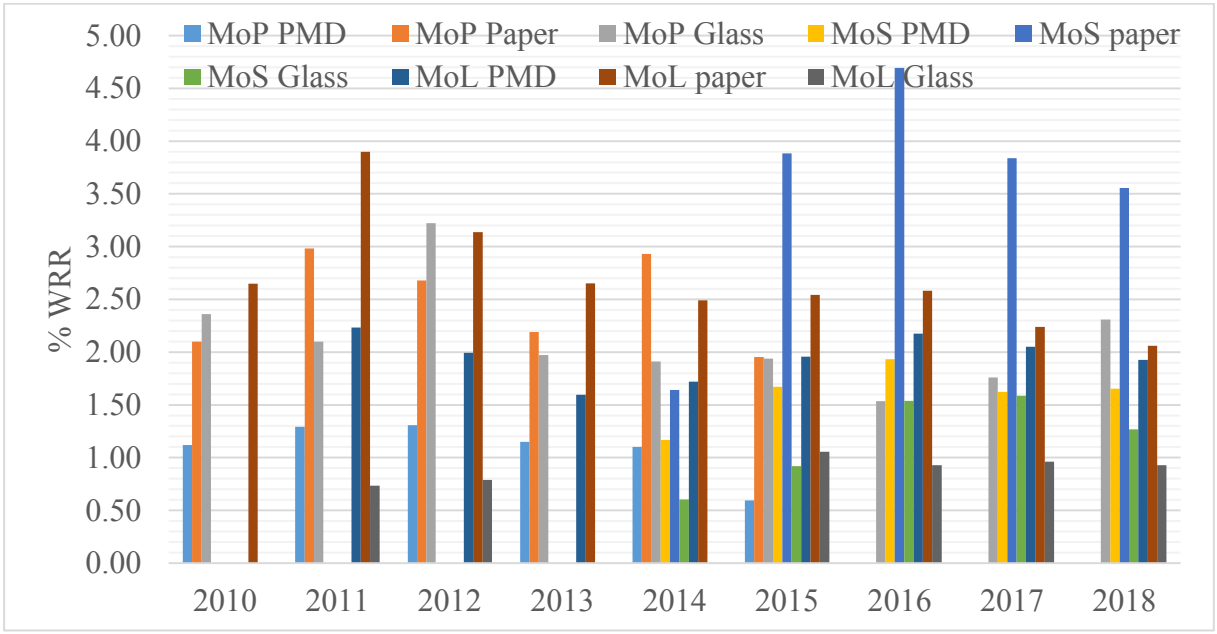

Figure 8b. Waste Generation Rate for the recyclable materials

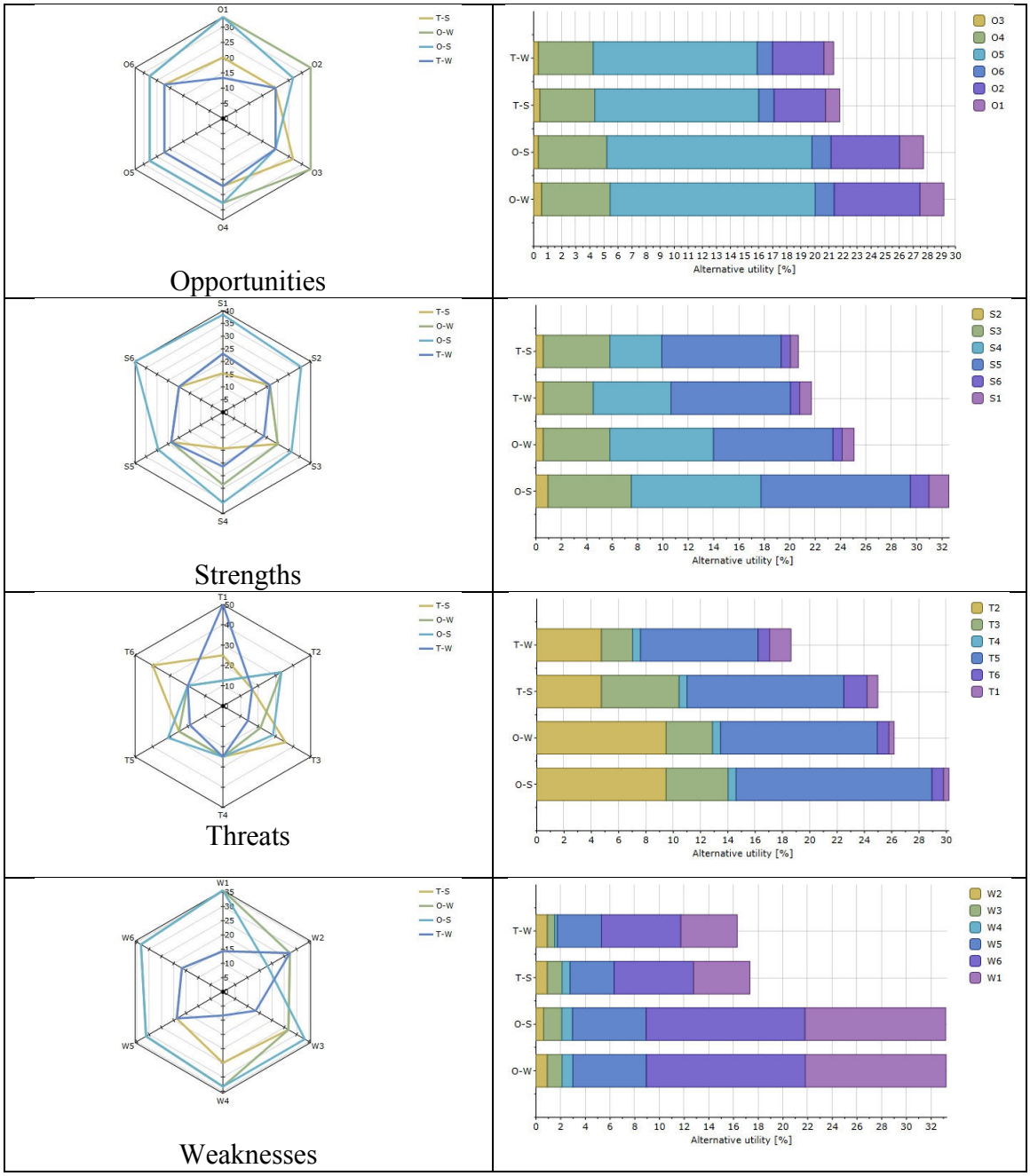

Figure 9. Sensitive Analysis for the selected Strategies in relation with SWOT analysis

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1314 Table 1. Clean Index identification classification

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Quality	Level of Services (LOS)	C.C.I	Classification
Very clean	1	0-2	No litter is seen
Clean	2	2-5	No litter is seen over a large area
Moderate	3	5-10	A few pieces of litter can be detected
Dirty	4	10-20	A lot of litter on shore
Very dirty	5	20+	Most of the area is covered with litter

Where the LOS is explained as:

1: Outstanding collection of waste at least 4 times per week and for some areas 3 times per day (morning, midday and afternoon), waste bins exist at least every 100 m as well as, other waste infrastructures (such as recycling separated bins, collection of hazardous waste, etc, awareness and informal signs) are observable, and furthermore, there is mechanical cleaning of the roads at least 2 times per week.

2: Acceptable collection of waste, 3-4 times per week and twice per day for some areas i.e morning and afternoon collection, average waste bins exist every 200 m, or other waste infrastructures (recycling bins, etc), awareness and informal signs are visible as well as exist implementation of mechanical cleaning of the roads at least once per week.

