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NEXT GENERATION METRICS

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- Ingrid Bauer (TU Wien)
- David Bohmert (Secretariat)
- Alexandra Czernecka (Delft University of Technology)
- Thomas Eichenberger (ETH Zurich)
- Juan Garbajosa (*Universidad Politécnica de Madrid*)
- Horia Iovu (University POLITEHNICA of Bucharest)
- Yvonne Kinnaird (University of Strathclyde)
- Ana Carla Madeira (University of Porto)
- Mads Nygard (Norwegian University of Science and Technology)
- Per-Anders Östling (KTH Royal Institute of Technology)
- Susanne Räder (formerly *Technische Universität Dresden*)
- Mario Ravera (*Politecnico di Torino*)
- Per-Eric Thörnström (Chalmers University of Technology)
- Kurt De Wit (KU Leuven)

CESAER is the European association of leading specialised and comprehensive universities of science and technology that: champion excellence in higher education, training, research and innovation; influence debate; contribute to the realisation of open knowledge societies; and, deliver significant scientific, social, economic, and societal impact.

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LETTER FROM THE PRESIDENT

In times of unprecedented challenges following the Covid-19 pandemic, we know for certain that other challenges are also looming: cultural, economic and social recovery; social exclusion; increasing economic inequality; climate change; plastic pollution; biodiversity loss; and the consequences of ultra-processed food, like obesity and coronary diseases. Universities are expected, and want, to contribute to tackling these challenges.

Thereby, they are measuring and are being measured in diverse contexts ranging from (i) institutional planning, monitoring and evaluation, (ii) external assessment of - some kind of - performance to (iii) positions in global rankings. There is an ever-increasing number of indicators on diverse dimensions that provide information to a variety of stakeholders, such as researchers, (prospective) students and their parents, governments, funders, business and industry, non-governmental organisations and the wider public. Some indicators are valuable to certain stakeholder groups while being less useful and meaningful to others. Indeed, the purposes of such data collection are equally diverse covering (i) reform and transformation of universities and research and education systems, (ii) determination of (public) funding, and (iii) support to identify the university of choice.

The urge to identify ´key metrics´ suitable to cover the increasing demands on, and expectations of, universities is considerable and grew exponentially since the introduction of New Public Management (NPM) in the 1980s. Consecutive waves of local, national and European interventions to reform and transform universities and the systems they operate in, and the emergence of global rankings making and breaking reputations put high pressures on universities to collect and process data on what might be called ´traditional indicators´. Recently, the tendency is to promote ´openness´ in science, education and innovation, urging universities to collect data on ´next generation metrics´. Universities thus invest considerable efforts and are confronted with additional administrative burdens.

Rather than providing a collective response from CESAER on the ongoing debate on the usefulness of measurement, assessment and ranking, this white paper arises from the genuine interest of our Members to stay at the forefront of science, education and innovation; to benchmark over time in order to pursue institutional development paths; and - ultimately - to optimise our contributions to society and the world.

Responding to the trend towards more openness and a broader view on measuring the quality of science, the writers describe the tensions, challenges and opportunities when moving from ´traditional´ to ´next generation metrics´. The findings, recommendations and indicators they present are neither conclusive nor exhaustive, but are based on the excellence, expertise and best practices from our Members and build on the longstanding and extensive work of our Task Force Benchmark.

On behalf of the Board of Directors, I thank the writers for preparing this paper, for exploring beyond the obvious trends and common grounds, and for outlining an inspiring agenda for the development of indicators for university development in the 21st Century.

Rik Van de Walle
President of CESAER
Rector of Ghent University

EXECUTIVE SUMMARY

We - the writers - of this paper summarise a methodological debate amongst experts from our Members on ´traditional´ and ´next generation metrics´ for science, education and innovation in the light of the developments and expectations towards greater ´openness´ to realise long-term ecological, economic and social sustainability and benefit to citizens and to the world. A broad range of indicators from various sources were discussed in terms of feasibility in different contexts, as well as their suitability to serve diverse purposes. Rather than presenting a formal position on behalf of CESAER, we present our synthesis of this debate. In chapter one, we provide the definitions, describe the methodology used and set the scope of this paper, thus setting the scene for the following chapters.

In chapter two, we report on our findings on metrics dealing with (open) science. Ever since E. Garfield's Journal Impact Factor (JIF) came into use in the mid-70s, and certainly with the h-index proposed by the physicist J. E. Hirsch in 2005, the rise of quantitative metrics in the assessment of research has seemed to be unstoppable - up to the use of ´views´, ´likes´ and ´tweets´. While in times of accountability and competing for visibility and funds, it is only reasonable to focus on the measurability and comparability of metrics as efficient means to display performance, the limitations of doing so are obvious. As a result, in the past years, a countermovement criticising this practice and questioning the validity of the metrics and reliability of the data used has become stronger. Moreover, there are strong (political) expectations to make science more open.

Metrics for (open) education and training are the topic of chapter three. In many (global) rankings of higher education institutions, the indicators used reflect the model of traditional, established, wealthy and largely English-speaking research universities (Hazelkorn, 2015). They are, therefore, ill-suited to truly give an idea about the quality or the performance of higher education more broadly, and they are limited in helping universities to set priorities. They do, however, reveal that there is still a lack of meaningful internationally comparable information on these matters.

By covering (open) innovation in chapter four, we complete the discussion of the mission of our Members. Open innovation promotes approaches that boost disruptive innovation rather than incremental, stimulate inventions produced by outsiders and founders in start-ups, and is based on a view on the world of widely distributed knowledge.

We synthesised our findings on the confrontation between ´traditional´ and ´next generation metrics´ and present ten each for science, education and innovation for use mainly within our Members and to monitor the desired progress over time (see annexe I).

While this might be interpreted as sufficient responsiveness to external expectations on our behalf, we instead advanced further and in chapter five suggest that universities strive towards ´progressive metrics´ and highlight the need to acknowledge knowledge as a common good, promote a culture of quality, risk-taking and trust and measure the contribution to sustainability.

That is why we conclude this paper with ideas for progressive indicators in annexe II, outlining an agenda for future work to stay at the forefront of science, education and innovation; to benchmark against like-minded institutions; and to pursue institutional development paths; and - ultimately - to optimise our contributions to society and the world.

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1 DEFINITIONS, METHODOLOGY AND SCOPE

In chapter one, we define traditional and next generation metrics, categorise the purposes of the use of metrics, explain our approach to indicators and set the scope of this paper thus setting the scene for the following chapters.

