

## **Electronic recycling as a strategy to strengthen the academic projects of engineering students**

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**Abstract:** Ecological damage requires society to work together. The university as a promoter of sustainable development must permeate environmental education in its training cycles. As a strategy to promote electronic recycling, the Faculty of Mechanical and Electrical Engineering (FIME) in Mexico put into practice the program of Disassembly of Electronic Scarp (DYME). This strategy allows students to deliver electronic equipment in disuse; in addition, they can take pieces for reuse in their academic projects. The experience of this program shows the satisfaction of the benefited students, who indeed strengthened their projects. The program is also a university social responsibility strategy, which promotes ecological habits.

**Keywords:** social responsibility, environmental education, electronic recycling, reuse, higher education

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### **I. INTRODUCTION**

The global reality demands a social development with three characteristics: universal, integral and sustainable. This means, a development that includes everybody, that fosters an integral growth of the person and that lasts for future generations. The university, which in essence searches the development of society, must commit itself to achieve concrete strategies of sustainable development. [1]

Higher education institutions, concerned for universal development, have generated in the last decades strategies to ensure quality. Standardization of university degrees have been achieved through the creation of national and international accreditation committees, promoting with this a better preparation for alumni. Even though these solutions are yielding results, it is necessary to build a social responsibility vision for the university, and construct strategies so that education is oriented towards sustainable development.

According to the United Nations Educational, Scientific and Cultural Organization (UNESCO) (2015):

“Sustainable development has not been achieved only with technological solutions, political measures and economic resources: we must also change our way of thinking and acting. To achieve this, a quality education for sustainable development is at all levels and in all social contexts.” [2]

As Cantú Martínez states, it is necessary to meet the demand for an education that contributes to sustainable development. Today, is needed an extraordinary attention to "legitimize sustainable development and improve conditions of equity and collective harmony; then so education would play a key role in sustainable human development.” [3]

Over the last decade, university social responsibility strategies have been constructed. Although social responsibility is a term coined for the first time in the business sector from several decades ago, the university has taken this concept to give it a renewed focus on its social meaning.

It is necessary for the university to have a starting point on its path towards social responsibility:

The relationship between the crisis of hyper specialized (fragmented) techno-scientific knowledge and its chronic blindness with respect to the global effects that it is, on the one hand, and the global social and ecological crisis, on the other, should be the starting point of a university. Reform of social responsibility that is not only cosmetic, but a deep reflection on the social meaning of the production of knowledge and the professional training of leaders in the era of science. [4]

The model of university social responsibility proposed by the philosopher François Vallaëys, which is widely diffused in Latin America, is based on the management of the impacts that the university generates with its environment. Impacts are grouped into four categories: organizational, educational, cognitive and social. Based on these, the model has four dimensions: responsible campus, professional and citizenship training, social management of knowledge and social participation. Figure 1 shows this model:

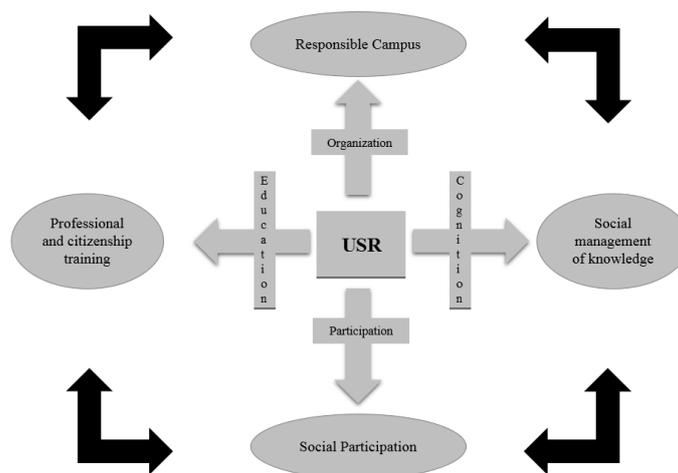


Figure 1: Model for university social responsibility strategies

Source: (Vallaey& de la Cruz, Responsabilidad social universitaria. Manual de primeros pasos, 2009) [5]

This work focuses just on two dimensions of the model: Responsible campus, and professional and citizenship training. The Responsible campus dimension implies the socially responsible management of the entire organization. It is about institutional processes such as working environment, human resources, internal democratic processes, community participation and environment care.

