
An international comparative analysis of sustainability transformation across seven universities

Comparative
analysis of
sustainability

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Abstract

Purpose – The purpose of this paper is to identify the key aspects of transformation of universities towards sustainability, such as the ideal characteristics of the “sustainable university”, and the drivers and barriers in the transformation, by comparing the strategies of seven universities world-wide.

Design/methodology/approach – A systems transformation analysis of seven case studies has been applied through a self-evaluation based on the tridimensional Framework-Level-Actors (FLA) method.

Findings – The study shows that none of the three dimensions of change is predominant over the others. The main barrier to be overcome is the lack of incentive structure for promoting changes at the individual level. The main drivers for change are the presence of “connectors” with society, the existence of coordination bodies and projects, and the availability of funding, all of which are important for progress. Enhancing interdisciplinarity is a strategic objective at almost all of these universities, while transformative learning is less present. A common characteristic for most of the institutions is establishing and supporting networks of expertise within the universities. These universities show important strategic efforts and initiatives that drive and nucleate change for sustainable development, the result of a combination of drivers.

Practical implications – The FLA-method has proved useful for being used at the level of comparing case-studies through a bird’s-eye perspective.

Originality/value – The paper demonstrates the application of a simple tool that gives a global perspective on transformational strategies used in seven cases world-wide in the search for commonalities and differences.

Keywords Sustainable development, Transformational leadership, Discipline, Higher education, Systems theory

Paper type Case study

1. Introduction

Through their pivotal and influential role in society, universities are key stakeholders in achieving a sustainable future (e.g. Cortese, 2003). As respected thought leaders, universities have the opportunity to elevate the importance of sustainable development

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(SD) through scholarly and public discourse. As complex organizations themselves, universities can also model for the community how an organization committed to sustainability ought to operate. In addition, universities have the opportunity to provide their communities with graduates who have the knowledge and skills necessary to help transform their workplaces and live as responsible global citizens.

There are promising signs that universities around the world are responding to these opportunities and beginning to engage in activities related to SD, whether through campus “greening”, development of special courses on sustainability, or offering collaborative research opportunities. But what is really required is radical innovation rethinking within universities (e.g. van Weenen, 2000; Lozano, 2006), both in their internal organization and operation as well as their interaction with external stakeholders.

Rather than looking at individual innovations in the classroom or facilities that constitute important incremental changes (see other articles in this issue for more on curriculum), the focus of this article will be on the transformations that would enable a university to more rapidly shift course.

2. Transforming the university

2.1 Key characteristics of a sustainable university

What does a sustainable university look like? In the literature we can find different identifications of key characteristics (e.g. van Weenen, 2000; Leal Filho, 2000; Holmberg and Samuelsson, 2006; Adomssent, 2006; Adomssent *et al.*, 2007). The authors, coming from three continents and seven institutions, came up with the following list of concepts, though there are undoubtedly others:

- Transformative education rather than merely transmissive education to prepare students capable of addressing complex sustainability challenges. Rather than being a one-way process of learning, it must be more interactive and learner-centric with a strong emphasis on critical thinking ability (Sterling, 2005; Wals and Corcoran, 2006).
- A strong emphasis on effectively conducting inter and transdisciplinary research and science (see, e.g. Max Neef, 2005; Van Dam, 2006).
- Societal problem-solving orientation in education and research through an interaction through multiple interfaces to be pertinent to societal goals. As a result, students must be able to deal with the complexities of real problems and the uncertainties associated with the future.
- Networks that can tap into varied expertise around the campus to efficiently and meaningfully share resources.
- Leadership and vision that promotes needed change accompanied by proper assignment of responsibility and rewards, who are committed to a long-term transformation of the university and are willing to be responsive to society’s changing needs (Lozano, 2006).

2.2 Potential barriers

There are many barriers to transforming institutions into sustainable universities (Thomas, 2004; Velazquez *et al.*, 2005; Lozano, 2006; Holmberg and Samuelsson, 2006).

Some of the barriers are internal, due to the culture and structure of the university, while others are imposed on the university by external sources:

- *The freedom of individual faculty members.* Most universities are bottom-up institutions where individual faculty members make decisions on how best to achieve research and education goals. As such, it is difficult for an administrator to propose changes and achieve consensus among groups of faculty at any level. Such freedom can be beneficial, however, in empowering early-adopter sustainability champions as well as by providing insurance against too much of an instrumentalist and prescriptive view “which would serve only to inhibit the possibilities for sustainable development” (Scott and Gough, 2006).
- *Incentive structure (salaries, promotions, and granting of tenure).* That does not recognize faculty contributions to sustainable development. Since most universities present resistance to even the most minor perturbations, such as changes in class size or in expectations of research support, an overly rigid incentive structure can be a barrier to amply rewarding faculty and staff participating in the university’s sustainability transformation.
- *Lack of desire to change.* Building quality educational and research facilities requires a great amount of time and investment, and once established, these activities may stay the same for years as long as the university is attracting good students, and faculty members are conducting successful research. In such institutions, it may be especially difficult to gain support for a major transformation.
- *Pressure from society.* Unless society demands major changes in the desired characteristics of graduates and research, a university may find little reason to make transformations and may continue with the *status quo*.

2.3 Drivers

In this section, the drivers for university transformation are discussed (see Holmberg and Samuelsson, 2006, for complementary perspectives). Like barriers, these drivers can be internal or external.

