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The path toward a sustainable green university: The case of the University of Florence

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ABSTRACT

Over the last thirty years, sustainability has become an increasing concern for academics, students and policy makers. In this scenario, universities may play a pivotal role in the building of a more sustainable society in two different ways. On one hand, by reducing the negative impacts of their activities on the economy, society and environment; on the other hand, by fostering sustainable practices in curricula and research programs. More precisely, a "green university" implements sustainability in all different dimensions of its activity (i.e., institutional framework, campus operations, teaching, research, community engagement, accountability and reporting). Literature has so far focused on specific aspects of sustainability in the higher education sector, without taking into consideration the simultaneous incorporation of green issues in all abovementioned dimensions. Therefore, the aim of this study is to fill this literature gap by exploring the path toward sustainability of the University of Florence. The results show that the University has defined clear strategies and well-structured initiatives to actually implement sustainable practices; moreover, the current Rector seems to strongly support the journey toward a greener institution. At the campus level, the main projects are related to green buildings, waste management and sustainable mobility, despite financial restrictions. The issues of sustainability are also widely spread both in the educational offer and in the research activity, but systematic coordination between these dimensions and sustainability still lacks. Furthermore, despite the efforts for increasing community engagement, also this dimension needs to be improved. A similar conclusion is possible for accountability and reporting dimension, where one of the weak points is precisely the limited engagement of external stakeholders.

1. Introduction

The current society is facing several economic, social, and environmental problems that require responses from individuals, organizations, and governments at all levels. In this scenario, sustainability and sustainable development have become crucial issues globally (Leal Filho, 2018).

The increasing need for a more sustainable society has deeply affected the higher education sector (Marques et al., 2019), in which sustainability is nowadays an increasing challenge for academics, students and policy makers (Yuan et al., 2013). This is especially due to the fact that many of today's universities have a significant impact on the economy, the society and the environment, as they resemble "small cities" in size and population (Ávila et al., 2017). Furthermore, universities educate current and future decision makers, thereby acting as "shapers of the values of society" (Godemann et al., 2014, p. 218). In this picture, the higher education sector has to promote the deep sustainable development of the society in two different ways: on the one hand, by reducing the negative impacts of its activities on the economy, society and environment (Leal Filho et al., 2019a); on the other hand, by implementing and fostering sustainable practices in curricula and research programs (Stough et al., 2018). Additionally, many studies have highlighted the higher education sector's strategic role as a driver of regional economic growth (Fuster et al., 2019). Based on the above considerations, it is possible to affirm that universities may contribute to sustainability both internally (i.e. as an

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organization) and externally (i.e. as an agent in the region) (Dagiliūtė et al., 2018).

The importance of sustainability on universities' agenda is also confirmed by the high number of national and international declarations developed regarding higher education institutions and sustainability (Lozano et al., 2013). Recently, the "UN Agenda 2030" and the UNESCO initiative "Education for Sustainable Development" have emphasized the pivotal role of universities in building a more sustainable society (Marques et al., 2019) and in achieving the well-known "Sustainable Development Goals" (Leal Filho et al., 2019b).

The literature has so far documented various ways in which universities have been incorporating sustainability into different dimensions of their activities. Such dimensions—as will be discussed in the following section—include the *institutional framework*, *campus operations*, *teaching*, *research*, *community engagement*, and *accountability and reporting*. From a theoretical perspective, scholars have defined that, when a university implements sustainability throughout all these dimensions, it may be considered "sustainable" or, with a similar meaning, "green" (Dagiliūtė et al., 2018). However, to the best of our knowledge, the literature reveals an absence of empirical studies regarding the "on-field" realization of a green university. To date, research concerning sustainability at universities takes into account the above-mentioned dimensions only individually, such as the implementation of green initiatives on campuses (Leal Filho et al., 2019a), the integration of sustainability principles into study curricula (Bradley, 2019) and the diffusion of sustainability reporting (Brusca et al., 2018). Few studies so far have explored the implementation of green concepts at universities in a comprehensive way, that is, taking into consideration all six dimensions. We believe that it is urgent to jointly analyze these dimensions with a case study, exploring the implementation of a green university where sustainability is applied in higher education management. Accordingly, there is a literature gap regarding the investigation of the simultaneous incorporation of green issues into all the main dimensions within higher education institutions (Yáñez et al., 2019).

In this vein, the purpose of this article is to fill the literature gap by investigating, with a single case study, the path toward sustainability of an Italian institution—specifically the University of Florence—and by exploring in depth how it has been incorporating sustainable practices into the different dimensions of its activities.

The remainder of this paper is structured as follows. Section 2 reviews the relevant literature on green universities, while Section 3 describes the research methodology adopted in this study. Then, Section 4 discusses the findings of the case analysis and, finally, Section 5 explains the major conclusions, outlining the limitations and providing suggestions for future research.

