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The accounting system as complementary data source for Organizational Life Cycle Assessment of Higher Education Institutions

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Having an environmental management system (EMS) certified in ISO 14001 or verified in EMAS in a Higher Education Institution does not ensure the availability of the data needed to carry an Organizational Life Cycle Assessment (O-LCA) according to ISO 14072. The integration of the accounting system as an information source might provide the necessary missing data.

This research studies the use of the information available in the accounting system as a complementary source of information to assess O-LCA of EPSA, an environmental unit of Universitat Politècnica de Valencia (UPV). The accounting system manage valuable information that can cover some of the information gaps that UPV EMS has. Nevertheless, structural changes are needed in order to be able to carry an O-LCA based on the data offered by EMS and the current accounting system. The strength and weaknesses of using the current accounting system as a complementary source to cover the lack of quality data of UPV EMS are highlighted. Measures are proposed with the aim of improving the register and management of environmental data.

Keywords: Accounting system; environmental performance; higher education institutions; environmental management system; organizational life cycle assessment

El sistema contable como fuente complementaria de información del Análisis de Ciclo de Vida en Institutos de Educación Superior

La certificación ISO 14001 o la verificación EMAS no garantizan que el sistema de gestión ambiental de una institución de educación superior gestione la información necesaria para llevar a cabo un análisis de ciclo de vida de la organización (ACV-O) según la ISO 14072. La integración del sistema de gestión económica como fuente de información podría aportar los datos faltantes requeridos. Esta investigación estudia el uso de los datos disponibles en el sistema contable como fuente de información complementaria para llevar a cabo el ACV-O de la EPSA, una de las unidades ambientales de la Universitat Politècnica de València (UPV).

El sistema contable gestiona información valiosa que puede cubrir algunas de las brechas de información que tiene el SGA de la UPV. Sin embargo, se necesitan cambios estructurales para poder llevar a cabo un ACV-L basado en la información que ofrecen el SGA y el actual sistema contable. Se identifican las fortalezas y debilidades del uso del actual sistema contable como fuente de información complementaria para cubrir la falta de datos de calidad del SGA de la UPV. Además, se proponen medidas con el objetivo de mejorar el registro y gestión de la información ambiental.

Palabras clave: Sistema contable; desempeño ambiental; instituciones de educación superior; Sistema de gestión ambiental; análisis de ciclo de vida de organizaciones

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1 Introduction

The commitment of Higher Environmental Institutions (HEI) with the environment by managing and assessing their environmental performance has increased the number of institutions with Environmental Management System (EMS) with different scopes (Lozano et al. 2015, Hancock and Nuttman 2014, Gustavo De Lima et al. 2016). The implementation and maintenance of an EMS has proven to be a useful tool to manage the environmental aspects (EA) of a HEI (Torregrosa-López et al. 2016).

In particular, EMS certified in ISO or verified in EMAS provide a structure to assess the impact of a wide range of activities and processes that constitute significant EA of the institution. These assessments can be made either through the evaluation of environmental indicators as an Ecological Footprint (EF) or achieving holistic environmental assessments as an Organizational Life Cycle Assessment (O-LCA) (Lo-lacono-Ferreira et al., 2016a, 2017).

The O-LCA is a life cycle approach for addressing the environmental footprint of organizations (United Nations Environment Programme, 2015). O-LCA is defined by ISO (2014a) as a “compilation and evaluation of the inputs, outputs and potential environmental impacts of the activities associated with the organization as a whole”. Therefore, all the activities, processes, inputs and outputs need to be identified and characterized. O-LCA is based on the four-phase methodology stated by ISO 14040 and 14044 (International Organization for Standardization 2006a, 2006b) where the definition of the goal and scope are required along with an inventory analysis, the impact assessment and the interpretation of results. One of the challenges of performing an O-LCA is being able to collect all the quality data required to guarantee the representativeness of the assessment without involving excessive costs for data collection (Martinez-Blanco et al. 2015c).

