AN ON-LINE MANAGERIAL INSTRUMENT FOR THE TRANSITION TOWARDS THE SUSTAINABLE UNIVERSITY

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ABSTRACT: In response to increasing concerns of society about environmental degradation and increasing demands for a transition to a more sustainable society, higher education institutions worldwide have begun to change their missions and educational practices and approaches to include sustainability. The role of higher education in the social context of an ongoing transition to greater sustainability has become a topic of significant scientific importance. Thus, universities worldwide are engaged into a process of transition to become sustainable universities. This paper proposes an algorithm for a decision support system which aims to help decision makers to fundament their approach to transforming the university into a sustainable one. Universities have different organizational cultures, values and resources, and the proposed algorithm helps to identify the most suitable solution for each university.
KEY WORDS: sustainable university, decision support system, university management

1. INTRODUCTION

Planet Earth has a limited capacity to meet the growing demand for natural resources made by socio-economic systems and to absorb the destructive effects of their use [24]. The impacts of overconsumption of resources have begun to have measurable negative effects both on socio-economic development and people's quality of life in vast areas of the planet [10].

Education is one of the most effective means available to society to shape the future [30]. However, according to Sterling [26:12] "it is the change of mind on which change towards sustainability depends; the difference of thinking that stands between a sustainable or a chaotic future." Otherwise, as David Orr [20:5] pointed out, "without significant precautions, [education] can equip people merely to be more effective vandals of the Earth."

Sustainability should not be just another issue to be added to a curriculum that is already overcrowded, but a "gateway to a different view of the curriculum, of pedagogy, of organizational change, of policy and particularly of ethos" [27:50]. The role of education in shaping the future is widely recognized. In a world that is becoming more complex, interdependent and unsustainable, education for sustainable development is given increased attention in universities worldwide. Transformation of education into sustainability education implies systemic thinking and interdisciplinary approaches to promote change of attitudes to learning and lifestyles.

2. WHAT KNOWLEDGE FOR SUSTAINABILITY?

One can generally say that in order to learn about sustainable development, one must be acquainted with several different branches of science. Paula Lindroos [17:93] observed that "learning about sustainable development is guided by a principle of organizing science and at the same time focusing on the problem solving capabilities of the students. This means that both content and learning methods become important for the courses."

Most notably however, issues of sustainability tell outside the realm of any specific discipline and even outside the realm of science. Hence teaching and learning on issues of sustainability requires the ability to bring together different realms of knowledge.

The role and importance of universities in transforming our society into a sustainable one has been highlighted by many scholars and institutions. In a position paper on global sustainability UNESCO [31:4] states: "With respect to higher education, there will be emphasis on the role of universities in refining the concept and messages of education for sustainable development, integrating environmental, demographic, economic, social and a range of other concerns inherent in the notion of sustainability. In re-orienting their research programmes and curricula, key will be the universities' capacity for flexible interdisciplinary cooperation and for collaboration with outside institutions… Universities will have to experiment by exercising more initiative and by risking new approaches."

Tilbury [29:98] argues that "Environmental Education for sustainability is an innovative and interdisciplinary process requiring participative and holistic approaches to the curriculum" and considers that there is a need for innovation, rather than integration of education-for-sustainability. Hart, Jickling and Kool [15:109] also imply that environmental education should be "interdisciplinary, participatory, critical, community-based, values-based and inquiry-based."

The Tbilisi report of 1977 states, among its many recommendations that "by adopting a holistic approach, rooted in a broad interdisciplinary base, [education for sustainability] recreates an overall perspective which acknowledges that the natural environment and man-made environment are profoundly interdependent..." [32:2].

According to Tilbury [28:196] the developing, more holistic notion of education-for-sustainability is "reflected in the broadening nature and scope of environmental education, marked by moves towards an inter-disciplinary dimension and from a more local to global approach."

When promoting sustainable development, we should research and develop our work so that we become a part of the knowledge building community for sustainable development.

In recent years, an increasing amount of universities have started organizing pedagogy courses for their teachers so as to specifically change the nature of teaching and learning [16].