2. Literature review

A "sustainable university" may be defined as a higher education institution that is managed in respect of green economic, social and environmental practices and that fulfills its function of teaching, research and community engagement in ways to favor the transition of the society toward sustainable lifestyles (Velazquez et al., 2006). Therefore, a green university is a "complex system" (Yuan et al., 2013) that is characterized by four different but closely interlinked dimensions, namely (*i*) *campus operations*, (*ii*) *teaching*, (*iii*) *research* and (*iv*) *community engagement*.

Universities' integration of sustainability principles initially focused on the first dimension (i.e. *campus operations*), which comprises—according to Leal Filho et al. (2019b)—the following areas:

- *Green building*, which refers to the planning, construction, maintenance, renovation and demolition of buildings in accordance with sustainability criteria (energy efficiency, use of renewable energies, use of non-toxic and sustainable material, etc.);
- *Waste management*, which includes the collection, transport and treatment (recycling or disposal) of office waste (paper, folders, cartridges), furniture (desks, chairs), laboratory or clinical waste (chemicals, equipment, wastewater), food waste from cafeterias and general waste from bins all over the campus;
- *Sustainable procurement*, which refers to the acquisition of goods and services following green public procurement guidelines, specifically in a way that generates benefits not only for the organization (i.e. university) but also for the society and economy by minimizing the damage to the environment;
- *Sustainable mobility*, which means ensuring that both business travel and the commuting of staff and students is cheaper and more environmentally sustainable (for instance, encouraging the use of bicycles, electric vehicles, public transport and car sharing). This area also includes accessibility for disabled people.

More recently, increasing attention has been paid to the inclusion of green concepts within the core activities of a university, that is, (*ii*) *teaching* and (*iii*) *research* (Ávila et al., 2017). Regarding the *teaching* dimension, many studies have emphasized that higher education institutions, being responsible for the education of future generations (including future leaders and policy makers), have the opportunity to increase students' awareness of environmental and social issues (Dagiliūtė et al., 2018) and hence to make them more successful in incorporating green issues into the organizations for which they will work (Jabbour et al., 2013). More specifically, Stough et al. (2018) argued that the integration of sustainability at the curriculum level can be achieved both vertically (through specific sustainability-related courses) and horizontally (by integrating sustainability principles into regular courses of the curriculum). From a different but complementary perspective, it has also widely been acknowledged that *research*—as a generator of new knowledge—is pivotal for sustainable development. As such, universities should consider research not as a mere "academic exercise" but as a "vital response" to the urgent need for a greener world, supporting all sustainability-related research in any field (biology, chemistry, economics, political science, etc.) (Waas et al., 2010). The implementation of sustainability can be translated into the research dimension through dedicated projects, patents, scientific publications, study centers and spin-offs coordinated by or affiliated with the university (Lozano et al., 2015).

Finally, universities are increasingly seeking to promote (*iv*) *community engagement* and create a sense of identity for their stakeholders, which include students, faculty, administrative staff, local firms, government and society at large (Sassen and Azizi, 2018). Indeed, it is crucial to share values, promote collaboration and make stakeholders fully aware of the importance of their actions in the institution's transition to sustainability (Blanco-Portela et al., 2017). Specific outreach activities can involve training the community in green issues (for instance, through dissemination courses or events open to the general public), partnerships between universities and profit or non-profit organizations (Jabbour et al., 2013), and new business idea for startup incubators (Secundo et al., 2017). In this way, universities may also play a central role in advancing sustainability at regional and national level (Sánchez-Barrioluengo and Benneworth, 2019).

Truly to incorporate green principles into these four major dimensions (i.e. *campus operations*, *teaching*, *research* and *community engagement*), holistic consideration of all the activities that are

related to sustainability is needed (Geng et al., 2013; Velazquez et al., 2006). Sustainable development indeed requires both structural and operational innovations (Ávila et al., 2017). The former involves deep changes in the governance, management, organization and accounting of universities, whereas the latter means coming up with entirely new ways of executing operational activities. Actually, to implement these innovations, higher education institutions must revise their business model and adopt a systemic approach to sustainability. In this respect, the development of an *institutional framework* (in terms of the mission, vision and policies) that makes the intentions of the university clear with respect to sustainability as a whole is essential. Therefore, such a framework is the first step as well as the logical premise of a greener institution (Leal Filho et al., 2019a).

