A SUSTAINABILITY ANALYSIS OF CAMPUS ECOLOGY

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ABSTRACT

This study determined the Ecological Footprint of the Social Sciences Building of Xavier University-Ateneo de Cagayan Main Campus' using the Ecological Footprint Analysis (EFA). Specifically it aimed to assess assess the sustainability implications of the building's ecological footprint. Five impact categories were considered in the determination of the ecological footprint of the Social Sciences Building. The information for the five impact categories were entered into a computer spreadsheet which is then assigned a land value to each of the components, and summed to come up with the overall Ecological Footprint of the Social Sciences Building of Xavier University Main Campus.

The various components of Social Sciences' ecological footprint reflect the role of the occupants of the building as major consumer of natural resources responsible for a wide range of ecological impacts. The components of the Ecological Footprint of the building listed in the table below require an area of land equivalent to 552 hectares or 717 soccer fields to sustain campus demands--including a campus and a half for the effects of water use, material use, food, travel, waste and recycling and electricity demand. Applying the approach to sustainability, Social Sciences' Building footprint is strongly sustainable.

From a strong approach to sustainability, it should be reiterated that the findings in this research only included a portion of the building's total ecological footprint. It is likely that, with the

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addition of other factors such as food, material use and so on for all students in the building and accounting for all wastes, the Building'sfootprint could not even be considered sustainable from a strong perspective. From a strong or ideal approach to sustainability there are plenty of opportunities for the building to move toward sustainability.

Keywords: Sustainability, Ecological Footprint Analysis

Introduction

Background of the Study

The issue on campus sustainability is not unique to Xavier University-Ateneo de Cagayan, as this disconnect is the norm at colleges and universities. Nonetheless, it is hoped that the University community will see the logic in that statement. This environmental challenge will test the creativity of the University as an educational institution. The campus ecological footprint is one useful tool toward meeting the challenge as many countries around the world used the Ecological Footprint Analysis (EFA) a tool to measure the sustainability of the consumption pattern of its citizens. Also, various universities in the United States like the University of Redlands and Ohio State University evaluated the university's consumption on energy, transportation and waste components and analyzed it using the EFA tool. This research will take a small, but ambitious step toward addressing this need. This is done by answering the question, "How big is Social Sciences Building of Xavier University's ecological impact?" using a modified version of a recently developed technique, the Ecological Footprint Analysis (EFA).

This research combined the ideas of economic sustainability and ecology. The extension of the building's ecology into the realm of sustainability is contingent upon an awareness of ecological problems and commitment to ameliorating them so as to be more in line with sustainability aspirations. This research will be based on the data and experiences at the Social Sciences Building of Xavier University-Ateneo de Cagayan Main Campus, and will show how two different fields can be combined to better understand both. It would be an exciting prospect possessing the knowledge and values necessary to take steps toward more sustainable practices.

Objective of the study

This study sought to undertake the Ecological Footprint Analysis to assess the sustainability implications of the Social Science compound of Xavier University

Review of Literature

An Ecological Footprint (EF) is the area, of productive land and water required for a given population to maintain their consumption and absorb the ensuing waste over the course of one year –at prevailing levels of technology. Developed in the mid-1990s by William Rees and Mathis Wackernagel at the University of BC in Vancouver, Canada, Ecological Footprint Analysis (EFA) starts with the observation that within a given period of time all consumption of energy and materials, and all discharge of wastes require a finite amount of land and water area for resource production and waste absorption. Work by Rees and Wackernagel and others reveal that the natural services now being consumed in many places throughout the world are, respectively and collectively, in excess of what can be produced at a renewable rate and thus the natural capital stock is being used up to fill the "consumption gap" –consumption beyond the renewable services that the stock can provide over the course of a year (indefinitely).