Internal drivers

- Visionary leadership in institutions where, to be effective, leaders must have appropriate assignments and responsibilities. This often requires university arrangements that promote cooperation and collaborative efforts rather than competition between units. Leadership may also be a driver when the leader sees transformation as a way to leave his or her legacy on the organization.
- Sustainability champions, often seen as “lone wolves” or “innovators” (Lozano, 2006) at their universities, can be important agents for change. By neglecting to provide institutional support to them to fuel continued work, universities run the risk of losing their most valuable supporters.
- Connectors refer to existing networks of people such as interdisciplinary research groups that reach across the university to include a critical mass of campus actors. The connector may help tender the shared language that is needed for interdisciplinary work, or give incentives for engaging in interactions between departments or to the greater society.

- Size may also act as a driver. Large universities of more than 10,000-12,000 students often find that the complexity of the organization reduces the possibility of rapid transformation.
- The existence of a coordination unit or project for the sustainability transformation may also be important, as it keeps the process of change alive and helps distribute responsibility for the different activities.

External drivers

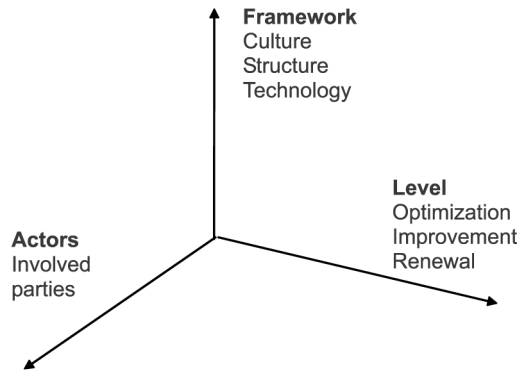
- Pressure from peer institutions or top-tier universities can serve as examples to promote change.
- Sources of funding and employment availability. University activities are often driven by its sources of funding – both its external research funders and its fee-paying students. Corporations or government bodies willing to pay for sustainability-focused research may drive a university-wide transformation, as may employers who demand university graduates with particular strengths in sustainability (see Table I for a list of internal and external barriers and drivers).

3. Conceptual framework for transformations

While there are undoubtedly some universities that are already on their way to embodying some of these ideals, achieving change at the majority of universities around the world will require tremendous effort. One way that can be described and assessed the necessary transformation is through FLA analysis, which provides a simplified approach to exploring the main paths of change (but does not aim to replace a sustainability assessment system). This method was recently proposed and is described elsewhere (Ferrer-Balas *et al.*, 2008) based on the concepts developed by Jansen (2003). According to Jansen system renewal is a concept integrating technological, cultural and structural elements, in which three interacting dimensions (framework, level and actors) can be distinguished in the process of change to more sustainable patterns of development (Figure 1). The framework (F) dimension relates to intensive interacting changes in culture, institutional structure and technology (means to satisfy the needs). The level (L) dimension describes the level of change that is required. Finally, the third dimension refers to actors (A), or those stake-holders who are involved in the transformation process. Of course, there are varying levels to which a given strategy for change might involve each dimension (Table II).

	Internal	External
Barriers	Academic freedom Incentive structure Conservative administration	Lack of pressure from society
Drivers	Leadership Champions Connectors Size Coordination unit	Pressure from peer institutions Sources of funding available

Table I.
List of internal and external barriers and drivers for universities in relation to change toward sustainability



Source: Jansen (2002)

Figure 1.
The framework, level and
actors – “FLA approach”:
three interacting
dimensions of change for
achieving SD

Dimension	Value
Framework (F)	0 = no changes are induced in structures, processes culture and/or technology of the institution 1 = initiates progressive changes in structures, processes culture and/or technology 2 = practices progressive changes in structures, processes, culture and/or technology 3 = establishes/mainstreams changes in processes, structures, culture and/or technology
Level of transition (L)	0 = no changes 1 = optimization of current processes. Changes in operational processes through quality management, maintenance, auditing, efficiency drives, at time scales of 1-5 years 2 = improvement of processes or products (revision, reorganization, redesign) in time scales of 5-20 years, leaving fundamental structures unchanged 3 = renewal of systems. Grow-out of long-term research, inducing changes in > 20 years
Actors (A)	0 = only one actor involved 1 = various internal actors involved 2 = internal/external actors of the same nature 3 = internal and external actors of different nature (stakeholders)

Table II.
Criteria followed in each
dimension in the
framework, level and
actors “FLA” analysis

We begin by considering the mechanisms of organizational change (F-axis). It is clear that sustainability requires long-term and systems thinking for a set of very different resources such as natural, human, social, manufactured and financial capital (Porrit, 2005). For a university bringing about framework shifts, changes cause an added degree of complexity given the typical disciplinary divides and management and funding structures. Hence, a logical progression seems to be the following: such changes are initiated and the benefits are shown through pilot projects. This step may reinforce the cultural shift that has induced them (positive feed-back loop), and the legitimacy is obtained in order to continue their integration. Finally, the way of

thinking has globally changed and become the mainstream. An example in the operational side can be giving strategic value to natural resources such as energy or water: instead of only counting performance financially, resource use may be a new comparison framework.