3. SUSTAINABLE UNIVERSITY

An important attempt to define what "sustainable university" means was made in 1990, through the Talloires Declaration [22]. Jean Mayer, president of Tufts University in the U.S., convened 22 leading universities in Talloires, France, so that they can express their concerns about the state of the world and develop a document to identify the key actions that universities need to do in order to create a sustainable future. Identifying the scarcity of specialists in environmental management and its related fields, and lack of understanding of professionals in all areas of the consequences of their actions on the environment and public health, the meeting pre-defined the role of the university as synthesized in figure 1.

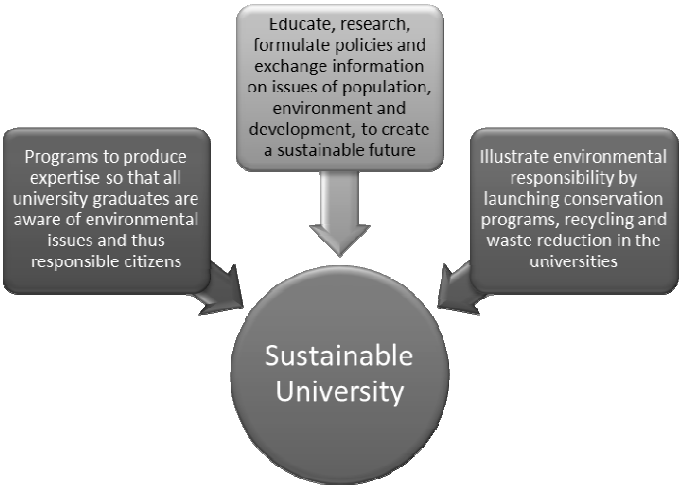

Figure 1. Sustainable University

The Talloires Declaration (1990) was signed by over 265 rectors and vice rectors of the universities in over 40 countries on five continents. This suggests a growing recognition that more academic research, education and university programs must lean on the challenge of sustainability. No doubt that signing the Talloires Declaration was, at that time, a symbolic act for some institutions. For others however, the document is still an incentive and a framework for sustained progress to achieve sustainability.

Promoting sustainability in higher education depends largely on the active engagement of those responsible of various disciplines with promoting attention environmental issues and sustainability as central objectives of practices and as a main mission in their areas of activity [11].

Fortunately, many of them have committed to review the subjects they teach, both nationally and locally. Members of various professional associations have established special interest groups, divisions or sectors focused on environmental issues and sustainability. There are emerging specialized journals such as Journal of Interdisciplinary Studies in Literature and Environment. Ante-mentioned publication provides a forum for debate and literary critical exposure stage built around environmental issues, including ecological theory, concepts about nature and capturing them in pictures, the dichotomy man - nature, and other such concerns [6].

3.1. The Transition to a Sustainable University

In response to increasing concerns about environmental degradation and the increasing demands for a transition to a more sustainable society, higher education institutions around the world have begun to change their educational missions and practices and include approaches to sustainability. Because this happened in the past decade, the role of higher education in the social context of a continuous transition to a more sustainable society became a subject of significant scientific importance [12, 21, 8].

Although this emerging literature on sustainability in higher education is diverse, is dominated by empirical and descriptive studies, specific approaches, strategies and initiatives to specific institutions, [18,1] but also includes prescriptive studies that often call to universities to play a more prominent role in education for sustainability [19, 7, 13, 4]. Much of the descriptive literature, so far, is focused on specific strategies or actions taken at specific institutions [2, 9].

The largely empirical focus of this emerging literature can be understood by taking into account the needs of short-term exchange of information in a fast changing environment and hybrid scientist-practitioner perspective of many people involved in, and evaluating sustainability initiatives in higher education. Given the early stage of this area of research, the emerging body of research seems to have a minimum of cohesion and a degree of repetition and redundancy. In addition, a strong base of theoretical research agenda has not been established.

4. A DECISION SUPPORT SYSTEM FOR THE TRANSITION TOWARDS THE SUSTAINABLE UNIVERSITY

Universities have different organizational cultures that value and promote learning and thus can play a vital role in the transformation of society that is based on educating new generations of citizens and leaders [25]. Higher education has always been responsive to social needs, and higher education history shows an evolution of the structure and goals of universities that directly reflect the dynamics of socio-technical systems of society [5].

Some of the literature on education for sustainable development seeks to identify best practices in one institution or set of institutions [33]. This approach can develop an ambitious vision of how an ideal sustainable university would look once it reaches the stage of "stabilization", but there is the risk of minimizing significant dynamics in the real world. For example, assuming that an ideal, stabilized state can actually be achieved, can be quite daunting for potential change agents, whose universities are far from the ‘ideal’ in a number of areas. What best practices analysis omits is precisely how these practices have been developed - and how these practices can have an impact in different contexts and cultures and can actually be considered "best" practices.

