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Management Systems for Sustainable Development on campus, a case study of University of Coimbra

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UNIVERSIDADE DE COIMBRA

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Abstract

In this work the term “sustainable campus” was defined according to the author’s perception and important factors of sustainable campus were determined. A set of the most applied assessment tools for a sustainable campus are introduced and examined. A short overview of sustainable development on Portuguese universities is given and the University of Coimbra is introduced. Assessment tools are then analysed according to their ability to manage sustainable development on the campus of the University of Coimbra. Thereby six management frameworks to manage sustainable development on a campus level are created through the application of a *plan, do, check, act* cycle on assessment tools and through the combination of several indicators of these assessment tools with a formal environmental management tool. The best management system according to criteria of the University of Coimbra is chosen using a Multi Criteria Decision Analysis method. Finally, as a conclusion, an action plan for UC to become a sustainable campus according to the definition is proposed.

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List of Abbreviations

AAC	Academic Association of Coimbra
AASHE	Association for the Advancement of Sustainability in Higher Education
AISHE	Assessment Instrument for Sustainability in Higher Education
BS	British Standard
CSAF	Campus Sustainability Assessment Framework
DHO	Dutch organization for the advancement of sustainable development in higher education
EFQU-INK	European Foundation for Quality Management and the Institute for Dutch Quality Management
EFS	Education For Sustainability
EfS	Energy for Sustainability
EMAS	Environmental Management and Audit Scheme
EMAS-EDIN	Environmental Management and Audit Scheme in Education Institution
EMS	Environmental Management System
GASU	Graphical Assessment of Sustainability in Universities
GRI	Global Reporting Initiative
ISO	International Organization for Standardization
MCDA	Multi Criteria Decision Analysis
MIT	Massachusetts Institute of Technology
NGO	Non-governmental organizations
PhD	Doctor of Philosophy
SD	Sustainable Development

SDMS	Sustainable Development Management System
SDWG	Sustainable Development Working Group
SES	Sustainable Energy Systems
SME	Small and Medium Enterprises
STARS	Sustainability Tracking, Assessment & Rating System
TBL	Triple Bottom Line
TV	Television
UK	United Kingdom
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
USA	United States of America

1 Introduction

Growing environmental pollution and rising energy prices are common news in contemporary society. News about rising prices for a fossil resource or negative effect of human activities on nature (forest fires, floods, smog…) is broadcasted nearly in a weekly frequency. Public awareness for such events grew since the Club of Rome published the book "Limits to Growth" in 1972. Also the 30-year update of the book has raised awareness of environmental effects of human activities. The word "overshoot" is introduced to describe human behaviour that goes beyond natural limits, to use natural resources faster than they can be replaced by nature. Sustainability however, describes the situation wherein human activities are in equilibrium within natural limits [1]. During the same year as the book "Limits to Growth" was published, the Stockholm Declaration (1972) introduced the idea of education in environmental matters [2]. With rising awareness of human impact on nature, the first measurable effects of the human footprint on the planet and the finite amount of natural resources, some nations started to care for environmental issues and decided to develop in a more sustainable way of interacting with nature. More than a decade after "Limits to Growth" was published, "Our common future", also known as Brundtland Report of the United Nations Organization (1987), describes the development towards a more sustainable relationship with nature and defines it as:

"Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs [3]."

In this sense sustainable development (SD) addresses the responsibility for future generations. This was acknowledged by the Talloires Declaration in 1990, a 10 point action plan to implement sustainability at universities. With this declaration universities recognize their impact on SD and their special responsibility for future generations [4]. Also the Agenda 21 of the United Nations Conference on Environment and Development in Rio 1992 recognizes the importance and responsibility of education institutions towards SD [5]. In 2005 the United Nations declared the UN Decade of Education for Sustainable Development (2005-2014) to mobilise educational resources towards SD.

Since then many occurrences have happened. Education for Sustainable Development has taken place in many countries and has, for example, led to situations in which children explain to their parents how to recycle in the correct manner. In this context, universities have a special responsibility in educating future leaders towards SD. In contemporary society there are only 2% of the world population attending higher education institutions and about 80% of the decision makers in industry and politics have a higher education graduation [6].

1.1 Sustainable Campus

Universities find themselves in a position of high responsibility in relation to society as they educate most future decision makers [6]. These decision makers face immense tasks in terms of climate change, environmental pollution and scarcity of fossil resources and should therefore be equipped with knowledge and answers to overcome arising problems. However, not only the curriculum is addressed, as a university teaches and usually host as many people as there are living in a small city, the energy consumption and pollutant emission being, likewise, quite high. Therefore, the university must apply energy efficiency measures to decrease its environmental footprint and lead SD transformation providing a positive example to society.

Since the mid 90´s of the last century some universities joined together in networks and organizations to form agreements regarding energy efficiency (*Appendix A*) [7], and to act according to their special responsibility towards sustainability and promote the approach of sustainable campus. Hereby campuses are motivated to encourage SD in order to represent a positive example for society and students.

The interpretation of sustainability at campus level varies among universities and has to be defined for this thesis. Some universities believe that sustainability is reached by signing an international declaration, others implement environmental guidelines and some get certifications for campus buildings from green building initiatives [8]. The author of this thesis defines a sustainable campus as follows:

A sustainable campus acknowledges its impact on environment and society, and engages itself in the promotion of sustainable development; to underline these ambitions, they can be anchored in the university policy. The sustainable campus recognizes all fields of interaction with society and environment and tries to improve in all fields. Therefore it has a Sustainable Development Working Group (SDWG) which develops a Sustainable

Development Management System (SDMS) that contains actions to be carried out in order to meet the goals of sustainable development on a campus environment. Furthermore, this working group is responsible to measure and report ongoing processes on the campus regarding sustainable development.

To meet its responsibility towards nature and society, a sustainable campus has to reach a balance between its economic, environmental and social development [9]. These three pillars of sustainability are defined by the Triple Bottom Line (TBL) framework which can be seen as a tool to define and to report sustainability [10]. In respect of the three P´s of the TBL: people, planet and profits, the university has to turn into a living laboratory towards SD where students can be involved in programs, activities, research and development regarding sustainable development.

To assess SD on a campus, a number of managing, rating and reporting tools were developed which differ from each other according to the developers' perception of sustainable campus. While some deal mainly with the physical structure of a campus (buildings, transportation and waste etc.) others focus only on the educational situation of a campus and evaluate only the level of Education For Sustainability (EFS). Only a few assessment tools provide a comprehensive evaluation which weights all fields of a campus activity. A campus must be evaluated in all its fields of action and not only according to its eco-efficiency [11].

1.2 Education for Sustainability

EFS describes the education towards SD. It addresses all age groups and disciplines. EFS teaches how the world works and the effect of human activities on the environment in all its matters [12]. It is designed to make people aware of the environmental effect in the choices they make and it provides tools to overcome existing problems in society and environment. Therefore it should be present in all educational institutions, from kindergarten to university.

Some universities already teach specialised courses regarding environment and SD matters, which is an incomplete response to the environmental problems as it is not the responsibility of a small number of experts to face and fight environmental problems [13]. Universities can teach EFS in any course they offer to show students how they can act in their specific discipline towards SD and to clarify the following misassumptions [14]:

- Humans are the dominant species and separate from the rest of nature.

- Resources are free and inexhaustible.
- Earth´s ecosystems can assimilate all human impacts.
- Technology will solve most of society´s problems.
- All human needs and wants can be met through material means.
- Individual success is independent of the health and well-being of communities, cultures, and the life support system.