The activities and processes that constitute an EA interact with the environment through its input and output flows. The evaluability of these EA depends on the availability of quality data regarding these inputs and outputs. Unfortunately, a certified or verified EMS does not ensure the availability of quality data to assess all the inputs and outputs. Previous studies have pointed out data availability and data quality as weaknesses of HEI's EMS (Lo-lacono-Ferreira et al. 2016b, 2017).

Escuela Politécnica Superior de Alcoy (EPSA), one of the environmental units (EU) of *Universitat Politècnica de València (UPV)*, has been chosen as pilot for several environmental assessments where these weaknesses have been highlighted (Lo-lacono-Ferreira et al., 2011, 2016a, 2016b, 2017). For example, the EMS of EPSA establishes a protocol for green procurement but does not register the purchases of material and equipment and their characteristics. Therefore, the information to properly assess the environmental performance is not accurate or enough detailed.

The lack of quality data has conditioned results that could only be obtained partially. Consequently, data flows are considered key aspects to fully understand how environmental information is managed and outline solutions for the short term. For that matter, the accounting system is proposed as an alternative data source to provide environmental information of those inputs under financial control.

In this paper, an analysis of EPSA accounting registers of 2015 has been made in order to explore the possibility of assessing life cycle impact assessment (LCIA) for past periods with no additional structures. The following characteristics have been explored:

- Suitability of the categories defined in the system: budget categories.
- Life cycle inventory (LCI) coverage.
- Quality of data.

Besides the detailed analysis of the accounting system of EPSA, a proposal to classify and manage the accounting registers with environmental purposes. Furthermore, the available data with acceptable quality is gathered and presented irrespective of its source (accounting system or EMS).

1.1 Case study description

EPSA is one of the 211 EU defined in UPV's EMS. The EPSA consist of 3 buildings located in the city of Alcoy. In 2015, EPSA hosted 2,494 students and was managed by 300 staff members between professors and administrative and service personnel.

EPSA has different degrees of control over its inputs and outputs. Table 1 gather all the inputs and outputs related to EA identified in previous studies (Lo-Iacono-Ferreira et al., 2016b, 2017) and the description of its control degree. Partial degree of operational control indicates that although the operational control is not fully in charge of EPSA, the EU has enough control to significantly influence the operations related to this input or output.

In 2015, the accounting system of EPSA managed over 180 different suppliers with more than 1400 registers (products purchases, service contract, taxes and other operations). All inputs under financial control of EPSA are also under operational control.

Table 1. EPSA Input / Output control description

	Input / Output	Financial control	Operational control
Inputs	Electricity	No	Yes
	Water	No	Yes
	Gasoil	No	Yes
	Natural gas	No	Yes
	Office supplies	Yes	Yes
	Supplies	Yes	Yes
	Automobiles	Yes	Yes
	Technology assets	Yes	Yes
	Movable assets	Yes	Yes
	Services	Yes	Yes
Outputs	SO ₂ , NO _x , CO, HFC, CO ₂ emissions	No	Partially yes
	Debris	No	Partially yes
	Electric waste	No	Partially yes
	Oil, fuel and hydrocarbon waste	No	Partially yes
	Paper and cardboard waste	No	Partially yes
	Light packaging waste	No	Partially yes
	Ink and toner waste	No	Partially yes
	Municipal solid waste	No	No
	CD waste	No	Partially yes
	Waste water	No	Partially yes

2 Method: Accounting system and budget analysis

Figure 1 shows the weight of each budget category. Items with less than 1% budget are grouped in a general category named others. This category includes mail and messaging costs, scholarships (including social security payments), purchases of equipment for information processes, fuel, studies and technical work outsourcing, software purchases, other miscellaneous expenses, acquisition of technical facilities, acquisition of equipment and tools,

acquisition of other tangible assets, laboratory equipment supplies, vehicles insurance, acquisition of intangible assets, local tributes, expenses of locomotion and other transport services.

