An innovative low-cost waste-tracking technology and rewarding mechanism to increase Citizen's participation in recycling

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Keywords: recycling, awareness, waste, innovation.
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In Europe, a continent where most countries already have specific policies and multiple technological options for waste recovery, there is a huge variation in recycling figures between developed and developing countries. Germany already recycles 47% of its waste, 10 countries are above the average European Union (25%), Bulgaria sends 100% of their waste to landfills and 17 countries are below the average (Eurostat, 2014). The European Union takes a leading position in recovery of materials by enhancing the enforcement of the principles of circular economy in the waste management sector in the scope to increase recycling of municipal waste up to 65% by 2030 (EC, 2016).

Considering this background, increasing public participation, and improving the behaviour of citizens is a priority in the European context where, in addition to economic incentives for a growing industry, authorities and public bodies are also promoting recycling programs. However, citizens require conditions to recycle, including waste recycling centers, awareness sessions and training and, even though these are essential factors and motivations for participation, there are cases where all technical and communication actions are provided, but participation levels are still very low (G. Morton et al., 2009). There is still a social challenge to enhance recycling rates especially in transition economies where recycling rates are still low and impurities into source separated recyclables are high (in some cases up to 50%). The behavioral impacts of current solutions are time limited and their effects may not be long-lasting. Current solutions that aim to increase recycling, result in minor behavioural change and have failed as are traditionally time limited to high cost campaigns. In addition, solutions that include incentive schemes to provide discounted offerings in a form of rewards are also ineffective, as are adhere to the value proposition with traditional discounts on the purchases from stores, which are located in the resident's area. In general, these purchases are typically a small percentage of consumers' total expenditure and do not involve great sums. Therefore, the total potential savings for participating households range from 2% to 8% of total expenditure. Despite this, it is believed that an increased recycling performance and longer-term citizen's engagement are potentially achievable if an effective waste-tracking technology and an innovative rewarding mechanism is available.

Under this context, the scope of the present paper is to introduce a novel methodology, that aims to engage citizens in recycling and guarantee on going citizens' participation. The methodology, which combines incentives and low-cost digital technology, has already received five environmental awards and has been introduced in three Greek municipalities with very promising results. More specific, the proposed methodology concerns a mixed-methods model (including qualitative and quantitative methods), that aims to introduce a cost-effective behavior solution, by leveraging a low-cost technology of QR-codes combined with behavioral economics, eco-feedback technology and environmental psychology. The model delivers appreciable savings in the household budget as well as creating a positive customer experience to maintain ongoing engagement. Furthermore, the proposed solution is treating consumer engagement and satisfaction as the most critical component of the success of any recycling related solution, as greater engagement means better recycling performance. Eventually, improves recycling performance practices by monitoring citizens' overall recycling performance patterns and rewarding them initially with appropriate monthly discounts. Thus, recycling volumes are increased, socially responsible behavioral change is fueled and savings are maximized all together creating a strong sense of community contribution and responsible citizenship.

The technological focal point of this study is a "smart" solution, which is a recycling management system for associating a collected refuse recycling bag, with a corresponding user. The system comprises a tag with a QR code that is attached on the bag, to obtain information of the designated owner of that bag. All the

users are provided with a recycling package, that consists of five (5) recycling bags and five (5) very durable tags, on which a personal unique QR-code ID is written on. The information on the tags would be the resident's name, address, and house/apartment number. This means, all recyclable materials have a designated owner technology and data analysis determinations can be made about how often and responsible our users recycle. The solution has several significant advantages and provides a huge potential for Data Analytics services and it works perfectly for both "single-stream" and "multi-stream" recycling systems.

In addition, the paper provides the results of the implementation of the proposed methodology into three pilot areas in terms of citizens' participation, levels of recycling achieved and purity of recovered materials. In fact, the solution has been deployed in three municipalities (Alimos, Glyfada & 3V) in Athens, which agreed to participate with funds and resources in the conduction of a large-scale pilot project (3,000 households) in their respective geographic areas in order to validate the proposed solution and measure its impact. Environmental (e.g. CO2 emissions), social (e.g. level of satisfaction, gender response etc.) and economic (e.g. marketability of recyclables) indices, which are directly or indirectly linked to the performance of the pilot project are examined.

Based on the results of the pilot project the paper stimulates reflection on the main factors and variables that increase likelihood of achieving successful levels of participation in recycling through the proposed model comparing to the main reasons of low participation in other traditional recycling programs. Specifically, it is explored how technology and factors of social change could play a role in the increase of recycling in developing countries and emerging economies, where recycling rates are very low. Finally, the following questions are examined: (1) How this solution could be an important agent of change? (2) Does ease of use and the importance of the rewards of this solution a capture the attention of people? and (3) Does this solution results in a spike in recycling performance or create a consistent behavior change, spark the interest, increase the recycling capture rates and result to an ongoing citizens' engagement compared with other existing practices? Answer to the above questions are provided in the form of conclusions.