Among the procedures that promote environmental, the USR model proposes that the university should have:

- 1) Institutional policy for environment care
- 2) Personnel training in environmental issues
- 3) Organization in the campus life that allows the acquisition of ecological habits

On the other hand, the dimension of professional and citizenship training relates to topics that link professional learning with current needs. It stands out for this paper, the variable entitled "articulation between professionalization and social and environmental needs". On this topic, the model proposes the existence of the following strategies:

- 1) Courses and research projects that link the program with social and environmental needs.
- 2) Organization of forums and activities related to the development of social and environmental needs.
- 3) Contact specialists in social and environmental development issues
- 4) Creation of groups or networks with social or environmental purposes.

Throughout the last decades, work has been carried out on individual activities to improve the affected environment. These initiatives have been developed by the industries, which are sometimes mistakenly considered as the protagonist in the negative impact on the environment. Through different ways such as cleaner production, environmental reviews, ecological balances, measurement of impacts, among other environmental management strategies.

Although these actions have been an important advance, it is necessary that universities work on an environmental education to permeate an ecological culture along the training cycles and thus achieve a culture of sustainable development. [6].

This paper presents the results of a strategy carried out at the Faculty of Mechanical and Electrical Engineering (FIME) in Mexico. This strategy aims to develop ecological habits through electronic recycling and strengthen the academic projects of engineering students.

## II. BACKGROUND

The FIME belongs to the Autonomous University of Nuevo Leon (UANL). In this school, 10 engineering careers are offered: Systems Administrator Engineer (IAS), Aeronautical Engineer (IAE), Electronics and Automation Engineer (IEA), Electronics and Communications Engineer (IEC), Manufacturing

Engineer (IMF), Materials Engineer (IMT), Mechatronics Engineer (IMTC), Software Technology Engineer (ITS), Mechanical Administrator Engineer (IMA) and Electrical Mechanical Engineer (IME).

In addition, it offers diplomas and technical careers. The UANL, committed with the environment, establishes in its 2020 Vision: "The implementation of sustainable practices in all campuses, including all academic and administrative dependencies" [7]

Therefore, the FIME, likewise, in its strategical plan proposes the practice of a responsible management program, establishing the following specific objective: "Articulate the projects and activities of all academic and administrative areas, in coherence to the development of social projects that promote an equitable and sustainable development" [8]

On the other hand, to implement the model of university social responsibility, the FIME conducted a self-diagnostic study. For this, several actors were surveyed: teachers, researchers, administrative staff and students. In terms of environmental care, lacks were observed in terms of the culture of ecological habits and the relationship between classes and environmental needs. In Fig. 2, it is observed the opinion of the sample of 465 students who were surveyed.

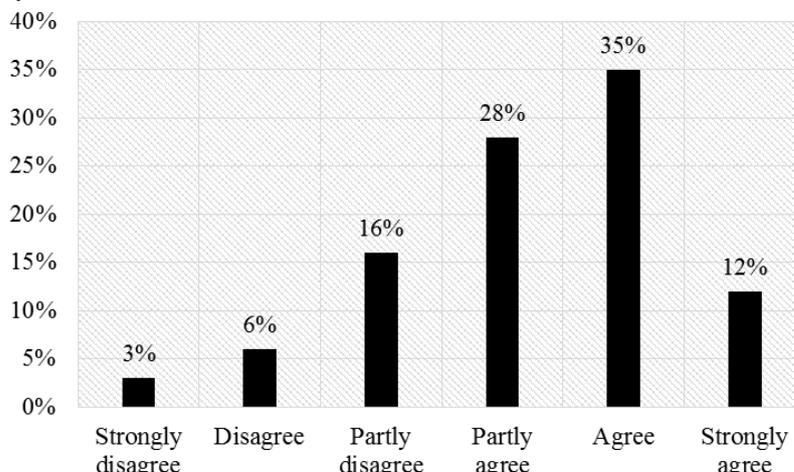


Figure2. Percentage in which teachers link their teaching with social and environmental problems  
Source: Prepared by the authors based on the self-diagnose data

As shown in the last graph, only 35% of students agree that teachers link their teaching with social and environmental problems.

However, 44% are partial in this respect: they are partially in disagreement (16%) or partially agree (28%).

On the other hand, the students also felt that there are deficiencies in the promotion of ecological habits

As shown in Fig. 3, 33% agree that they have developed ecological habits during their stay at the university. However, 32% partly and 13% partly disagree.