The budget category with more representation is the one that gathers miscellaneous outsourcing with more than a 37% of the overall weight. In this category are clustered all those services outsourced without a specific budget; social network and communication management are part of this category. The relevance of the environmental impact of this 37% of the budget is difficult to assess as no detail information is included in the concerning invoices. These services may require high environmental impact equipment and travelling impossible to evaluate without full collaboration of the service provider.

The second budget category with more than 28 points of difference is 'advertising and propaganda expenses' with over 9%. This portion includes the design and display of online banners, outdoor advertisement and broadcasting. As in the previous category, its environmental impact assessment requires close involvement of providers.

'Protocol and representation' and 'supplies of other products' are the following categories represented by a weight of 8.1% and 5.7%, respectively. *Other products* refer to all the products that are not office or laboratory supplies represented by specific categories. This category includes from keys to light bulbs passing through nails, ropes or gloves. Most of these supplies are purchased at hardware or variety stores where their invoices or receipts either have internal code descriptions or no description at all. However, the environmental impact of some of these supplies might be relevant due to its composition and or provenance. An approach could be possible with direct information from the people that generates the purchase orders or the orders themselves. Anyhow, a system or protocol needs to be built in advance to ensure the accurate register of data. It should also be considered that most of the providers are third parties and not manufacturers, so the assessment process, an LCIA for example, will require extra resources in order to obtain all the information needed for the assessment.

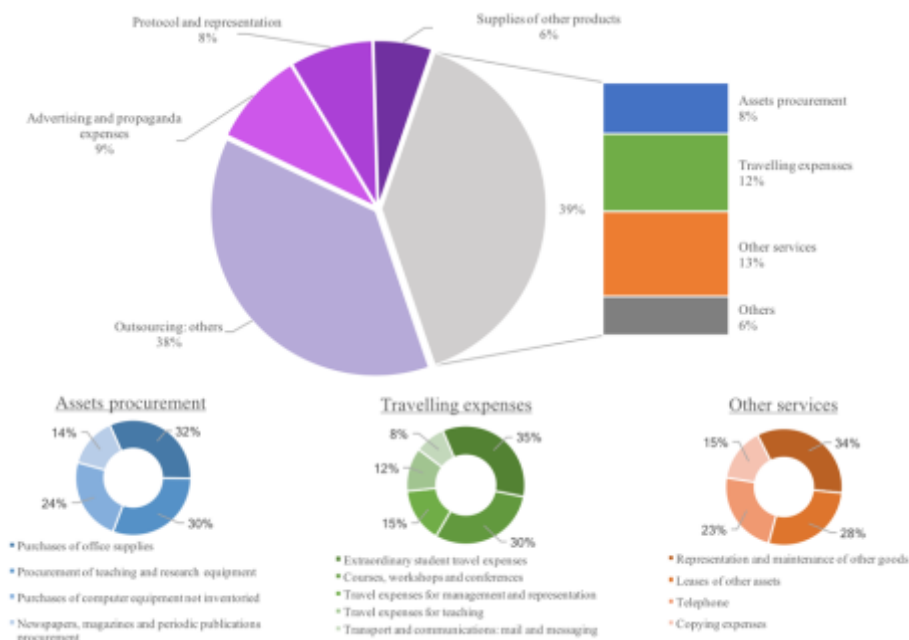
Protocol and representation partition is, mainly, restaurants and transport services although there can be some institutional gifts purchases. Even though the accounting regulation forces to attach a short letter with the purpose and the attendee names, this information is not computerized. In addition, recipes and invoices not always describe the dishes but a general reference to the menu or diners. Having accurate data to assess the impact of each event might be complicated.

With an impact between 5% and 1% of the budget of EPSA there are thirteen categories that can be classified in three sub-categories: assets procurement, travelling expenses and other services. Assets procurement includes office supplies and computer equipment not inventoried, teaching and research equipment, newspaper, magazines, etc. Travel expenses includes extraordinary student trips as the ones made for a conference, a visit to a company, contests and congresses charged to EPSA accounts. Telephone costs, leases, maintenance of certain goods (as the owned vehicle) and copying expenses might be included in the service sub-category.