The integration of ecology into economic decisions is a necessary movement that takes on the daunting task of quantifying environmental values that are currently viewed as externalities in economics. EFA attempts to minimize the gap between ecology and economics by considering the flows of energy and matter to and from a given economy and correlating them to ecologically-productive area required to sustain them. EFA measures the consumption of a certain good or service and estimates the ongoing ecological supply of that good or service (Wackernagel and Rees 1996).

Ecological footprint analysis supports the argument that to be sustainable, economic growth must be much less material and energy intensive than at present (Pearce, 1994). It therefore supports the case for ecological tax reform in aid of resource conservation (von Weizsacker, 1994). For example, depletion taxes and marketable quotas on natural capital inputs to the economy would: a) stimulate the search for more materially and energy efficient technologies; b) preempt any resultant cost savings, thereby preventing the economic benefits of efficiency gains from being redirected to additional or alternative forms of consumption, and; c) generate an investment fund that could be used to rehabilitate important forms of self-producing natural capital (Rees, 1994).

Ecological footprint analysis provides a measure of both ecological deficits and the global sustainability gap. The latter in particular is a measure of the extent to which the human economy must be dematerialized in order to fit within global carrying capacity. The present and related analyses confirm that a "factor-10" reduction in the material and energy intensity per unit of economic service, as suggested by researchers at the Wuppertal Institute in Germany (Schmidt-Bleak, 1993), is a reasonable if daunting goal. "Reasonable" because a reduction in throughput of this magnitude seems necessary, "daunting" because a reduction of this magnitude through material efficiency alone seems impossible, at least within in the next few decades. Sustainability may require that competitive individualism and the consumer lifestyle give way to cooperative mutualism and an economy of sufficiency.

If demand exceeds the capacity of the natural system to supply the natural resources and services and to absorb the wastes, then the system is not sustainable. This is the common predicament throughout the world. A Footprint of Nations study conducted by Mathis Wackernagel in 1997 exposed the United States as the country with the greatest per capita ecological footprint, at a level of about ten and one-third hectares. The amount of land available to sustain each human being at the current population is less than two hectares. This disparity entails a massive consumption gap, an excessive immediate dependency on natural resources and services that result in their premature depletion. It also often implies a high material standard of living for industrialized nations at the expense of the subsistence of other human beings throughout the world.

Chambers *et. al*. (2000) summarized Wackernagel and Rees' original application of EFA to 52 countries, accounting for 80% of human population. This area is quantified in global hectares per capita (ha/cap). Global EFA includes the calculations of cropland needed for food, animal feed, and other products, pasture land needed for animals, harvesting land for wood, fiber, and fuel, marine and freshwater fishing area, infrastructure area for housing, transportation, and industrial production, and area needed to sequester carbon released from the burning of fossil fuels

(Wackernagel*et al*. 2002). In 1995, Wackernagel and Rees found the overall human footprint to be 2.2 ha/cap (Chambers *et al* 2000).

Overshoot occurs when the EF is greater than the area available to sustain that region and regenerate resources (Wackernagel and Yount 1998). An overshoot figure can be used to imply the unsustainability of a given lifestyle. Human activity has exceeded the global capacity since the 1980's, and with increasing technology, industrialization, development, and population, the human footprint may only grow (Hancock 2006).

Many institutions recognize their environmental impacts and try to reduce these impacts by changing policies and implementing environmental management projects. Some colleges and universities are assessing these environmental impacts through campus auditing. To date, 596 Campus Environmental Assessments have been completed in the United States and 637 assessments have been completed at institutions outside the United. A well-developed literature has emerged within the campus sustainability area. An international journal, the *Journal of Sustainability in Higher Education* started in 2000. A wide range of case studies and "how-to" books also has been published(Creighton 1998; Keniry 1995; National Wildlife Federation 1998; National Wildlife Federation 2001). Numerous websites describe campus projects (NWF 2002; Penn State Green Destiny Council 2000; SCI 2002).