It is therefore necessary to involve students in environmental projects during their time on campus, in that they learn applied and practical skills in dealing with environmental problems [15]. Active participation in projects fosters deep learning in contrast to superficial learning. Thus, it facilitates overcoming of arising problems from environmental pollution and rising energy prices. If all students are equipped with knowledge of the environmental effects of their actions and answers to overcome problems arising from such actions, a big step within SD will be achieved. Furthermore, subject specific education in this field can also attract a further employer as such skills are often connected with savings in energy, water, waste and other environment related costs an organization has to pay [16].

Citing A.D. Cortese, [14]: “If higher education does not lead the sustainability effort in society, who will?”

1.3 Main Actors

It is important to determine the actors or interest groups within a campus and the campus´s relationship with the local community. It will be clearly understood that not all groups present on a campus follow either the same idea or the same interest and have therefore to be analysed.

Sharp [17] suggests three actors on a campus: students, management and staff (academic and non-academic). Saleh et al. [18] determines four actors on a campus: students, staff and management, the fourth actor being local community which stays in relation with all the previously named actors. Figure 1 shows the groups within the campus and the relation to the local community. After graduation the students join the local community as members with higher education, possibly becoming decision makers in the future [6].

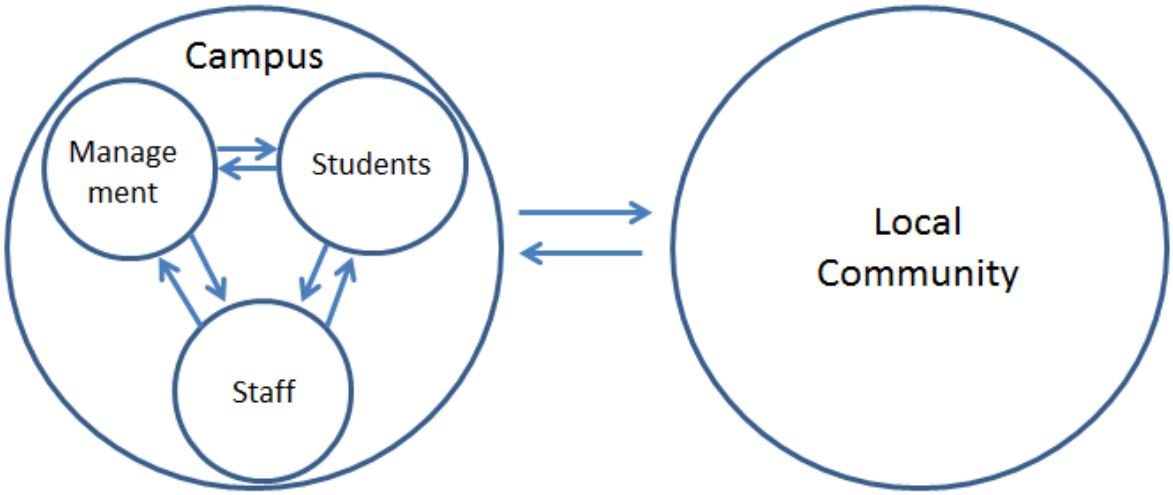

Figure 1: Main actors on a campus in relation with the local community.

Among these actors different interest groups can be identified:

- Students want to study and achieve graduation in their field of study. They want a proper study atmosphere and a high quality education.
- For university staff, both academic and non-academic, the university is their workplace and they demand a good working environment and a pleasant relationship among each other and with the students. While the non-academic staff rather cares for the general environment, the academic staff also values professional scientific equipment and research funding.
- Administrative or management of a university is interested in managing the university in a way where the study conditions are continuously improved and the academic staff as well as students achieve positive outcomes in order to raise positive acknowledgement of the university. Nevertheless, the management is interested in achieving its goals with minimal investment.

Priotini et al. [19] and Yonk et al. [20] see here a Principal-Agent problem among the interest groups students and staff and the management regarding energy efficiency on the campus. The management is interested in decreasing the energy bill and to spend as little as possible while maintaining service to students and a pleasant work environment to staff. Students and staff tend not to care for energy usage and therefore behave rather wastefully. Figure 2 shows the Principal-Agent relationship at campus level.

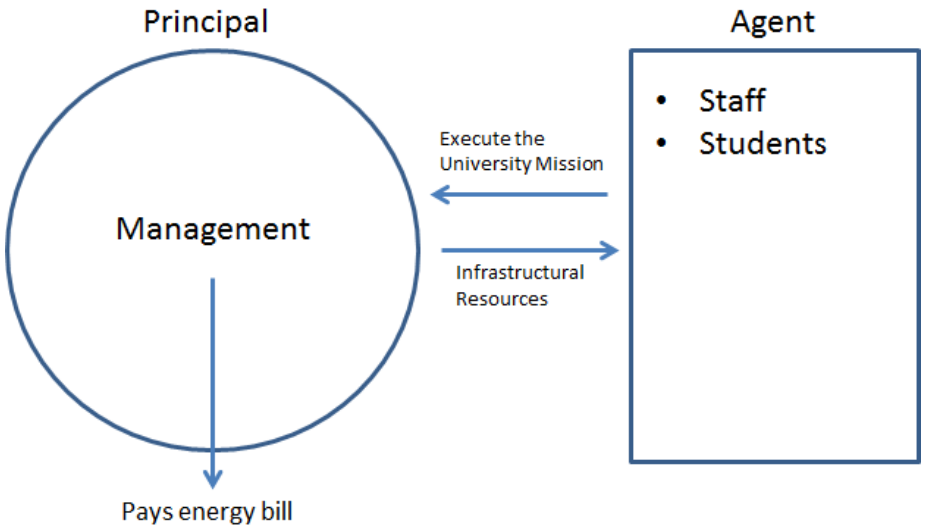

Figure 2: Principal-Agent relationship on a campus.

In order to achieve a positive movement towards SD on campus an integrated management approach is needed. A university does not, unlike an enterprise, exist in a formal hierarchical structure [21]. Universities are not manageable like a company where the decision makers give orders to employees. Rather, a university is a service unit with many stakeholders whose actions are outside the direct authority of the management. Not only the administrators should be motivated and work towards a sustainable campus approach but also staff and students should be motivated and involved. It is therefore important to achieve both, a top down approach where the administrators regulate and order SD, as well as a bottom up approach where students and staff actively participate and fulfil their part in a transition towards a sustainable campus [16]. Furthermore, a university as a high education institution hosts researchers and scientists which are experts in their fields and should be involved in a management program.

To involve all actors on a campus, awareness programs can be launched where the basics of SD are explained and questions are answered. Burke et al. [22] finds that awareness programs, in particular, for the management are a key factor in SME organizations. Furthermore, participants of such awareness programs are more likely to act environmentally friendly [23] and properly not only on campus but in their homes as well.

Bekker et al. [24] conducted a short study over 3 weeks on a student's residential hall where he motivated residents to save energy with posters and flyers. A reward was promised

depending on the amount of energy saved, from free coffee for a week, up to a movie night with ice cream and pizza. The study showed positive results in energy savings, money savings being enough to reward the participants and to recover the investment cost.

Wu et al. [25] conducted a survey and suggested that competitions in energy reduction between students accommodations could be carried out, inter- and intra-campus. Such behaviour change is likely to be applied also at home as the survey indicates.

Matthies at al. [26] conducted a comprehensive study to assess behaviour patterns of campus staff. Staff where surveyed about on and off switchable power strips in offices and to which extent they are used. Furthermore, the office heating and air ventilation was analysed as well as light use, and whether or not computers were in standby or shut off after work or during short breaks. It was found that there is a potential to save energy through changes of the behaviour of staff if they are continuously reminded to act economically. The study resulted in a reduction of heat energy of 0.7% and a reduction of 7.7% in electricity consumption. These represent 8% of the saving potential in heat (9%) and 45% of the saving potential in electricity (18%).