1.1 TRADITIONAL METRICS

New Public Management (NPM) (Hood 1991) was introduced in the 1980s as the guiding concept for remodelling universities through ´key metrics´, introducing competition similar to that in the private sector, putting ´service and result´ at the core, adopting ´cascading´ chains of management to aid transparency and introducing lean administrative systems. Typical examples of such traditional metrics are the number of scientific publications of a researcher, the number of citations of each publication, the Hirsch index (h-index) and various kinds of journal impact factors.

1.2 NEXT GENERATION METRICS

The effort to devise the ´next generation metrics´ proposed in this white paper has been primarily driven towards getting interesting and suitable metrics for universities of Science and Technology (S&T), and not (necessarily) for ranking purposes.

The focus has been on ´useful´ rather than ´new´ metrics. By measuring the performance at the level of a university, a faculty or a department, they can realise changes that nudge them towards improving their contributions to society. The metrics are not mainly focused on benchmarking between our Members. Instead, our metrics are primarily intended for benchmarking universities on their institutional development paths to know where they were some years ago, are today and want to be some years ahead. The focus is consequently on what should be measured, and not on what is easy to measure.

In order not to raise the administrative burdens unnecessarily, most bibliometric data suggested are already calculated and made available by others, since collecting data and making calculations is time-consuming. We did not just add ´more metrics´ on top of existing ones.

Next generation metrics in this white paper are not considered the same as ´altmetrics´, such as views, mentions, book-marks, downloads, social media discussions and likes. However, altmetrics may be part of next generation metrics.

An expert group on altmetrics did not give a concise definition of ´next generation metrics´ (European Commission, 2017c). Rather, they concluded that there was a need to develop such metrics for open science. To evaluate openness in science, both quantitative and qualitative metrics as well as expert judgements are needed, they claimed. The focus should be on measuring what is needed and what really matters. They concluded that existing metrics can be used in a better way, some altmetrics could be included and it should all be based on an open, transparent and linked data infrastructure. Rather than be conclusive, they addressed the ongoing work to define a set of (good) open science metrics for Horizon Europe. Those thoughts are to a large extent in line with the ones expressed in this paper, though the inclusion of altmetrics is limited in this white paper.

1.3 INDICATORS

When discussing and presenting indicators, we address the differences, tensions and opportunities arising from qualitative and quantitative approaches to metrics, including scientific excellence, peer review and cultures of quality. We differentiate between the following categories of indicators: (i) input-, (ii) process-, (iii) output- and (iv) impact-related, acknowledging that a combination thereof is often the most informative. Moreover, we took challenges created by conditions and contexts at local and national level and the modes of collection and application within universities into account. Finally, the source and availability of data helped us judge the administrative burdens involved in collecting and processing such data. In our view, good indicators have to be ‘SMART’:

- Specific dealing with exactly what is intended to measure;
- Measurable in terms of being clearly defined, so that they are interpreted in the same way by all involved and that they can be followed up by anyone;
- Accepted and Actionable by those measured and affected by the indicators;
- Realistic to measure with available resources and existing conditions;
- Time-limited in terms of being measured during clear time intervals and suitable to be changed after time.

1.4 SCOPE

We acknowledge large differences in dealing with the collection and processing of data amongst universities, systems and countries due to different institutional development strategies, laws and regulations. Rather than presenting a comprehensive overview of these differences and of institutional best practices, in this paper we present a set of findings and recommendations based on (i) the personal and professional expertise of the writers, (ii) best practices at our universities, (iii) analysis of relevant publications and - probably most importantly - (iv) the synthesis of the discussions between the experts in the various task forces of our networks. Thus, this document is neither meant to be descriptive nor prescriptive.

We aim to connect broad (political) trends and developments with operational descriptions of indicators. That is why we have separated the presentation of our findings in chapters two to five and the sets of concrete indicators in the annexes I and II.

Ultimately, this white paper seeks to (i) inspire Institutional Research (IR) professionals at universities (of S&T) when benchmarking, developing and implementing institutional development paths; (ii) inform university leaders about the opportunities for metrics aligned to universities’ (of S&T) desired contribution to society; and (iii) inform interested experts and the general public alike about the lines of thinking and best practice at our Members.

2 SCIENCE METRICS

2.1 FROM FOCUS ON QUANTITY AND COMPETITION

Traditional science metrics, such as bibliometric indicators, have been increasingly applied in the last decades for: (i) measuring the scientific performance of individuals, groups, departments, or institutions; (ii) personnel recruitment; and (iii) allocation of research funding. Some of these indicators have also been used by international university rankings.

The main traditional science metrics - such as number of publications and citations - are focused on research output. Among the most frequently used citation-based indicators are the h-index (Aksnes D. *et al*., 2019) and the Journal Impact Factor (JIF), but the field-normalised citation impact and the number/proportion of highly cited papers are increasingly used in recent years.

Issues may arise with such traditional science metrics with regards to what they measure, how they are applied and to which set they belong to. For example, the h-index does not include corrections for career length, which means that this indicator disfavours younger researchers. Concerning the JIF, one of the criticisms is that it does not accurately capture the citation impact of individual articles (EC, 2017 c). However, while some indicators have obvious flaws, other traditional science metrics (such as ´Top 10% most cited publications’) can be useful in some contexts and with modifications, but should not be used in isolation.

2.2 OVER TRANSITION TO FULL OPEN SCIENCE

According to the Organisation for Economic Cooperation and Development (OECD), ´open science´ refers to efforts by researchers, governments, research funding agencies or the scientific community itself to make the primary outputs of publicly funded research results – publications and the research data – publicly accessible in digital format with no or minimal restriction as a means for accelerating research. These efforts are in the interest of enhancing transparency and collaboration, and fostering innovation (OECD; 2015).

The European Commission (EC) considers ´open science´ as scholarly research that is collaborative, transparent and reproducible, and whose outputs are publicly available. The EC identified a set of recommendations to be taken as the next steps towards the long-term vision for open science (EC; 2017a): (i) rewards and incentives; (ii) research indicators and next generation metrics; (iii) the European Open Science Cloud (EOSC); (iv) changing business models for publishing; (v) research integrity; (vi) citizen science; (vii) open education and skills; (viii) Findable, Accessible, Interoperable, and Reusable (FAIR) data.

The EC published a report on ´Evaluation of Research Careers fully Acknowledging Open Science Practices´ (EC; 2017b). It recognises that the emerging open science movement opens an opportunity to develop an adequate and fair evaluation system for hiring and promotion away from the JIF, which it finds to be unsuitable for the assessment of research. It states furthermore: “In general, evaluating a researcher cannot be reduced to a number because their merits and achievements are a complex set of different variables, difficult to be summarised by a single figure. A better approach is through multi-dimensional criteria evaluation, taking into consideration what is expected from a researcher and what is relevant for his/her career/recruitment.”