Furthermore, due to the impact that universities have on the economy, society and environment, in recent years there has been an ongoing call for more *accountability* and *reporting* on how these institutions are managed (Brusca et al., 2018). The need for social reporting is justified by the fact that universities are facing growing competitive pressure due to the globalization, the increase of student numbers and the overall decline of public funding (Lombardi et al., 2019). In response to this evolving scenario and to the emergence of new challenges and expectations, since the 1980s there has been a movement toward the "corporatization" of public universities (Brusca et al., 2018; Ntim et al., 2017), while other scholars confirm the traditional role of higher education institutions in producing research and disseminating human knowledge (Pelikan, 1992). In this sense, the "corporatization" involves adopting entrepreneurial concepts and tools to manage higher education institutions more effectively (Küpper, 2013). The "corporatization" of these institutions took place in several developed countries starting from Australia, Canada, New Zealand, the USA and UK and expanding to EU countries like Italy and Spain (Buckland, 2009). The universities' need to adopt an entrepreneurial approach in their actions and practices gave birth to the so-called "entrepreneurial university" (Ektzkowitz, 2016), which has strong connections with university spin-offs and incubators, firms, institutions, and territories (Lombardi et al., 2017). From a managerial perspective, many concepts and tools are then being borrowed from business and tailored to the specific needs of higher education institutions (Yáñez et al., 2019). In particular, as nowadays universities are increasingly required to monitor and measure their performance under multiple dimensions (legal, political, financial, etc.), sustainability reports can be viewed as a useful tool to communicate universities' efforts toward sustainability (Alonso-Almeida et al., 2015) and to document a sustainable use of the allocated public resources (Del Sordo et al., 2016). By providing information in voluntary sustainability reports, universities can disclose their commitment toward greater accountability and transparency with positive consequences for the institutional image and the reputation (Moggi, 2019), thereby satisfying stakeholders' expectations (Chatelain-Ponroy and Morin-Delerm, 2016). Consequently, they could obtain access to important resources, such as donations and grants (Ntim et al., 2017). Therefore, accountability and reporting represent another important dimension of the path toward sustainability.

To summarize, universities may promote sustainable development by including sustainability principles in their mission and vision, introducing new ways to manage and live on their campuses, restructuring their curricula, modifying their research programs, enhancing community engagement and, finally, reporting these activities to stakeholders. Hence, in a comprehensive way, a green university may be seen as a complex system based on a total of six dimensions: *institutional framework*, *campus operations*, *teaching*, *research*, *community engagement* and *accountability and reporting* (Fig. 1).

Nevertheless, there are some barriers that universities encounter when they seek to implement green practices. First, many institutions have not explicitly stated their mission, vision and policies when it comes to sustainability; therefore, they lack a proper institutional framework, which greatly hampers their progress toward sustainability (Lozano et al., 2015). In addition to this, the lack of both financial and human resources represents an important obstacle for almost all universities (Larrán Jorge et al., 2015). Most institutions fail—partly or completely—to integrate sustainability into their curricula and research programs, especially because human resource policies regarding annual performance reviews often do not reward sustainability practices (Ávila et al., 2017). Furthermore, many universities have not yet developed effective relationships with internal and external stakeholders (Blanco-Portela et al., 2017); this evidence, as well as the lack of mandatory regulations on sustainability disclosure, explains the limited diffusion of sustainability reporting within the university sector (Alonso-Almeida et al., 2015).

3. Methodology

Considering the novelty of the topic, this research has an exploratory nature. Accordingly, we adopted a qualitative approach that is particularly suitable when little is known about a certain phenomenon (Lune and Berg, 2017). Specifically, we used the case study method, which enables researchers to obtain in-depth and comprehensive information about the phenomenon in its real context (Yin, 2018).

In particular, this research puts forth the case of the University of Florence (hereinafter, also simply "University"), which may be considered an interesting case for exploring the journey toward sustainability within the higher education sector. The rationale for our choice is twofold. First, this institution is the fourth (alongside the University of Parma) among the Italian universities in the "University Impact Ranking 2019" drawn up by the international weekly magazine *Times Higher Education* as well as a member of the *European School of Sustainability Science and Research* (ESSSR), the *Italian Sustainable University Network* (RUS) and the *Italian Alliance for Sustainable Development* (ASviS). Second, this University is one

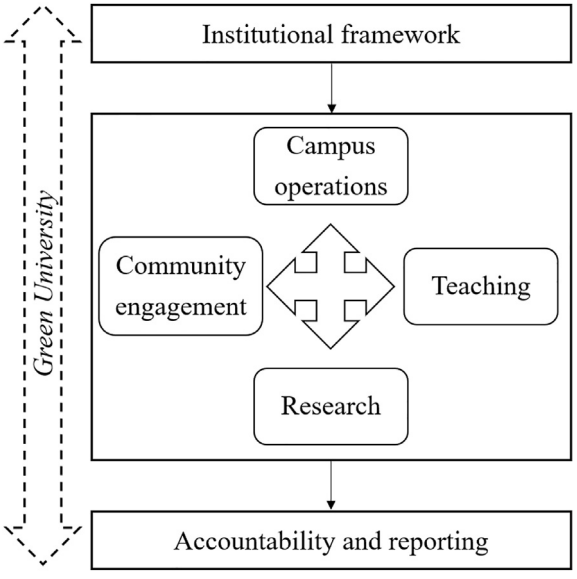

Fig. 1. The dimensions of sustainability at green universities.

of the (only) four Italian State universities (alongside those of Pisa and Turin and Ca' Foscari of Venice) that publish sustainability reports included in the GRI database.[1] This evidence suggests that, over the last years, the University of Florence has been paying increasing attention to green issues.