The processing of the cash flows associated with these categories does not require, in the current system, a quality description that may allow a detailed assessment of their environmental impacts. An additional 'other' category gathers the seventeen categories below the 1% of representation in budget.

The categories that compose the budget have been defined according to the needs of the accounting management only. As a result, these budget categories can feed more than one activity and process of the EU and those activities and processes can require inputs from more than one budget category.

Figure 1. Budget of EPSA by categories. Notice that categories in bar graph are not formal categories of the accounting system but groups of categories with a common base. These groups are detailed in the doughnuts graph



2.1 Registers classification proposal

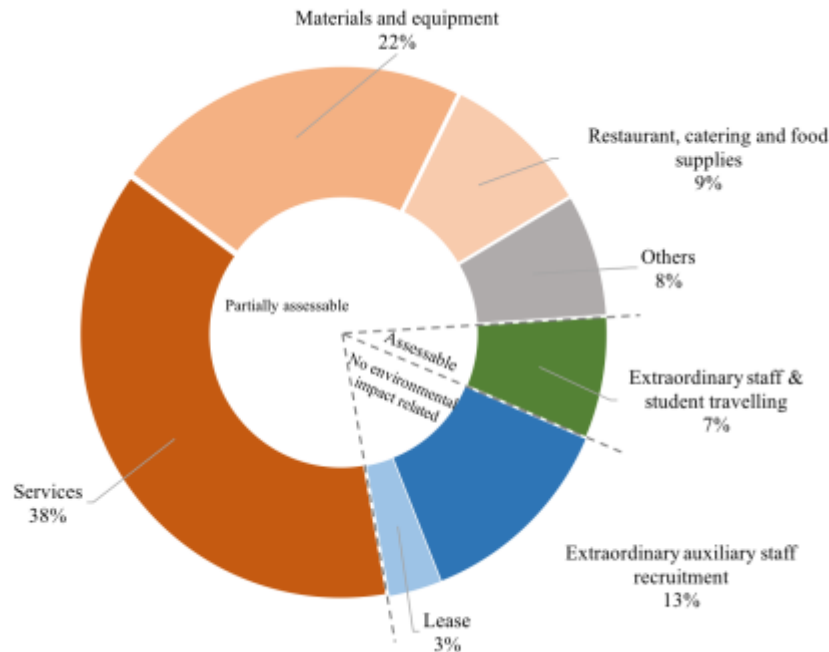
For a better analysis over the environmental performance of the EU a classification of the register in the accounting system, despite their budget classification, is proposed. Each register is classified in restaurant, catering and food supplies, lease, extraordinary auxiliary staff recruitment, extraordinary staff and student travelling, materials and equipment, services and others for those registers that cannot be placed in one of the previous categories. Figure 2 represents the monetary contribution (excluding VAT) of each category for EPSA in 2015. VAT has been excluded in order to simplify the analysis and to set the basis for a future correlation of results for comparing purposes. It is belief that useful correlations can be made in future assessments considering GDP variations; excluding VAT fees, that can also vary in time due to economic policies, the uncertainty of any operation is reduced.

The first category 'restaurant, catering and food supplies' gathers work meals, protocol lunches and dinners, coffee breaks services hire for special events and additional supplies like coffee capsules or others purchases for the daily use at the office. Lease category includes all the registers linked to the leasing of complementary facilities. Extraordinary auxiliary staff recruitment category responds to the recruitment of students through UPV founding 'Servipoli'. This is an organization with the purpose of complementing the training of students through work experience inside and outside UPV strengthening their employability. Students are employed for short periods to cover the needs of UPV services or special events like conferences. Extraordinary staff and student travelling category covers all the expenses of extraordinary trips like meetings in other campuses, field trips, etc. paid by EPSA. Materials and equipment category gathers all the purchases including office supplies, lab supplies, tools, computers and other equipment. Services represents all services hires by the EU from external printing services and advertising to laundry services and mail costs.