2 Assessment of a sustainable campus

Different assessment tools are used to evaluate, report and rate a university campus according to its actions towards SD. Thereby the tools evaluate SD as the creator of the tool perceives it. Some of the assessment tools care more for eco-efficient measures, some deal with social and health issues and some give a higher importance to EFS. For this thesis all these fields are equally important. However, universities usually use a model which matches the most with their perception of SD and many also create a tailor made framework for their own campus, either by using an existing framework and adjusting it, or in constructing a whole new approach. Van Weenen [27] shows this different perception in a three dimension model where he states that the engagement in SD of a university can be explained in the way universities answer the questions:

- Why should we be involved?
- What could we do?
- How would it be organized?

Each of these three questions describes a dimension (Figure 3). The first one describes the objectives or drivers of SD on campus. The second defines what the university does and describes the level of engagement. The third dimension describes how the university carries out its ambitions. In all dimensions different levels are defined. As for the SD dimension, equity between industrialized and developing countries is the highest level, recognizing the limits (world's resources are not infinite) is the lowest level. The engagement dimension ranks from simple operations (energy, water, waste) up to university mission, which involves the engagement in the university mission statement or policy. In the organization dimension environmental management is the lowest level followed by a sustainable university approach, a sustainable network up to a sustainable society, which is the highest level in this dimension and in which the whole society is involved and addressed.

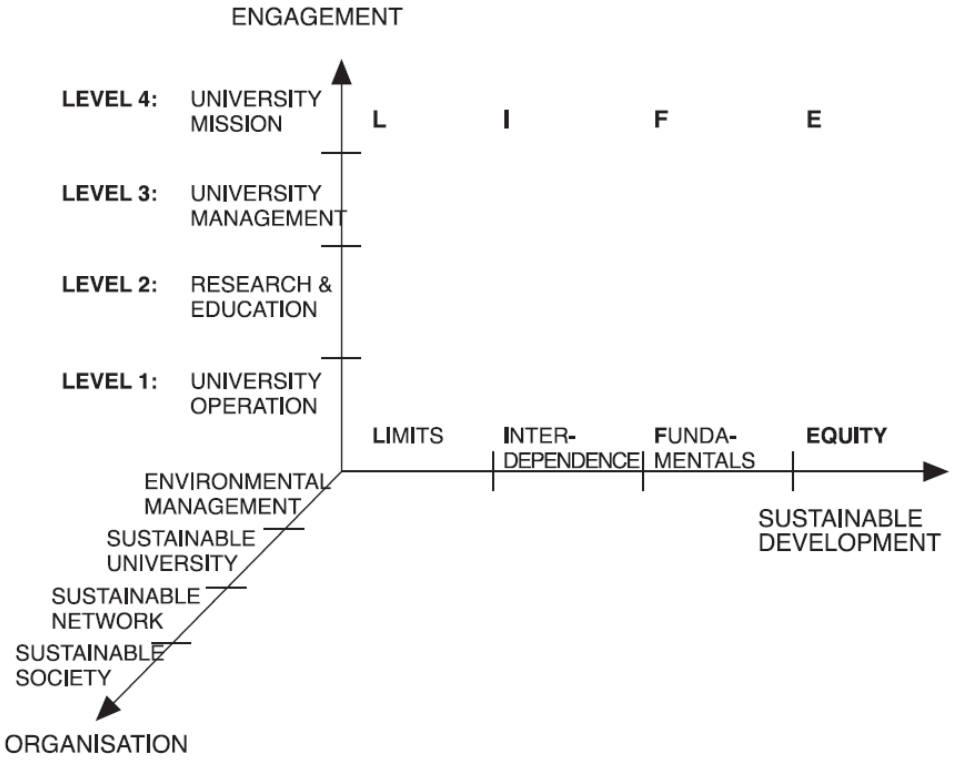

Figure 3: Van Weenen´s sustainable university classification model [27].

This framework is in accordance with the work of Clarke [21], in which three generations of drivers for an environmental management system are described (Table 1). The drivers rank from basic environmental management to reduce costs and to comply with regulations, up to drivers that could be described as SD drivers on a campus as defined for this thesis. The three generations distinguish from each other in comprehensiveness in management. While the first

generation suggest a simple EMS the third generation drivers make a sustainable development management system necessary.

Table 1: Three generations of drivers for applying an EMS at a university campus [16].

Category	Campus EMS drivers
First Generation	Cost savings and long-term pay-off; Due diligence and compliance; Reduce liability and insurance; Regulators; Financiers; Complying with suppliers and Legitimate efforts.
Second Generation (Internal)	Educational responsibility; Educate ourselves; Employee morale and health; Less use of resources and environment; Quality of service; Declarations; Role of research; Charismatic people and stakeholders; Legitimate efforts to internal audience; Increase market; Improve internal communication; Improve internal cooperation; Improve management generally.
Third Generation (External)	Good citizen; Leader, role model, best practice; Community image and concerns; Influence suppliers; Relationship with associations; Prepare the future; Legitimate efforts to community; Improve external communication.

Disterheft [16] introduces three stages of sustainability implementation in universities, which depend on the universities perception of sustainability. In the first stage, SD is not fully understood and no strong effort is done. Stage two describes a situation where SD operations are carried out and the principles of SD are broadly understood. In the third stage the university fully understood SD principles and has applied long term contributions to SD, such as forming a SD policy and the implementation of certifications (ISO14001, EMAS).

Applying an EMS on a university campus is just a part of a whole SD approach and helps to manage the physical impact of a campus. Thus, it also has the potential to reduce costs of campus management and can underline the ambitions of a university if a formal and certified EMS is applied.

Saadatian [28] compared 17 assessment approaches for SD in higher education institutions, and Fadzil et al. [29] found that of these 17 assessment methods only two are comprehensive. In this part some of the most known and applied tools are introduced and discussed (Table 2). Some tools can rather be used to rate, others to report and some to manage environmental issues and SD on campus. The reason for these different types of assessment tools can be found in the simple fact that continuous rating or rerating includes reporting to always access the latest data, and continuous reporting requires some kind of management system. In order to assess SD, some kind of tool should be applied and frequently re-evaluated to visualize development. While the management tools suggest a whole management system, the rating tools just rate the university according to its latest reported data. The knowledge of these tools was hereby achieved through the study of articles, scientific papers and online research (Savely et al. [30], Lozano [31], Lozano et al. [32], Roorda et al. [33], Collins [34], Lozano [35], Fadzil et al. [29], Alshuwaikhat et al. [9], Yuan et al. [36], Pipjelink [37], Saadatian et al. [28], Shriberg [11]).

Table 2: Most applied and widely known assessment tools for sustainable campus assessment.

Assessment tool	Type
Graphical Assessment of Sustainability in Universities (GASU)	Reporting/Rating
Sustainability Tracking, Assessment & Rating System (STARS)	Reporting/Rating

International Organization for Standardization (ISO14001)	Management/Reporting
Environmental Management and Audit Scheme (EMAS)	Management/Reporting
Campus Sustainability Assessment Framework (CSAF)	Reporting
Assessment Instrument for Sustainability in Higher Education (AISHE)	Reporting/Management
British Standard 7750 (BS7750)	Management

Graphical Assessment of Sustainability in Universities (GASU)

The GASU was developed by Lazono [35] and is based on the Global Reporting Initiative (GRI) 2002 guidelines. It was developed to complement the guidelines with an additional factor so that they can be applied for a comprehensive assessment and reporting of a university.

The GRI 2002 guidelines exist in three categories (Economic, Environmental and Social) which were expanded to a forth category to also cover the educational dimension of a university.

In this assessment approach, 174 indicators evaluate a university in six fields; Profile, Economic, Environmental, Social, Educational, Interlinked issues and dimensions [32]. The performance is calculated as a mean of all indicators. The indicators are evaluated according to their coverage and their performance. Hereby the indicators assessment capability and its performance are evaluated. The results are then plotted in a spider web diagram which makes the strengths and the weaknesses of a university visible. It also enables comparison and ranking of universities, as well as their benchmarking.

