WASTE TREATMENT FACILITY LOCATION FOR HOTEL CHAINS

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Abstract
Tourism generates huge amounts of waste. About half of the waste generated by hotels is food and garden bio-waste. This bio-waste can be used to make compost and pellets. In turn, pellets can be used as an absorbent material in composters and as an energy source. We consider the problem of locating composting and pellet-making facilities so that the bio-waste generated by a chain of hotels can be managed at or close to the generation points. An optimization model is applied to locate the facilities and allocate the waste and products, and several scenarios are analysed. The study shows that, depending on the transportation, treatment waste and production management costs, the installation of facilities is profitable for the hotel chain.

Keywords: location-allocation, bio-waste, tourism, optimization.

INTRODUCTION

While tourism plays an important role in the economy, it also has a negative impact from the point of view of resource consumption and waste generation. These drawbacks are commonly aggravated by the concentration of visitors in time and space, and by the fact that some destinations may not be designed to withstand the pressure that comes from inadequate waste management. Circular economy models constitute an alternative to the way resources and waste are managed, recycled, and reused in the tourism sector (Florido et al., 2019; Ghisellini et al., 2015; He et al., 2018; Rodríguez et al., 2020).

Among the different types of waste generated by the hospitality sector, a large proportion is food waste. Some studies found that around 40% of all the waste generated in the hospitality sector is food waste (Castiglioni Guidoni et al., 2018; Pirani and Arafat, 2014), while another reported that 47% of hospitality waste sent to landfill in the UK was food (Williams et al., 2011). In the paper by Papargyropoulou et al. (2016), after analysing the generation of food waste in a restaurant located in a 5-star hotel in Kuala Lumpur, Malaysia, an average 1.1 kg of food waste per guest per day was estimated. In the study presented by Phu et al. (2018) of 120 hotels in a tourist city of Vietnam, it was found that the mean amount of waste generated was 2.28 kg/guest/day, with the amount for a particular hotel influenced by capacity, price, garden surface, type of restaurant, and managerial practices, among others. For this case study, the highest amounts of waste corresponded to kitchen (35.5%) and garden (15.5%). Interesting reviews of food waste management in the hospitality sector can be found in Filimonau and De Coteau (2019), and Pirani and Arafat (2014).

In this paper, we are interested in bio-waste generated in hotels, which includes biodegradable waste from gardens and food waste from kitchens and restaurants, and the focus is on the recycling stage. Biodegradable waste can be decomposed by the natural action of living organisms and recycled as compost, which can be used to fertilize gardens, parks, agricultural fields, etc. Plant remains from pruning or gardens can be used to make splinters and pellets. Pellets can be used both in the composting process and as bio-fuel.

Our contribution is an optimization model to determine where to locate bio-waste processing facilities and how to allocate the waste generated to the treatment facilities, and the products made in them to demand points, to meet a set of objectives. Location models have been applied to select sites for the installation of solid waste processing plants and landfills (Eiselt and Marianov, 2014; Eiselt and Marianov, 2015; Ghiani et al., 2014; Hrabec et al., 2017; Karagiannidis et al., 2004; Yadav et al., 2017; Yadav et al., 2018). These papers consider economic and environmental objectives and are focused on public facilities. We consider both public and private bio-waste facilities for the treatment of hotel food and garden waste, and the allocation of products of the recycling process to demand points. More specifically, we

consider a hotel chain which plans to manage the bio-waste generated in its installations using their own treatment equipment. The economic objective is the minimization of the total cost, and the environmental aim is connected to the circular process and the reduction of transportation.

METHODS

We apply a location-allocation model to determine where to locate the facilities and how to plan production and allocate the products. We consider three types of waste (food, garden-soft, and garden-hard) and two products (compost and pellets). The decision maker wants to determine where to install the facilities, the type of facility to be installed, the waste to be treated at each facility, and the distribution of the products among the demand points. The waste not processed in other places goes to the *ecopark* where the capacity is assumed to be infinite.

The problem is formulated as a mixed integer linear model and solved using the GAMS software. The objective function includes capital cost, operating cost, transportation cost, treatment cost and product cost. Different types of variables are used, location variables (binary), continuous variables representing amounts of waste and product, and continuous variables introduced to linearize the model.

FINDINGS or ANTICIPATED FINDINGS

The application of the location-allocation model to a particular tourist region provides solutions under different scenarios. The willingness of the hotel chain to invest in treatment facilities will depend on the prices, the transportation costs, and the cost associated to surplus production. The results indicate the most promising locations (hotels) to instal facilities. Although the data used in the analysis are simulated in part, the example shows the utility of the model.

CONCLUSIONS

Except when the transportation and treatment cost are very low, and the surplus cost is high, the installation of composters in some hotels is profitable for the chain. Several extensions of the study could be tackled. From the point of view of the hotel chain, variations in the amount of waste generated, capacity, production coefficient, and costs, could be considered, and the implications on the solution could be analysed. From the perspective of private investment and public managers, the possibility of increasing the local offer of bio-fuel could be studied. From the public sector perspective, policies which promote suitable environmental practices in the hospitality sector could be evaluated.

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