To collect data, we performed in-person semi-structured interviews with key personnel of the University of Florence (the Rector, the Pro-Rector for communication and public engagement, the Pro-Rector for sustainability and the Pro-Rector for budgeting and financial reporting). Additionally, secondary sources (i.e., the official website and sustainability reports of the University) were used to supplement the information obtained through the interviews and hence to increase the validity of the results through the triangulation of data collection.

4. Findings

The University of Florence is an ancient institution dating back to 1321 and officially recognized as a "university" from 1924. It is a relevant entity for research and higher education in Italy, with 1800 lecturers and academics, 1600 administrative staff and over 1600 research assistants and doctoral students. Currently, the University offers a wide range of educational programs at different levels (over 130° courses organized in 10 schools), with about 51,000 national and international students enrolled.

In the following pages, the case study of the University of Florence is discussed, by considering the six different dimensions of sustainability at green universities as presented in the literature review section.

4.1. Institutional framework

Sustainability is one of the basic strategic paths of the current Rector of the University of Florence.

It was almost obvious that the University of Florence accepted the sustainability challenge. After all, the topic had already been addressed [before my mandate] by community members through spontaneous activities. However, the University is now committed, for the first time, to promoting well-structured initiatives. (Rector).

Therefore, the case under study demonstrates the commitment of the university management to defining strategies aimed at realizing a green university. Accordingly, it may be seen as a good example of an institutional framework designed to define a sustainable mission and vision.

As previous studies have noted, the actual implementation of sustainability within universities requires strong support from the high management (Yuan et al., 2013) and consequent—and consistent—organizational changes (Blanco-Portela et al., 2017). From this perspective, the Rector has decided to strengthen his team with some actors specifically committed to favoring the implementation of a green university, thereby realizing some important structural innovations in the governance of the institution (Ávila et al., 2017).

At the beginning of my mandate in 2015, I nominated the Pro-Rector for sustainability and the "Sustainable University" team was set up with the task of operationalizing the green initiatives identified in the strategic plan. Encouraged by the new strategies promoted by the University, the team consolidated the activities that had been already started by undertaking new sustainable initiatives. (Rector).

More precisely, besides a specific Pro-Rector for sustainability, the Rector team comprises—among others—two new organizational positions related to sustainability issues, namely the Pro-Rector for communication and public engagement and the Pro-Rector for sustainable mobility for students and academic staff (also called "mobility manager"), and a special organizational unit (named the "Green Office"). Being in a staff position to the general direction, this unit has the responsibility of collecting data, coordinating activities and monitoring projects in the sustainability field (for instance, with regard to waste management and sustainable mobility), thereby supporting the university management in adopting greener behavior. In this sense, the Green Office acts as a hub from which all sustainability-related activities are managed; accordingly, it plays a significant role in addressing the issue of sustainable development (Leal Filho et al., 2019a). Furthermore, this unit is responsible for both the sustainability plan and the sustainability report of the University. Therefore, in a wider sense, the activities of the Green Office are strongly linked to the achievement of the sustainability goals provided by the European Agenda 2030 (University of Florence, 2018).

Nevertheless, despite the increasing attention paid by the University of Florence to sustainability in recent years, there is still much to be undertaken. In particular, the main critical issue concerns the lack of full integration between the different actors involved in the institution's path toward sustainability. As the Rector stated, the University needs to realize stronger coordination between the different actors committed to putting the sustainability strategies into practice.

It would be necessary to improve integration between those working, sometimes even unconsciously, on sustainability matters. (Rector).

Indeed, actually to implement sustainability, an integrated approach is needed, and collaboration between different units should be encouraged so that the best practices can be shared and implemented by all the units (Geng et al., 2013).

4.2. Campus operations

The strategic pathways toward sustainability of the University's campuses are described in the strategic plan, and their results are then presented in the sustainability report. The main projects are related to green buildings, waste management and sustainable mobility.

As concerns the first point, the University of Florence is striving to create new buildings that are totally green and to introduce green solutions into the existing structures. However, the renovation of the latter buildings in a green sense requires huge financial resources, which represent a crucial resource for the implementation of sustainable practices for any institution (Blanco-Portela et al., 2017). Hence, the lack of sufficient funding is one of the main barriers to sustainability in the higher education sector in general (Ávila et al., 2017) and for the University of Florence.

Undoubtedly, the most difficult objective is to achieve sustainability within the University's buildings, especially because of the significant financial resources necessary. The older buildings, dating back to the 70s, are too outdated for any intervention and, therefore, the University's effort to achieve sustainability is focused primarily on new buildings. (Pro-Rector for sustainability).