This system is carried out successfully at a number of universities that use the GASU method to publish their GRI report and to compare with other universities [31]. The assessment is quite comprehensive and most data is easily available especially in the economy and environment categories, although it seems to be a little bit of a problem for universities to report in the social category, as many of the universities who apply GASU achieve low

values in this area. This might be caused by the fact that an evaluation in this field is not so easy to measure as physical data in the environment category [31].

Sustainability Tracking, Assessment & Rating System (STARS)

The rating and reporting system was created by the Association for the Advancement of Sustainability in Higher Education (AASHE) in 2010. STARS is a self-assessment tool developed and run by volunteers of the AASHE. It is widely used in USA and also in Canada, with currently 472 registrations worldwide [38].

The evaluation process evaluates four fields of action: academics, engagement, operations and planning & administration. Sub-categories exist in all fields which can earn a certain number of points, depending on their performance. The sum of all points in the sub categories rank the university in one of four classes: Bronze (25), silver (45), gold (65) and platinum (85). The data should be updated at least every three years so that universities can be compared in a status quo situation. Universities that submitted their data and do not want to be ranked have the option to participate as reporter and their data is not published [39].

STARS is a comprehensive tool which reports in all fields, its detailed technical manual facilitating sustainability reporting at a university. Most of the points can be earned in the field “operations” which implies that this is seen as the most important field, followed by academics, engagement and planning & administration. However, most of points in universities are earned in Education & Research (STARS version 1 – 1.2) which equals Academics in STARS version 2.0.1.

International Organization for Standardization 14001 (ISO14001)

The ISO14001 is the environmental management standard of the ISO14000 series. The standard manages the environmental impact in all fields of an organizations products and service [40]. It cares more for physical than for social influences on the environment and is rather designed for industry or businesses [35]. However, the tool is widely known, accepted and applied, and has a good reputation. The standard provides a clear and structured framework to report and manage environmental impact in organizations. It is not specifically designed for universities and does not imply education and social aspects in the reporting and management structure but is still used in the USA and Europe by a large numbers of universities [9]. The tool is a typical management tool and works after the principle: *plan, do,*

check and act. It would have to be complemented with some additional management and reporting tool in order to cover the social and educational field as well, thus satisfying the sustainable campus criteria. An advantage in this ISO14001 is that it is not a self-evaluating tool and the organizations are evaluated by a third party. This makes the results more trustworthy and the evaluation process is not biased by "subjective judgement" which was analysed as a problem by Saadatian et al. [28].

The tool is combinable with the quality management standard of the ISO, the ISO9001. Both ISO standards report in the same way and sometimes even in the same field. Thus the implementation of the ISO14001 will be simplified in organizations which use the quality management framework already, as it has experience in reporting to the ISO standards.

The British Standard 7750 was first published in 1992 and addressed organizations to manage their environmental impact. Hereby the tool assumes the same characteristics as the ISO14001 and the EMAS. No special version for universities is available. Some universities in the UK are using it. Some of them additionally apply ISO14001.

Campus Sustainability Assessment Framework (CSAF)

This tool was developed in the master thesis of Lindsey Cole at the University of Victoria in Canada [41]. Hereby, Cole had the support of many researchers and co-workers in this field to develop a comprehensive framework to assess sustainability on campus. As Saadatian et al. [28] found it is one of the most used frameworks in campus sustainability and reaches the highest evaluation together with STARS, according to the used methodology in Saadatian et al. [28].

CSAF consists of 169 indicators divided in 10 subcategories: Air, Water, Land, Materials, Energy, Knowledge, Community, Health & well-being, Economy & Wealth, and Governance. Each of the indicators can either achieve one or zero in the evaluation. The performance is calculated trough the quotient of the achieved point to the sum of points which could be achieved. If it is not possible to evaluate an indicator, the indicator is expelled from the evaluation. If it is not possible to assess more than 40% of the points, an evaluation is not possible [41].

The tool is quite comprehensive and widely used. It provides a comprehensive framework to assess the sustainable state of a university and can be used to benchmark and rank universities.

Assessment Instrument for Sustainability in Higher Education (AISHE)

The AISHE is based on a quality management model of the European Foundation for Quality Management and the Institute for Dutch Quality Management (EFQM-INK) [37]. It was developed in 2001 by the Dutch organization for the advancement of sustainable development in higher education (DHO) [33].

AISHE is a management method to measure and manage sustainable education or education for sustainability. It can be used to assess a university or parts of it (faculties, single courses, etc.). However, it was proposed to carry out not one but a series of assessments for a large (30000 people) university, which involve different buildings, campuses, research units or individual study programs. The AISHE can be used as internal self-assessment or as external assessment in order to achieve a certificate. The process is the same but the external assessment involves a certified AISHE assessor.

AISHE works like a common management tool and contains continuous improvement with a *plan, do, check, act* approach. It works as an interactive assessment, where groups of 15 - 20 people meet and define goals and assess the status quo of a university or faculty. The group composition consists of members in all fields of the evaluated unit, e.g. management, students, staff, etc. The evaluation is carried out for 5 modules (operations, education, research, society and identity) each of which contain 6 criteria. These criteria are defined by 5 development stages (activity oriented, process oriented, system oriented, chain oriented and society oriented); the stages are cumulative and all the requirements to reach one stage are always required to reach the next higher stage. At the end of the assessment a policy can be defined by the management according to the set goals [42].

The use of the tool involves quite a lot of effort in order to assess a whole university as it is time consuming and involves a lot of people, which is seen as a disadvantage. However, the fact that the tool not only manages sustainability on a campus but also has the ability to define an organization policy makes the tool a valuable approach in the assessment of SD at universities and has the appeal for global reach [11].

Environmental Management and Audit Scheme (EMAS)

The EMAS is the European environmental management standard and was first published in 1993 and is continuously updated since [40] [43]. It is an evaluation and reporting tool to manage environmental performance of an organization.

The EMAS works after the same principal as the ISO14001 works and differs actually only in detail from the ISO14001. The additional requirement of the EMAS compared to the ISO14001 is that the EMAS requires that an organization publishes environmental performance reports. This means that when the EMAS requirements are met also the ISO14001 requirements are fulfilled [40] [44].

In the projects EMAS-EDIN (Environmental Management and Audit Scheme in Education Institution) and EMAS@SCHOOL the EMAS was applied at a university to manage the environmental influence. Especially in the EMAS@SCHOOL the participation of staff and students is suggested and a deep Bottom-up approach is proposed, not only to involve professional researchers in process but also to deliver "hands on" skills to students and let them participate in the data collection and planning [15] [45].

3 Situation in Portugal

To create an overview of the sustainable campus culture on Portuguese campuses a small research was conducted to see how and what other campuses in Portugal do to achieve campus sustainability.

While many universities in Portugal are offering university courses dealing with environmental and sustainability issues, only a few write sustainability reports. Only two higher education institutions could be found that apply a whole EMS (Table 3). The following list displays higher education institutions in Portugal and their effort towards sustainability [46] [47] [15].

Table 3: Portuguese higher education institutions engaged in SD.

University	Reporting	Management
Escola Superior Agrária Coimbra	EMAS requires mandatory report	EMAS
Universidade do Minho	GRI (without education)	-
Faculdade de Engenharia / Universidade do Porto	GRI (without education)	-
Campus Verde - Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa	-	ISO14001

4 Case Study: University of Coimbra (UC)

The University of Coimbra (UC) is the oldest university in Portugal and one of the oldest in Europe. Its history goes back to the 13th century when the university was founded in 1290 and located in buildings in Coimbra-Sofia to be later moved uptown (Alta) in the Royal Palace of Alcáçova in 1537. On Jun 22 in 2013 the UNESCO added the University of Coimbra Alta and Sofia to the list of world heritage.