In spite of all these recommendations and the wide consent of their desirability, academic and research institutions, as well as funding agencies, still heavily rely on traditional, rather simplistic measures such as impact factor or h-index to evaluate candidacies for open positions, promotions or research proposals. This is largely because they are easy to deploy: assessing a candidate's genuine research, education and innovation contributions is complex and requires specialist knowledge, while comparing indicators is straightforward and can easily give the impression of being 'unbiased' or 'objective'.

With a full implementation in mind, we propose a set of indicators for measuring research performance through open science (annexe I). The purpose of this set is to help to: (i) move towards open access publishing of scientific publications; (ii) involve citizens more in science; (iii) promote FAIR data; (iv) store more scientific data on open repositories; (v) strengthen transparency and integrity in research; (vi) inspire policy-makers, research institutions, funding bodies and researchers themselves to use context-appropriate metrics to complement qualitative assessments for monitoring and stimulating development.

2.3 TOWARDS TRUE EXCELLENCE AND EXTENDED COOPERATION

More than 350 researchers, policy-makers and representatives from industry and Research Funding Organisations (RFO) agreed on a Declaration (Council of EU, 2009) stating that European research policy should focus on global 'grand challenges' such as climate change, water shortage and pandemics. In 2015, the European Union (EU) adopted a revisited Lund Declaration (Council of EU, 2015) recognising that Europe must speed up finding solutions to tackle the grand challenges through research, alignment and impact. Importantly, the Declaration on Science for Global Sustainable Development (World Science Forum, 2013) outlined (i) international scientific cooperation and coordinated national actions for global sustainable development; (ii) education to reduce inequalities and promote global and sustainable science and innovation; (iii) responsible and ethical conduct of research and innovation; (iv) improved dialogue with governments, society, industry and media on sustainability issues; (v) sustainable mechanisms for funding science.

Moreover, we sense an increasing trend within university development towards establishing a culture of quality, risk-taking and trust. Although this applies equally to innovation, education and training, within research-based universities of S&T these developments are primarily driven by the motivation to increase scientific excellence. It is clear that in this context the focus is on cooperation to tackle the above-mentioned global challenges pointing into the direction of research as a global public good (see also annexe II).

3 EDUCATION METRICS

3.1 FROM MASSIFICATION AND COMMODIFICATION

Traditional education metrics address university characteristics that have not been defined to necessarily help these universities assess the progress towards their goals in society. Following the NPM perspective, such indicators are rather meant to facilitate comparison and increase competition at all levels, from individual teachers to universities or even whole education systems. Examples are simple numbers and ratios, such as the number of students enrolled, the number of graduates, or the ratio of number of bachelor degrees to doctorates awarded. These traditional metrics were used to measure the massification of higher education in a context dominated by NPM, leading to market-style performance measurement, with monitoring ostensibly focused on ‘efficiency’ narrowly defined in economic terms, and goals defined in terms of competition and isolation rather than collaboration and connectedness.

3.2 OVER FOCUS ON EMPLOYABILITY AND ENTREPRENEURSHIP

Inamorato dos Santos *et al* (2016) define ´open education´ as "a way of carrying out education, often using digital technologies. Its aim is to widen access and participation to everyone by removing barriers and making learning accessible, abundant, and customisable for all. It offers multiple ways of teaching and learning, building and sharing knowledge. It also provides a variety of access routes to formal and non-formal education and connects the two."

It is about educating for the future and investing in people who will make the change (Lamy, 2017). Open education is to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all. The UN have set clear goals to be achieved by 2030 (UN, 2015):

- ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university;
- substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship;
- eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations.

Universities are thereby implicated in seven ecosystems, i.e. knowledge, culture, learning, human subjectivity, social institutions, natural environment, economy (Barnett, 2018). People are expected to learn continuously, to engage in the public cause and to be open, critical and creative. Embracing the use of digital technologies (EC; 2017c) and teaching digital skills (Carretero Gomez *et al*, 2016 and 2017) ranging from information and data literacy, communication and collaboration, digital content creation and safety to problem solving is vital.

In this context we propose a set of indicators that provide essential information on the readiness of higher education to provide their graduates with the skills needed in the 21st century. The next generation indicators (see annexe I) are partially existing and partially new, but for us all seem relevant for future higher education.

3.3 TOWARDS ACCESSIBILITY, CREATIVITY AND PUBLIC ENGAGEMENT

The turn towards next generation metrics already indicates that broader issues are at stake than can be grasped by traditional metrics. The role of higher education should not be confined to a purely economic role (e.g. generating income, increasing GDP, supplying students to industry), as this would deny the full potential of the contribution higher education can make within society. Higher education is closely connected to the different ecosystems of society and increasingly perceived as a global common good. In this sense, there also is growing attention to the training provided by universities in the context of lifelong learning.

Hence, we advise a university to measure where it stands on the indicators in annexe I. They could be included in international databases such as Eurostat, the European Tertiary Education Register (ETER), or U-Multirank, which would provide interinstitutional comparability and could function as a starting point for benchmarking with comparable universities, for identifying institutional learning opportunities, and for increasing the relevance of (public) policy-making.

The ideas for progressive indicators (see annexe II) move the focus onwards to inclusiveness, student dispositions, public engagement and sustainability. Each university should decide on its position towards each of its ecosystems, starting from its mission and vision.

4 INNOVATION METRICS

4.1 FROM LIMITED SHORT-TERM UTILITY AND SERVING VESTED INTERESTS

Traditional indicators relating to innovation usually use metrics that are easy to provide, often collected from different forms of public databases or internal systems, and measure innovation from a commercial result and non-open point of view. Metrics for revenues are typical examples.

4.2 OVER TRANSITION TO OPEN INNOVATION

Open innovation (open-by-default, only closed when needed) promotes a mind-set toward innovation that runs counter to the privacy (closed-by-default) of traditional corporate research labs. In open innovation, openly sharing innovations and ideas in a collaborative way is seen as stimulating new inventions. Innovations are increasingly produced by outsiders and founders in start-ups, working to a greater or lesser degree in collaboration with existing organisations. The central idea behind open innovation is that, in a world of widely distributed and interconnected knowledge, companies cannot afford to rely entirely on their own (closed) research. Instead, they are advised to openly engage and seek collaboration with any knowledge providers. This includes buying and licensing processes and inventions (i.e. patents) from other organisations. In addition, internal inventions that are not being used in a firm's business can be taken outside the company e.g. through licensing, joint ventures or spin-offs.

