

# WASP-TOOL: DEVELOPMENT OF A WEB-BASED SUPPORT TOOL FOR WASTE PREVENTION AT LOCAL AUTHORITY LEVEL

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**ABSTRACT.** The “WASP Tool project” (LIFE10 ENV/GR/622) has been developed, in order to investigate, demonstrate and optimise the waste prevention potential at the Local Authority (LA) level, in Greece and Cyprus. The core of the Project is the development of a web-based tool, namely the WASP-Tool, that will enable LAs to select and implement the optimum waste prevention programmes for their local circumstances as well as to prepare their Waste Prevention Plans. The WASP Tool is implemented as a knowledge-based decision support system, which extracts characteristics and features of the waste prevention strategies, models them, and applies multi-criteria evaluation techniques in order to facilitate decision making. The tool interacts with users to determine the significance of each factor and evaluates waste prevention activities accordingly.

**Keywords:** *Waste prevention; expert system; decision support tool; knowledge base;*

## Introduction

The European Union (EU) Waste Strategy addresses waste prevention as one of its priority issues. According to the revised European Union (EU) Directive on Waste -2008/98/EC [1], widely known as Waste Framework Directive (WFD), waste prevention embraces all the measures taken before a substance, material or product has become waste, that reduce the: i) the quantity of waste, ii) the adverse impacts of the generated waste on environmental and human health, and iii) the content of harmful substances in materials and products.

The co-funded by the LIFE financial tool “WASP Tool” project (full title: “Development and Demonstration of a Waste Prevention Tool for Local Authorities – LIFE10 ENV/GR/622) has been developed to support the basic objectives of current EU waste policy using an impact-based, Life-Cycle thinking approach. More specifically, the project contributes to the EU policies and legislation by (a) the development of a decision support tool, the “WASP-Tool” (acronym of the words Waste Prevention), to assist LAs in Greece and Cyprus to elaborate their customised waste prevention strategies, (b) the demonstration and incorporation of the “WASP-Tool” utility in the preparation of such strategies, and (c) the pilot implementation of waste minimisation activities in the Mediterranean region.

The “WASP-Tool” utilises information and analysis of the waste prevention activities that have been implemented worldwide. It has been developed in Greek to reflect Greek and Cypriot waste data, context and waste prevention potential, with selected information material available in English. A similar web-based tool has been developed by the “Pre-waste” project (co-financed by the European Regional Development Fund, INTERREG IVC programme).

## Methodology

The core of the project is the development of the web-based decision support tool, the “WASP-Tool”, which is expected to be delivered by the end of March 2013 and further refined on the basis of the actual data obtained during the implementation of specific waste prevention interventions in the participating LAs by September 2014. The tool is implemented as a knowledge based decision support system, which extracts characteristics and features of the waste prevention strategies, as identified in the previous analysis step, models them, and applies multi-criteria evaluation techniques in order to facilitate decision making. It interacts with users to determine the significance of each factor and evaluates waste prevention

activities accordingly. The output of the system includes a ranking of the appropriate waste prevention activities, as well as estimated results for each activity, taking into account local demographics and waste parameters.

In order to develop the web-based “WASP-tool”, a state-of-the-art review on waste prevention was produced through bibliographic research, interviews, questionnaires and desk study. The review was international in its coverage and assembled a considerable amount of information on waste prevention activities that have been applied worldwide and evaluates them in respect with their diversion potential, cost of implementation, level of behavioural change and environmental benefits. Moreover, the review includes information on waste prevention assessment methods and analysis of the waste production characteristics and the existing waste management system in the study areas. The WASP Tool utilises the information and analysis from the aforementioned evaluation.

### Results and Discussion

WASP Tool is a knowledge based decision support system which aims at facilitating LAs in determining the most suitable waste prevention programmes, based on their demographics and specific waste composition data, their requirements for environmental impact and their community strategic design goals.

The knowledge base incorporated in WASP Tool stores data concerning the environmental impact of waste prevention strategies, as identified by the state-of-the-art review, conducted in the previous step of the project. Each waste prevention strategy modelled includes indicators such as reduction of the produced waste quantity (tn/year), potential CO<sub>2</sub> reduction (kg/year), waste diverted from landfilling (tn/year), implementation cost (5-year in €), number of employment positions created, implementation difficulty (scale 1-3), required citizen behavioural change (scale 1-3), appropriateness for application on a local level (scale 1-3). Moreover, the target materials (for example, biowaste, metal, plastic etc) for each waste prevention strategy are also indicated.