Furthermore, the University is committing to reducing the existing buildings' energy consumption. Between 2016 and 2018, the total energy consumption was reduced to 35 million of kwh, with a global saving of 370,000 euros. Currently, electric energy and gas represent 98% of the annual consumption, while diesel covers only 1%, with a significant reduction of harmful emissions produced by this source of pollution. However, renewable sources only account for 0.12% of the electric energy. In future years, the University of Florence aims to increase the use of renewable sources and to undertake new projects to reduce the energy consumption of

[1] https://database.globalreporting.org (accessed 27 December 2019).

campuses and buildings (such as the replacement of traditional light bulbs with LED ones). As discussed before, one of the main constraints that affects sustainable strategies is the availability of financial resources.

Regarding energy saving, the University is promoting the use of LED lighting in all buildings. However, the implementation of this environmental action is strongly slowed down by financial restrictions. (Pro-Rector for sustainability).

Regarding waste management, the University has installed 22 water dispensers (called "Fontanelli"), which, by providing students and academic staff with free water, aims to favor the reduction of the use of plastic bottles. Indeed, as shown by Thongplew and Kotlakome (2019), water dispensers may support the "routinization" of a sustainable consumption practice. Thanks to this initiative, from 1 January 2018 to 10 December 2019, the dispensers delivered 795,080 L, with a plastic saving of about 1,368,600 single-use bottles. The university has also supported this project by giving students 20,000 aluminum bottles with the institutional logo. Although this initiative could be considered very simple, the educational impact on the younger generation is potentially very high.

The university can be regarded as a unique city where 80% of its population (which amounts to about 60,000 people) are aged 19–26. In this sense, educating students on green issues means investing in a more sustainable future. (Rector).

Another sustainable activity on the University campus is related to paper and plastic recycling. The institution has increased the number of recycling boxes and, at the same time, defined some principles for the circular economy with regard to IT hardware, office equipment and other furniture. Moreover, the University has activated 7 recycling points for students, staff and citizens at large, who are allowed to bring some goods that are not eligible for the normal public waste service (for instance, exhausted batteries, toner and ink cartridges, spray bottles, small IT equipment and expired drugs).

Concerning sustainable mobility, an interesting project is linked to public transportation for students. From the academic year 2018/2019, the University has provided students with a public transportation card, which encourages them to use public transport in the metropolitan area of Florence. Indeed, this card is sold at a very reasonable price, thanks to financial support from the University itself. The total number of cards provided in 2018 was 39,600.

The "public transportation" card is affordable for students but, above all, it is educational, as it encourages the green practice of using public transport. In Italy, in addition to the University of Florence, only the University of Catania has started a similar initiative. (Rector).

Furthermore, in 2019, the University joined the national network RUS (the Italian University Network for Sustainable Development) and the European U-Mob Life (European Network for Sustainable Mobility at Universities). The aim of both projects is to promote the exchange of experiences about the promotion of sustainable mobility in public universities, with particular attention to students, academic and administrative staff.

4.3. Teaching

The educational offer of the University of Florence regarding the issue of sustainability can be analyzed vertically and horizontally (Stough et al., 2018), that is, exploring the presence of curricula with a primary focus on sustainability and the inclusion of courses on sustainability within curricula that are not specifically devoted to this topic.

Following the vertical approach, the institution has developed some specific sustainability-related curricula. The academic units involved are the Schools of Agriculture, Architecture, Economics and Management, and Engineering. In more detail, the educational offer in sustainability issues is composed of six master's degrees, 1 s-level master's course and one PhD program (Table 1).

In the teaching area, the University is also developing a project that aims to give a "green label" to the curricula covering a certain number of the Sustainable Development Goals defined by Agenda 2030 and thus is strongly committed to sustainability issues.

Furthermore, another of the University's projects concerns the development of a specific postgraduate course on sustainability. This would certainly be an interesting initiative, as several studies have pointed out that there is a link between employability and sustainability skills (e.g. Azeitero et al., 2015). Indeed, companies increasingly need employees who are able to support their CSR policies; in this respect, a graduate with a degree title clearly showing knowledge of sustainable issues could be a more attractive candidate in the current labor market (Zorio-Grima, 2020).

Due to the interdisciplinary nature of sustainability, a specific training course for professional "sustainability managers" is still lacking. Indeed, the analysis of the courses activated for the current academic year has revealed that sustainability is part of different curricula [in the Schools of Agriculture, Architecture, Economics and Management, and Engineering], confirming the multidisciplinary approach to the study of sustainability. Accordingly, the University's goal is to organize a postgraduate course strictly devoted to green issues. (Pro-Rector for sustainability).

From the horizontal perspective, the University of Florence has activated 21 courses specifically dedicated to sustainability issues, most of which are part of master's degrees (Table 2).

The University of Florence is also a founding partner of the European School of Sustainability Science and Research (ESSSR), a university consortium aimed at promoting master's degrees and PhD programs on the issue of sustainability in the EU context.

4.4. Research

The University of Florence is involved in different research projects in the field of sustainability. To confirm this statement, we performed research in the digital repository of the University (called "Flore"), in which data and activities related to research projects are collected, using the keywords "sustainability" and "sostenibilità" (translation into Italian) and searching for papers, books, chapters and other research products. However, it should be noted that the database is not updated in real time; hence, it is impossible to draw an exhaustive picture of the research projects produced.