Looking next at the L (level) dimension, three degrees of change can be identified. The first degree, system optimization, involves changes in operational processes through quality management, maintenance, auditing and efficiency drives (with time scales up to five years). The next degree, system improvement, would leave fundamental structures and technologies unchanged but produce incremental change through revision, reorganization, redesign (at time scales from 5 to 20 years). Finally, systems renewal might entail step-function changes that result from long-term research and fundamentally affect structure, culture and technology (with time scales over 20 years). Campus greening measures focusing on energy efficiency or recycling are often the “system optimization” degree, whereas many of the culture-shifting characteristics outlined in Section 2 such as triggering and legitimizing academic spaces for interdisciplinary research in long-term SD challenges would be examples of systems renewal.

Finally, considering the A (actors) dimension, the simplest situation would involve only one actor making a change. An added degree of complexity would include a host of internal actors (such as faculty, operational staff, students, administration). Further complicating this would be to include external actors with similar functions (i.e. faculty at other universities or building managers). Finally, at the highest degree of complexity in the A dimension, one might include a full gamut of actors including governmental bodies, private producing parties, scientific and technology institutions, and NGOs, including consumers and local communities.

In order to facilitate comparison between different universities and transformation strategies, the qualitative evaluation of each dimension (F, L, and A) can be assigned a quantitative level (from 0 to 3), as described in Table II. Considering the F, L, and A dimensions as axes on a three-dimensional diagram, with the degrees of complexity increasing as one moves away from the origin, it is possible for us to visualize the depth of change that is being attempted.

4. Case studies of transformation strategies

Having described a basic framework for how to assess the level of transformation, the strategies employed by a number of universities around the world as a means to create a sustainability transformation will be studied.

4.1 Technical University of Catalonia (Spain). A decade of curriculum greening

The Technical University of Catalonia (UPC) is a young public university, founded in 1971 as the result of merging a number of existing engineering schools. It includes 15 technical schools on seven campuses, with approximately 35,000 students. Compared to other universities in the country, UPC is seen as a dynamic university, with strong links to Catalonia’s industrial base.

From 1996 to 2005 the institutional commitment has been shown through two successive environmental plans that included actions in education, research, campus and communication (Ferrer-Balas, 2004; Ferrer-Balas *et al.*, 2006). In them, curriculum greening became a declared objective at UPC and there were many projects developed

and revisions of curricular materials and programs. The projects generally involved motivated staff and students who were supported by the environmental plan unit.

Over the period 1996-2005, the percentage of all courses that included environmental content rose from 11 per cent to more than 21 per cent, and many specific optional courses on environment and sustainability also appeared. With only a few exceptions, however, the curriculum has largely remained unchanged, proving to be an incremental, progressive change rather than true university transformation.

In its attempts to change, UPC has taken advantage of a number of drivers. Internally, these drivers include leadership and vision of a few individuals in the top-management, a handful of indefatigable champions on campus, and a board-supported coordination unit. Externally, the drivers include a small amount of financial support from the government, influence from other universities (namely, TUDelft). However, efforts at UPC have also encountered major barriers. One has been the difficulty getting buy-in from individual staff members, who have been reluctant to accommodate institutional mandates and declarations, and had no real incentives to cooperate. The lack of support from most of the deans and administrators has been a further hindrance. Externally, although there has been a small amount of financial assistance from the government, it has not been sufficient, perhaps since UPC is the first university in Spain to make sustainability such a priority.

Since 2006, with the help of an international experts' evaluation and an internal participatory process, UPC has initiated a new strategy called UPC Sustainable 2015 (Ferrer-Balas *et al.*, 2008), which aims to be a further step. External links and the explicit orientation to sustainability and to long-term issues are its core elements. Also, the creation of the Center for Sustainability in 2005 has been helpful in accelerating this transformation. The Center, which is led by a Vice rector for SD, is therefore directly linked to the board and has the mission of integrating sustainability within all the activities of the University, and to create opportunities for innovation in sustainability. A detailed description of the new strategy and the FLA analysis comparing the previous strategy and the current one can be found elsewhere (Ferrer-Balas *et al.*, 2008), and is summarized graphically in Figure 2(a). On the *F*-axis, UPC is between initiation and practice in changing the structure and culture towards sustainability. Concerning the *L*-axis, the predominant level is still optimization, though some attempts to go beyond already exist. Regarding the actors, the current efforts are oriented to make use of the good connection of UPC with society (but not oriented to sustainability thus far) to create external solid links to work jointly towards SD, but this is still under progress.

4.2 TERI University (India). A small new research-oriented university

TERI University, located in New Delhi, India, is a private university created in 1999. In comparison to public Indian universities TERI is very small. The small size of the university (currently 300 students, and expected to peak at 1,000 within a couple years) is intentional, allowing the university to function as a "research university" and cater to the niche areas of energy, biosciences, environment, public policy, and infrastructure management.

