Available online at www.sciencedirect.com

ScienceDirect

Procedia - Social and Behavioral Sciences 223 (2016) 95 – 100

Procedia
Social and Behavioral Sciences

2nd International Symposium "NEW METROPOLITAN PERSPECTIVES" - Strategic planning, spatial planning, economic programs and decision support tools, through the implementation of Horizon/Europe2020. ISTH2020, Reggio Calabria (Italy), 18-20 May 2016

Landfills sizing in metropolitan areas

Chiara D'Alpaos[a,]*, Michele Moretto[b]

[a] DICEA – University of Padova, via Venezia 1, Padova 35137, Italy
[b]DSEA – University of Padova, via del Santo 33, Padova 35131, Italy

Abstract

Waste managers have often to decide whether to undertake an irreversible one-shot capital outlay and invest in a potentially over-sized facility or to proceed with sequential investments to adapt to changes and reduce potential losses. In this paper, we determine the value of managerial flexibility to decide the capacity sizing of a landfill according to the Real Option Approach. We model the investment decision as the exercise of a compound option, where an earlier investment cost represents the exercise price required to acquire the subsequent option to continue operating the project until the next stage comes due.

Peer-review under responsibility of the organizing committee of ISTH2020

Keywords: Landfill; investment decisions; growth options; sequential investments; uncertainty.

1. Introduction

Metropolitan areas due to high urbanization and high population density are facing an alarming rise in solid waste production that shorten the length of landfill life. Population growth and dense urbanization result in receding landfill space that in turn represent a major issue for policy makers and local administrators. The limited number of agents, both public or private, able to meet the solid waste management demands, compete for financial resources to extend landfill life or obtain permits to invest in new infrastructure. There are many contributions in the literature that address theoretical waste management facility expansion and waste flow allocation within a solid waste management system under uncertainty (Huang, Baetz, & Patry, 1995; Davila, Chang, & Diwakaruni, 2005).

* Corresponding author. Tel.: +390498276717; fax: +390498276716.
E-mail address: chiara.dalpaos@unipd.it

Peer-review under responsibility of the organizing committee of ISTH2020
doi:10.1016/j.sbspro.2016.05.316

At the same time due to the scarcity of land and the environmental and social costs of landfilling such as. emissions to air, soil and water or 'disamenities' such as odours (Eshet et al. 2006; Nahman, 2011), during the last 30 years municipal waste management focused on the objective to divert as much waste as possible from landfill. The literature on the choice among different waste management solutions is vast and has provided a consistent set of arguments in favor of a policy targeted at reducing waste flows addressed to landfill and recovering materials and energy (Pires, Martinho, & Chang, 2011; Massarutto, de Carli, & Graffi, 2011; Marella & Raga, 2014).

Starting from the 1990s the EU introduced compelling regulations on the construction and operation of landfills in order to promote recycling to better comply with sustainability constraints on land conservation and achieve environmental policy targets set by the EU (Kinnaman, 2006; EEA, 2009). In many Countries Governments have issued directives to minimize the amount of waste sent to landfills, nevertheless, it is impossible to eliminate the need for landfills because some materials are impossible to recycle (Diaz & Warith, 2006). In this respect the EU 2008/97 directive sets the objective to minimize landfill requirement, that should be used only for ultimate waste (waste that cannot be recovered in any way). Although landfilling had strongly reduced in the past decades in favor of recycling programs, a complete phase-out of diverting waste flows from landfills has not been achieved yet. Italy, United Kingdom, France and Spain are still landfilling around 40-50% of their solid waste (Antonioli & Massarutto, 2012; Massarutto, de Carli, & Graffi, 2011). It is therefore evident that landfilling represents a critical issue for policy makers and local administrators level because of the self-sufficiency principle (i.e. waste should be handled as close as possible to its origin to prevent from transport costs and related external costs).

Usually municipalities delegate solid waste treatment and disposal to third parties and have long-term contracts (i.e. procurement or concession contracts) with private firms that operate as regional or local monopolists and have, as a counterpart, to fulfill public service obligations and the legal obligation to receive waste from the concerned territory at regulated prices. It is commonly agreed that the provision of the service and related investments are characterized by great uncertainties. Uncertainty over future demand due to recycling programs and incineration, increasing operating costs and tightening up of regulatory requirements make de facto investment decisions more crucial than ever (Teisberg, 1993; Teisberg, 1994). In this evolving scenario, waste managers have often to decide whether to undertake an irreversible one-shot capital outlay and invest in a potentially over-sized facility or to proceed with sequential investments to adapt to changes and reduce potential losses.

Traditional Discounted Cash Flows techniques may be inadequate to cope with dynamic decisions and clearly underestimate the value of compound investments (Trigeorgis, 1996; Gamba & Fusari 2009; D'Alpaos *et al*., 2013; D'Alpaos & Marella, 2014). It is widely recognized that Discounted Cash Flow Analysis fails because it cannot properly capture managerial flexibility to adapt and revise later decisions in response to unexpected market events (Triantis & Hodder, 1990; He & Pindyck, 1992). Indeed, the importance of this flexibility becomes of paramount importance when market conditions are volatile and technology is flexible, thus permitting managerial intervention at limited cost (Dixit & Pindyck, 1994; D'Alpaos & Moretto, 2005; D'Alpaos, Dosi, & Moretto, 2006). In a framework of economic action under uncertainty and irreversibility (or costly reversibility), waiting for new information that reduce uncertainty may affect the investment profitability (Brennan & Schwartz, 1985; McDonald & Siegel, 1986).

In this paper, we determine the value of managerial flexibility to decide the capacity sizing of a landfill according to the Real Option Approach. We model the investment decision as the exercise of a compound option, where an earlier investment cost represents the exercise price required to acquire the subsequent option to continue operating the project until the next stage comes due.

The remainder of the paper is organized as follows. In Section 2 we provide the basic model and we derive the optimal investment strategy. In Section 3 we present a stylized case study and provides numerical simulations to illustrate the model's theoretical results. Section 4 concludes.

2. The model

Landfill design and construction technology have rapidly advanced during the past two decades in response to more stringent regulatory constraints on the one hand, and to highly variable waste generation and demand on the other. It is quite common to design solid waste landfill facilities which can be expanded by sequential investments over time. Landfill construction is in fact constrained to a phased programming and usually consists of construction