Due to its long history, the university includes many old buildings and valuable treasures such as the Royal Palace of Alcáçova and the university library. UC is aware of its important role in both cultural and historical domains and puts effort in the protection of its heritage. This includes that the university hosts several museums and engages in cultural activities as well as hosting a cinema and a theatre [48].

Today UC has three campuses and hosts 12 faculties and similar units, 45 research units, two stadiums, 25 libraries, one botanic garden and two museums. All together 2988 people (academic and non-academic) are directly employed and 24403 students are registered at the university. More than 27000 people are involved in the UC´s activities, which makes up about 19% of the population of the city of Coimbra (143396), the university has thereby a major impact on the city [49] [50].

4.1 University Management

The management council of UC consists of the rector, one vice rector, the university administraton and optionally one student (depends on the rector). Hereby, the management council in which the rector can designate two additional elements who can participate in the administration meeting (without a voice), manages the university as the major decision maker. The management council manages the administrative management, finances and human resources. While the vice rectors and the management are designated by the rector, the rector is elected by the general council. The general council is assembled of 35 members who represent different interest groups on the campus; students (2 first cycle students; 2 second cycle students; 1 PhD student), academic (professors and researchers) and non-academic staff. Elected members of these interest groups have a mandate period of four years, except for the students, with two years. The rector is responsible to report to the general council about the strategic plan, midterm plan, general guidelines, the yearly activity report, budget

and consolidated financial statements and the consolidation or elimination of organic units [48]. An organogram of the university is attached in *Appendix B*.

4.2 Academic Association of Coimbra (AAC)

The AAC is the oldest students' organization in Portugal. Established in 1887, it was founded by older student organizations. Nowadays it is the umbrella organization for all students' organizations at UC. It consists of numerous sport and culture clubs and has its own radio and TV station. The organization is led by a general direction which is made up entirely of students. Political activities against the government led to a close down in 1971, AAC reopened in 1974.

4.3 Energy for Sustainability (EfS) initiative

The EfS initiative was launched in 2006 and engages in SD issues in research and education. It assembles researchers from 14 UC research units and works in close cooperation with industry and independent research & development units. The initiative works together with the Sustainable Energy Systems (SES) PhD course of the MIT Portugal program and offers a master course and an advanced studies diploma in Energy for Sustainability [51]. For knowledge exchange the EfS initiative holds conferences and connects with partners worldwide.

5 Methodology

To achieve long-term effects in sustainable development UC is interested in a comprehensive management system for SD. Therefore, based on the above mentioned assessment tools, comprehensive SD management systems were developed, as will be shown in section 5.2. Hereby the tools which assess SD in reporting and rating but which are not designed to manage, are integrated in a *plan, do, check, act* cycle to be able to manage the university's operations according to its clearly defined sustainability measures. The other systems, especially the EMSs, are extended to cover also other fields of SD on campus in order to be comprehensive.

The created SD management frameworks are then compared to each other using a Multi Criteria Decision Analysis (MCDA) method. MCDA methods help a decision maker to find the best solution out of a set of solutions. There exist numerous MCDA methods all with a

different decision making framework. While some of the methods rank solutions according to their overall performance in all criteria in the decision making process, others determine the one solution which performs best in pair wise comparison. MCDA allows the user to tailor the decision criteria to the analyzed task. In the case of UC, its unique campus and organization are analyzed and a set of criteria are chosen and evaluated according to their importance.

To create management frameworks for SD on campus there must be a definition of which fields the university operations are evaluated in. STARS [39] evaluates four blocks of indicators (Academics, Engagement, Operations and Planning & Administration) and AISHE finds five blocks of indicators (Operations, Education, Research, Society, Identity) [42]. Depending on the assessment tool, the fields of action of a university campus are divided in more or less blocks or fields of activities. All deal with social, educational and operational measures. While some split this or that block into smaller pieces, here the focus will be concentrated on three core fields of activity. These fields are built upon the major areas of campus influence on SD which are described as organization, education and social engagement. These three fields can be seen as the three pillars of a sustainable campus (Figure 4). The block “Organization” manages the physical and financial matters of a campus including planning, buildings and all kinds of energy and waste flows. As UC is a public, non-profit oriented university, less attention is spent to its economy, and this part is embedded within the “Organization”. It seems to be logic that operations can only be carried out if money is available. Block “Education” describes the educational initiatives regarding SD such as awareness programs, specialization programs (master, PhD), participation programs and comprehensive EFS programs. In the “Social” block the interaction with the local community is addressed as well as internal justice and equity. It exists mainly from awareness programs and participation programs for local community.

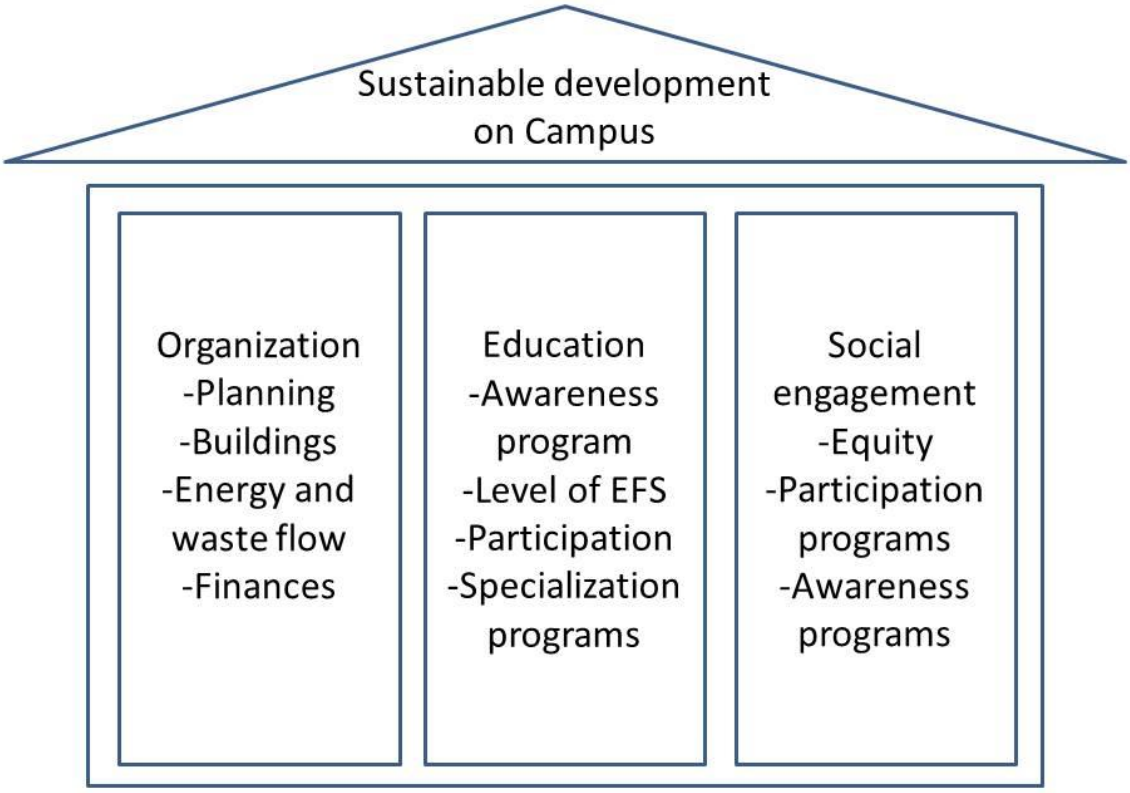

Figure 4: The three fields of action at a sustainable campus.