In open innovation, universities can either receive ideas from companies, the public sector or seek to create and disseminate ideas and inventions that can be commercialised or used by external parties. In order to create a good environment for open innovation, entrepreneurial universities seek to stimulate and create close interaction and exchange with industry, the public sector and other research institutes and universities. Universities exchange staff and doctoral students with industry or research institutes, generate research centres, disseminate new findings in articles and co-publish with industry, give continuing education for third parties, transfer licenses, patents, create incubators, start-up companies etc. In short, universities (of S&T) have diverse roles in their innovation ecosystems. The set of indicators relating to the universities involvement in open innovation should represent this range of activities and the flow of ideas from and to a university (Bloch *et al*; 2012) and we have included them in annexe I.

4.3 TOWARDS KNOWLEDGE TO CONTRIBUTE TO TACKLING GLOBAL CHALLENGES

University-industry collaboration is often a stimulus for innovation, bringing the research conducted in universities to match industry needs. It is not just industry who may have expectations for research and innovation from universities, but they may also be utilised by public and third sector organisations. Such activity is usually referred to as ´knowledge exchange´ as the benefits, research and innovation, are a two-way dialogue with external partners.

Measuring innovation and knowledge exchange is acknowledged as a difficult process (Dziallas and Blind, 2019), especially in an international context. Each country will have its own mechanisms and reporting requirements, and it is a challenge to compare information across different boundaries, both geographical and institutional.

At the heart of measuring innovation through metrics from the university perspective is the desire to see how it translates into society, and how it can be of benefit locally, nationally and globally.

Within universities, there is a significant amount of research and innovation taking place which can help to address societal challenges. Working with all sorts of non-academic partners will allow the knowledge to be exchanged and developed. The co-creation of solutions to societal and industrial needs ensures that all partners benefit from the results of research and innovation from universities.

It is important that comparable metrics continue to be captured so that universities' innovation can be monitored, resourced effectively and - more importantly - recognised internationally. However, it is also important that we look at new ways of recognising the contribution metrics can make to providing data and the way forward for research, education and innovation through progressive metrics (see annexe II).

5 FROM NEXT GENERATION TO PROGRESSIVE METRICS

The confrontation of traditional metrics (which are known and easy to deliver) with next generation metrics (which are known, but more difficult to deliver) to grasp their openness in the previous chapters was a feasible undertaking for our experts and institutions.

The current (political) debate about openness is important and relevant to our Members, but in the previous chapters it has become clear that there are more fundamental challenges that will require progressive metrics in order to enable our Members to address them. Such progressive metrics are intended to measure progress in areas where there is a need for development, but where neither traditional metrics nor next generation metrics capture the essence of it.

In this chapter, we elaborate on the greater and cross cutting topics emerging from the previous chapters: 1) acknowledge knowledge as common good, 2) promote a culture of quality, risk-taking and trust and 3) measure the contribution to sustainability. In the light of these emerging topics for the 21st century, a change in mindset is needed to address the drive to define progressive metrics. Thus, in annexe II, we present (i) examples of more established ´progressive metrics´ and (ii) ideas for advanced ´progressive metrics´ up for further development. We conclude this paper with 4) recommendations when using various sets of metrics.

5.1 ACKNOWLEDGE KNOWLEDGE AS A GLOBAL PUBLIC GOOD

The emergence of a `Europe of knowledge´ acknowledged that "… real wealth creation will henceforth be linked to the production and dissemination of knowledge and will depend first and foremost on our efforts in the field of research, education and training and on our capacity to promote innovation" (EC; 1997). The measurement of the progress of this crucial agenda "to become the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion" (European Council; 2000) took place in the context of the European Semester for a period, but was not progressed under Commission Juncker.

Interestingly, the current political concept of ´openness´ replacing the Europe of knowledge does not seem to cover fully the removal of imbalances in access to knowledge and the obstacles confronting it. The United Nations Educational, Scientific and Cultural Organization (UNESCO) in its World Report Towards Knowledge Societies (UNESCO, 2005) addressed disparities evolving from a ´knowledge-based economy´ approach, and directed the debate to knowledge sharing by asking: "What kind of knowledge are we talking about? Do we have to endorse the hegemony of the techno-scientific model in defining legitimate and productive knowledge? And what of the imbalances that mark access to knowledge and the obstacles confronting it, both locally and globally? […] To remain human and liveable, knowledge societies will have to be societies of shared knowledge. The plural here sanctions the need for an accepted diversity."

The Declaration on a New Era of Global Science (UNESCO & ICSU, 2011) called upon the scientific superpowers to overcome knowledge-divides. They aim to measure and change the behaviour of researchers and institutions rather than expressing the various roles, rights and responsibilities of knowledge as a non-excludable and non-rival good (Stiglitz; 1999). Any of the current approaches fail in acknowledging knowledge as a global public good as we lack the international efforts, adequate intellectual property rights provisions and metrics.

5.2 PROMOTE CULTURE OF QUALITY, RISK-TAKING AND TRUST

The San Francisco Declaration on Research Assessment (DORA) in 2012 was a breakthrough in the research evaluation discourse: it initiated a series of statements and reports. DORA claims that there is an urgent need to improve how scientific output and performance is evaluated. One of the main points is that the content of a research paper should matter more than the impact factor of the journal in which it appears. After DORA, for example the National Science Foundation decided to change the terminology of ´publications´ to ´products´ in their instructions to enable applicants to acknowledge research output other than solely publications. DORA maintains a helpful list of good practices of institutions who have implemented it.

In 2015, the Leiden Manifesto for research metrics stated (Hicks *et al*; 2015): “Research evaluation has become routine and often relies on metrics. But it is increasingly driven by data and not by expert judgement. As a result, the procedures that were designed to increase the quality of research are now threatening to damage the scientific system.” In contrast to DORA, the Leiden Manifesto is more elaborate and includes ten principles for the responsible use of bibliometrics that can be applied across all disciplines and settings.

In the UK’s review of the role of metrics, the findings of Wilsdon *et al* (2015) point in the same direction: “Inappropriate indicators create perverse incentives. (…) The worst example of this is the widespread use of impact factors, where journal level metrics are ascribed to its non-homogenous articles as a proxy for quality.”

In response, a responsible metric agenda was defined addressing (Wilsdon *et al*; 2015) (i) robustness, i.e. base metrics on the best possible data in terms of accuracy and scope, (ii) humility, i.e. recognise that quantitative evaluation should support, but not supplant, qualitative, expert assessment, (iii) transparency, i.e. keep data collection and analytical processes open and transparent, so that the evaluated can test and verify the results, (iv) diversity, i.e. account for variation by field and use a range of indicators to reflect and support a plurality of research and researcher career paths, (v) reflexivity, i.e. recognise and anticipate the systemic and potential effects of indicators and update them.