It would be pivotal to map the research on sustainability. Although some attempts have been made, we are still unable to identify easily both all those dealing with this topic and the works produced. (Pro-Rector for sustainability).

The result is that members of the University's academic staff have authored 898 research products concerning the issue of sustainability in several research domains (such as agriculture, the environment, communication and reporting, and tourism). Moreover, as regards the research projects funded by international and national institutions, the University is involved—as a coordinator or a participant—in several initiatives. In more detail, the research projects funded by the European Union that were underway in 2018 are analyzed in Table 3.

The University is also involved in different research projects funded by the Italian Ministry of University and Research connected with sustainability in heritage assets and sustainable materials. Other projects are funded by regional institutions and cover topics like forestry, sustainable agriculture, innovative and sustainable technologies in the dairy industry and so on. Finally, it is

Table 1
Vertical sustainability educational offer.

	Schools			
	Agriculture	Architecture	Economics and Management	Engineering
PhD program	• Sustainable management of agricultural resources, forestry and food			
2nd-level Master's degree		• European urban agenda for sustainable development. Principles, policies and practices for a European urban system		
Master's degrees	• Agricultural sciences and technologies. *Curricula*: (*i*) Sustainable management of the agro-ecosystem; (*ii*) Sustainable management of livestock systems • Forest Systems sciences and technologies. *Curriculum*: Sustainable, responsible and environmentally friendly wood production		• Design of sustainable tourism systems • Economic sciences. *Curriculum*: Production systems, territory and sustainability	• Environmental engineering. *Curriculum*: Sustainable management of natural resources

Table 2
Horizontal sustainability educational offer.

	Schools				
	Agriculture	Architecture	Economics and Management	Engineering	Mathematics and Science
Master's degrees	• Biotechnological applications for sustainable crop production • Biotechnologies for sustainable livestock management • Molecular plant pathology and disease control • Sustainable soil management • Tools for a sustainable precision farming	• Design for sustainability • Living in risk area. Sustainable requalification in urban area • Technologies for the sustainability • The historical contexts between memory and innovation: The identity survey and the responsive design for sustainable enhancement	• Sustainable tourism for local system development	• Eco-sustainable design of industrial products and processes • Sustainable design of specialized building types	• Innovative analytic methodologies for sustainable energy • Sustainability and biological crisis
Bachelor's degrees		• Sustainable management of water and waste in urban areas	• Geo-economics and geopolitics of sustainable development • Social economy and sustainable development • Sustainability supply chains	• Energy, sustainability and the environment • Reliability, safety and environmental sustainability of machines • Sustainable management of water and waste in urban areas	

also worth noting that there are some academic spin-offs that, acting as an important vehicle of knowledge transfer (Fuster et al., 2019), are committed to developing innovative and sustainable solutions to meet the everyday needs of people and companies.

4.5. Community engagement

As communication strengthens actions and makes internal and external communities more sensitive to sustainability issues, we have to describe and share our green initiatives [with all stakeholders]. (Associate Rector for communication and public engagement).

In general, the main communication channels of the University of Florence are the official website and the digital magazine. Through these media, the University provides information on its institutional activities and on the sustainable initiatives implemented. However, the principal means of communication about the latter topic is a special website of the University (https://www.

Table 3
The University of Florence's research projects funded by the European Union and ongoing in 2018.

Research projects	University's role	EU program
Operationalizing the increase of water use efficiency and resilience in irrigation (OPERA)	Coordinator	Eranet JPI Water Works 2015
Master Program on Bio-Based Circular Economy: From Fields to Bioenergy, Biofuel and Bioproducts in China (BBCHINA)	Coordinator	Erasmus+
Sustainable Precision Agriculture: Research and Knowledge for Learning how to be an agri-Entrepreneur (SPARKLE)	Coordinator	Erasmus+
Sustainable Hydropower Use and Integration in China and EU (SHUI-ChE), Lot. 4 (SHUICHE)	Partner	Europeaid
Biocatalytic solar fuels fur sustainable mobility in Europe (PHOTOFUEL)	Partner	Horizon 2020
CEreal REnaissance in Rural Europe: embedding diversity in organic and low- input food systems (CERERE)	Partner	Horizon 2020
Climate change impact mitigation for European viticulture: knowledge transfer for an integrated approach (Clim4Vitis)	Partner	Horizon 2020
Efficient harvesting of the wind energy (AEOLUS4FUTURE)	Partner	Horizon 2020
Marine Renewables Infrastructure Network for Enhancing Energy Technologies, Part 2 (MARINET 2)	Partner	Horizon 2020
Pastures vulnerability and adaptation strategies to climate change impacts in the Alps (PASTORALP)	Coordinator	Life
Sustainable Monitoring And Reporting to inform Forest and Environmental Awareness and Protection	Partner	Life
Waste Electrical and Electronic Equipment (WEEE): treasures to recover! (LIFE WEEE)	Partner	Life
Innovative wireless tool for reducing energy consumption and GHGs emission of water resource recovery" (LESSWAT)	Coordinator	Life Environment
Demonstrating Remote Sensing integration in sustainable forest management (FRESH)	Partner	Life Environment
New approaches for protection in a modern sustainable viticulture: from nursery to harvesting	Partner	Life Environment
Shaping future forestry for sustainable coppices in southern Europe: the legacy of past management trials (FutureForCoppices)	Partner	Life Environment