Since these indicators are highly diverse, both in value ranges as well as in semantics, WASP Tool performs normalization steps in order to be able to express them in a uniform way and consequently utilize them to produce meaningful evaluation and ranking of the available waste prevention strategies. Normalization is first performed using the variation rate, calculated for each value as  $(\text{value} - \bar{x}) / s$ , where the mean value and standard deviation are defined as:

$$\bar{x} = \frac{x_1 + x_2 + \dots + x_v}{v} = \frac{1}{v} \cdot \sum_{i=1}^v x_i \quad s^2 = \frac{1}{v} \sum_{i=1}^v (x_i - \bar{x})^2 \quad s = \sqrt{s^2}$$

Consequently, the values are expressed as a percentage, using the variation coefficient, defined as

$$CV = \frac{s}{\bar{x}}$$

LAs-specific data concern demographics, such as population and quantity of waste per inhabitant per year, and local waste composition percentages. The system has predefined values provided by the local authorities of Chania (Greece), Heraklion (Greece) and Paralimni (Cyprus), which take part in the program, as well as default values, which can be modified for each execution of the decision support tool. Since each waste prevention strategy concerns only specific target-materials, waste composition percentages, combined with the quantity of waste per inhabitant are taken into account in order to calculate the exact impact of each waste prevention strategy indicators.

The next step of the decision making process is the determination of the significance of each indicator, according to user preferences. This is achieved through the ability to modify the weight assigned to each indicator; initially, all weights are equal. In order to ensure the soundness of the results, the final weights are normalized, adding up to 1. Finally, the output of the system is a ranking of the strategies, corresponding to these specific parameters, taking into account the weights and the evaluation of each waste prevention strategy for each indicator in a multi-criteria evaluation process. The output also includes the estimated results for each activity, taking into account local demographics and waste composition parameters.

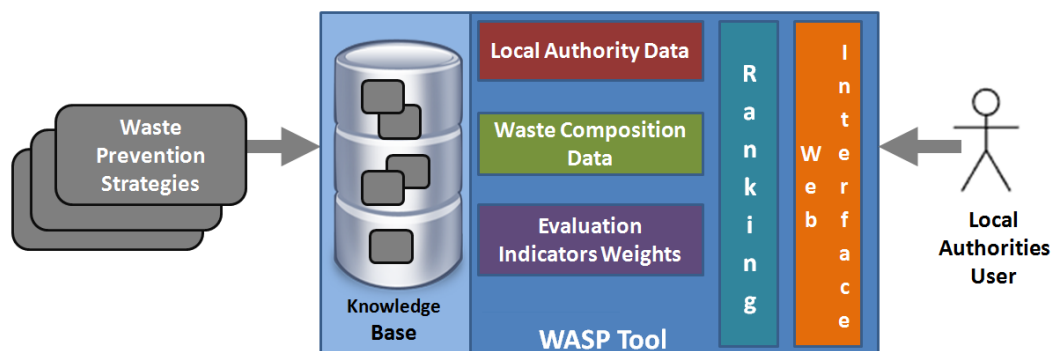


Fig.1. Architecture of the WASP Tool.

WASP Tool is designed for non-expert users; for this reason, optimal values for each step of the process are predefined in the system. The tool is intended for use by LAs in order to easily determine the most appropriate waste prevention strategies for their area. The main contribution of the tool lies in the fact that it provides an easy and intuitive interface for defining impact indicators and their significance for users, encapsulating the complexity of the multi-criteria decision making process.

WASP Tool is implemented in PHP, using an underlying MySQL database. Its prototype version is currently deployed in Harokopio University NOC servers.

### Conclusions

This is the first time that a waste prevention decision support tool is developed and implemented via identification and evaluation of different waste prevention activities using Life-Cycle thinking for municipalities. It is of particular interest also to Testing the utilization of a WASP Tool in two countries that share many similarities and characteristics of the Mediterranean space, but still posing many differences (i.e. population size, structure of administration and waste managements systems), is of particular interest. The toolkit can help produce or update a waste prevention strategy to other Mediterranean countries that face similar problems with their waste management.

### Acknowledgement

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### References

- [1] European Parliament and of the Council (2008) Directive 2008/98/CE. Official Journal of the European Union, 22 October, p. 312.