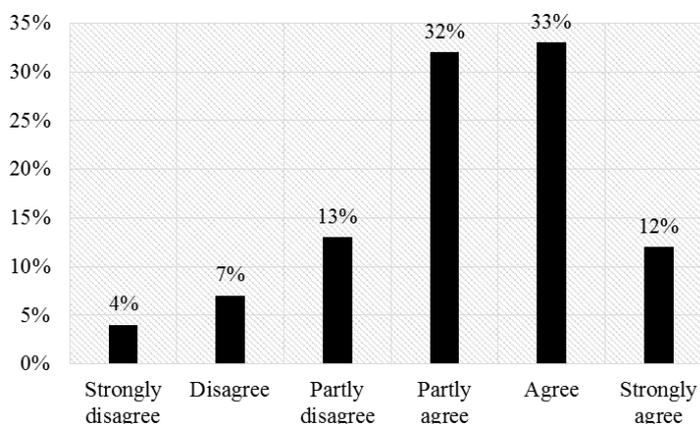


Figure 3. Percentage in which students have developed ecological habits  
Source: Prepared by the authors based on the self-diagnose data

With this background, FIME established recycling campaigns for solid urban waste (SUW). The SUW are generated in the houses because of the elimination of materials used in domestic activities, for example bottles, jars, packages, objects in disuse. Another source of SUW are commercial establishments or public roads, places where the waste is derived from the cleaning of public places. To be considered as SUW, wastes must have similar characteristics and quantities to domiciliary trash, existing a legislation that classifies them. [9]

Among the SUWs collected at the FIME are paper, PET, aluminum and electronic devices. Which, after being collected, are classified and channeled to local companies for their respective recycling or confinement.

The negative impact generated by electronic devices is very high. The amount of this waste is growing due to the continuous technological advances in the process of obsolescence of these. Waste electronic devices, in the fastest growing group in the world, it is estimated that 75% of them are stored in warehouses, offices or in the homes of users because they do not know how to dispose of them, according to the data of the SEMARNAT [10]

From this reality, in the SUW campaigns carried out by the FIME, a program called "Disarmed and Yonke of Electronic Materials" (DYME) was established. The DYME program seeks to promote the reuse of electronic devices, before their confinement, in academic engineering projects. In this way, the DYME contributes to reduction of the negative impact of electronic devices and at the same time strengthen the professional training of engineering students.

If there is no sustainable management, the waste from electrical and electronic equipment ends up in the landfill and they are not ready to handle components of these equipment (lead, phosphorus, cadmium, nickel and brominated plastics) [11] and manipulated by people who do not know the risk of its handling, nor does it have the necessary information for the recycling possibilities that these materials have, for that reason, after the collection, the reuse of the devices and once all that the waste can do is the FIME has the collaboration with companies dedicated to the recycling of electronic recyclable waste with the permission of the Ministry of Environment and Natural Resources [10]

### III. RESULTS

The DYME procedure is based on the following stages of the recycling process: collection, classification, reuse and confinement. The following stages are described below:

**Stage 1:** A dissemination is made among students, administrative staff and the public of the next recycling campaign.

**Stage 2:** For 1 or 2 days, all electronic devices were received in a large and open space.

**Stage 3:** The devices are classified according to their type: appliances, power sources, computers, keyboards, mouse, screens and monitors, printers, scanners, etc.

**Stage 4:** Students of the different FIME careers are invited to participate in the Yonke for the selection of equipment or pieces that they can reuse in their academic projects.

**Stage 5:** The remaining devices are moved to an authorized local company that gives them its proper confinement.

In the last edition of the DYME, there was a participation of 1069 students of the different races. According to Fig. 4, most students who participated in the DYME, were career engineers (IMTC) with 36%, followed by the careers of System Administrator Engineer (IAS) and Electric Mechanical Engineer. (IME) with 14% and in third place the career of Software Technology Engineer (ITS) with 13%.

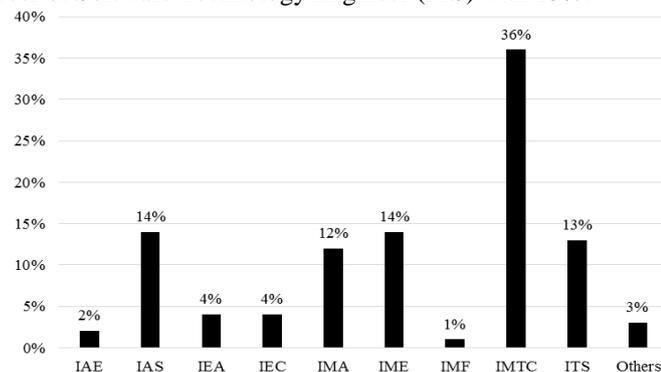


Figure 4. Student percentage by career that participated in the DYME

Source: Prepared by the authors based on the survey data

Of the students participating in the DYME, 74% used the recollected pieces for final projects and 26% said that for repair and personal use.