In these literatures, researchers argue that sustainability education needs to be completed at colleges and universities for both philosophical and practical reasons (Creighton 1998; Keniry 1995; National Wildlife Federation 1998; National Wildlife Federation 2001). Other researchers have argued that sustainability education needs to be a focal point of higher education (Clugston and Calder 1999). Cross-institutional assessments recently have been published, assessing the state of environmental management and sustainability in United States higher education (National Wildlife Federation 2001).

In fact, since the early years of the environmental movement, people on college and university campuses have made great strides toward making their, respective, campuses "greener" places. Because of these actions, on campuses around the world, more trees have been planted, a higher percentage of less waste is being recycled or composted, energy is being conserved, there has been a decline in the use of products associated with toxins, and the list goes on. As effective as these and other efforts have and continue to be there is still progress to be made.

Methodology

The calculations of EFA components was done through a spreadsheet called Schools Global Footprint Workbook created by EPA Victoria with the help of The Centre for Design at RMIT, Redefining Progress and the National Centre for Sustainability. This was modified to fit the specific characteristics of the campus. A more detailed description of the methodology, variables, and formulas used for each impact category can be found in the Appendices.

Research Instrument and Sources of Data

The process of data collection was quite involved and time-consuming. Most ecological footprint studies of institutions rely heavily on survey data to determine consumption. In the case of this research, two surveys were conducted for students and faculty and staff to generate the data for the assessment for the impact categories relating to materials use. The survey asked the respondents for estimates for the commonly used materials in the different units in the Social Sciences Building.

*Population.*A number of equations in the calculator require the number of Social Sciences Building of Xavier University Main Campus community members in order to generate a footprint. The number of students was obtained from Registrar Facts and Figures reported every semester which was accessed online via the EIS system. The number staff and faculty was obtained directly from their respective offices. The sample size was obtained using Slovin's formula.

Ecological Footprint Areas

Five areas were considered in the determination of the ecological footprint of the Social Sciences Building. Each area is discussed below.

Materials Use. It is extremely difficult to measure all facets of consumption of materials. Furniture, computer equipment, construction materials and lab equipment are all consumed at high rates, yet it is an unfeasible task to track all of their purchases and determine their weights and compositions. While such comprehensiveness may seem desirable, this level of precision is unachievable at this point in time. Thus, this research focused more the use of paper, books, computer and printer toner or cartridges.

*Energy/Electricity.*In the absence of energy meter for the Social Sciences building, electricity bills or consumption data cannot be obtained. To come up with an estimate, the researchers requested the Electrical engineering Department to conduct monitoring to determine the approximate total amount of electricity used by the building.

*Water.*The annual water use of SS Building was sourced from the data obtained through observation and surveys for all restrooms and offices with pantries. Ti is to estimate the average water consumption from all rest rooms and offices within the building. Data from each water activity such as toilet flushing, urinal flushing (male toilets), and hand washing were recorded from all rest rooms and offices.

*Built-up Land.*Built-up land of the building included the total area of the building. This was entered as values in square meters into the calculator; which was converted to hectares, multiplied by an equivalence factor to scale them to world average productivity, and added to the total footprint of the building. It is assumed that much of the building was built over arable land.

*Waste and Recycling.*Information on waste is not usually readily available. Waste audits will was carried out regularly, i.e. weekly as the periodic garbage collection. General Services was contacted to obtain the most recent waste audit report. The information contained therein was enough to complete this section of the calculator.

Information on recycling was a bit more difficult to obtain. Again coordination with General Services was arranged to monitor the number of bags collected per week of different types of recyclables (paper, plastic, glass, cans, etc.). Interviews to different offices were also conducted to track recycling practices within each office.

Data Analysis

The information for the five impact categories were entered into a computer spreadsheet which is then assigned a land value to each of the components, and summed to come up with the overall

Ecological Footprint of the Social Sciences Building of Xavier University Main Campus (i.e. the amount of land, per year in hectares, that is required to support all of its functions).