ateneosostenibile.unifi.it/) that is specifically devoted to disclosing analytical information on the actions and projects realized in the sustainability field. Unfortunately, there is no English version of the website, and this constrains its usability for non-Italian speakers. "Ateneo sostenibile" also has an official Facebook page, while the University is in general active on the main social media platforms (Facebook, Instagram, LinkedIn, Twitter and YouTube).

As regards community engagement, over the last years, the University of Florence has organized lectures ("Encounters with the Town") in which academics and researchers talk about various topics (including sustainability), which are freely open to the public. Lessons are held once a month on Sundays during the academic year. The topics cover some of the most debated issues in the current society and are selected by a scientific committee composed of university Pro-Rectors. In the academic year 2018/2019, the public participation was high, with an average number of applicants equal to 230; 3 lessons (out of 10 in total) addressed issues related to sustainability and were the ones that registered the largest number of participants.

The lessons dealing with issues related to the territory—Tuscany and, above all, Florence—and to sustainability have the most participants. (Associate Rector for communication and public engagement).

Moreover, sustainability issues have recently been included in the programs of the European Researchers' Night (ERN), an event that takes place every year across Europe on the last Friday of September. In Tuscany, this initiative is realized through the project "Brilliant Researchers Impact of Growth Health and Trust in Research" (BRIGHT), which aims to enhance the visibility and perception of researchers among the Tuscan people. BRIGHT brings researchers into the squares and street of the historical centers of the many different cities involved in the project, like Florence, Pisa and Siena. In BRIGHT 2019, the events related to sustainability were organized in various forms: a discussion of works made by high school students (170 students involved) with university staff; a discussion of master's and doctoral theses in different disciplines; and some conferences on the issue of food sustainability and climate change.

However, the University needs to undertake more projects and define more focused strategies to engage students, academic staff and citizens in the initiatives concerning sustainability. Indeed, as discussed in previous research, community engagement has a pivotal role in the University's transition to sustainability (Blanco-Portela et al., 2017). Moreover, by making people more sensitive to green issues, the institution may play a leading role in enabling its community to develop more sustainable ways of living (Ávila et al., 2017).

4.6. Accountability and reporting

The University of Florence was a pioneer in sustainability reporting among Italian universities. The first experience dated back to 2006 and was replicated ten years later, in 2016. From 2016, a sustainability report was realized each year and integrated into the accountability system of the University.

Currently, the report is prepared in accordance with the Global Reporting Initiative (GRI) guidelines, as they are the most widely accepted standards for sustainability reporting in private and public entities (Yáñez et al., 2019). The report is compiled taking into consideration other national standards defined by the Italian praxis as well, and, starting with the 2018 version, it contains explicit links to the Sustainable Development Goals (SDGs) that the institution has addressed through its activities.

Since 2018, we have indicated in each section of the sustainability report the different SDGs reached by the institutional activities described in the section itself. All in all, it comes to light that almost all 17 SDGs were touched upon in our report. (Pro-Rector for financial resources).

Considering the content of the sustainability report, it is possible to find a specific section called "Sustainable University", in which all projects and strategies in this area are reported in detail.

As outlined in the literature, sustainability reporting allows universities not only to communicate their actions and performance but also to engage their multiple stakeholders (Brusca et al., 2018); in turn, the involvement of stakeholders is critical for facilitating the real implementation of green concepts (Marques et al., 2019). From an entrepreneurial perspective, the sustainability report also highlights the activity of the University of Florence, with other local and national partners, aimed to developing the innovation ecosystem and supporting the start-up and spin-off programs.

Considering that sustainability reporting is a pillar of a sustainable university, the experience of the University of Florence suggests some future developments and some possible risks. In future editions, the strategy of the University is to realize an embedding process of the social report in its strategic planning. In this sense, the sustainability topics discussed in the social report could be analyzed before defining the future strategic path of the

University. On the risk side, one of the main issues is continuing to report after the turnover of the university management. In other words, the problem to solve is to be sure that the social reporting will continue in future years and become part of the accountability system of the institution. A possible solution is to embed the social reporting as a performance goal of the sustainability managers.

The main risk is that the sustainability reporting will be in peril when those looking after it today leave. A possible strategy could be to turn sustainability reporting into a managerial goal. (Pro-Rector for financial resources).