The academic community is now at the point where it agrees that using quantitative metrics as the sole indicators is not the way to proceed, but these insights and convictions have not yet found broad application. Instead, researchers and universities are faced with an ever-increasing use of quantitative metrics such as in the fast-growing rankings market. Against this background, universities may ask themselves whether traditional metrics are meaningful for achieving their goals. The crucial question is not only how to define and evaluate (research) quality, but also how to boost it.

In addition, and in line with the responsible metrics agenda which we acknowledge as the right way to proceed, we suggest a responsible metrics approach, which fits the mission and values of the individual institution. They should not replace existing quantitative approaches, but enrich them by making research quality visible, focusing on scientific excellence and going beyond the ´traditional´ and ´next generation´ metrics. See annexe II for inspiration on how such metrics can be designed and how they can contribute to establishing a culture of quality.

A culture of quality cannot be imposed upon an organisation. However, applying such metrics can stimulate participation and open dialogue and help an organisation shape its values, beliefs and self-conception regarding quality and, most importantly, open up space for not only new perspectives, but excellent research that might otherwise stay invisible. In this approach, it is crucial that opening the floor to a discussion of quality beyond standardised and often ill-fitting quantitative metrics applied without any context, at the same time means moving from a rather passive form of being assessed by a one-directional, tight set of predetermined metrics to a self-determined, transparent form of assessment with built-in reflection. A commitment to a culture of quality, risk-taking and trust can be, and should be, promoted.

In the sense of an open sharing of knowledge (and its products), reflections on quality have an impact in both directions: internal into their own organisation, but also external towards the discourse in the academic community, linked to open science, education and innovation. In fact, the empowerment of researchers and higher education institutions regarding the judgement of the quality their work is not possible without high engagement from the whole community, and thus the practice of peer review. Equally, peer review is going through a process of modernisation through the influence of social media and forms of modern web-based communication. Peer review is not only a necessity for a thorough application of this type of qualitative metrics, but also the engagement of researchers and other relevant players (such as student representatives helping to review educational strategies, or industry partners helping to review innovation strategies) therein can itself constitute a goal in a broader mission.

In developing a new evaluation system, a predominantly quantitative and output-driven academic evaluation process should make way for a culture of fostering academic freedom, quality, risk-taking and trust - instead of control. The rationale is that highly and intrinsically motivated people do not need to be controlled in order to perform well. In a culture of quality, researchers are also evaluated as part of a team, taking into account the missions and objectives of their broader research group and their institution. Risk-taking can be promoted through the stimulation and rewarding of creativity, the provision of a sustainable long-term perspective and allowing people to fail. Trust refers to the engagement of the assessed in the assessment.

As ground-breaking research, education and innovation and their impact result from creativity and out-of-the box thinking, evaluation and assessment systems should allow flexibility to respond to opportunities that can positively influence the quality of research and careers, and avoid sets of strict *a priori* defined indicators. Creating a culture of quality, risk-taking and trust will lead to a positive and stimulating research environment that will also benefit the university and society at large in the long run. Such new systems can only be developed if universities closely work together with other players such as policy-makers, funders, rankers and stakeholder organisations.

5.3 MEASURE CONTRIBUTION TO SUSTAINABILITY

For about forty years, educational institutions and the scientific community have been expected to play indispensable roles in the creation of public awareness and political change about the global challenges of our times and contribute to sustainable development (UN, 1987). Therefore, the UN outlined a new ‘social contract’ for science for the 21st century in Budapest in 1999 departing from an analysis of the state and direction of sciences, their social impact in the past and society’s expectations of them. The Declaration on Science and the Use of Scientific Knowledge (UNESCO & ICSU, 1999) underlined the political commitment to solving problems and the Science Agenda - Framework for Action (UNESCO & ICSU, 1999) provided a framework for fostering partnerships and the use of scientific results for development and for the environment.

The Resolution on the 2030 Agenda for Sustainable Development adopted by the UN General Assembly on 25th September 2015 (United Nations, 2015) provides the single most important global narrative and guiding agenda for the coming decades, and the metrics to assess the progress in achieving them are widespread and becoming well established. The seventeen Sustainable Development Goals (SDG) and corresponding 169 concrete targets are universally applicable and aim “to end all forms of poverty, fight inequalities and tackle climate change, while ensuring that no one is left behind”. Science, education and innovation in general, and universities in particular as primary generators of knowledge, are expected to adhere to the UN SDG and to contribute to achieving the targets. Universities thereby do their utmost to support developing countries in the application of S&T knowledge in a manner that is most appropriate for their societies and cultures. Moreover, they have a catalytic role in raising the awareness of and the response of governments and other stakeholders to sustainability issues and in creating public support for it.

By 2020, science, education and training, and innovation are expected to contribute to tackling global challenges such as the global spread of viruses leading to pandemics (such as Covid-19); cultural, economic and social recovery; social exclusion; increasing economic inequality; climate change; plastic pollution; biodiversity loss; and the consequences of ultra-processed food, like obesity and coronary diseases.

The most prominent examples of measuring the contribution of universities to ecological, economic and social sustainability are: (i) the University of Indonesia’s (UI) Green Metric ranking since 2010, and (ii) the Time Higher Education (THE) University Impact Rankings, which is based on the UN SDG and now in its second year. However, key issues for clarification concern the integration into the mission of universities, the role of leadership in overcoming internal resistance and promoting change, effectiveness of ethics and values and multi-stakeholder collaboration.

5.4 Recommended use of several sets of metrics

We recommend taking the following into account when working with ´traditional metrics´, ´next generation metrics´(such as the indicators proposed in annexe I) and the (ideas of) ´progressive metrics´ (such as proposed in annexe II):

1. Be careful when changing one metric system for another - consider using traditional and next generation metrics in combination.
2. Consult and reach mutual agreement with students and staff, allowing for differentiation according to specific cultures in diverse scientific fields.
3. When metrics are applied in HR policies and instruments - such as recruitment, career development and performance assessment - caution must be taken. It is recommended to apply a polychrome approach and to use indicators to complement qualitative expert assessment.
4. Consider integrating principles of open science broadly within other initiatives such as the human resources strategy for researchers.
5. There are serious limitations to the positive effects of quantifying and measuring. Thus, do not measure too much (be selective in what you measure) and be careful about which measures you will use actively on an ongoing basis, as compared to a one-off or periodic check.
6. Another issue is the availability of data. Especially regarding background characteristics of students and staff. The degree to which higher education institutions in different countries are able to, or allowed to, gather and register such data must be respected. Working with a composite metric in such cases might help to reduce problems with privacy and confidentiality regulations (McLaughlin, J.; 2016).
7. Metrics used by universities are advised to be useful to employers and society.

