The determination of waste generation and composition as an essential tool to improve the waste management plan of a university

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ABSTRACT

When many people work in organized institutions or enterprises, those institutions or enterprises become big meeting places that also have energy, water and resources necessities. One of these necessities is the correct management of the waste that is daily produced by these communities. Universities are a good example of institution where every day a great amount of people go to work or to study. But independently of their task, they use the different services at the University such as cafeterias, canteens, and photocopy and as a result of their activity a cleaning service is also needed. All these activities generate an environmental impact. Nowadays, many Universities have accepted the challenge to minimize this impact applying several measures. One of the impacts to be reduced is the waste generation. The first step to implement measures to implement a waste management plan at a University is to know the composition, the amount and the distribution of the waste generated in its facilities. As the waste composition and generation depend among other things on the climate, these variables should be analysed over one year. This research work estimates the waste generation and composition of a Spanish University, the Universitat Jaume I, during a school year. To achieve this challenge, all the waste streams generated at the University have been identified and quantified emphasizing on those which are not controlled. Furthermore, several statistical analyses have been carried out to know if the season of the year or the day of the week affect waste generation and composition. All this information will allow the University authorities to propose a set of minimization measures to enhance the current management.

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Contents

1. Introduction

The huge amount of waste produced, and consequently the great difficulty involved in eliminating it, is still a problem in the developed societies. This problem is embedded in the economic

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system of production and consumption of current society, which generates an increasingly large amount of waste. This increase in waste production leads to a risk for both human health and the environment (Tejedor, 2011). To contribute to a correct waste management, the design and implementation of new tools are needed that allow users to reduce the amount of waste generated and improve waste management. Moreover, the amount and composition of the waste generated can depend on several factors such as the time of the year, the climate, the degree of development, the standard of living, and the eating habits (Aranda Usón et al., 2012; Mendoza and Izquierdo, 2007; Tchobanoglous et al., 1993).

Nowadays, universities can be considered small towns, as they have several campuses and buildings where the consumption of energy, water, paper and other resources such as restaurant, cleaning, reprography and photocopy services are important. All these issues have an influence on the daily activity of many people and enterprises. Furthermore, they generate several direct and indirect impacts on the environment. For this reason, universities must accept their institutional responsibility (Capdevila, 1999). In any case, these impacts could be minimized by applying appropriate technical and organizational measures (Alshuwaikhat and Abubakar, 2008).

Like the rest of the institutions involved in knowledge transmission, from the research as well as the teaching point of view, universities cannot ignore the environmental challenge. For this reason, many universities have conducted studies to implement measures to reduce the impact generated in their facilities. One of these measures is correct waste management.

The design of university waste management systems (UWMS) in the industrialized countries started 20 years ago and there are both voluntary as well as institutional programmes (Armijo de Vega et al., 2003). Some of the initiatives implemented to recycle and reduce waste have been very successful. In the USA, recycling programmes are one of the most popular measures, where 80% of schools and universities have institutional programmes (Allen, 1999). Currently, a large number of U.S. universities have extensive recycling and waste reduction programmes, some of them with over a decade old (GRRN, 2016). In addition, the implementation of waste reduction and recycling strategies in colleges and universities is mandatory in the USA (Armijo de Vega et al., 2008). These programmes are based on previous studies about waste characterization because the knowledge of waste composition and the market for recyclable materials make them more successful than if they are copied from other places where the conditions are different (Armijo de Vega et al., 2008).

The international studies that have been published are varied. In Mexico, the Universidad Autónoma de Baja California (UABC) published a report in 2003 where the authors described the necessary measures to implement a waste management plan, highlighting the need for the cooperation of all the sectors of a university to achieve an efficient waste management plan (Armijo de Vega et al., 2003). In 2008, pursuing this policy, they obtained a waste generation rate at the UABC of 45.60 g/user/day taking into account the three generation sources analysed: academic and administrative buildings (including laboratories), gardens and corridors, and the community centre (store, dining room and cafeteria areas). The larger proportion of waste was recyclable or potentially recyclable waste, which represent 55% in the case of buildings, 88% in the case of gardens and 85% in the case of the community centre (Armijo de Vega et al., 2008). The research centre "Centro de Investigación y de Estudios Avanzados de Mérida" (CINVESTAV-Mérida) of the National Polytechnic Institute implemented a programme to minimize and recycle the waste generated at the university. This fact allowed the University to reduce the amount of waste sent to a landfill in 2003 by 67% as well as to yield large savings for the institution, mainly through the reduction of the costs involved in transporting waste to the final disposal places (Maldonado, 2006). In Mexico D.F., the Universidad Iberoamericana (IBERO) quantified and characterized its waste in the years 2008–2009 with the aim of presenting proposals to improve waste management. The results of their study showed a maximum generation rate of 330 g/user/day. They also noted that 52% of the waste generated is suitable for composting, 27% is recyclable material and 21% should be sent to a landfill (Ruiz Morales, 2012).

Furthermore, in Venezuela, in 2007 the Universidad Simón Bolívar (USB) proposed a recycling programme to allow waste reduction. They also implemented a pilot phase where some students collected paper and cardboard separately and afterwards sold it with the aim of increasing the number of students involved and raising their awareness about the problem (Pellegrini Blanco and Reyes Gil, 2009).

The University of Massey (New Zealand) described how to implement a "Zero Waste" programme on the campus (Mason et al., 2003). Subsequently, they studied the waste source separation carried out on the campus and obtained a waste generation rate of 42 g/user/day (Mason et al., 2004).

On Prince George campus of the British Columbia University (NBCU) in Canada, during the academic year 2007–2008, a study about its waste generation and composition was carried out. The biggest waste fraction was the paper-cardboard fraction, followed by plastics and organic waste. Moreover, they concluded that more than 70% of the waste could have been recycled or composted and that the University's waste generation rate was 59.20 g/user/day (Smyth et al., 2010).

During the academic year 2009–2010, the University of Tabriz (Iran) studied the quantity and composition of the solid waste generated as a previous step to implementing the management strategies. From this study, they obtained a daily generation rate of 131.50 g/user/day. Organic waste represented the biggest proportion (almost 45.30%), followed by plastics and paper-cardboard (Taghizadeh et al., 2012).

In Nigeria, the University of Covernant carried out a study in the same way. They obtained a generation rate of 60.50 g/user/day and observed that the biggest fraction was food waste, followed by polyethylene bags and plastic bottles (Okeniyi and Anwan, 2012).

Spanish universities have paid more attention to the impact of waste on the environment. The Universidad Autónoma of Barcelona and of Madrid (UAB and UAM, respectively) were pioneers in proposing measures to reduce this impact (Pujol and Espinet, 2002). The Universidad Politécnica de Cataluña (UPC) was also a pioneer in designing a UWMS and conducted research studies related to the waste management at the University (Tejedor, 2011). The different Spanish studies in this field, at present, are based on surveys, interviews and/or statistical data, but none of them show results about waste characterization.

As mentioned earlier, the first step to implement measures to allow an efficient UWMS to be established is to know the composition, amount and distribution of the waste generated. The lack of studies dealing with the characterization of the waste generated at universities makes it clear that there is a need to research in this field.

In this work, waste generation and composition at the Universitat Jaume I has been estimated throughout one academic year. For this reason, all the waste streams generated at the University have been identified and quantified, with emphasis given to those which are not controlled. Furthermore, several statistical analyses have been carried out to determine whether the season of the year or the day of the week affect waste generation and composition. All this information will help to establish and improve waste recycling and recovery activities and it will allow the University authorities to propose a set of minimization measures to enhance the current UWMS.