Within this three pillar system, an organizational structure can be worked out to describe which organs participate and manage which block of the sustainable campus (Figure 5). All the management regarding to SD is carried out by a working group that reports to the administration. The working group is responsible to work out awareness programs and the curriculum and is thereby supported by the EfS initiative, which consults. The AAC might support activities regarding social engagement and might promote the ambitions via university radio and TV to engage and reach more people. The facility management is responsible for the environmental management and is thereby supported by the EfS initiative which intervenes as consultant and connects the facility management with interested students to engage them in environmental tasks on campus.

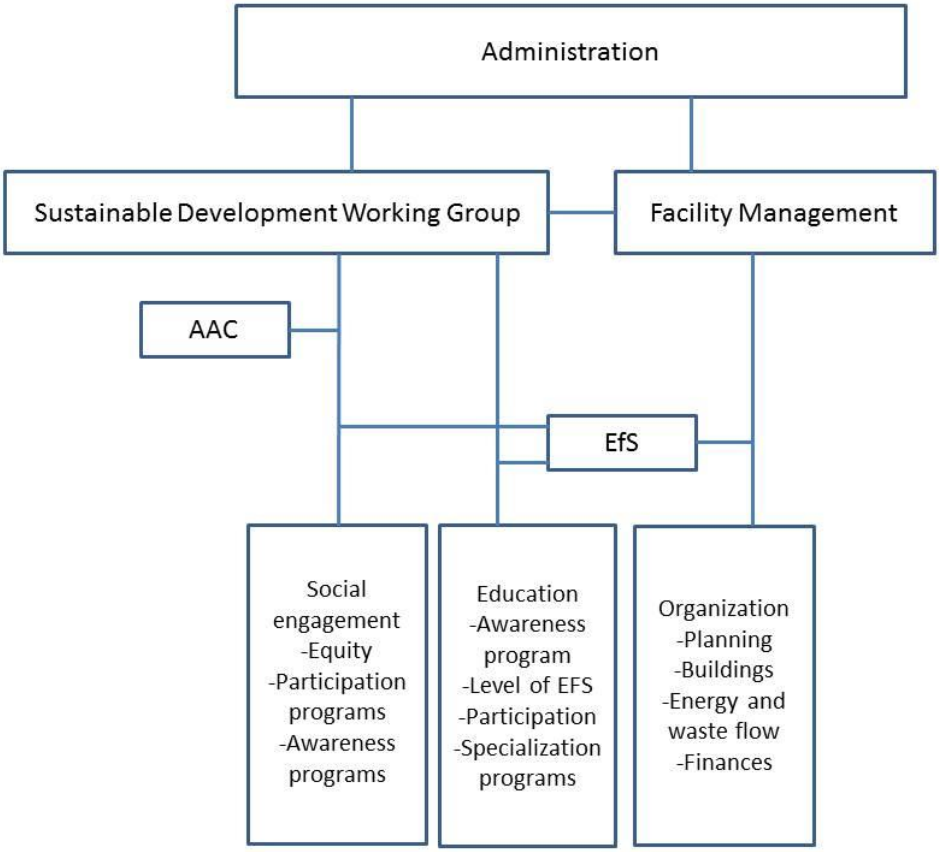

Figure 5: Management structure for a sustainable campus Coimbra.

5.1 Criteria selection for UC

Every university is managed and organized in a different way and, according to its unique situation, has different requirements and characteristics which have to be respected in choosing a management system. To choose an appropriate management system a set of 6 criteria which could be determined as important to UC are chosen and their importance is indicated by their weighting (Table 4). The criteria are chosen and evaluated together with an expert who has more than 30 years of experience at UC.

Table 4: Important criteria and their weighting for choosing an appropriate sustainability management system for UC.

Criteria	Weighting
Finances	0.24
Participatory engagement	0.16
Comprehensiveness	0.13
Recognition	0.16
Benchmark	0.13
Simplicity	0.18

The financial situation of UC is the most important issue due to the current financial crisis in Europe also affecting severely the university. Although the university is likely to achieve savings through carrying out EMS´s, the university will have to invest at first to set up a management system. The investment cost is hereby to keep at a minimum.

Mentioned above, a high participatory approach is desired so that students and local community learn applicable tools to keep their energy consumption and waste production at a low level, decreasing thereby the overall energy bill as well as leading to a cleaner environment.

UC is interested in applying a comprehensive SDMS in order to have all fields of action evaluated after SD campus criteria defined above, a comprehensive and detailed system being therefore of interest. Comprehensiveness can be evaluated through the number of indicators used. It is evaluated with mean importance.

Having a sustainable campus UC would like to be recognized in the field of sustainable management. Formal management systems support this in awarding a certification. Furthermore, such systems help to avoid subjective judgment as in a formal system the assessment is carried out by an analyst who is not biased by his subjective or personal interest.

As an institution UC would like to perform benchmark analysis in the field of SD on campus and to be considered an example by society and other universities. Therefore the benchmark is evaluated as a criterion with a mean importance.

Another important point is the management effort, as human resources are closely connected with financial capital and are thereby limited. Furthermore, a complex management system is rather complicated to manage, mistakes are predictable and a total fail of the system is not impossible. A smaller number of people to carry out a management system are always easier to handle. This criterion is therefore seen as an important one.

5.2 Sustainable Development Management Systems (SDMS)

A management system for SD on a campus environment must cover all activities of a university campus related to SD. It should manage environmental issues (water usage, energy consumption and waste flow etc.) as well as the level of education and social engagement (see three pillars of a sustainable campus above). In the following a set of comprehensive

management systems to manage SD on campus are introduced (Table 5). These frameworks are described and evaluated according to their performance in the six criteria explained above. Only the absolute performance is evaluated, on a scale from 0 to 10 (the higher the score, the better the performance). For example, a good performance in the criterion Finances is indicated with a high number. (*Appendix C*).

Table 5: Created frameworks to manage SD on campus.

Framework	Approach
A	STARS + *plan, do, check, act* cycle
B	CSAF + *plan, do, check, act* cycle
C	AISHE
D	GASU + *plan, do, check, act* cycle
E	ISO14001 / EMAS / BS7750 + additional indicators of STARS
F	ISO14001 / EMAS / BS7750 + additional indicators of CSAF

Framework A

In this framework the STARS indicators are combined with a *plan, do, check, act* cycle to manage its 65 comprehensive sustainability indicators on campus. To apply the framework at UC the four core groups - Academics, Engagement, Operations and Planning & Administration - will be merged to three to fit under the sustainable campus "roof" as described above. Hereby the block "Operations" is combined with the block "Planning & Administration" to "Organization" in the three pillar model.

STARS was designed to serve as a self-assessment tool. Therefore, the indicators are clearly defined, which facilitates the evaluation process and has a positive effect on the required investment. Using this framework the university is also able to participate in the STARS rating system and can carry out benchmark analysis with other universities. However, the fact that it is a self-evaluation system lowers the recognition as no formal certification is attained.

Framework B

Here the CSAF tool is applied to a *plan, do, check, act* cycle which transforms the assessment tool into a management framework. It is expected that this tool is more comprehensive and detailed than Framework A as 175 indicators instead of 65 indicators have to be evaluated. The ten subcategories (Air, Water, Land, Materials, Energy, Knowledge, Community, Health

& well-being, Economy & Wealth, Governance) of CSAF have to be fit in the three pillars system described above. Therefore indicators for Air, Water, Land, Materials, Energy and Governance are merged to the block "Organization". Indicators for Community and Health & well-being are combined to the block "Social engagement", while Knowledge remains as one block, renamed to "Education". Like all comprehensive tools the investment to manage CSAF will be higher. Also CSAF is no formal management system and no certification is attained, which lowers its recognition. However, it can also be used to benchmark.