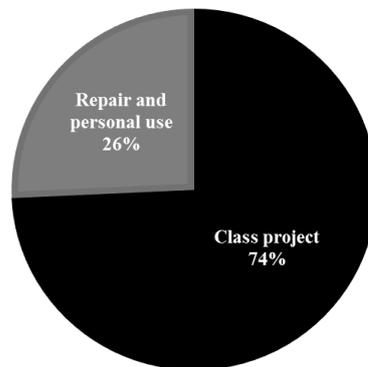


Figure 5. Type of usage of the electronic pieces obtained in DYME

Source: Prepared by the authors based on the survey data

As shown in Figs. 4 and 5 most of the students are the careers where the final projects require electronic pieces for their preparation, and as 74% of the students responded, it is precisely where they planned to use these same in the final projects of class. That is why at the end of the scholar period, the FIME looked for students who used the recycled pieces in final projects and applied them a second survey.

About the usage of the recycled electronic pieces as showed in Fig. 6, 96% said that the pieces were useful for their final projects of the courses.

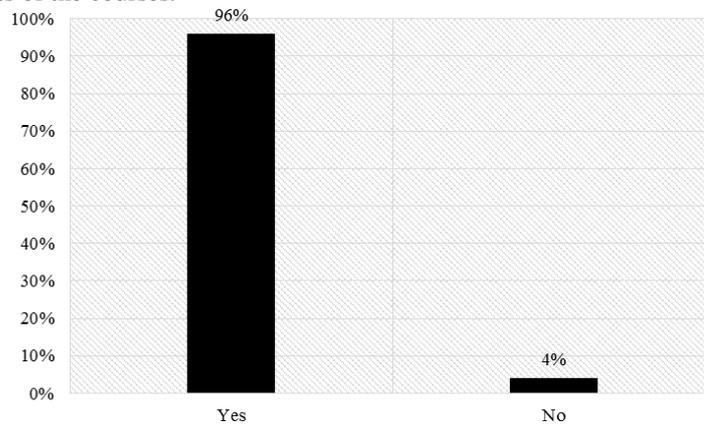


Figure 6. Usage of the electronic pieces obtained in DYME

Source: Prepared by the authors based on the survey data

Additionally to the usage of pieces, students were asked about how much the pieces were used in their projects. As shown in Fig. 7, 74% of the students answered considerably, while 22% answer few and 4% not at all.

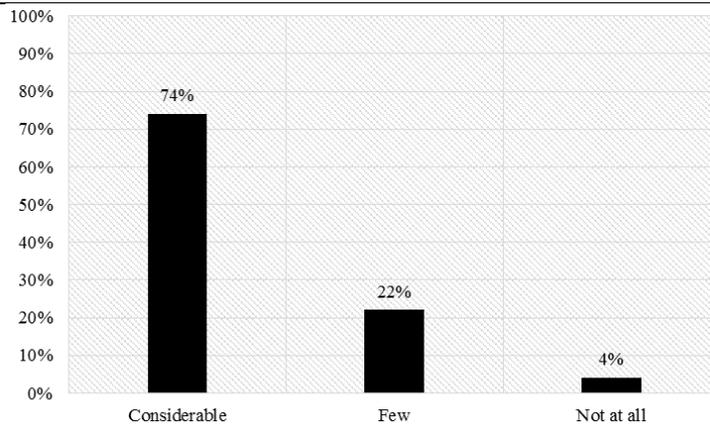


Figure 7. Percentage in which students use the pieces in their final projects  
Source: Prepared by the authors based on the survey data

Another important item to measure is the percentages of economic savings that implied the use of recycled electronic pieces in their final projects. As shown in Fig. 8, 66% of students expressed that the saving was considerable, while 26% said the financial savings were few, and 8% that they had no financial savings in their projects.

