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Solid waste management index for Brazilian Higher Education Institutions

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ABSTRACT

This paper presents the Solid Waste Management Index (SWaMI) for Higher Education Institutions (HEIs). The main objectives are to present how SWaMI was developed, to apply the Index in three different universities in Brazil and one in United States, to statistically compare the results and to present an analysis of these HEIs under the SWaMI assessment dimensions perspective. The SwaMI fills a gap regarding a specific waste management tool for HEIs decision makers, considering the responsibility of educating and training future leaders and the need to insert the sustainable waste management discussion in its end activities. Criteria were selected through literature review and divided in dimensions, further weighted according to their significance in waste management. These weights were discussed and stipulated based on expert opinion using the Budget Allocation Process (BAP) weighting method. The individual indexes for each dimension were further combined into a composite index through the Linear Aggregation Method. Main findings shows that when comparisons were deployed between HEIs, no statistical significance was noticed when the means were compared between universities using ANOVA with Tukey test. Nevertheless, when comparing each dimension within each HEI, there was significant difference between the Policy and Management dimension and the other three dimensions of the evaluation criteria at USP. Researchers concluded that the SWaMI provides decision makers with graphic results concerning HEIs solid waste management situation, hence, it allows the creation of a baseline data on how the current system works, pointing out the dimensions that present the greatest weakness allowing to perform benchmarking between buildings, institutes, and even between HEIs.

1. Introduction

Decision makers have labored to make Higher Education Institutions' (HEIs) sustainable best practices role models (Liedtke et al., 2012), inserting social-environmental premises in management and operations through a transversal and integrated way (Levy and Marans, 2012). In this context, solid waste management, one of society's main problems, must be discussed in HEIs' research, teaching and outreach activities (Taghizadeh and Ghassemzadeh, 2012).

Strategies have been adopted by HEIs to insert social-environmental aspects in their daily management and operational processes, which have proven effective in this transition towards sustainability. However, these decision spaces need support tools, deploying diagnosis and monitoring, and presenting results in a concise form. Composite indicators are a major environmental assessment tool, supporting self-reporting and further analysis regarding HEIs' sustainable aspects (Moldan et al., 2012).

This paper presents the Solid Waste Management Index (SWaMI) for Higher Education Institutions, which fills a gap regarding a specific waste management tools for HEIs decision makers, considering the responsibility of educating and training future leaders and the need to insert the sustainable waste management discussion in its end activities. If applied longitudinally, the SWaMI is able to identify weaknesses in educational (teaching, research and outreach), management and operations aspects where decision makers should focus efforts and graphically showing dimension behavior and tendencies.

The SWaMI can be calculated through a criteria framework that addresses a HEIs Educational, Engagement, Operational, and Policy and Management major aspects. The criteria of the composite

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index were selected through an extensive literature review regarding solid waste management, containing data from scientific articles, sustainability reports, certification standards, Brazilian laws and norms, and other HEIs' best practices throughout the world.

HEIs' waste management must deal with an enormous diversity of activities, such as teaching and research laboratories, housing, conference buildings and restaurants which affect their potential negative environmental impacts if not properly managed (Zhang et al., 2011), In this sense, diagnosis and monitoring tools, such as indexes, to support decision making concerning waste management are of paramount to a sound public health.

The use of indexes as information support tools enhance decision-making regarding solid waste management, researchers conclude that the use of this type of tool contributes to a systemic and temporal view, allowing to perform benchmark comparisons (Mendes et al., 2013) between HEIs and by creating a baseline that can be compared over the years.

This paper aims to present how the Solid Waste Management Index for Higher Education Institutions was developed and its application.

2. Waste management at Higher Education Institutions

The implementation of sustainability at HEIs decision-making and operational processes has gained strength in the last decades as a response to the pressure over the environment, one of the main problems that have been tackled is the exponential growth of waste generation and inadequate disposal (Felder et al., 2001; Mason et al., 2003; Rouse, 2006; Malakahmad et al., 2010; Baldwin and Dripps, 2012; Thomas et al., 2012; Lim et al., 2015).