The university owes its origin to its parent body, The Energy and Resources Institute (TERI), a not-for-profit independent research institute recognized globally for its contribution to scientific and policy research in the realms of energy, environment, and SD. TERI is a unique institution engaged not only in research that supports the

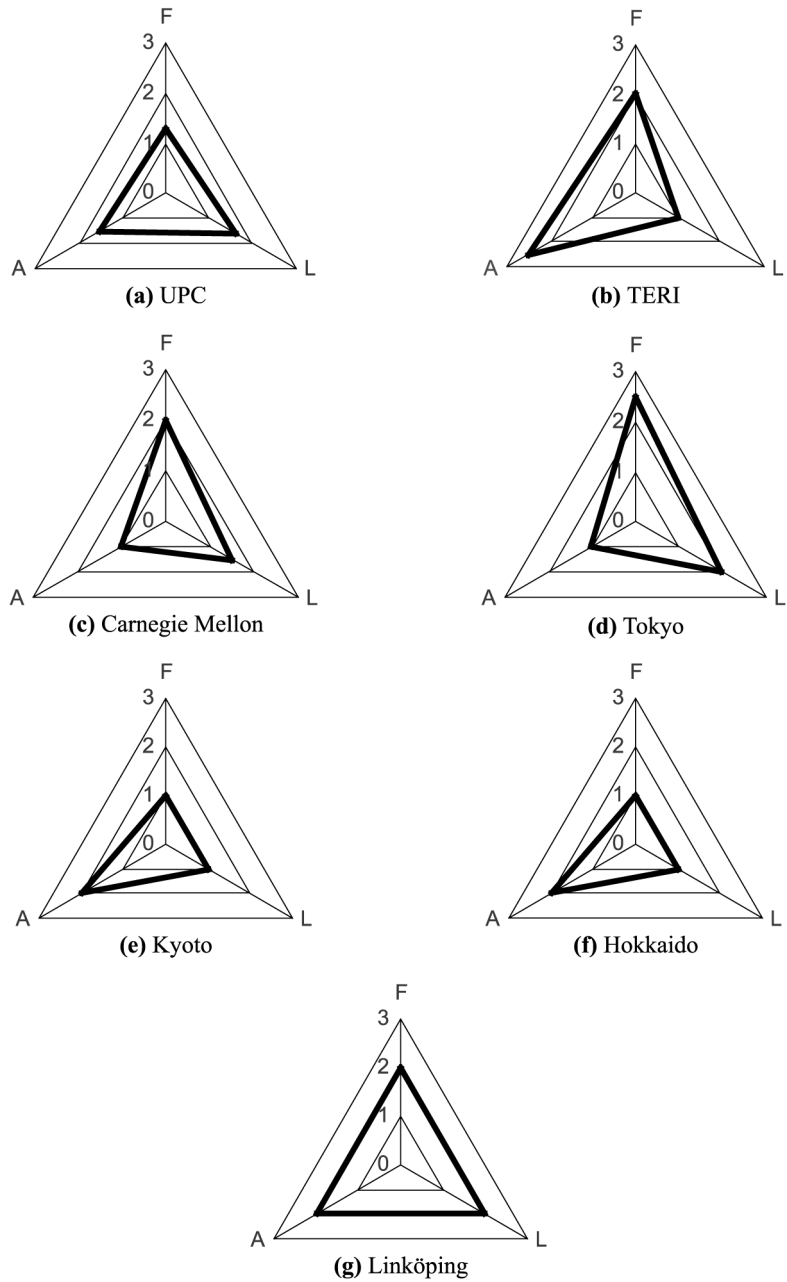


Figure 2.
Comparison of the
framework, level and
actors "FLA" approach
applied to different cases

objectives of SD but is also a practitioner in the field, regularly engaging all types of stakeholders in fulfilling its mission.

While TERI and its leadership have acted as the direct drivers behind the genesis of TERI University, there are a set of indirect drivers that have contributed to the growth of the latter. Among these are a growing demand for environmental managers from the corporate sector; government support for capacity creation among its officers on policy making for SD; interest among donor agencies to fund the uniquely designed academic programs; and growing social awareness of career opportunities linked to unconventional areas of education.

The university's academic programs have been structured around the research experience, resources and skill sets gained in TERI over the last three decades. All the masters-level programs are interdisciplinary in nature and combine theory with practice. A key feature of the programs is the way they seek to ground concepts in reality by allowing students to study real life problems. The administration of such programs has led to extensive networking by the university with corporate and civil society organizations, government, bilateral and multilateral donor agencies, which act as host bodies for students under a system of co-supervision. This has ensured that there is wider societal participation in the university's educational programs.

A unique feature of the university is that its departments are structured around themes (e.g. natural resources management or policy studies) rather than disciplines. Not only is faculty expertise shared across academic programs, but there are also individual courses that are common to students registered for the different streams (e.g. M.Sc., M.A., MBA) and handled by teams of multidisciplinary faculty members. This has facilitated interdisciplinarity in the design of programs and also provided greater choice for students in selecting courses.

While the small size of the university has no doubt facilitated innovation in the programs design, the same characteristic is likely to act as a barrier for the university in achieving financial strength once support from donors is gone. High student fees can reduce motivation, and the pressure on faculty to generate funds from sponsored research may serve to divert attention from teaching over a period of time.

In terms of the FLA analysis (see Figure 2(b)), TERI is a good example of practicing structural and cultural changes in its day-to-day framework. However, the changes promoted by the research and education still focus on optimization of present systems (applied research mainly). Indeed, a main strength of this university is the strong link, by its initial design, with different stakeholders.

4.3 Carnegie Mellon University (USA). A culture of interdisciplinarity

Carnegie Mellon University (CMU) is a mid-sized private university with roughly 6,000 undergraduates and 2,000 graduate students. It is consistently ranked as one of the top 25 universities in the USA. The focus is on science and technology, but there are also excellent colleges of business and fine arts.

CMU is located in Pittsburgh, a formerly industrial city known for its steel production. In the past five decades, the city has worked hard to transform itself from one of the most polluted cities in the USA to a relatively clean urban center today. Sustainability efforts at the university can be traced back to CMU's consistent support as a partner in the city's environmental efforts..