Thus, we propose a Decision Support System for university managers who seek to embark in this challenging transition towards the Sustainable University. Some recommendations might be efficient in certain cases, but we are aware that it is impossible to find a recipe for success that works in every situation. The Sustainability Decision Support System (SDSS) is a tool that helps decision makers choose from more possible decision alternatives which suits best the University that they manage, based on a set of decision criteria.

The algorithm that underlies the SDSS is an innovative approach that combines two well-known algorithms: the hierarchic-analytic process, used mainly in operations management and the advanced multi-criteria analysis based on

FRISCO formula. The SDSS is applicable for an unlimited number of decision alternatives and selection criteria. For exemplification, we have chosen to present the situation with 5 selection criteria and 5 decision alternatives.

The system allows the decision maker to define his/her own selection criteria and decision alternatives. In table 1 there are presented the ones used for exemplification.

Table 1. Selection criteria and decision alternatives

Selection Criteria	Code	**Selection Alternatives**	Code
Costs	**C1**	New degree program	**A1**
Number of Lecturers Involved	**C2**	Mandatory Course	**A2**
Number of Students Involved	**C3**	Optional Course	**A3**
Student implication	**C4**	Change existing courses	**A4**
Attractiveness to students	**C5**	Extracurricular activities	**A5**

After naming the criteria, the decider has to define the relationships between every pair of two criteria. In other words, every criterion is compared against the others and a quadratic matrix that presents how these criteria relate to each other is filled in by the decider. When comparing two criteria the decision maker faces three possible situations:

- Criterion 1 is more important than criterion 2 – in this situation the score for criterion 1 is "1" and the score for criterion 2 is "0"
- Criterion 1 is equally important as criterion 2 – in this situation the score for both criteria is "0.5"
- Criterion 1 is less important than criterion 2 – in this situation the score for criterion 1 is "0" and the score for criterion 2 is "1"

In order to simplify the completion of the relationship matrix, a formula has been added to the cells below the main diagonal of the matrix, so if the decider believes that criterion 1 is more important than criterion 2, the formula automatically shows that criterion 2 is less important than criterion 1. Also the main diagonal has been automatically filled in with "0.5", showing that each criterion is equally important with itself. This eliminates the risk of inconsistency of the relationship matrix. Table 2 shows how the matrix is filled in, highlighting with different colours the fields that can be filled in by the user and the ones that will be automatically filled in.

Table 2. Relationship matrix

Selection Criteria		C1	C2	C3	C4	C5
Costs	C1	0.5	0.5	0.0	1.0	1.0
Number of Lecturers Involved	C2	0.5	0.5	0.0	0.0	0.0
Number of Students Involved	C3	1.0	1.0	0.5	1.0	1.0
Student implication	C4	0.0	1.0	0.0	0.5	1.0
Attractiveness to students	C5	0.0	1.0	0.0	0.0	0.5

It is important to remember that the scores presented above are the choice of the decision maker. This choice can be based on recommendations from the literature, vision, mission and strategy of the university, market research, specific particularities of the university etc.

After the relationship matrix is complete, the SDSS will apply FRISCO formula (1) to rank the criteria and allocate an importance coefficient or weight factor (γi) for each of them. The FRISCO formula (an empiric formula given by a well-known creation group in San Francisco - USA) was chosen as it is recognized worldwide as being the best and most used formula for this type of analysis [3:1933].

$$\gamma_i = \frac{p + \Delta_p + m + 0.5}{-\Delta_{p'} + \frac{N_{crt}}{2}} \quad (1)$$

where:

- p is the sum of the points (on a row) scored by the analysed element;
- Δp − the difference between the score of the analysed element and the score of the element on the last level; if the regarded element is the element on the last level, Δp will have the value *0*;
- m − number of criteria outranked (standpoint of the score) by the regarded criterion;
- $Ncrt$ − number of regarded criteria;
- $\Delta p'$ − difference between the score of the regarded criteria and the score of the first criteria (resulting in a negative value); if the regarded criteria is the one place on the first level, the result will be *0*.