3: Average collection of waste, 2 times per week but once per day, average waste bins or other waste infrastructures, with limited awareness and informal signs, and periodically implementation of mechanical cleaning of the roads

4: periodically collection of waste once a week, limited waste bins or other waste infrastructures and zero implementation of mechanical cleaning of the roads

5: zero cleaning programs in the area with-out any waste infrastructures and zero implementation of mechanical cleaning of the roads as well as absence of any awareness or informal sign

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1324 Table 2. Accumulation Rate and Index classification

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	LOS	WAI	WAR (items/m^2/day)	WAR (items/km^2/day)
Extremely low	1	≤1	0.000001	1
Very low	2-3	1-2	0.00001	10
Low	2	2-3	0.0001	100
Moderate	3	3-4	0.001	1000
High	4	4-5	0.01	10000
Very high	4-5	5-6	0.1	100000
Extremely high	5	≥6	1	1000000
The classification of LOS is presented in Table 2				

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1330 Table 3. Encoding of SWOT and PESTLE.

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	Internal Aspects (int)		External Aspects (ext)	
SWOT	S (+)	W (-)	O (+)	T (-)
PESTEL				
Political (Pol)	Pol, int, +	Pol, int, -	Pol, ext, +	Pol, ext, -
Economic (Eco)	Eco, int, +	Eco, int, -	Eco, ext, +	Eco, ext, -
Social (Soc)	Soc, int, +	Soc, int, -	Soc, ext, +	Soc, ext, -
Technological (Tec)	Tec, int, +	Tec, int, -	Tec, ext, +	Tec, ext, -
Legal (Leg)	Leg, int, +	Leg, int, -	Leg, ext, +	Leg, ext, -
Environmental (Env)	Env, int, +	Env, int, -	Env, ext, +	Env, ext, -
Each factor is rated with a significance coefficient, from 1 to 5, with 1 (one) being minor, 2 (two) less important, 3 (three) average, 4 (four) important and 5 (five) very important.				

In front of each significance coefficient, the proposed "+" or "-" representing whether it is a positive aspect (for the internal environment) or a negative aspect (for the external environment).

Table 4. Waste relevant cost per house

Year	MSW-P t	Gate Fee €	Waste Collection €	Number of houses	MSW-P per House in t	Total Waste Management Cost €	Gate Fee/house €	$TWMC_{per\ house}$ €
MoP								
2011	15093.11	1476406.93	2220981.00	5324	2.83	3697387.93	277.31	694.47
2012	16602.23	1624047.62	2332030.05	5764	2.88	3956077.67	281.75	686.34
2013	18262.23	1786452.39	2448631.55	6120	2.98	4235083.94	291.90	692.01
2015	21915.15	2143742.86	2693494.71	6300	3.48	4837237.57	340.27	767.82
MoS								
2011	2477.3	170659.73	23830.07	1718	1.44	194489.61	99.34	113.21
2012	2419.5	166677.70	23274.07	1722	1.41	189951.77	96.79	110.31
2013	2326.3	179997.12	25295.62	1735	1.34	205292.60	103.74	118.32
2015	2394.9	167379.22	23372.12	1760	1.36	190751.00	95.10	108.38
2016	2535.4	174662.10	24199.43	1795	1.41	198861.40	97.30	110.79
2017	2710.7	190185.09	29178.26	1801	1.51	219363.20	105.60	121.80

2018	2841.4	195742.13	30030.77	1825	1.56	225772.91	107.26	123.71
MoL								
2011	33595.82	2504278.45	6222086.00	19679	1.70	872636.45	127.25	443.43
2014	30035.98	2041549.00	4988923.44	20203	1.49	7030472.44	101.05	347.99
2017	33916.93	2259862.93	5294059.36	21016	1.61	7553922.29	107.53	359.43

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1356 Table 5. Relevant cost of the disposables waste in €