Framework C

Here the AISHE is a ready to use framework to manage sustainability on campus. It covers all fields in its core blocks and it is designed to manage. Also, here the five blocks will be merged in theory to three, and the blocks "Operation" and "Identity" are combined to "Organization" as well as the blocks "Education" and "Research" to "Education". The advantage of this framework is that it can first be carried out on campus without certification and, if demanded, an assessor can be invited to guide a certification process. Furthermore, AISHE can also be used as a policy tool and serves thereby an extra purpose as a policy is needed to underline the universities ambitions. AISHE was designed to be applied on individual study programs. To evaluate a whole university an enormous mobilization of people is required. In a campus with about 30000 people involved, depending on the courses, about 25 assessments are needed, involving 15 to 20 persons each.

This framework is very comprehensive and fosters engagement of all actor groups, it can be applied either as a formal or an informal process, thus a certification can be attained. However, a disadvantage is seen under the financial criterion and in its bad performance in simplicity, as the number of people who would be engaged in this assessment makes it very difficult to manage.

Framework D

The GASU is especially designed for universities to report sustainability in all fields of operation. From reporting it is only a small step forward to integrate a whole *plan, do, check, act* cycle. Its 174 indicators are more comprehensive than the fewer 65 indicators of Framework A. The above mentioned problem of reporting in the social category can be overcome with time as the performance of indicators is also evaluated and these will improve over time as experience is earned with each *plan, do, check, act* cycle.

To apply the framework to the three pillars mentioned above, the evaluation blocks Environmental, Economic and Profile are merged to “Organization” and the field Interlinked issues and dimensions is not considered. The remaining block is the same as in the UC example.

Many companies do GRI reports and the framework offers thereby chances to benchmark. Although it is a little complicated to carry out, as the problems of evaluating in the social field show, it is quite comprehensive and evaluates a large number of indicators.

Framework E

In this framework the ISO14001/EMAS/BS7750 is extended with some indicators of the STARS assessment systems. Hereby the indicators for Academic and Engagement are used to form a comprehensive tool to manage sustainable development on campus. Altogether 27 indicators join the EMS to form a SDMS.

A likely tool was designed by Burke et al. [22] where the ISO14001 is expanded to assess SD for small and medium enterprises in industry. In this framework a *plan, do, check, act* cycle is carried out together with the ISO14001/EMAS/BS7750 and while the ISO14001/EMAS/BS7750 is certified, the other blocks remain uncertified. An advantage of this system is that through the ISO14001/EMAS/BS7750 a formal management system is implemented which recognizes the environmental effort of the university. Furthermore, the university gains experience in dealing with management and indicator issues and can use this knowledge in assessing the additional indicators. The university will act more carefully in all its management issues as it aims to achieve a certification.

Which specific EMS may later be used, ISO14001, EMAS or BS7750, is up to the university and depends on the preferences and simplicity in the implementation process. The two systems are alike in their cores. However, as the university applies the ISO9001 quality management system, the implementation of ISO14001 is facilitated as there is experience with ISO evaluation methodology and these two ISO standards share some fields of evaluation.

Simplicity is quite high as a formal management system follows strict guidelines and additional 27 indicators are quite understandable. Because formal systems as ISO14001, EMAS or BS7750 are widely known, recognition will be quite easy. However, additional 27 indicators to evaluate two blocks are now very comprehensive in contrast to a whole formal

management approach. The application of a formal system will require significant financial resources.

Framework F

This framework is similar to Framework E above with the difference that instead of the STARS indicators some CSAF indicators are used to complete the EMS (ISO14001/EMAS/BS7750) to become more comprehensive. Hereby the indicators for the fields Knowledge, Community, Health & well-being are joined to ISO14001/EMAS/BS7750. Indicators for Knowledge are used to assess the block "Education" while Community and Health & well-being deliver the indicators to assess the "Social engagement" block.

This framework will only distinguish from the above mentioned in its comprehensiveness and simplicity and thereby also in financial requirements, as more indicators are involved.

5.3 Multi Criteria Decision Analysis tool

To analyze the best performing framework according to UC´s criteria a spider web diagram was plotted to indicate whether any of the frameworks can be outranked (*Appendix E*). As all the alternative frameworks have their strengths and weaknesses in different fields, none of them can be outranked and, therefore, a simple additive weighting method was chosen to rank the frameworks according to their achieved sum. In Equation 5.1, k_j stands for the weight of the criterion j, g_j represents the performance on the criterion j in alternative a_i.

$$S(a_i) = \sum_{j=1}^{n} k_j g_j(a_i) = k_1 g_1(a_i) + k_2 g_2(a_i) + ...k_n g_n(a_i) \qquad i = \{A, B, C, D, E, F\}$$

Equation 5.1: Simple additive weighting method.

The achieved values are then summarized for each framework is listed in (*Appendix D*). The framework with the highest sum performs best according to UC´s preferences and should be applied to manage SD on campus at UC.

5.4 Result and discussion

Appendix D shows the achieved sum for each framework. Framework E earns the highest sum followed by Framework A, both at a distance to the other frameworks. This is due to the high importance of the finance criterion under which these frameworks achieve high values as both are based on the same assessment method. A high value in the recognition criterion

helps Framework E to perform better than Framework A. The lowest sum and thereby the worst performance according to UC´s weights is Framework B, which achieves low values in recognition and benchmark, while it performs only average in the other criteria. Therefore, as both are based on the same assessment method, also Framework F performs slightly better. Framework C and Framework D achieve sums near the mean although they are very different from each other. Framework C has the lowest value in finances but it achieves the highest values in participatory engagement and comprehensiveness. Framework D however, always performs rather average. The big distance of Framework E score to the other frameworks leaves no doubt that it is the overall winner and satisfies the assumed UC´s preferences best.

6 Conclusion: Action Plan towards a Sustainable Campus

As it was indicated in the definition of a sustainable campus, in the beginning of this thesis, UC should establish a Sustainable Development Working Group (SDWG). This group should consist of all actors on campus, as defined above. It is responsible to collect data of all university activities to draw a baseline and to start to set up a management plan to improve in all fields. Furthermore, the group should launch comprehensive awareness courses for students and local community and apply behaviour change programs in order to reduce energy consumption and waste. These awareness courses can be carried out with the help of the EfS initiative and could be promoted in the AAC radio. To facilitate the data collection for the baseline, students can be involved in these exercises through part time jobs and thesis projects. Thereby students earn practical skills and the SDWG achieves quicker results. The SDWG reports once a year to the administration, students and local community what has been done and achieved in one year, including spending and savings from its programs.

6.1 Sustainable Development Management System

A management system for SD on campus is needed to assure the right application and continuous improvement of sustainable campus indicators. Thereby it should satisfy the university´s demands and operate in the framework of the university. The applied MCDA method indicated that Framework E is the choice that fulfills UC´s criteria best and should thereby be applied to manage SD on campus. Framework E consists essentially of the ISO14001 and additional indicators of the STARS assessment framework combined in a *plan, do, check, act* cycle. It is expected, that the application of ISO14001 is facilitated due to the fact that UC operates already the ISO9001 quality management framework. Furthermore,

27 additional indicators to manage the fields on social engagement and education of UC are applied, which is a comprehensible number and well explained in the STARS implementation guide. Applying STARS indicators facilitates also the participation in the STARS university reporting and rating as nearly two thirds of the assessment indicators are already used in management. It is suggested that UC takes time with implementing the ISO14001 to achieve long term effects and real change rather than try to achieve results in the short term [22].