For the example given above, the weights for each criterion, calculated using the FRISCO formula are given in table 3:

Table 3. The weights for each criterion, calculated with FRISCO formula

	C1	**C2**	**C3**	**C4**	**C5**	**SCORE**	**RANK**	**Dp**	**Dp'**	**m**	**FRISCO**
C1	**0.50**	**0.50**	**0.00**	**1.00**	**1.00**	3.00	2	2.00	-1.50	3	**2.125**
C2	**0.50**	**0.50**	**0.00**	**0.00**	**0.00**	1.00	5	0.00	-3.50	0	**0.250**
C3	**1.00**	**1.00**	**0.50**	**1.00**	**1.00**	4.50	1	3.50	0.00	4	**5.000**
C4	**0.00**	**1.00**	**0.00**	**0.50**	**1.00**	2.50	3	1.50	-2.00	2	**1.444**
C5	**0.00**	**1.00**	**0.00**	**0.00**	**0.50**	1.50	4	0.50	-3.00	1	**0.636**

Then, the decision alternatives are compared against each other, based on the extent to which they satisfy each criterion. Thus, in the example given, the alternatives have been compared to each other five times – once for each criterion. The same algorithm was applied when the quadratic matrix was generated and the scores 0, 0.5 and 1 were allocated as shown above.

In addition to the calculation of the weights based on FRISCO formula, which show how each alternative satisfies the criterion, there has been calculated the "array of importance".

The array of importance is calculated with the algorithm specific for the hierarchic-analytic process [23]:

- After the quadratic matrix has been generated, it is "normalized", generating a new matrix, noted with A. Each value of each column is divided to the sum of the values of that column, using the formula (2):

$$b_{ij} = \frac{a_{ij}}{\sum_{k=1}^{n} a_{kj}} \quad (2)$$

- The array of importance, w, is calculated as the average of each line from the normalized matrix, using formula (3):

$$c_{ij} = \frac{\sum_{k=1}^{n} b_{ik}}{n} \quad (3)$$

Given the fact that the quadratic matrix is filled in based on the algorithm presented above, it is consistent and thus the calculation of consistency is no longer required.

The final score for each decision alternative is calculated by adding the products generated by multiplying its score of the alternative for each criterion with the weight of the respective criterion. This is done both for the weights generated with FRISCO and the array of importance. Then the arithmetic average is calculated between these values, for each alternative and the one with the highest score is the optimal solution (see table 4).

Table 4. The final decision

Decision Alternatives		Score W	Score FRS	Average	Rank
New degree program	**A1**	0.59	11.22	5.91	5
Mandatory Course	**A2**	1.43	16.49	8.96	4
Optional Course	**A3**	1.17	18.19	9.68	2
Change existing courses	**A4**	**3.64**	**36.63**	**20.1**	**1**
Extracurricular activities	**A5**	1.14	17.64	9.39	3

5. THE SUSTAINABILITY DECISION SUPPORT SYSTEM – ONLINE

The usefulness of the Sustainability Decision Support System for the transition towards a sustainable university is highlighted by the need to make decisions based on real facts and needs specific to each university. However, the algorithm presented is complicated and it requires good mathematic abilities for the decision maker, and this can therefore limit the usage of the proposed decision support system.

In order to ease the use of the SDSS and increase the number of potential users, the Sustainability Decision Support System was put online. The SDSS allows an indefinite number of criteria and decision alternatives in a user friendly interface. For this purpose an extension for the Content Management System Joomla! 1.5 has been developed. It can be easily integrated into any website created with Joomla! 1.5 (see figure 2) [14].

First, the user is requested to enter the number of criteria and the name (or label) for each criterion (figure 3). Then the quadratic matrix is generated and the user has to compare each criterion against the others, having the option to choose whether it is more important, equally important or less important than other criteria (see figure 4).