Results and Discussion

Building's Ecological Footprint (EF)

The various components of Social Sciences' ecological footprint reflect the role of the occupants of the building as major consumer of natural resources responsible for a wide range of ecological impacts. The findings attach a numerical significance to some of our most influential deeds. The components of the Ecological Footprint of the building listed in the table below require an area of land equivalent to 552 hectares or 717 soccer fields to sustain campus demands--including a campus and a half for the effects of water use, material use, food, travel, waste and recycling and electricity demand.

Table1: Total Ecological Footprint of the Social Sciences Building

Total ecological footprint is:	427.3 global hectares (gha)
	552 Hectares or 717 Soccer Fields

Ecological Footprint Component Analysis

Table 2: Ecological Footprint Rank of Consumption Goods,
in Global Hectares per Capita (gha)

RANK	SCHOOL BUILDINGS	EF
2	The school building and grounds	22.4
1	Electricity consumption	78.4
4	Gas consumption	-
3	Water consumption	0.0

RANK	GOODS	EF

5	Copy paper and toners	0.0
2	Printed books	0.1
4	Paper for note taking	0.0
3	Stationery	0.0
1	Computer	8.1

RANK	FOOD	EF
1	Students' lunches	242.0
2	Teachers' lunches	129.0

Food

The food items consumed by the occupants of the Social Sciences' Building have the largest component of our ecological footprint. This can be attributed to the fact that 51 % of both employees and students in the building consume meat in their lunches daily and only 7% of the total population are vegetarian. Growing, processing, packaging and transporting food requires huge energy. The energy used in these activities might come from sources that would release carbon dioxide. The more carbon dioxide released, the bigger the greenhouse footprint will be.

A study conducted by Solano and Cruz (2011) as they measured the ecological footprint of Digos City, Davao del Sur generated similar result with this paper. According to their study, food generated a per capita waste of 60 percent and contributed 25 percent of the ecological footprint or 193. 26 m^2/ capita. Although their study focused on the city-scale compared to this paper but it can be inferred that just as with their findings, food contributes largely on the ecological footprint.

Electricity

Electricity represents by the second largest and most monetarily costly component of our ecological footprint, at a level of 78.4 hectares. The supply of 246,295 kilowatt hours is drained in all sectors of the building. This includes practices such as twenty-four hour lighting in some areas in the building, inefficient lighting techniques, and constantly running computers and other electrical devices. The EF clearly indicates that this should be an area of great concern to our community, as it is a most obvious example of ecologically detrimental actions.

Hydropower is the largest source of renewable, commercial energy. Hydropower is fully renewable, clean and green energy just like wind and solar power. However in this study, the contribution of electricity consumption to the building's ecological footprint ranked second. Existing studies from different countries that calculated ecological footprint would also give us similar results. The source of electricity in some countries like the United States and United Kingdom is primarily sourced from coal, gas or nuclear.

Janis (2007) on her study on the Ecological Footprint of Ohio State University assessed the energy footprint and concluded that the OSU used an average of 438, 488, 699 kilowatt hours of electricity per year, equivalent to about 361, 927 tonnes of carbon dioxide emitted per year solely from electricity. The Social Science building only emits 246, 295 kilowatt hour far from OSU and can be explained due to the source of electricity used and the area and scope of the university campus. Ohio State University uses coal as its main source of electricity whereas in the SS Building coal is not the primary source. Moreover, the results showed consistency in terms of its contribution to the ecological footprint. Electricity ranked second after transportation in the OSU's ecological footprint and in the SS Building it also ranked second.

Material Use, Recycling and Waste

The material use represented by paper and computers has the third largest component of the ecological footprint. Materials such as paper and computers are all consumed at high rates within the building, yet it is an unfeasible task to track all of their purchases and determine their weights and compositions. Computer usage in the building is common because the building houses the offices of one of the largest college of the university. Computer usage can also be traced to the electricity consumption which is a top contributor to the building's ecological footprint. In Victoria, Australia usage of electronic devices such as computers, laptops and other gadgets contribute greatly on its ecological footprint. Services (includes telecommunication and electricity) contribute 22 percent of EF, Residential Energy Use (includes appliances, computers, laptops, lightbulbs) contribute 16 percent of EF.