The 50% of expenditures are covered by services, materials and equipment. Both categories might have a relevant environmental impact due to its nature. However, the information

available in the current system for the year of analysis is not detailed enough to allow an environmental impact assessment. Regarding services, invoices usually contains general information. It is believed that a good approach can be made for further studies if service providers already have or are willing to conduct an environmental assessment of their performance and share their results.

Figure 2. Monetary distribution of EPSA inputs for 2015 by category.



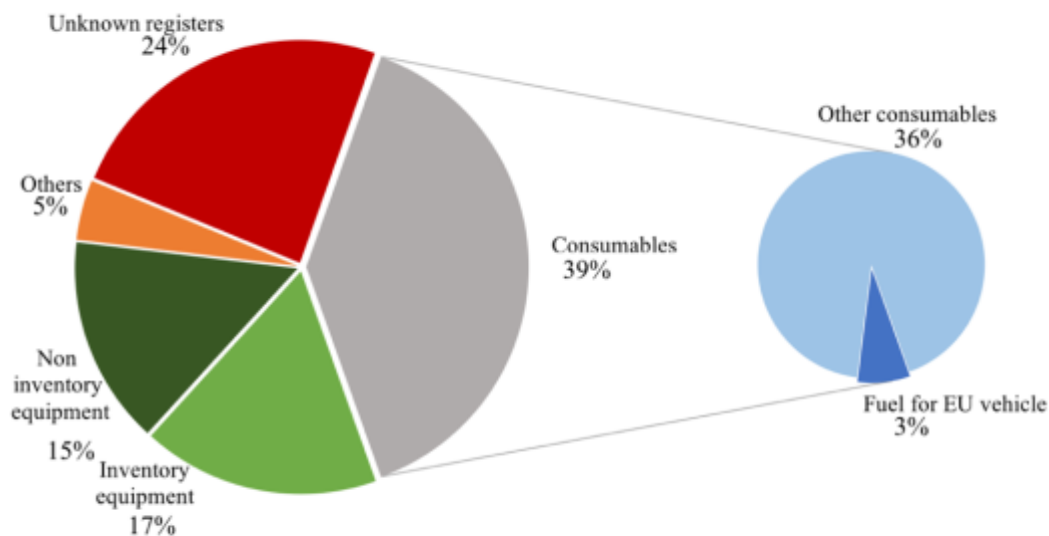
Materials and equipment environmental impact category might also be approached at least in a fraction. For a better analysis of this category, an additional sub-classification is proposed where purchases are distinguished between inventory equipment, non-inventory equipment, consumables and others (Figure 7-3). Also, the consumable category is deeply analyzed to highlight a specific type of register: fuel purchases for the vehicle owned by the EU. This sub-category has a special meaning because (a) it has a significant environmental impact regarding its GHG emissions in the use phase as shown in previous studies (Lo-lacono-Ferreira et al., 2016a) and (b) it is fully assessable only by the information contained in the receipts. Although there are 4 of the 25 purchases that do not attach the corresponding receipt, knowing the date of purchase, the amount paid and the type of fuel the volume (in liters) it is easy to draw conclusions using the history average price of fuel published by the Spanish Ministry of Industry, Energy and Tourism (2015).

There are 100 registers of non-inventory equipment which include different types of products from desktop calculators to small tools. Some of these products have a life of less than a month while others might be in use for several years. The equipment that is registered in the inventory contains computers, lab equipment and other types of complex equipment with unknown composition or manufacturer information. 'Other consumables' include office supplies, maintenance supplies and all type of consumables most of them registered with a generic identification. It is extremely difficult to make assumptions over the composition or manufacturing process of inputs without full collaboration of staff that request the materials, suppliers and manufacturers.

For example, there are more than 20 different registers of adhesives and glues generally described and a similar amount of wires where the type and length is not always registered.