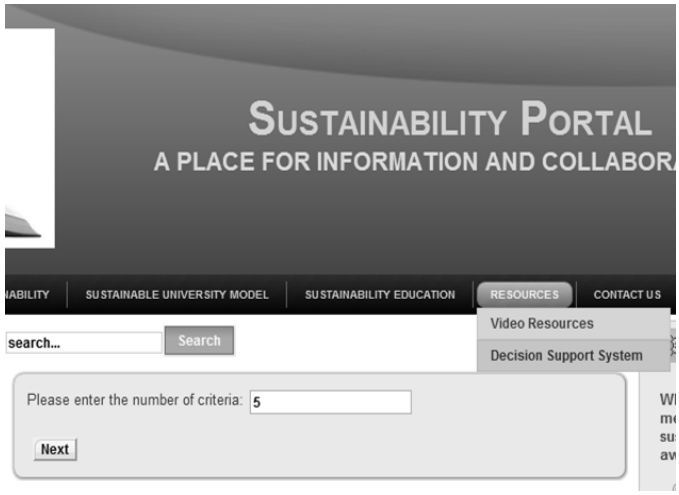

Figure 2. The SDSS integrated in a website

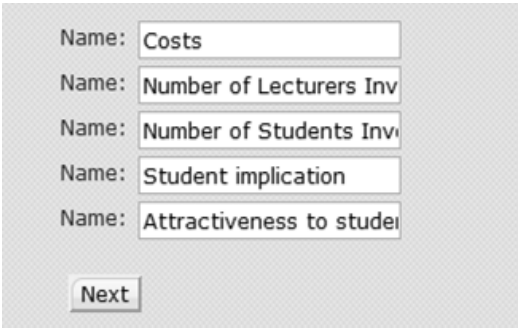

Figure 3. Entering the criteria

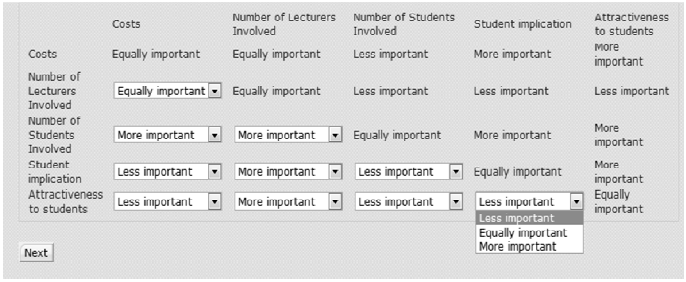

Figure 4. Generating the quadratic matrix

Then, the user is asked to enter the alternatives and then to compare each alternative based on each criterion (see figure 5).

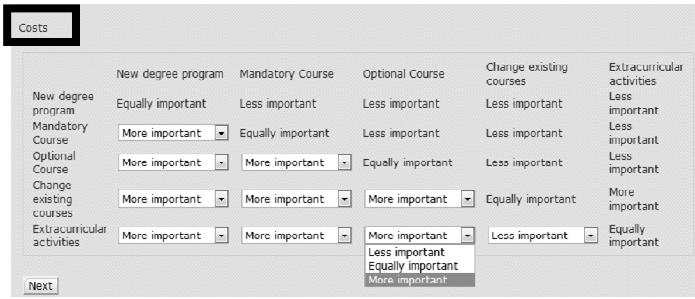

Figure 5. Comparing each alternative from the point of view of criterion "Costs"

The software then uses the algorithm described in paragraph 4 and returns the optimal solution, as shown in figure 6.

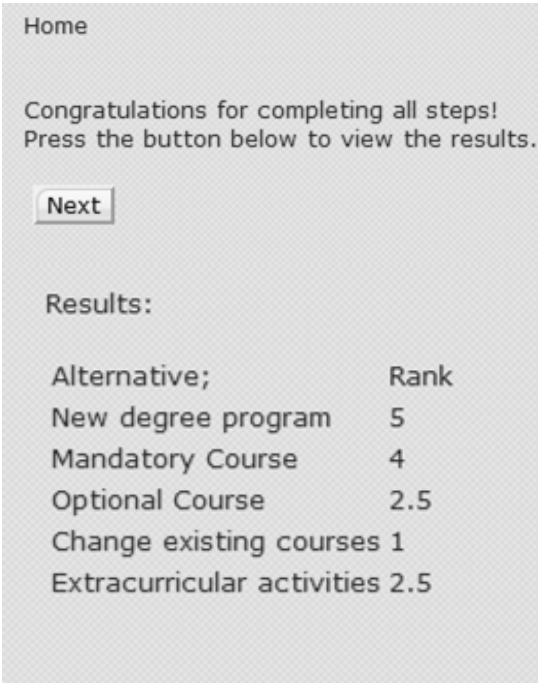

Figure 6. The optimal solution

6. USING WEB 2.0 TECHNOLOGIES TO FOSTER SUSTAINABILITY EDUCATION

As we have argued somewhere else [14], some of the multiple barriers that are encountered in the process of transforming the university into a sustainable one can be overcome by an instrument based on Web 2.0 technologies. Explicitly, a website for disseminating information and best practice and problems sharing, addressed mainly to the teaching community of the universities, but also to the students could ease the transition towards sustainability education.