CMU's sustainability transformation has also been influenced by a highly interdisciplinary institutional culture. Students in one department frequently take courses in other departments, and faculty from different departments and colleges at the university work together on research projects. The university also has many "problem solving" courses where an entire class tackles real-world, open-ended problems. Such open-ended problems have been a hallmark of the Engineering and Public Policy (EPP) Department on campus, in which all undergraduate students must have a "home" department which is in a traditional engineering discipline. Graduate students in EPP, however, can pursue M.S. and Ph.D. degrees in EPP alone or as a double major with a traditional engineering department.

CMU has been able to begin a transformation that involves improving environmental education at the university at all levels and for all students. This includes introduction of innovative environmental courses (e.g. see Davidson *et al.*, 2007a) and short environmental sections known as "modules" for traditional courses such as general chemistry, history, or design. Such courses have thrived at CMU, although these courses are still limited in number at the university. These have been articulated by the umbrella environmental organization on campus, the Steinbrenner Institute for Environmental Education and Research (SEER). However, it should be emphasized that these efforts toward environmental education are only beginning.

With the recent establishment under the SEER umbrella of the Center for Sustainable Engineering (CSE) at CMU, the University of Texas at Austin, and Arizona State University (Davidson *et al.*, 2007b), the transformation toward improved environmental education at CMU should be facilitated. The CSE organizes workshops for faculty members in engineering around the country so that courses can be revised to include issues in sustainability, and also hosts a website for educational materials. Furthermore, with the expansion of green practices on campus (Dzombak and Davidson, 2004), there should be new opportunities for faculty to engage their students in environmental issues.

The President of Carnegie Mellon, an environmental engineer by training, supports such transformational activities. Furthermore, CMU is smaller than many schools and can move relatively quickly when necessary. It also benefits from a number of champions who are willing to put time and effort into change and the presence of connectors who can bridge gaps across disciplines.

Of the barriers previously discussed, academic freedom and lack of incentives have the most potential to hinder progress in the transformation at CMU. Although the most enthusiastic faculty members have signed onto improved environmental education at the university, the majority of faculty members are not environmentally oriented and may be more difficult to convince. The second barrier, lack of incentives to promote environmental education, is unlikely to change in the near future. As with many other high-profile universities, CMU has resisted change in tenure and promotion policies, and this may make it difficult for faculty to be rewarded for their efforts to improve environmental education in their classes.

Regarding the framework dimension, the interdisciplinary culture is augmenting change by enabling expansion of courses outside of their traditional boundaries. The level of transformation dimension in this context deals with revision of courses to accomplish incremental change, and includes assessment of change through faculty-course evaluations and other mechanisms. Finally, the actors dimension is

less important at present, since major renewal of systems is not yet being discussed outside the university. However, buy-in from large groups of faculty will eventually become important as revisions become the norm in more individual courses, and as revised courses possibly lead to new degree programs and other major changes.

4.4 The Integrated Research System for Sustainability Science (IR3S) and its partner universities (Japan)

The Integrated Research System for Sustainability Science (IR3S)[1], established in 2005, consists of five leading Japanese partner universities: the University of Tokyo, Kyoto University, Hokkaido University, Osaka University and Ibaraki University. There are two major aims for the creation of IR3S. One is to establish “sustainability science” as a new academic discipline. The other is to solve real-life problems that threaten the sustainability of human life and the ecosystem. IR3S also aims to promote joint projects and publish an international academic journal by providing coordination for these partner universities and associate institutions. At the same time, IR3S forms international alliances, seeks academia-government-industry cooperation, and promotes outreach.

Under this overall framework, the partner universities develop their research activities under their own research themes which would utilize their strength backed up by the wealth of knowledge resulting from their various research experiences. IR3S on the other hand identifies common research themes that all partner universities can pursue together, gathers their expertise, generates diverse, high-quality results, and aims to promote sustainability science through the combined effect of these efforts.

The following sections illustrate how three partner universities have performed under these IR3S-led initiatives which, if pursued seriously, inevitably require a great transformation of each university itself.

4.4.1 The University of Tokyo. The University of Tokyo (known as Todai) is the oldest Japanese national university established in 1877 (www.u-tokyo.ac.jp/gen01/UnivToday/ut01_04_j.html), and is the center of the academic and educational activities in Japanese higher education system. Todai has 29,000 students and 15 graduate schools, 11 institutes and 21 university-wide centers.

Todai has been the leading partner which facilitates the creation and development of the IR3S. In line with the IR3S initiatives, the university aims to accelerate and consolidate university-wide interdisciplinary academic activities by transforming itself. In order to achieve this goal, it established the Trans-disciplinary Initiative for Global Sustainability (TIGS). Its overall research theme aims to develop a global sustainability strategy based on structuring knowledge on sustainability science drawn from a wide range of academic disciplines and issues.

Todai established the Division of Environmental Studies at the Graduate School of Frontier Sciences in 1999 with the goal of developing a platform for Todai faculty members and students to find common interests and research partners so that they can successfully conduct interdisciplinary research and educational activities. It decided to go further to accelerate collaborations in sustainability by launching a new masters program, in collaboration with TIGS. Thus, the transformation process at Todai has included the development of a new unit, TIGS, and an associated network of faculties and schools including the Division of Environmental Studies.