Some registers do have detailed information; this is the case of writing material. There are more than 420 pens, pencils and markers that do have the detail of brand, color and model; in this case, it would be possible -with additional resources and the collaboration of the manufacturers or solid research- to approach their environmental impact. Something similar happens with the batteries that are more than 80. Without a first full assessment, it is extremely difficult to have a realistic approach of the environmental impact of these materials and, therefore, to apply any additional cut-off criteria. Same happens with the more than 250 services that would need an evaluation of the suppliers or, at least, a more detailed description.

Figure 3. Analysis of registers of the material category for EPSA 2015.



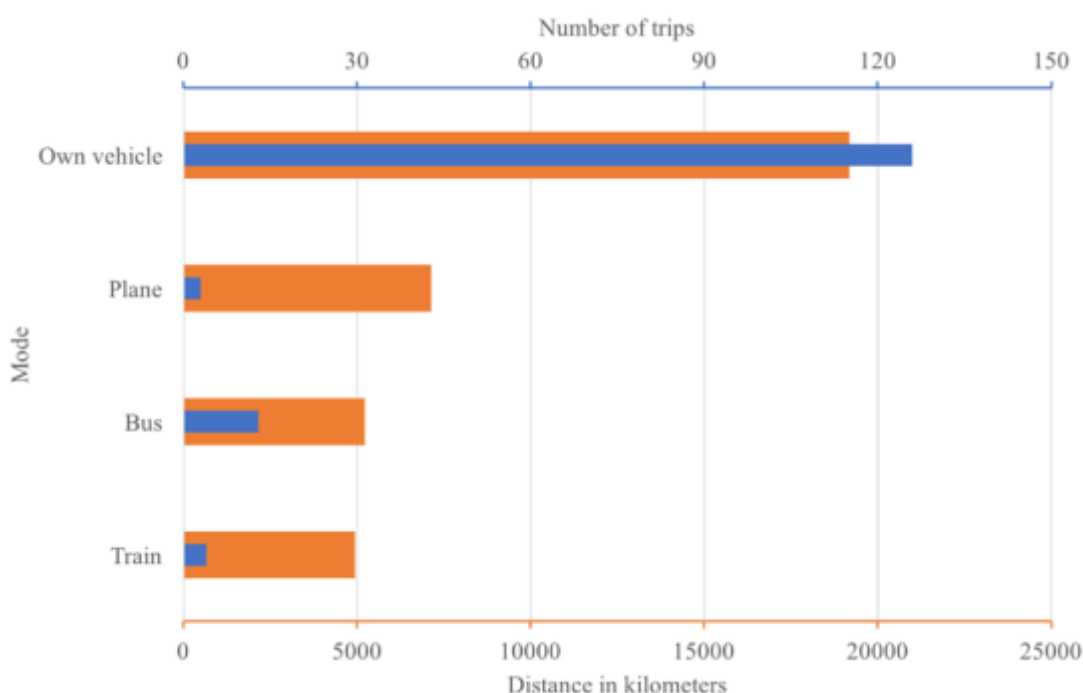
In the overall analysis of these sub-classification, an unknown category has to be included as there are registers with incomprehensible description based on an internal supplier's code or abbreviations not possible to be classified without the collaboration of the supplier or whom made the request; not always identified in the invoice or receipt and not identified in the system.

The next most relevant category in the monetary distribution of EPSA inputs for 2015 (Figure 2), extraordinary auxiliary staff recruitment, does not have a direct environmental impact associated as it is a temporary growth of employee workforce. The indirect impact that this increment of human resources implies is reflected in other categories by an increment of services, materials consumption, food supplies, etc. Something similar can be considered for the lease category by increasing services, equipment, materials, etc.

Restaurant, catering and food supplies represents 9% of the inputs while the category assigned to extraordinary travelling of staff and students is 7%. Both categories might have a significant environmental impact. Nevertheless, the category of restaurant, catering and food supplies is mainly a third-party contribution category. These impacts are difficult to assess; the full collaboration of the suppliers is needed as already discussed. In addition, 42% of the more than 200 registers related to this category have generic information, i.e. menu for 3, where no details of food and drinks are provided. In some cases, even the number of diners are not clearly defined. The other 58% have more specific information (i.e., coffee, small bottle of water, beer) but still not enough details to carry out a proper assessment.

