Process model of monetary cost and environmental burden for household solid waste collection management for a community of high ecological value

Modelo de proceso de carga ambiental y monetario para manejo de residuos sólidos domiciliarios en una comuna de alto valor ecosistémico

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DOI: http://dx.doi.org/10.6036/9803

A model to manage the process of household solid waste collection (HSWC) was developed for a Chilean rural community within a Biosphere Reserve [3]. The model determines monetary costs and environmental burden in terms of energy consumption and CO_2 emissions.

In Chilean rural areas, waste management is deficient and causes environmental issues derived from a low frequency of HSWC, leading to waste incineration and micro-dumps. The HSWC process is performed by highly loaded vehicles, which travel long distances to the landfill (127 km approx). The high cost and energy required for HSWC raise interest in establishing management strategies. The complexity of these processes makes it difficult to compare alternatives [2], as there is no model that can predict all the parameters that affect energy use, CO_2 emissions, costs etc. There is scarce information when it comes to this type of research, however reports such as [1], describe a model inspired by the life cycle of HSWC focusing on energy consumption and monetary cost.

A model for the HSWC process was developed that can identify collection costs as well as the environmental burden associated with energy consumption and CO_2 emissions, with predictive potential, that can support the management and decision-making process[3]. The process model for waste disposal in this study is based on a spreadsheet which considers identified variables and creates a data model associated with economic and environmental equations and indicators.

HSWC implies a significant monetary cost for the local Council since it demands the greatest amount of resources and working hours, due to its high frequency (6d/week), and large distances involved. The most relevant cost for the HSWC process is wages, followed by operational costs such as those corresponding to waste disposal in the sanitary landfill and fuel costs. These three factors represent 90.6% of the total costs.

A monthly record of landfill HSW disposal from June 2016 to April 2018 is shown in Fig. 1. The HSWC process used the highest amount of mobile resources, and thus, the greatest fuel consumption. The HSWC process model identified that vehicles with a higher energy expenditure were the ones most recently acquired (more routes), and yielded energy consumption indicators of 12.0 MJ/Km and 655.26 MJ/Ton. The collector vehicles emitted the highest amount of CO_2 (Figure 1).

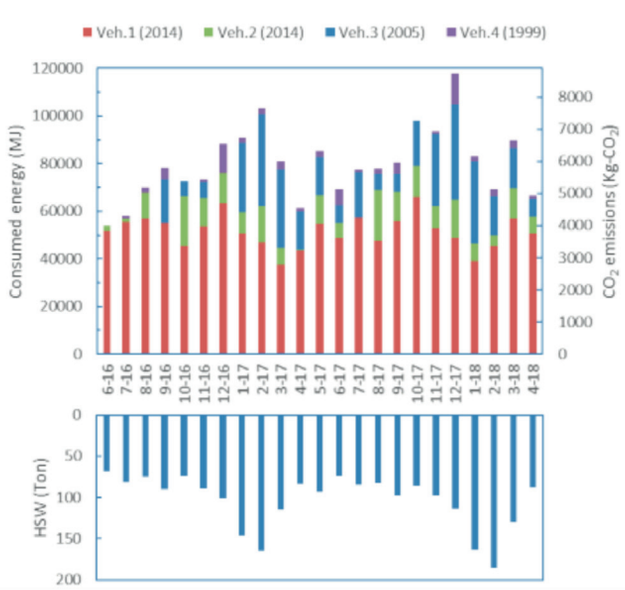


Fig. 1. Energy consumption, CO_2 emissions and landfill disposal involved in the HSWC process

Records of kilometers traveled, liters of fuel consumed, and tons of HSW disposed in the landfill allow the comparison of these variables over time and helps in future projections. Results revealed relevant information regarding HSWC, the items with most significant costs were identified, which is important in terms of management, cost planning, and budget assessment for future actions. In addition, the model can determine on average, levels of CO_2 emissions and energy consumption involved in these processes; which is valuable information in terms of environmental certification.

Finally, this model can be complemented with vehicle trajectory programming models in order to optimize costs and reduce circulation, which in turn, would decrease energy consumption and CO_2 emissions.

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ACKNOWLEDGEMENTS

CORFO funding, Engineering Project 2030/ CORFO14ENI2-26866- ID18-40.
City Council of San Fabián de Alico – Chile (for information provided).