ANNEXE I - NEXT GENERATION INDICATORS

The focus is on internal comparison over time, which means that for some of the more progressive metrics, each university can develop suitable ways to measure it internally. If, at a later stage, it becomes desirable to make the metrics fully comparable between universities some measuring details need to be aligned. The metrics are made as SMART as possible and when possible, open metrics have been chosen. Open is, in this context, defined as both available and free of charge. The aim has been to focus on one set of metrics, not on two (or more) versions of the metrics. Size-independent metrics are preferred (e.g. percentage), but for some metrics it was found that absolute numbers better serve the purpose of showing progress for internal comparison over time.

#	NAME	DESCRIPTION/DEFINITION	SOURCE	CATEGORY	RATIONALE / DISCUSSION
			(OPEN) SCIENCE		
1	Open access publications	Share of publications published open access	SCOPUS, Web of Science, CWTS Leiden Ranking (WoS based), Unsub (formerly Unpaywall)	Output	This indicator is to check the state of institutions on their way towards 100% open access (= available and free). The indicator is needed in a 5-10 year perspective, after that we are hopefully close to 100%.
2	Top 10% most cited publications	Share of the publications that, compared to all other publications in the same field and in the same year, belong to the top 10% most cited publications, excluding author self-citations. Recommended to use bibliometric data from a professional supplier or ranker.	CWTS Leiden Ranking (WoS based) or UMR “Top Cited Publications” (WoS based) or SciVal (Scopus based)	Output; Impact	This is a good indicator for measuring impact and ´quality´ of an entity. It can also be used for specific research fields/subjects.
3	Citation impact	Average number of citations of the publications, normalised for field and publication year. Excluding author self-citations. Recommended to use bibliometric data from a professional supplier or ranker.	CWTS Leiden Ranking “MNCS” (WoS based) or UMR “Citation Rate” (WoS based) or SciVal “FWCI” (Scopus based)	Impact	Together with indicator 2, this metric helps indicate the strength or weakness in the publication pattern of an entity. Can also be used for specific research fields/subjects.
4	Interdisciplinary publications	Share of publications within the field’s top 10% of publications with the highest interdisciplinarity scores. Recommended to use bibliometric data from a professional supplier or ranker.	UMR (WoS based)	Output	Interdisciplinary research is needed to tackle big societal challenges. It is desirable that this kind of research is as open as possible. It is important to have in mind that disciplinary research is also needed.
5	Publications with non-academic sector	Share of publications that have at least one co-author from the non-academic sector. This sector includes e.g. private hospitals and clinics, governmental and	Scopus, Web of Science, University repositories	Process; Output; Impact	To collaborate and publish research done outside the academic sector indicates engagement in society. Indicator 7 in open innovation constitutes part of this metric, but this

#	NAME	DESCRIPTION/DEFINITION	SOURCE	CATEGORY	RATIONALE / DISCUSSION
		societal organisations, non-profit research institutes, other non-profit organisations like NGO´s, but also industry and for-profit organisations. This has to be a university-based calculation, since no-one seems to provide these data at present.			metric has a much wider definition. We should not strive for 100% collaboration with non-academic partners. Publications with academic partners alone are also needed.
6	International PhD students and postdocs	Share of the PhD students and postdocs which are of foreign nationality.	University	Input; Process	International influence enhances the openness of the university as a whole and stimulates collaboration.
7	Repository traffic	Number of searches in the institutional repository	University	Process; Impact	To spread information about publications, as well as full texts as wide as possible.
8	Open and FAIR data sets	Share of the publications that have a research data set, for which the data set is ´open and FAIR	University	Process; Output; Impact	To make data used and reused, thus improving possibilities to reproduce results, but also to build on old data. 100% FAIR data is desired, but not 100% open – some data should perhaps be sold. The indicator is needed in a 5-10 year perspective, after that we are hopefully close to 100%.
9	Citizen science projects	Number of citizens involved in citizen science projects	University	Input; process; Impact	To make engagement by citizens in science visible and thereby making science more accessible
10	Open science training	Number of open science courses or workshops or events run.	University	Process	To make training in open science available to employees and thereby making openness more attractive. The indicator will probably become obsolete over time since we believe that this will become common practice. Therefore, it will only be needed for starting staff.
			(OPEN) EDUCATION		
1	Graduation rate	Bachelor-level and master-level graduates as percentage of enrolment	University	Process; Output	Focus on the share of students who graduate is important.
2	Employment rate of graduates	Employment rate of bachelor-level and master-level graduates, a certain period after graduation (one year/18 months)	University	Output; Impact	Focus on students getting an (appropriate) job.
3	Alternative student recruitment	Percentage of students entering higher education through an alternative route, such as vocational education and training, work experience, accreditation of prior learning, aptitude and entrance examination, post-secondary non-tertiary education	University	Input; Process; Impact	To visualise the differentiation in the student body and to a certain degree special student educational track. Should be above a certain threshold.
4	International experience	Share of bachelor and master graduates with international experience during their studies. This means spending at least three months at a foreign university or at a foreign company.	University	Process; output; Impact	International experience is increasingly important to broaden students' perspectives.

#	NAME	DESCRIPTION/DEFINITION	SOURCE	CATEGORY	RATIONALE / DISCUSSION
5	Internship experience	Share of bachelor and master graduates that have completed an internship in a non-academic organisation, national or international. This means having worked in a non-academic organisation for at least three months during your studies, before graduation.	University	Output	Real life work experiences are important, as it enriches the academic experiences.
6	Digital skills	Share of bachelor and master graduates having completed training in digital skills. This means having acquired advanced, and highly specialised digital skills in courses, intertwined in courses or as a combination, equivalent to at least 30 ECTS in total.	University	Process; Output	Digital skills are increasingly important in preparing students for work-life as it is getting more and more technology driven. The indicator should not be needed in a 5-10 year perspective.
7	Core professional skills	Share of bachelor and master graduates with 'core professional skills'. This means having acquired a number of transferable skills, e.g., leadership, ethics, philosophy, communication and innovation, in courses, intertwined in courses or as a combination, equivalent to at least 30 ECTS in total	University	Process; Output	Core professional skills are increasingly important in preparing students for work-life, to be able to work well in different and changing environments.
8	Open educational resources	Number of open educational resources, i.e. free and available material (e.g. e-learning material, e-books, videos, animations) that is created and offered by the university to other universities.	University	Process; Output; Impact	To share our inventions in the educational area with others is most reasonable, because most universities are basically funded by governments.
9	Open on-line courses	Number of free and available on-line courses, e.g. MOOCs (Massive On-line Open Courses) and micro degree courses.	University	Process; Output; Impact	To share our knowledge is a portal into academia. At the same time, it is a service to the public.
10	Life-long learning	Share of educational income from continuing professional education.	University	Output; Impact	Life-long learning and continuing professional development are keys to a sustainable work-life, but also a tool for universities to additional income.
		(OPEN) INNOVATION			
1	Granted patents	Number of patents granted based on work from the university.	University	Output; Impact	Patents are important to protect research ideas for a limited time, to make it possible to explore the idea further and/or to exploit it.
2	Incubator supported projects	Number of projects that are assisted by incubator facilities linked to the university, i.e. helping the initiators realise their ideas by advice, funding, networking or legal support.	University	Process; Impact	Incubator facilities are important parts of the entrepreneurial ecosystem. It also opens up the possibilities for turning ideas into profitable ventures.
3	Surviving spin-off companies	Number of spin-off companies, existing for at least three years, stemming from the university, i.e.	University	Output; Impact	Spin-off companies illustrate the innovative willingness, strength and ability of the university