The main drivers for these transformations have been the government's support of the IR3S as well as the presence of collaborative projects through TIGS, other IR3S participating universities and the Division of Environmental Studies. The biggest barrier at Todai has been the non-uniformity in the degree of excitement among faculty and departments ranging from indifference to enthusiasm.

The transformation efforts at Todai are still in process and thus it is difficult to fully assess their impact. Figure 2(d), however, uses the FLA approach to provide a summary of activities to date. Regarding the radical renewal of systems (level), Todai's activities have been oriented towards the enhancement of transdisciplinary research and educational activities with a long-term orientation. More changes in the academic culture of the institution are being pursued in order to achieve the framework or organizational transformation. Finally, in terms of actors, a key issue of the sustainability strategy of the University of Tokyo has been including more actors in the process (i.e. students, faculty and staff especially at the Institute of Environmental Studies, an organization which alumni of the program are likely to work for).

4.4.2 Kyoto University. Kyoto University (KU), founded in 1897, is the second oldest national university in Japan, housing 17 graduate schools, ten faculties, and 13 research institutes. Nearly 23,000 students are enrolled. The most outstanding feature of academic traditions is a respect for the spirit of freedom, which arises from Kyoto's cultural and philosophical traditions. For over 1,000 years, Kyoto was the capital of Japan, the heart of politics and culture.

In 2002, the Graduate School of Global Environmental Studies (GSGES) was established for tackling environmental issues. GSGES has a unique educational system which includes an internship study program so students can develop problem-solving skills and take various environmentally related courses. In 2006, the Kyoto Sustainability Initiative (KSI), a network for sustainability science in Kyoto University, was launched. This network consists of GSGES and six research institutes, and promotes research and education on sustainability science. In 2007, a new diploma program called the "Sustainability Science Program" was established.

There are two major internal drivers behind the creation of these programs. One was the recognition that it was important for KSI to fulfill its commitment to the IR3S by establishing a new education and research system. The second internal driver was GSGES's intention to add more value to its activities, in order to strengthen its institutional base as a new graduate school and help it become one of the leading institutions in the environmental field. An external driver prompting the transformation was government policy on sustainability which has created more public financial support for research and education in related topics.

KU's strategy has also met with several barriers. All KSI researchers who have permanent positions are working for both KSI and their original departments, and have little incentive to contribute to interdisciplinary work. In order to increase incentives and activate KSI, it is important to deepen common understanding of the activity of KSI among existing faculties and institutes. The project has also found that the small number of job opportunities for students trained in sustainability science is proving to be a barrier. KSI is attempting to overcome this barrier by creating an internal cycle in which graduates play an active role in society, thereby attracting high-quality students who aim to follow these role models. They are also working to

find strategic partners that provide employment and have worthwhile projects for students to work on during their internship program.

While the structure of the university has been transformed due to the creation of KSI and the activities it has pursued since then, big framework changes in culture and technology are yet to be seen (see Figure 2e). The direction in which this transformation proceeds needs to be reevaluated as drastic changes will happen on structures and resources after the grant from IR3S ends in 2010. Regarding the level of the transformation promoted, KU is in an early phase. The education and research system on KSI has been constructed for two years and now it is almost structured, but is again highly dependent on a grant from IR3S. Regarding the actors dimension, networks on human resources have been broadened to external actors through symposia, meetings and group/individual research efforts.

4.4.3 Hokkaido University. The origin of Hokkaido University (HU) was the Sapporo Agricultural College, the first national agricultural college established in 1876. It now boasts a wide variety of academic disciplines within its 26 institutes and research centers and 17 graduate schools and faculties, and includes more than 18,300 students.

Through its Sustainability Governance Project (SGP) formed in April 2006, HU attempts to establish sustainability science along the framework of the IR3S. Accordingly, SGP's aim is to develop both a practical system of sustainability in society, and also the research and education systems necessary to support it. The project includes a core team of four researchers appointed especially for the project, and links with additional 55 academic staff members from across the university.

HU has drawn on its expertise working with regional partners to position SGP as an interdisciplinary, university-wide project, with an explicit focus on the local context. It is thus natural for SGP to attempt to develop networks among local citizens and organizations including NGOs. Reflecting its background, it has chosen primary industries and agriculture in particular as SGP's research focus. In order to accomplish its missions stated above, SGP aims to turn itself into a center for sustainability science in the four year time period.

The underlying drivers that led to the formation and development of SGP were two-fold. First, there was the Japanese government's call for more an integrated approach towards sustainability, which eventually resulted in the establishment of the IR3S. Second, there was a strong consensus among many faculty members at the university that something had to be done to tackle ongoing challenges – ranging from environmental destruction to North-South divides to aging population – all related to the sustainability of society. In response to the government's call, some of the staff members, or “champions”, played the role of internal drivers that led to the establishment of SGP.

The founding of SGP has also encountered a number of barriers. First, it has been difficult to facilitate the participation of faculty members across the university, as most staff members are already busy with their own research and education activities. Without incentives, many faculty members are not interested in the SGP-led process, and even some of the project “champions” lament that their busy schedules prevent them from attending the activities of SGP, despite their interest. These barriers have constrained the scope of disciplines covered. As a result, coordination among research projects in the university is rare, and many projects and curricula whose contents are similar to those of SGP are carried out at other locations on campus.