On the contrary, extraordinary staff and students travelling concept have a stricter regulation requiring more specific information. The type of transport and the distance traveled are essential requirements for processing any economic compensation for extraordinary trips made both by staff and students. Figure 4 shows that the most common transport mode was by personally-owned car with almost 20,000 km traveled in 2015. The bus was the mode used for field trips for groups of students regardless the distance. Train and plane were used by staff for meetings and conferences outside UPV where distances were over 200 km; the meetings that took place in one of the other campuses of UPV (Valencia or Gandía) or inside Valencia Region commonly request one person only that takes, for convenience, his own vehicle. Distance for these last trips were between 15 and 300 km while train was used for distances between 200 and 1000 km.

Figure 4. Analysis of extraordinary travelling of staff and students of EPSA for 2015.



The category that gathers all the registers that cannot be assigned to any of the previous is a not less significant 8%. This category is composed by taxes, fees and other registers with not enough specifications. The environmental impact of it is uncertain.

3 Results: EPSA available environmental quality data

Regarding electricity, water and natural gas consumptions of EPSA (including air conditioning and heating system requirements), it is important to notice that these inputs are not under financial control of the EU. These services are paid from the general budget managed by the rector's office. The analysis of the accounting system of EPSA has no coverage over these inputs and, therefore, no financial control over the environmental aspects related to them. However, there is a direct operational control that allows actions to optimize the use of these supplies. Furthermore, the consumption data related to these inputs is managed by the EMS; as EPSA is a EU of the HEI, the information is allocated allowing its individual assessment.

According to the prioritized list of activities and processes for EPSA that considers the controlling state and the significance of the aspects involved (Lo-lacono-Ferreira et al., 2017), the electricity consumption is a relevant input. Please notice that all the electricity consumption

requirements are gathered in this activity/process item. Something similar happens with the water consumption that is represented by the sanitary system item in the EA list. Heating system, however, is the less relevant item of all the activities and processes described. Depending on the value assigned to the cut-off criteria, the consumption of gas could be left out of the analysis. For the cut-off proposed by Lo-Iacono-Ferreira et al., (2017), a 5%, the gas consumption that is fully represented by the heating system would be left out of the assessment.

In any case, electricity, water and natural gas consumption are inputs easy to assess as specific data in consumption units (kWh, m³, etc.) can be obtained from the invoices if there is access to these documents. However, UPV EMS currently includes these data in the annual public report, making easier to take into any assessment.

Regarding outputs, the EO monitors waste generation and emissions as a regular activity of the EMS. There are defined protocols to assess each flow either by direct measurement or by estimation. These protocols are validated by the EMAS verification procedure and available to every member of the community.

As a summary, Table 2 shows all available input and output data for EPSA for 2015 where AS source stands for accounting system. Notice that, in 2015, EPSA had 2494 students and 300 staff members (personnel). The table also includes information regarding the type of procedure:

- **Direct**, when the data is obtained directly from the source
- **Estimated**, when an estimation procedure is needed to obtain the data. Estimation procedures, when required, are defined in the corresponding protocol as part of the EMS, therefore, are also validated.

Table 2. EPSA available inputs and outputs data for 2015.