#	NAME	DESCRIPTION/DEFINITION	SOURCE	CATEGORY	RATIONALE / DISCUSSION
		companies started either by students or employees (or ex.) with or without IP, or started by others based on university IP.			
4	Licences	Number of licences, based on work from the university, sold by the university.	University	Output; Impact	Licenses can be important parts of the process to commercialise research ideas. It is a real test of the practical applicability of research.
5	Open source software	Share of software (either in size or in number of packages etc.), created by the university, that is free to use and/or modify.	University	Output; Impact	Open Source Software is a way to share knowledge with the community and also to make an impact for the university. We should not strive for 100%, some software might be better to commercialise.
6	Industrial collaboration	Share of research income funding industrial collaboration, i.e. coming from industry or intended for industry collaboration.	University	Input; Process; Output; Impact	Industrial collaboration shows that our research is creating value that is worth financing by different kinds of funding bodies. We should not strive for 100%, as independence is important.
7	Industrial co-publication	Share of publications co-written with at least one author coming from industry. Recommended, but not necessary, to use bibliometric data from a professional supplier or ranker.	Scopus, WoS, University repositories, CWTS Leiden Ranking (WoS based) or UMR (WoS based) or SciVal (Scopus based)	Process; Output; Impact	Co-publishing with industry reflects close co-operation between universities and industry. We should not strive for 100%, as e.g. fundamental research is important too.
8	Publications cited in patents	Share of all publications at the university that are cited in at least one international patent. Recommended to use bibliometric data from a professional supplier or ranker.	UMR "Publications cited in Patents" (WoS based)	Output; Impact	Citation of publications in patents indicates that research plays an important role for patents.
9	Industry-employed PhD students	Share of doctoral students that are industry-employed.	University	Process; Impact	This reflects the attractiveness, to government, industry and university, of having industry-employed PhD students.
10	Entrepreneurial skills	Share of bachelor and master graduates with entrepreneurial skills, i.e. having acquired entrepreneurial abilities through taking courses, participating in projects or equivalent, i.e. through a combination of education and research, equivalent to at least 30 ECTS in total.	University	Process; Output; Impact	To shape a creative and entrepreneurial mindset for students, is a base for future innovation.

ANNEXE II - TOWARDS PROGRESSIVE INDICATORS

In the light of the global challenges, higher education institutions are repositioning themselves and the perception of performance metrics might be quite different in the future. In this annexe II, we present (i) examples of already established ´progressive metrics´ and (ii) ideas for advanced ´progressive metrics´ up for further development. Progressive metrics (might) enable us to measure progress in areas where there are neither traditional metrics nor next generation metrics to capture their essence. Rather than presenting detailed definitions of such metrics, we outline them.

THEME	TOWARDS INDICATORS	CONSIDERATIONS
KNOWLEDGE AS A GLOBAL PUBLIC GOOD		
Quality of life	Outputs that impact the quality of life (education, health, communication, integration) of disfavoured or sensitive communities (e.g. elderly people) This could include to rebuild the future in connection with ecological, economic and social recovery	Could be both physical and meta-physical output like procedures for inclusiveness.
Service to greater public good and progress	Embedding of greater public goods and progress in the university's mission and operations. • How was, and is, such a service embedded in the mission and operations of the university? • What are the triggers for the university to adapt its service? • How is such a service addressed in the vision and strategic planning?	Universities - and universities of S&T in particular - have served, are serving and will serve (i) greater public goods such as helping to cope with natural disasters (think of pandemics and earthquakes), and contribute to (ii) (societal) progress (think of industrialisation and civil engineering) and to (iii) wellbeing and health of people (values driving innovations and design).
Societal engagement for collective benefit	A university should show concern not only for the economy, but also for culture, knowledge, learning, people, social institutions, and the natural environment. A university should therefore research and evaluate all these domains, find out where failures are apparent, and actively search for solutions and different scenarios in view of collective enrichment (not particular gain). Indicators could chart the university's activity in these domains.	This could be evaluated through ´impact cases´ i.e. short descriptions of how a university has investigated a field, found things, acted and received credit for it.
Open-mindedness	A considerate and ethical, but also critical, attitude towards the world should be the basic stance within the academic community. This requires that academics keep an open, investigative, and evaluative mind, and that they train students in that way too.	This culture could be measured by looking into the ways in which the curriculum allows students to follow their own pathways and challenges and stimulates students to leave their comfort zone, for instance by confronting them with other disciplines, viewpoints, and cultures; by giving them responsibilities (e.g. as a voluntary worker, entrepreneur, or cultural participant); or by treating them as future professionals (that will have to cooperate, challenge each other's ideas, judge complex situations, come up with creative solutions).
International enrolment and diversity in student and staff body	A composite diversity metric based on the number of students with specific background characteristics (international students, gender, non-native speaker, first-generation, migration background, study grant, and disability), by level of education as a percentage of the total student population	Could be a way of ensuring that everybody gets access to university studies.