6.2 Network

It is advised to apply to one or more of the networks listed in *Appendix A* to learn about initiatives and actions carried out at other campuses. Hereby important knowledge can be earned and expensive planning mistakes can be avoided. Furthermore, such contacts also lead to exchange of students or even academic staff in order to share experience or to hold conferences regarding sustainability and sustainable development at university campuses. The Copernicus alliance is recommended as a European approach. This network was founded in 1993 when the European University Association acknowledged the important role of universities in sustainable development. Its goals are defined as [52]:

- Networking: Exchanging and enhancing knowledge on Education for Sustainable Development between European Higher Education and student organizations that work for sustainability.
- Policy: Promoting Higher Education for Sustainable Development in European policy making.
- Service: Disseminating tools for sustainability integration in higher education.
- Outreach: Promoting sustainable development in European Higher Education.
- Representation: Representing European Higher Education for Sustainable Development in international committees on Education for Sustainable Development.

The network consists of members of different types such as universities, NGO´s, public institutions, higher education entities and individual members. It is financed by a fee each member has to pay depending on the type of member. Copernicus alliance organizes working groups where persons of different member institutions work together on topics regarding sustainable development, on campus and elsewhere.

6.3 Comprehensive behaviour change program

Behaviour change programs are one of the cheapest solutions to reduce energy and water consumption as well as to decrease waste flows. Such programs have the ability to reduce the energy consumption of public buildings by 5 to 15% [26]. Thereby, actors in such buildings are addressed to behave more economically in terms or energy consumption.

Information and awareness programs are necessary but not enough to encourage students, staff and local society to reduce their energy consumption. Whereas feedback and reminders have proven to be successful, other methods to influence consumption behaviour are self-commitment and goal setting [26]. It is suggested to implement behaviour change programs together with the awareness programs. Furthermore, these programs should not only focus on the university campus but also on the social community to achieve an overall behaviour change in the society of Coimbra and transform Coimbra to the leading City of SD in Portugal.

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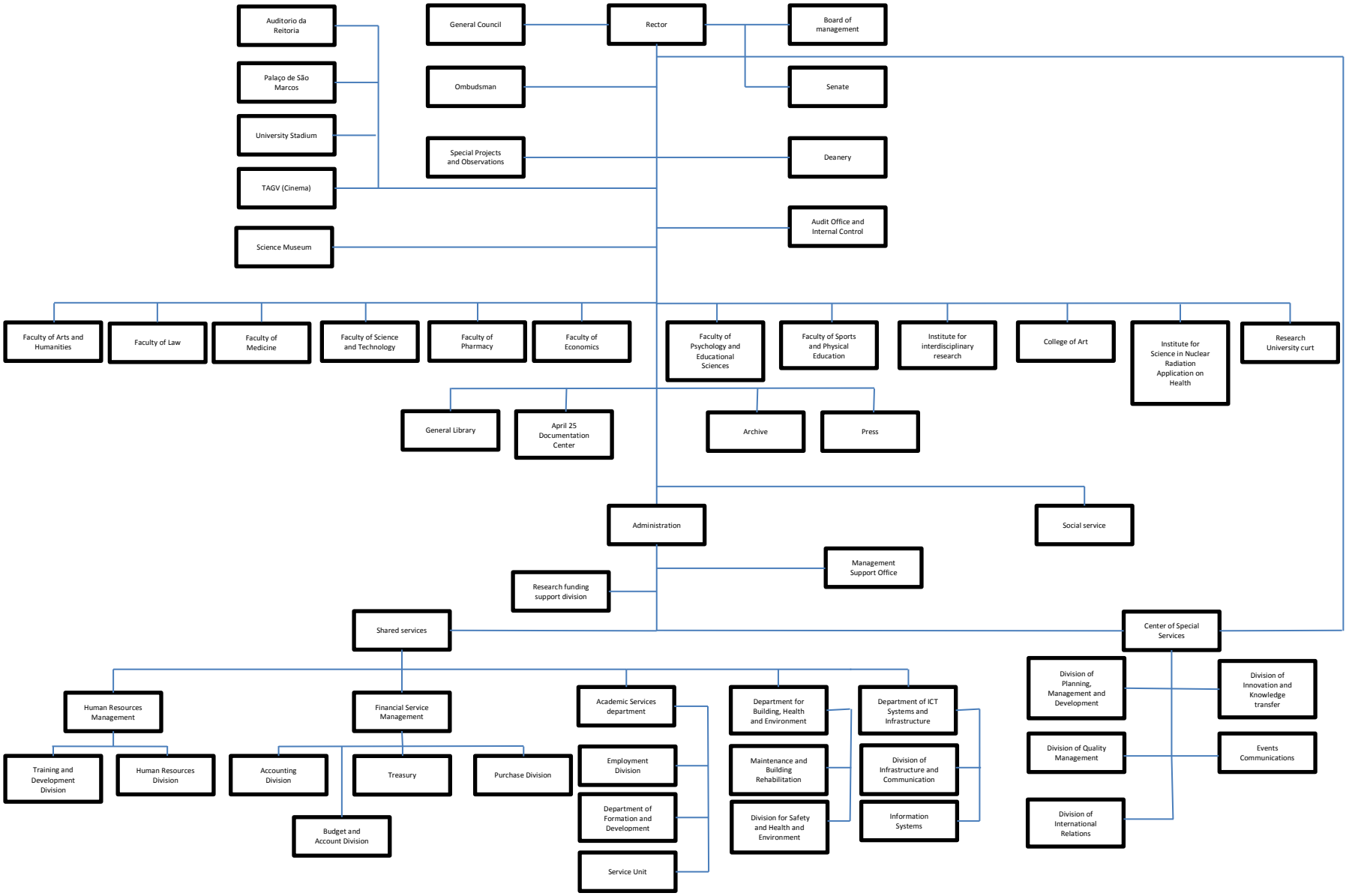
8 Appendixes

Appendix A: Networks of and for universities to implement environmental management systems and sustainability on campus.

Network	Characteristic
The Billion Dollar Green Challenge	Motivates universities to create a green revolving fund (GRF). Offers a GRF tracking system [53].
International Sustainable Campus Network (ISCN)	A forum that engages in the exchange on information regarding the transition to sustainable campus [54].
University Leaders for Sustainable Future (ULSF)	Supports sustainability in education, research and operations [55].
The Association for the Advancement of Sustainability at Higher Education (AASHE)	Provides knowledge in leadership, opportunities for professional development and the STARS sustainability rating system [38].
Environmental Association for Universities and Colleges (EAUC)	Non-profit organization (members for members). Exchange knowledge, organizes conferences and training [56].
Sierra Youth Coalition (SYC)	Engages in the education of young people regarding sustainability, organize international awareness champagne, and offers the CSAF reporting frame work [57].
COPERNICUS Alliance	European alliance to promote sustainable development in higher education institutions. Provides networks in education for sustainable development and tools to integrate sustainable development on HEI [52].



Appendix B: Organogram of the University of Coimbra.

Appendix C: Framework performance table for each criterion. Values are given in a scale from 0 – 10.

Framework\Criteria	Finances	Participatory engagement	Comprehensiveness	Recognition	Benchmark	Simplicity
Framework A	7	5	5	3	8	8
Framework B	5	5	7	3	6	5
Framework C	3	7	9	6	7	3
Framework D	5	6	8	4	7	4
Framework E	6	5	6	7	6	7
Framework F	5	5	8	7	6	4

Appendix D: Performance of each framework after weighting of the criteria. The last column indicates the sum of all criteria of a framework.

Framework\Criteria	Finances	Participatory engagement	Comprehensiveness	Recognition	Benchmark	Simplicity	Sum
Framework A	1.66	0.79	0.66	0.47	1.05	1.47	6.11
Framework B	1.18	0.79	0.92	0.47	0.79	0.92	5.08
Framework C	0.71	1.11	1.18	0.95	0.92	0.55	5.42
Framework D	1.18	0.95	1.05	0.63	0.92	0.74	5.47
Framework E	1.42	0.79	0.79	1.11	0.92	1.29	6.32
Framework F	0.95	0.79	1.05	1.11	0.66	0.74	5.29

Appendix E: Spider web diagram of the performance of each framework.