Some of the advantages of choosing this Web 2.0 tool for overcoming the barriers to implementing sustainability teaching can be:

- teachers can access the website according to their timetable;
- reduces travel cost and time to and from school
- teachers (who in this case will be learners) may have the option to select learning materials that meets their level of knowledge and interest;
- teachers can study wherever they have access to a computer and Internet;
- self-paced learning modules allow teachers to work at their own pace;
- flexibility to join discussions in the bulletin board threaded discussion areas at any hour, or visit with classmates and instructors remotely in chat rooms;
- different learning styles are addressed and facilitation of learning occurs through varied activities;
- development of computer and Internet skills that are transferable to other facets of teacher's lives;
- teachers don't have the feeling that something is being imposed to them - they can access the website on a voluntary basis;
- partnerships and collaboration between lecturers can be facilitated by this online tool.

By sharing ideas, concepts, tools, experiences learned in different contexts, it is anticipated that we will all learn many things that will help us to help our academic communities and companies to develop the skills to make progress towards sustainable development.

7. ATTITUDES OF THE ACADEMIC COMMUNITY TOWARDS THE E-TOOLS FOR THE TRANSITION TOWARDS THE SUSTAINABLE UNIVERSITY

A research has been carried out in order to identify the need of such an on-line platform in Romanian Higher Education [14]. This research was intended to be a pilot study, and it was carried out at "Lucian Blaga" University of Sibiu. The pilot university was chosen based on convenience grounds. The research aims also to find out if Romanian teachers are aware of the issues of sustainability and the need of changing education towards sustainability education. The use of Internet, the efforts to integrate sustainability related issues into the curriculum and their opinions regarding interdisciplinarity have been also analyzed.

The research confirmed that most of the didactic staff in higher education institutions are aware of the importance of sustainability and are preoccupied by it and agree that traditional education should switch towards sustainability learning (collaborative learning, student-centered approach, interdiscipinarity, etc.). The study also highlighted the need of the proposed instrument, as most of the lecturers appreciate the usefulness of an online info-platform for easy access to relevant information, examples and suggestions, collaboration and discussion with other learners or students. The features available in the developed platform foster collaboration and an easier integration of sustainability into teaching and learning practices.

The excellent attitudes of the lecturers regarding the issues of sustainable development and their awareness that universities have an important role in shaping the society encourage the implementation of the proposed online info-platform. The web literacy of the lecturers ensures a good usage of the platform and good premises for a successful implementation.

It is encouraging that 86% of the respondents are willing to change their courses and teaching methods in order to switch from traditional education towards sustainable education, but 70% don't want to be told by their superiors what to do. The research confirmed the theory that academic staff sees education for sustainable development as an imposition, but the research results infirmed the ideas that sustainability is considered by lecturers as something that is not commensurate with their discipline or that they lack the knowledge, skills and expertise to implement sustainability related teaching and learning.

Thus, a legal framework to regulate sustainable education in Romania is demanded, both by the concerns of the international community, by companies that operate in Romania, by students and by lecturers, who are preoccupied by the future of our Planet.

8. CONCLUSIONS

Sustainable development is the biggest challenge to universities in the twenty-first century [34]. Since there are many different definitions and interpretations of the concept, the strategies of the universities that are beginning to strive for sustainability show some differences. Various universities have

already become engaged in the process of integrating sustainable development in their activities [34].

The sustainable university is not easy to be achieved, but all the efforts, energy, resources and time invested in many universities around the world show progress [35]. The Sustainability Decision Support System, presented in this paper, is intended to help decision makers in their journey towards the sustainable university.

Universities have different approaches of the transformation process towards a sustainable university. Some incorporated sustainability in their visions and missions; others focus on sustainability education or research integration, while others have created environmental policies or campus strategies, but what is desirable is an approach that incorporates all the components of the model. A holistic approach can transform the university into a sustainable one, encouraging students, professors and other members of the academic community to commit themselves to help society make the transition towards sustainable life styles.

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