Paper footprint in this study, however, gave an insignificant ecological footprint value. Even so, different studies from universities gave a significant value with regard to paper use and waste management. Though a study has not been performed on waste stream composition at the Social Sciences' Building, total waste stream in the study was delineated into paper, plastic, glass and food by-products. A typical urban university waste stream is comprised of 57.29% paper, 21.33% plastics, 3.88% metals, 11.60% food, and 3.83% glass (Engineering, 2005). Paper accounted for the greatest volume of the recycling stream. As a result of the low turnout on recycled materials, this portion of the EFA has the least score. Further, it was converted using Ventoulis (2001) factors, which indicated that paper accounted for the greatest waste component with a footprint value of 0.22 hectares/ capita/ year.

Water

The water component of the Social Sciences' Building ecological footprint accounts for the second smallest portion of impact from assessed actions, at a total of 0.0 hectares. This represents the impact of water usage for indoor purposes, including drinking, washing and other personal needs. The value generated lead to a negligible value given that water consumption by the occupants in the building is very minimal.

Sustainability Analysis

In this section the findings are considered from three different but related approaches to sustainability: ideal, strong, and weak. These conceptual frameworks were liberally adapted from Baker et al. (1997), who focus more clearly on the political and economic implications of weak, strong, and ideal sustainable development, and Common (1996), who clearly draws the distinction between weak and other forms of sustainability.

As a precautionary statement, there is no one agreed upon definitive definition of sustainability. Some versions focus on the interactions between governance, civic engagement, economy, ecology, and the distribution of benefits and costs among groups, while others may concentrate on just one or several of these or other factors. Arguably, an approach that balances out these different emphases has not reached definitive inter-subjective meaning among theorists, scholars, or practitioners (Venetoulis, 2001). For some this means sustainability is without meaning, while others may see the need for substantial refinement (Viederman, 1996). While an interdisciplinary approach to sustainability can pose conceptual ambiguity, it has allowed room for open-minded theorists and practitioners to venture different interpretations to the term. The emphasis here is placed upon three versions of ecological sustainability, though some equity implications could be inferred.

One thing that the three approaches to sustainability have in common is that the use of natural services and capital beyond renewable rates are considered not to be sustainable. From all three perspectives, in addition to the university's ecological footprint, the other important piece of information needed to do a sustainability analysis is an area-based measure of how much ecologically productive land (services) is available on a renewable basis annually. The differences among the approaches lead to different answers about how much this amounts to and thus what, at least in part, constitutes sustainability.

An ideal approach to sustainability is premised upon the contention: living within the means of nature is sustainable when all consumption and absorption of ensuing waste occurs in the place where consumption directly occurs. The ideal approach implicitly holds that the allocation/availability of natural resources to support a population is predetermined by the place they live. So, the endowments of a place provide the empirical ecological limiting factor.

From this perspective, the prospects for sustainability are limited to a footprint roughly the size of the campus or in this case the size of the building plus its available space**.** The building is 5,298.96 square metersin total floor area. The Social Sciences' Ecological Footprint require an area of land equivalent to 552 hectares or 717 soccer fields to sustain campus demands—for all its member (includes students, faculty, and staff).

The strong approach to sustainability, considers individual ecological impacts associated with consumption within the context of global carrying capacity. To be strongly sustainable, then, building members regardless of location would have to have an environmental impact that on average is the same or less than the global amount of ecologically productive land (nature) available on a per global citizen basis. According to Wackernagel et al. (1997) there are roughly 2.23 hectares of annually renewable ecologically productive land/services available in the world on a per capita basis. However, because the data being analyzed in this paper do not include activities outside the campus, what is left is about 1.34 hectares per person or about 722.26 hectares of available footprint space for the entire building. From the strong approach, Social Sciences' Building footprint is strongly sustainable (Figure 5).