<i>Flows (Inputs / Outputs)</i>	<i>Value for 2015</i>	<i>Units</i>	<i>Source</i>	<i>Type of procedure</i>
Fuel for EPSA vehicle	1149.25	l	AS	Direct
Distance traveled by staff and students using their own car	19173.8	km	AS	Direct
Distance traveled by staff and students by train	4954	km	AS	Direct
Distance traveled by staff and students by plane	7144	km	AS	Direct
Electricity consumption	1368.87	km	EMS	Direct
Natural gas consumption	1341001	kWh	EMS	Direct
Water consumption	6661	m ³	EMS	Direct
Paper and paperboard waste generation	29040	kg	EMS	Estimated
Light packaging waste generation	25840	kg	EMS	Estimated
Glass waste generation	2562.02	kg	EMS	Estimated
Municipal solid waste generation	81504.33	kg	EMS	Estimated
Batteries waste generation	87	kg	EMS	Direct
RAEEs	1520	kg	EMS	Direct
Land use	28717	m ²	EMS	Direct
HFC direct emissions	0	t CO ₂ e/personnel	EMS	Estimated
SO ₂ direct emissions	0.0004	t/personnel	EMS	Direct
CO direct emissions	0.0001	t/personnel	EMS	Direct
NO _x	0.0002	t/personnel	EMS	Direct
GHG direct emissions	0.92	t CO ₂ e/personnel	EMS	Estimated

The flows with available data covers partially the activities and processes identified. For example, the data of the inputs and outputs of lighting and lifting system, sanitary system, heating system and air conditioning system is registered in the current system. The other activities or processes have part of the information. However, the assessment of those activities or processes that do have available data of their flows is not possible without an allocation procedure of its flows. For example, although the consumption of electricity of EPSA is known, there are no electrical instruments that allows a proper allocation of the individual consumption of each process that requires electricity. For more details about the identification of flows by activities and processes, please see Lo-Iacono-Ferreira et al., (2017).

In a midterm, with some resources, additional features can be included in the accounting system in order to sub serve the incorporation of more and better data with environmental assessment purposes. For example, a register of the purchase orders with details of the items would allow a cross check with invoices that might help identifying the elements. The identification of the person who sets the order might also be useful to assist in some stage. Something similar can be applied with services hired. This could convert the 22% of material and equipment and the 38% of services category in the monetary distribution (Figure 2) in assessable.

Moreover, with more details about the number of diners and the collaboration of the establishments, some estimations can be made over the category related to food services. As most of the off-campus restauration events take place in a limited number of establishments, it is feasible to make an approach of the impact for the most frequent places previous commitment of the responsible of the establishment and with active support from the HEI. The relation can also serve as tool to improve the performance of the local establishments and the city by supporting and encouraging stakeholders to implement actions to minimize the impact of their activity (i.e. Green Seal Standard for Food Service GS-46).

4 Discussion and conclusions: structure, coverage and quality

In the light of the results obtained for the analysis of the budget structure and the registers of the accounting system, only two categories or sub-categories can be assessed with the current information in the system: extraordinary travelling of staff and students that represents a 7% of the monetary distribution of inputs, and the purchase of fuel for the vehicle owned by the EU that represents a 0.6%. However, this 7.6% rises up to an 8.4% when only the value of the registers that have an environmental impact associated (84% of the total monetary value of inputs) are considered.

In conclusion, although the budget categories are not completely appropriate for an environmental analysis, a classification has been proposed to address the analysis of the inputs with financial control from EPSA. This proposal classifies inputs in:

- services,
- extraordinary travelling of staff and students,
- restaurant, catering and food supplies,
- lease,
- extraordinary auxiliary staff recruitment,
- materials and equipment that are sub classified in inventory equipment, non-inventory equipment, consumables (separating fuel from other consumables) and
- others

The quality of data is not appropriate and makes impossible an assessment except for the two subcategories described: fuel for the vehicle owned by the EU and extraordinary travelling of staff and students; just 8.4% of all inputs that directly affect the environmental performance of the institution. The lack of information and the diversity of products and services exclude the

possibility to develop a proper assessment. Although some tools like LCA commonly applied monetary cut-off criteria, there is no straight relationship between the monetary value of a product or service and its environmental impact so the uncertainty of the analysis will be unknown. Not knowing the environmental impact of a whole category makes it difficult to assign a relevance value to one of its fractions.

Overall, the accounting system manage valuable information that can cover some of the information gaps that UPV EMS has. Nevertheless, structural changes are needed in order to be able to carry an O-LCA based on the data offered by EMS and the current accounting system.

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