HEIs have the potential to generate large quantity and diversity of waste accordingly to their research and teaching profiles (Zhang et al., 2011), hence, in some cases may not have an environmentally adequate disposal. A study deployed by the University of Brasilia has identified that from 278 university laboratories, 144 use chemical products, 61% throw their waste "down the sink" or in trash cans. Araujo and Viana show in their study, in the University of São Paulo's School of Arts, Sciences and Humanities (EACH - USP), that in one day, 233 kg of waste were generated in the restaurant located in the unit, of which 84% corresponded to organic matter, the authors highlight how these values underline the need to implement awareness programs concerning how waste must be managed by students, researchers, faculty and staff, and how important is the role that they execute in this process.

Many studies show the potential environmental risk of waste generation within HEIs (Morrissey and Browne, 2004; Ramírez Barreto, 2008; Suttibak and Nitivattananon, 2008; Baldwin and Dripps, 2012; Taghizadeh et al., 2012; Tu et al., 2015). Additionally, data shows the lack of standardization of waste management processes in HEIs. It is worth mentioning that waste management varies according to HEIs financial, social, cultural, population, size, and teaching, research and extension profiles (Zain et al., 2012). Botelho (2012) states that HEI waste management, when poorly, done can lead to the deterioration of public health.

HEIs are tackling social-environmental issues by adopting Environmental Management Systems (EMS) (Iojã et al., 2012; Ramos et al., 2015), and Sustainability Certification (Ceulemans et al., 2015). In Brazil, the University of Passo Fundo, implemented an EMS based on the International Organization for Standardization (ISO 14000) set of standards, significantly reducing its negative impacts on the environment (Tauchen and Brandli, 2006). The University of Monterrey adopted a sustainability reporting system, based on the Global Reporting Initiative postulating goals to encourage the entire university community to reduce natural resource consumption (Bremer and López-Franco, 2006).

Sustainability certifications for HEIs are also successful strategies to pursue sustainability, e.g. Sustainability Tracking, Assessment & Rating System (STARS) and Green Metrics, however, these tools do not specifically address waste management, hence they are not sensitive enough to support decision making regard waste prevention, and recycling.

3. Methods

3.1. Solid waste management index for Brazilian Higher Education Institutions

The Index is specific for Brazilian universities since it uses specific legislations in its construction and criteria selection. Through field research and literature review, several criteria were selected and must be considered when discussing waste management at HEIs. These criteria are divided into items that can positively foster and that can strengthen the university's transition towards sustainability.

This set of criteria aims to provide the right questions on how to proceed to enhance HEIs' waste management systems, such as: Are we discussing waste management in all our possible means of communication? Are we concerned about engaging our community? What are we doing to minimize our impacts on natural resources? What can we do to tailor waste management to a more environmentally friendly bias?

Applying these criteria will allow for a type of diagnostic view. It will replace the creation of basic data on the performance of the environmental and sustainability aspects of the HEI before the implementation of the framework, as well as advising on how the institution pursues and manages these aspects.

For the criteria selection, articles concerning sustainable waste management were selected and studied according to literature review. Data from ISO 14000 EMS series, Global Reporting Initiative self-reporting framework, and Green Metrics and Sustainability Tracking Assessment & Rating System (STARS) HEIs sustainability certification, and specific Brazilian legislation were used.

3.2. Dimensions criteria assessment descriptions

Four dimensions were considered in this work Engagement, Educational, Operational and Policy & Management. These can be further divided in sub dimensions as will be shown in Section 4.1.

The Education (Teaching, Research and Outreach) Dimension is a key part of the Index, and it assesses how the HEI integrates environmental issues in its students training pillars. It is paramount to understand that the HEIs, different than other institutions, have the obligation to build knowledge and to train its community to serve society challenges, such as climate change, and to tackle a more sustainable development.

The Engagement Dimension criteria were selected to picture HEIs' responsibility to prepare new leaders, based on sustainability principles, given the opportunity for raising awareness and sustainable culture by engaging its community in daily activities, by preparing them to see daily challenges and solve it through more sustainable approaches.

The Operational Dimension pictures a diagnosis of the waste management initiatives promoted by the HEIs concerning its operational daily activities, its criteria tackle to assess what and how much is being generated?

The Policy & Management criteria asses if there is any policy to support waste management initiatives, or if the higher management focuses in transitioning or strengthening the HEI to a sustainable waste management.