From this perspective, to be sustainable, the average building member has a (net) ecological footprint less than the ecological limits of the global average on a per person basis. However, it should be reiterated that the research in this paper only included a portion of the student population's footprint. It is likely that, with the addition of other factors such as wastes and so on, the building's footprint might be higher and fall on the weak sustainability perspective.

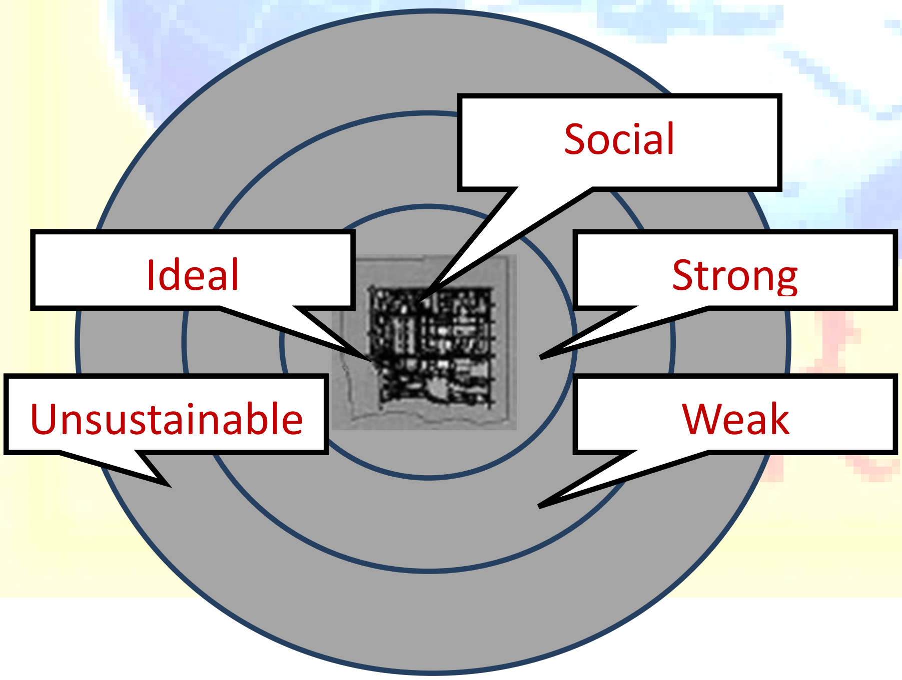

Figure 5 :Social Sciences' Building Ecological Footprint from Different Sustainability Perspectives

In summary, the main findings for the Social Sciences' Building are consistent with the strong conceptualization of sustainability, since the amount of natural services consumed and waste output is lesser than what is naturally provided and absorbed, and demand is consistent with supply. Thus there is still extra amount of natural capital that can be used to provide natural services in the future. From this strong approach to sustainability the campus may be sustainable, though the inclusion of other environmentally intensive consumption factors could counter these findings.

Summary of Findings, Conclusions and Recommendations

Summary of Findings

The various components of Social Sciences' ecological footprint reflect the role of the occupants of the building as major consumer of natural resources responsible for a wide range of ecological impacts. The findings attach a numerical significance to some of our most influential deeds. The components of the Ecological Footprint of the building listed in the table below require an area of land equivalent to 552 hectares or 717 soccer fields to sustain campus demands--including a campus and a half for the effects of water use, material use, food, travel, waste and recycling and electricity demand. The 1.08 per capita footprint for faculty and staff sets their school lifestyle below the globally sustainable level or also known as world average biocapacity at 1.79 gha and suggests that our total individual impacts are characteristic of the typical developing country, sustainable ecologically and socially (Human Development Report 2013, UNDP).

The results of our study revealed that food and electricity consumption are the major components of the Social Sciences' Building EFA, corresponding with the results of other studies that emphasize the significance of these components (e.g., Barrett et al., 2002; Wiedmann et al., 2006; Kissinger and Haim,2008).