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	MoP (2012)	MoS (2017)	MoL (2018)
PMD	128299.8	14644.25	242935.3
Paper	155908.6	20159.61	213331.1
Glass	78692.49	9889.62	112993.1
Metal	10630.13	1711.67	13333.19
Toilet & Kitchen Paper	175544.8	21490.91	234121.8
Edible Food Waste	74410.91	9889.62	312539
Inedible Food Waste	219098.8	21681.09	390278.3
Biodegradable (Fruits & Green Waste)	404683.1	58196.61	477961
Aluminium	12401.82	1141.11	21920.67
Plastic Non-recyclable	33366.8	2282.22	9265.438

Plastic film	65257.19	6656.48	35705.83
Other	118112.6	22441.83	195478.1

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Table 6. correlation of the Municipalities existing targets with the proposed targets from SDG 12, CES, EGD

	Waste Recovery Rate %				Awareness Activities	Prevention activities	Compost Production	Energy Recovery	CO_2	Green Points	European Projects related with MSW
	Food Waste	**PMD**	**Paper**	**glass**							
SDG 12	By 2030, food waste must be reduced at the retail and consumer levels as well as food losses along production and supply chains, including post-harvest losses By 2030, waste generation must reduce taking into account prevention, reduction, recycling and reuse activities By 2030, all citizens anywhere must have all the appropriate information and awareness related with sustainable development								To be reduced		
CES	< 10% (to be announced)	70%	85%	75%	To be done yearly	The CES is based on this	Is taken into consideration		To be reduced		
EGD					To be done yearly			At least 40% cuts in greenhouse gas emissions (from 1990 levels) At least 32% share for renewable energy. At least 32.5% improvement in energy efficiency.			
MoP (2010-2018)	Zero recovery to very limited in some cases which cannot be measured	Average =0.73±0.58	Average =1.65±1.29	Average =2.12±0.48	Periodically implemented 1-3 times per year	200-300 houses from the 6000 in home composting	There is no any composting unit	There is decision to collect FW from hotels for biogas production		1	1 (WASP TOOL LIFE10 ENV/GR/000622)
MoS (2010-2018)	Zero Recovery	Average =1.68±0.75	Average =3.77±1.84	Average =2.25±0.66	Often In a monthly base	Few individuals	There is no any composting unit	None		None	None
MoL (2010-2018)	Zero recovery to very limited in some cases which cannot be measured	Average =1.74±0.68	Average =2.69±0.54	Average =0.60±0.46	Often In a monthly base	Less than 500 houses from 21061 in home composting	There is an agreement to collect biodegradables to produced compost	There is decision to collect FW from hotels for biogas production		1	3 LIFE project PAYT - Tool to reduce waste in South Europe (LIFE15 ENV/PT/000609)

Table 7. Clean Index identification from the selected area

	C.I (i)	Classification	C.I (ii)	Classification	C.I (iii)	Classification
MoP	2.1±2.8	Very clean to moderate	9.45±5.98	Clean to dirty	3.6±2.92	Clean to moderate
MoS	1.89±2.5	Very clean to moderate	8.09±8.02	Clean to dirty	4.1±2.01	Clean to moderate
MoL	2.85±2.12	Very clean to moderate	9.29±7.48	Clean to dirty	4.9±6.08	clean to dirty

Clean index was calculated per 100 m^2 for taking into account only the central roads which was

(i) The central road front of the town hall of each authority which was 1.5 km for MoP, 350 m for MoS and 2.1 km for MoL

(ii) The central road entering to each Municipality for all the directions which was 3.2 km, for MoP, 4.2 for MoS and 7.5 km for MoL

(iii) Central plaza square which was 7500 m^2 for MoP (front of the metropolitan church), 2500 m^2 for MoS (front of the town hall) and 15625 for MoL (front of the town hall)

All the calculations and the survey audit were mean value of the 5 sampling (one day per week and for 5 weeks during spring period) and during afternoon between 16:00-18:00