The external relationships with other IR3S partner universities and associated institutions offer SGP opportunities and challenges. On the one hand, the interactions with researchers from other outside organizations through the IR3S-led joint projects undoubtedly enrich the understanding of sustainability of SGP staff members. On the other hand, due to the large number of the IR3S-related organizations to which SGP has to maintain its ties, there is a great burden in organizing events and attending frequent meetings.

In the light of the FLA approach, the framework dimension in the case of HU has gone through structural changes (as SGP). However, the question of how changes in culture and technology which induce transformation would occur is yet to be tackled. Similarly, the level dimension is still in its infancy, with hopes that recent efforts to establish longer-term programs will improve the score in the future[2]. The score is higher for the A-axis, since the major actors involved in this transformation process are as follows: internally, academic staff members from HU; externally, those from the IR3S-related organizations. While SGP tries to expand its networks outside of the major actors, the coverage of these networks is still limited.

4.5 Linköping University (Sweden). Structuring thematic research

Linköping University (LU) is a young educational center which started in 1965 with pure technical and medical education. In 1967 liberal arts education was added and in 1975 the University was established as the sixth university in Sweden with technical, science and arts education and research. Linköping University is a public university and has today approximately 26,000 students and over 100 educational programs. It is located in the interior of the southern part of Sweden.

At present, there are four faculties at LU:

- (1) Educational Science.
- (2) Science and Engineering.
- (3) Health Science.
- (4) Arts and Science.

In 1980 LU began “theme” research with the ambition to promote interdisciplinary research and to distinguish itself from its discipline-oriented Swedish counterparts. The back-bone of this idea was promoting students from different disciplines to come together and focus on joint interest such as water, communication, technique and societal change, and health and society. Administratively these themes were placed directly under the Faculty of Science and Arts (one of four University faculties) with 14 departments that remain unattached to any particular faculty. The faculties are the entities that decide on the educational and research agenda and orders courses from the department that executes them.

This theme structure, which enables university researchers to more adequately address complex societal problems, has led to important linkages with the surrounding community (e.g. to fund externally 14 research positions, something very rare in Swedish universities, or to increased university-industry collaborations).

While a theme structure is, in itself, no guarantee of a Sustainable University, such a structure promotes tackling complex societal questions without being hindered by organizational barriers. In this perspective, LU has the character of an interdisciplinary

university that can move more freely and tap into varied expertise around the campus to solve sustainability problems. This structure, largely in place thanks to active promotion by University, has also minimized many of the barriers discussed in section 3.2.

Another key driver to LU's innovative structure is its desire to compete with more established national universities, driving the leadership to listen more carefully to societal demand. In addition, the leadership of the University has been given a mandate from the Swedish Government to promote environmental consciousness and theme-based activities. Such engaged leadership has reduced the pressure placed on individual "champions" to enact change.

Regarding the FLA approach (see Figure 2(g)), the framework of the university can be categorized with a change in structure due to the creation of themes rather than traditional faculties. In terms of level of transition the age of the university and the context in which it was born are key aspects. The will to change traditional structures has been implemented since the start as a competing strategy against other older universities in a small and sparsely populated country like Sweden. This has, however, been done without eliminating fundamental structures, leaving LU at level of transformation of 2. The interaction with the local community has been strong since the university's creation, yet the nature of the interactions are made with actors with similar nature, suggesting an actor level of 2.

5. Discussion

5.1 Comparing the predominant dimensions of change within the universities

Based on the information considered in each case, and with the close knowledge of these realities from the authors, the FLA method has been applied and the results are shown in Figure 2. The varying shapes of the graphs highlight the different foci of the universities' strategies. As explained in Section 3, the strategy that aims to create the deepest, longest-lasting transformation extends to the farthest reaches on each axis, appearing as a well balanced and large triangle in the graph.

A first overview shows that no common pattern among these seven universities is found. Each case has its own particularities, and for instance, there is no common predominant axis for all them. One can see that among the seven cases, very high values on any axis can only be seen in a couple of cases. One of them, University of Tokyo, shows the highest value in the Framework axis, thus reflecting the importance of transdisciplinary structures. In effect, this university is promoting science in the boundaries of disciplines, and particularly leading the IR3S project. It is also interesting to notice the case of TERI and realize how this university is stressing the actors' dimension, by putting more emphasis in participation of the university in society. Linköping is the most balanced university, which is a sign of rather comprehensive evolution towards sustainability. While less advanced, UPC is also an example of balance in combining efforts in the three dimensions. Carnegie Mellon has a good effort in the framework dimension by developing sound interdisciplinary efforts over many years. In comparison, Hokkaido and Kyoto put the accent in the actor's side, influenced by the positive effect of the collaboration with other universities under the IR3S project.

5.2 *The effect of drivers and barriers on the strategies*

Table III identifies the main barriers and drivers that have been important for these universities. Considering barriers, the predominant trend is the lack of incentive structure to promote changes at the individual level. Interestingly, those universities that do not emphasize this barrier show higher values on the F-axis, indicating that there is some correlation between developing incentives and a better organizational framework for SD. Other barriers such as academic freedom, and the lack of pressure from society, have been identified by some universities. The fact that the first is not identified by all of them means that academic freedom can actually have a positive effect on transformation, allowing room for champions to act. The barrier of the lack of pressure from society is mentioned by one university where transformation efforts are focusing on improving the connection with external actors, and so perhaps this barrier is more evident in this case than in the others (Figure 2a). It is also important to notice, as another predominant trend, that no one has identified conservative administrations as a barrier, thus reflecting that, in comparison to their peers, these seven cases are pioneers in the field.