Applying the approach to sustainability, Social Sciences' Building footprint is strongly sustainable. From this perspective, the 552 hectares of the building's EF is less than the requirement of 722.26 hectares of available footprint space for the entire building. However, it should be reiterated that the research in this paper only included a portion of the student population's footprint and other components of the EF were not fully accounted for. It is likely that, with the addition of other factors such as wastes and so on, the building's footprint might higher and might fall on the ideal sustainability perspective.

Conclusion

All the categories that fall under the ecological impacts or consumption/waste cannot be measured with 100 percent precision using EFA. One such example is the total waste products including toxic wastes put out by the building. Nor can the subtleties and full meaning of the impacts on nature from human activities be captured in the type of research carried out in this paper.

This paper is intended to support schools pursuing sustainability by imparting a practical way to implement EFA as an educational tool. By analyzing the building activities through the different components, the occupants in the building can identify the relative contribution of specific activities to the building's overall ecological load. From a strong approach to sustainability, the building may be sustainable, however, it should be reiterated that the research in this paper only included a portion of the building's total ecological footprint. It is likely that, with the addition of other factors such as food, material use, energy consumption and so on for all students in the building and accounting for all wastes, Social Sciences' Building footprint could not even be considered sustainable from a strong perspective. From a strong or ideal approach to sustainability there are plenty of opportunities for the building to move toward sustainability.

Recommendations

Methods for Reduction

With a quantitative measure of the ecological impacts of Social Sciences' Building daily processes, the occupants have the capacity to act in accordance with the findings of the EFA which may imply that the different units should focus all of their efforts on changing food consumption patterns and lowering electricity use, components that have the biggest accounts in its footprint, and continue to be conscious with water conservation, because water only represents the least of its footprint. However, each element of the building's operations, including those not included in the EFA, holds numerous opportunities to reduce the overall harmful environmental impact.

It may be helpful to pursue reductions in a manner that addresses all of these elements. A percentage reduction plan for each component could accomplish a steady collective reduction while not neglecting any particular areas. Monitoring is a major step in pursuing a reduction plan. In particular, all units within the building must have a record of all its material use, such as paper, computers and related products. This has been a challenging task for the researchers in the documentation process. Another aspect of monitoring is the metering of the electricity and water consumption per unit. Currently, the devices are not installed, thereby, making it difficult to assess consumption in every unit. Aside from, monitoring, intensification of university policies must be addressed. Specifically, the university has adopted the waste segregation practice. However, this is not strictly enforced or has left out certain areas in the segregation process. For instance, segregation is more pronounced in putting up containers for plastics but not on paper products. Also, there is absence of systems and procedures for paper disposal and recycling as well as for the electronic equipment such as computers, printers and toners and cartridges. This is very important because these are some of the biggest by-products of the academic activities pursued in the building.

In order to work toward sustainability, it will be necessary to act creatively and consistently in a manner that incorporates all occupants of the Social Sciences' Building. These efforts will range from collective action by formation of a committee represented by all units in the building. It can utilize advancements in technology in changing processes within the university, ie., installing energy-efficient light bulbs and equipment or increasing paper-less transactions. With EFA, they will be able to gauge the success of the efforts and set a long-term goal for reducing ecological footprint.

Further Studies

The data and findings from the EFA can be utilized in a myriad of informational and education ways. The databases constructed during the project are building specific, providing details to guide the focus of efforts. A more comprehensive analysis, though not a perfectly detailed one, would be beneficial in attempts for raising awareness and tracking progress. This study can also be carried out in coming school years, and its results will be publicized throughout the community, in hopes for education and action. It will hopefully be part of a long-term vision and plan for the evolution of Xavier University into an ecologically sustainable community.

Finally, because EFA is a reproducible methodology, there are possible positive spin-offs, the main one being the introduction of a tool that can be used for similar research on other buildings or campuses of Xavier University. The results also provide many opportunities for comparison. It can be replicated to evaluate level of impact in relation to the rest of the Xavier University, to other institutions of higher education, or to other types of institution.

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