Table 8. The interaction of SWOT into a PESTEL analysis

External Aspects														
Opportunities		Pol	Eco	Soc	Tec	Leg	Env	Threats		Pol	Eco	Soc	Tec	Leg	Env
O1	To improve the existing environmental performance	+2	+2	+5	+4	+3	+5	T1	Lack of public policy that is concerned with environmental issues	-3	-1	-4	-2	-1	-5
O2	Promoting Environmental Management Systems (EMS) in competent authorities such as Green Office, EMAS, ISO 14001 etc	+3	+4	+1	+3	+3	+5	T2	Lack of awareness activities regarding waste strategies (i.e prevention activities, reused etc)	-2	-2	-4	-1	-4	-5
O3	Creates a value chain based on biodegradable waste for the production of natural fertiliser	+3	+3	+3	+3	+3	+5	T3	Minimum support from competent authorities	-1	-3	-3	-1	-1	-5
O4	Minimized unnecessary valuable waste to be disposed of (such as recyclable waste)	+2	+3	+3	+3	+5	+5	T4	Municipalities waste cleaning departments are no independence authorities	-1	-4	-4	-4	-1	-4
O5	To change citizens attitude and behaviour regarding waste disposal	+1	+1	+5	+1	+3	+5	T5	Seasonality such as Tourist activities increase wastes	-2	-5	-4	-2	-1	-5
O6	To cover the targets, rise from CES, EGD, SDG	+1	+4	+3	+2	+5	+5	T6	Size of Municipality	-1	-3	-3	-3	-1	-4

Internal Aspects														
Strengths		Pol	Eco	Soc	Tec	Leg	Env	Weaknesses		Pol	Eco	Soc	Tec	Leg	Env
S1	Possibility to turn waste streams into valuable resources and improve the sustainability	+1	+5	+3	+2	+4	+5	W1	The absence of a holistic waste strategy	-2	-2	-4	-3	-3	-5
S2	Reduction of GHGs emission	+1	+5	+5	+4	+4	+5	W2	High waste management cost	-4	-4	-5	-1	-1	-5
S3	To increase recycling index	+2	+2	+2	+2	+3	+5	W3	Absence of waste management infrastructures	-2	-1	-4	-1	-2	-5
S4	To increase quality of Life	+5	+3	+5	+3	+1	+5	W4	Lack of Pay as you throw policy	-1	-4	-1	-1	-1	-4
S5	To reduce food waste	+1	+5	+5	+1	+4	+5	W5	Lack of awareness activities, advertising and marketing for existing waste strategy may lead to illegal disposal methods	-3	-5	-5	-1	-1	-5
S6	Level of educational, incomes and activities of the permanent population	+1	+3	+3	+2	+4	+5	W6	Traditional management practices from the Municipalities council	-5	-2	-3	-1	-1	-3

Each factor is rated with a significance coefficient, from 1 to 5, with 1 (one) being minor, 2 (two) less important, 3 (three) average, 4 (four) important and 5 (five) very important.

In front of each significance coefficient, the proposed "+" or "-" representing whether it is a positive aspect (for the internal environment) or a negative aspect (for the external environment).

Table 9. SWOT Corelated Matrix Table**.**

THREATS	T6				✔				✔				
	T5	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	
	T4	✔		✔		✔		✔		✔	✔	✔	
	T3			✔	✔	✔	✔			✔	✔	✔	
	T2	✔		✔		✔		✔		✔	✔	✔	
	T1	✔	✔	✔	✔	✔	✔	✔		✔	✔	✔	✔
OPPORTUNITIES	O6	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
	O5	✔		✔		✔	✔	✔	✔	✔	✔	✔	
	O4	✔	✔	✔	✔	✔	✔	✔		✔	✔	✔	
	O3	✔	✔			✔	✔	✔		✔	✔	✔	
	O2		✔	✔				✔			✔		
	O1	✔	✔	✔	✔	✔	✔		✔	✔	✔	✔	
SWOT MATRIX		S1	S2	S3	S4	S5	S6	W1	W2	W3	W4	W5	W6
		STRENGTHS						**WEAKNESSES**					