5. Discussion, conclusions and future research

Because of their impact on the economy, society and environment, the role of universities in supporting the building of a more sustainable society is currently a topic that is increasingly studied by academics (Marques et al., 2019). However, the literature so far has focused on specific aspects of sustainability in the higher education sector, without taking into consideration the inclusion of green issues in all the main dimensions of university activities (including the *institutional framework*, *campus operations*, *teaching*, *research*, *community engagement*, and *accountability and reporting*). Thus, our study attempts to fill this gap by analyzing the path toward sustainability of the University of Florence.

In the institutional dimension, the University has defined some clear strategies and well-structured initiatives actually to implement sustainable practices within the institution. Furthermore, the current Rector strongly supports the journey toward a green university. In this sense, the institution appears to be aware of the importance of developing an adequate institutional framework (Leal Filho et al., 2019a) and having top management that is truly committed to sustainability issues (Blanco-Portela et al., 2017). In this regard, future research may investigate the institutionalization level of a green university using multiple case studies and taking into consideration higher education institutions operating in different countries.

The sustainability policies need to be implemented on the campuses where teaching and research are put into practice. In this respect, the main initiatives of the University concern renovating buildings in a sustainable way, the reduction of energy consumption, a decrease in the use of plastic bottles, the recycling of paper and plastic and sustainable mobility. Consistently with other studies (Ávila et al., 2017), we found that the main obstacle remains the lack of adequate financial resources. As previous studies have often taken into account such initiatives only individually, future research could jointly analyze these activities so as to explore whether a certain institution has implemented them following a mere "greenwashing" approach or aiming at realizing a real green university.

The issues of sustainability are spread across different educational programs in the University of Florence and, from a horizontal perspective, the academic offer seems to be linked to the matter of green universities. The same situation could be perceived regarding the vertical approach, for which different specific programs can be found, fully dedicated to sustainability (Stough et al., 2018). However, for the next years, the strategy of the University is to undertake new efforts to build new programs for sustainability managers and other multidisciplinary courses. A similar consideration can be attributed to the results of the research activities, as the University of Florence is involved in many projects funded by the European Union and other national and international institutions and so it is also fundamental to use transparency in documenting the use of public funding (Del Sordo et al., 2016). However, the research revealed that, for the moment, coordination in the form of a research strategy in the area of sustainability is absent. From an overall view, it is possible to conclude that research and teaching are the activities in which the issues of sustainability are more diffused. This evidence is consistent with the fact that these activities represent the traditional "core business" of a university (Ávila et al., 2017), to which most staff and financial resources are indeed allocated.

The University of Florence has been working on different activities for engaging the community in issues of sustainability, but the results are currently at an early stage. Despite the efforts to increase community engagement and make the stakeholders more sensitive to sustainability, this dimension needs to be improved, for instance by using some innovative channels like digital tools. This represents a crucial aspect for any university that is truly committed to sustainability; indeed, the involvement of the local community is fundamental to a greener institution (Blanco-Portela et al., 2017). In other words, the stakeholder engagement represents a pivotal dimension that future studies on green university should investigate more-in-depth.

It is possible to reach a similar conclusion for the accountability and reporting dimension. The University of Florence was a pioneer in sustainability reporting in Italy, with a project dating back to 2006. Currently, the institution has integrated sustainability reporting into its accountability system, but full integration into strategic planning is still lacking. Although the literature has widely investigated this matter, the integration of sustainability reporting within the overall management of a higher education institution remains still hard. Moreover, one of the weak points is again the engagement of stakeholders in the reporting process, especially with regard to external parts.

From a theoretical point of view, this research provides a first on-field study about the implementation of a green university and, differently from previous studies, takes into account all six dimensions of sustainability in a comprehensive way. Consequently, this paper contributes to fill the literature gap and also to provide some opportunities for future studies on green university model.

This research has some managerial implications, especially for the managers of a university that is interested in the issue of sustainability. Indeed, reading this study, a manager may find some room for thought about how to apply the sustainability principles to all the dimensions of university activity, from teaching and research to communication and reporting.

The current study has at least one limitation that should be addressed in future research. Indeed, it is based on the analysis of a single case and, accordingly, the results cannot be generalized. In this sense, future research could apply the framework developed in this study to other institutions in order to identify general features and hence a general model of green universities. Finally, it could be interesting to repeat this research in the next years to monitor the efforts of the University of Florence toward sustainability, thereby drawing a more comprehensive picture of this institution's path toward the target of a green university.

CRediT authorship contribution statement

Silvia Fissi: paragraphs "1. Introduction" and "5. Discussion, conclusions and future research" can be attributed, All authors have read and agreed to the published version of the manuscript. **Alberto Romolini:** "4.3 Teaching", "4.4 Research", "4.5 Community engagement" and "4.6 Accountability and reporting", All authors have read and agreed to the published version of the manuscript. **Elena Gori:** "3. Methodology", "4. Findings", "4.1 Institutional framework" and "4.2 Campus operations", All authors have read and agreed to the published version of the manuscript. **Marco Contri:** "2. Literature review", All authors have read and agreed to the published version of the manuscript.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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