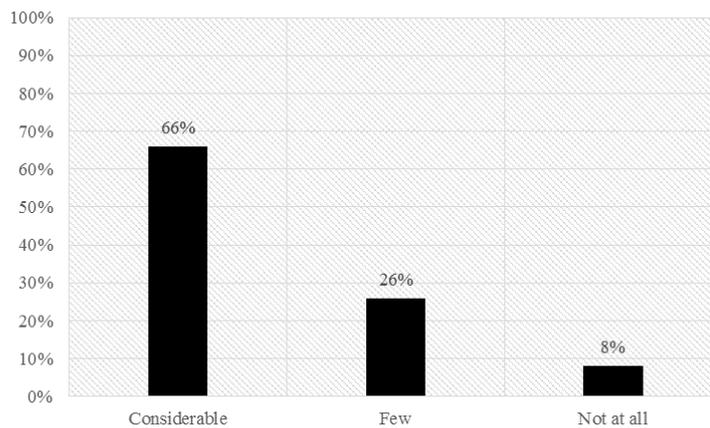


Figure 8. Saving percentage for using the recycled electronic pieces.  
Source: Prepared by the authors based on the survey data

As previously mentioned, FIME seeks to promote activities oriented towards social responsibility, for which the recycling program is carried out, but also seeks to help young people with their class projects. The students were asked if they consider important to carry out this type of events that encourage recycling. 92% responded affirmative, while 8% negatively, results are shown in Fig. 9:

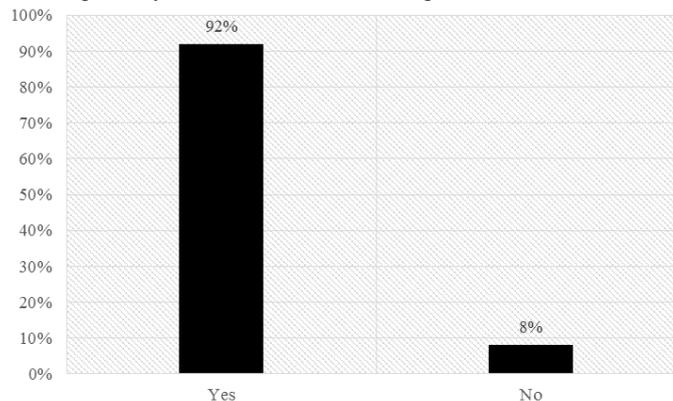


Figure 9. Percentage of importance of this type of events that promotes recycling.  
Source: Prepared by the authors based on the survey data

Finally, the students who participated in this program were asked for their evaluation of the DYME, having a response of 80% of the students who rated it as good, while 20% rated it as regular and nobody rated it negatively (see Fig. 10)

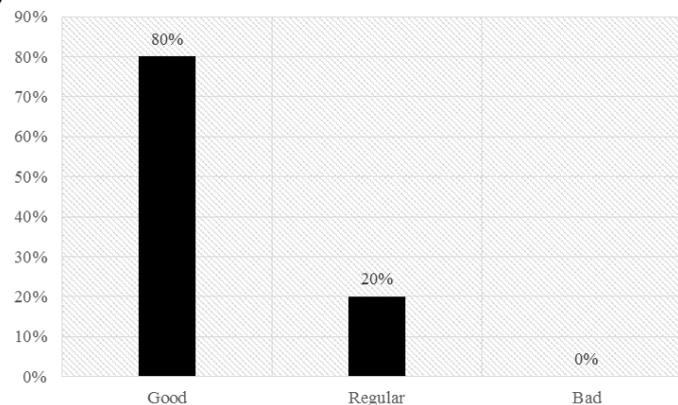


Figure 10. Percentage of rating that would be given to the program  
Source: Prepared by the authors based on the survey data

#### IV. CONCLUSION

Although several actions have been carried out for a long time to improve the environment, through the collection of waste, pollution control, the design of new technologies less harmful to the environment, among many others, it is observed that the main action to achieve is the personal development of ecological.

The achievement of the development of ecological habits, falls in much in the role played by the university, which is an institution that educated people, taking into consideration the social development.

Through attractive campaigns, the university can encourage the development of ecological habits in its students and also make them share in the benefits of recycling.

Through the DYME program, the FIME proved that the reuse of recycled equipment and parts is useful for engineering students. The students participated by donating their electronic devices, thus promoting the ecological habits. On the other hand, they benefited from reusing electronic devices in their academic projects.

This type of programs that require effort and organization on behalf of university is a strategy that demonstrates that social responsibility is possible. Through the joint work of the different actors of society, creating links, it is possible to reduce the environmental damage and encourage the change of ecological habits.

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