Regarding drivers, the presence of “connectors”, the existence of coordination bodies and projects, and the availability of funding are present in almost all cases. The creation of centers or other structures that act as an interface to external actors and may also be important internally is seen as a converging driver. Only Linköping University does not identify it, perhaps because this function is already met by its inherently interdisciplinary structure. The fact that these drivers correlate to funding probably reflects that they are useful in order to act as fund-raisers.

Three universities highlighted the importance of human drivers such as leadership and champions. These drivers are not something that can willfully be created, but may be used to stimulate transformation where they are present. The three IR3S universities also identified the importance of the government role in the setting of such a program. While pressure from peer institutions is only suggested by two universities, at a time when the top universities are each adding sustainability initiatives, it is reasonable to suppose it must have been an implicit factor for many institutions. The two smallest universities highlight their size as a driver, confirming that the nimbleness of smaller organizations may indeed aid the transformation.

5.3 *Advances towards the ideal university*

If the characteristics that have more to do with the level of changes achieved are taken, in some of the cases studied, the clearest advances seem to focus the development of new research through trans-/interdisciplinary academic activities. At least, it is a declared strategic objective, if not a design criteria, and therefore resources are allocated and structures devoted to trigger it. Good examples of those are the universities working under the IR3S project, Carnegie Mellon and Linköping Universities. These efforts are also having consequences on the framework, because they create an interdisciplinary culture and need the creation of new structures. In general, however, fewer aspects reflecting the practice of transformative education have been found. As this other key characteristic has to do mainly with a significant change in educational paradigm, it seems to be only possible when a certain level of maturity is reached.

	UPC	TERI	Carnegie Mellon	Tokyo	Kyoto	Hokkaido	Linköping
<i>Barriers</i>							
Academic freedom	✓		✓		✓		
Incentive structure	✓		✓		✓		✓
Conservative administration							
Lack of pressure from society	✓		✓				✓
Leadership	✓		✓				
Champions	✓		✓				
Connectors	✓		✓		✓		✓
Size		✓	✓				
Interdisciplinary University by design		✓	✓				✓
Coordination body or project	✓	✓	✓	✓	✓	✓	✓
Pressure from peer institutions	✓			✓			
External funding available	✓	✓		✓	✓	✓	✓
<i>Drivers</i>							

Table III.
Drivers and barriers that
were emphasized in the
description of each case
study

In relation to the actors' dimension, the authors have identified efforts helping progress in different perspectives. Most of the universities have developed expertise networks around the campus, which also contribute to creating cultural change and therefore to the framework evolution. Also, relevance to societal needs is being worked out through increasing contact with external stakeholders (e.g. TERI). Hence, one can find examples in different places of creation of multiple channels of interaction between university and society, through centers or institutes (e.g. UPC, Carnegie Mellon, Tokyo). Furthermore, it can also be found some societal problem-solving orientation in education and research, like in TERI and Linköping.

Finally, an aspect that refers to the framework evolution is the existence of leadership and vision. Although the universities studied have not identified the issue of personal leadership, it is possible to see examples of good visions of change in their institutional projects, such as the IR3S global project in Japan, the Transdisciplinary Initiative for Global Sustainability (Tokyo), Kyoto Sustainability Initiative, Sustainability Governance Project (Hokkaido) or UPC Sustainable 2015 Plan.

6. Conclusions

This paper has studied seven universities in different parts of the world that manifest particular leadership towards SD. A common list of characteristics for a sustainable university has been presented, as well as the drivers and barriers that affect the transformation toward sustainability.

The analysis has been carried out using a simple method (FLA-analysis) based on the idea of sustainable transitions from a systemic and multidimensional (framework-level-actors) perspective, which has proved useful for comparing case-studies.

The results show that no common path for the universities is found. Overall none of the three dimensions of change is predominant over others. Some cases such as Linköping University and UPC show efforts that are well-balanced in the different dimensions, while others focus more in one or two dimensions.

In general, the main barrier to be overcome is the lack of an incentive structure for promoting changes at the individual level, unless they have rooted interdisciplinarity from the design of the structure itself. On the other hand, as drivers, the presence of "connectors" with society, the existence of coordination bodies and projects, and the availability of funding seem to be keys for any progress.

Trans- and interdisciplinarity is being declared as a strategic objective in almost all universities, while transformative learning is less present. Regarding the relationships within important actors for universities (internally and externally), a common characteristic for most of the institutions is establishing and supporting networks of expertise within the universities. At a lower level, establishing connections with society is also present as an increasing trend. Almost all universities show important strategic efforts and initiatives that drive and nucleate change for SD, which are the result of a combination of drivers more than based on personal leadership.

Notes

1. The Educational Visions of IR3S Participated Universities (www.ir3s.u-tokyo.ac.jp/en/project/edu.html)

2. Recently, there have been signs of positive changes. In 2008, the G8 summit will be held in Hokkaido. The University has launched on a series of research activities on sustainability in order to contribute to the debates carried out at the summit. This would provide SGP with an opportunity to coordinate many competing activities so that it could become a base for transforming the university for sustainability. Moreover, Hokkaido University has recently launched the rearrangement of its education programmes on sustainability all over the campus. The institutional framework for the establishment of an education center for sustainability science has been formulated, in which SGP is expected to play a major role in designing and overseeing its curriculum

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Further reading

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