THEME	TOWARDS INDICATORS	CONSIDERATIONS
CULTURE OF QUALITY, RISK-TAKING AND TRUST		
Assessment of performance in accordance to mission and goals	Using a set of assessment indicators tailored precisely to the mission and goals of an individual, a unit or a university to be evaluated.	Standardised indicators should be avoided.
Assessment of production	Thorough and dialogue-based assessment of an individual, a unit or a university considering their contexts through interviews and peer-review.	Production must always be put in context and this context can't just be made up of different metrics. It must be evaluated through some kind of dialogue.
Contribution to societal challenges	Dialogue-based assessment to shift the focus away from the success of an individual researcher, unit or university to a more holistic view on their contribution to solve societal challenges through interviews and focus groups.	Impact stories might be one way for self-assessment, prior to peer-review.
Assessment along five-star papers approach	Selection of the best papers (or any other output) according to an individual's, unit's or university's own judgement and motivation offered for peer-review	To let the assessed choose and motivate gives a new dimension to an assessment.
Benchmarking	Taking the best practices of a university and using them as a comparison point for the university to be evaluated, to determine its research performance versus its competitors in a qualitative way.	Benchmarking in practice often tends to become quantitative metrics and not qualitative descriptions. Both are needed.
Collaboration tools and approaches	Qualitative assessment of beneficial participation, collaboration and decision-making tools and approaches between various communities.	In this category tools and approaches that help reduce divides are included. Divides are everywhere, in all sectors and activities.
Solid (high-quality) products	Tools and products designed to be especially solid, reliable and without weak spots or bugs.	Link could be made to achievements, relevant awards and other forms of societal recognition.
Risk-taking	There is a need to measure the 'space' (resources, time, freedom) of researchers, department heads, and institutional leaders to pilot new high-risk/high-gain approaches and projects.	It is not only about measuring running long term and high-risk projects, it is also about measuring the possibilities to start such projects.
Trust	The way in which researchers and departments can decide upon themselves which indicators to be assessed and rewarded on.	The way in which an evaluation system does not consist of an *a priori* calculation model, but rather is a personalised evidence-based retrospective where quantitative accountability is purely supportive and subordinate to qualitative, evidence-based accountability. Trust also means allowing for differentiation in core tasks (research, teaching, institutional & societal engagement) according to individual talents of researchers and the strategic goals of the group.
Agility	Ability of the university and its departments and researchers to change direction and to move fast, also in response to external triggers.	It is a definite strength to be able to identify needs and to quickly respond to external triggers (e.g. societal needs) that come up, such as the coronavirus pandemic. Self-declaration underpinned by (external) evidence from e.g. web news and project descriptions might be the way forward to measure such agility.

THEME	TOWARDS INDICATORS	CONSIDERATIONS
	CONTRIBUTION TO SUSTAINABILITY	
Contribution of science	Science contributes directly to the policy planning, monitoring and evaluation of the UN SDG, e.g. geo-observation. Many scientific fields such as the environmental sciences directly contribute to the UN SDG. Other disciplines like mathematics are indirectly crucial in delivering sophisticated algorithms for simulation and modelling. ● Percentage of research output that contributes to sustainability ● Is there specific training for researchers and technical/administrative support staff on sustainable development? How many hours? ● Percentage of academic staff trained in sustainable development ● Is the research mapped against the UN SDG?	Universities - and universities of S&T in particular - have demonstrated enormous transformative forces in the past, think of their roles in helping to exploit the resources of our Earth, deploy military power and rebuild countries after war. Now, the issue is how to measure their capacity to act as agents of great transformation and autonomous players in society. We think that key technologies for the 21st century – such as artificial intelligence, biotechnology and quantum technology – are pivotal. Moreover, linking the Social Sciences and Humanities (SSH) with STEM in terms of Science, Technology, Engineering, Arts and Mathematics (STEAM) education and training and inter-, super- and transdisciplinary research seems essential. There are currently different approaches to ´mapping´ such contributions to sustainability, including input (e.g. number of courses) versus output (applicable knowledge about sustainability), direct (environmental sciences through e.g. geo-observation) and indirect (e.g. algorithms for simulation and modelling). Moreover, there are large differences in the (legal) obligation of individuals, units and universities to report on contributions and on the frequency thereof.
Contribution of education and training	Education delivers experts in addressing sustainability directly (such as environmental scientists), but also contributes indirectly by providing graduates with the transversal skills needed (such as understanding the challenges of our times and being able to communicate them, or applying sustainability in one´s field of expertise e.g. circular economy). ● Ability of graduates to apply sustainability in their field of expertise ● Percentage of teaching and training courses addressing sustainability ● Percentage of teaching and training courses contributing to sustainability education	
Contribution of innovation	Innovation has been identified as the main driver for development (Stiglitz, 1999) and in the context of sustainability the focus is on the transformative power of disruptive innovation, creativity and collaboration between academic and various non-academic partners. ● Percentage of innovation output that contributes to sustainability	
Catalytic role of universities on national and local response in home country	● What significant relationships does the university have with their local/regional governments in shaping their response to the challenges of sustainability? ● What significant relationships does the university have with its central governments in shaping their response? ● How much public support does the university raise within the public for sustainable development?	Universities can play a catalytic role in stimulating the response of other potential contributors to the SDGs in their local and national environments. The intellectual leadership and knowledge of universities, together with the respect with which they are held as objective voices, are crucially important in shaping the broader policy responses.
Cooperation with partners from developing countries	● What direct sustained relationships do universities of S&T have with partners from developing countries? ● Number of co-publications with researchers from developing countries ● Percentage of collaborations with partners from developing countries from total collaborations	Cooperating with any partners from developing countries, universities seek to understand how other nations and their societies wish to integrate the knowledge and innovative ideas of universities of S&T into their own societies, economies and cultures in the most effective manner and with sensitivity.
Cooperation across disciplines	● What collaborative work is effectively linking SSH with STEM within the university or with colleagues from other partners? ● Number of co-publications between researchers from SSH and STEM	Working with colleagues from other faculties (linking SSH with STEM) can make support and intervention to sustainability significantly better directed.

THEME	TOWARDS INDICATORS	CONSIDERATIONS
Sustainable university management and operation	Sustainable university management and operation may refer to reducing the carbon-emissions or even achieving zero-emission organisations. It also touches upon mobility of students and staff, energy balance, human resources management, waste management and green procurement. • Percentage of total university budget associated to initiatives and actions related to sustainability • Carbon-emissions of institution • Ecological footprint of institution • How does the university calculate its carbon footprint? • What is the path to reduce the carbon footprint? • What is the path to have a net-zero footprint?	The International Sustainable Campus Network (ISCN) laid down a Sustainable Campus Charter (ISCN & GULF; 2016a) and corresponding guidelines (ISCN & GULF; 2016b) jointly developed with the World Economic Forum's (WEF) Global University Leaders Forum (GULF). Concerning the gross carbon footprint of universities, the top priority is the minimisation of the gross emissions to enable a net-zero, at worst, impact, as rapidly as possible. The overall issue is how to define the footprint of a university taking into consideration the full supply chains for all that is produced and consumed by all estate, workforce and student population. A net-zero footprint can of course be pursued through meaningful and only short term off-setting measures.
Role of university leadership	Existence/types of incentives for sustainability related activities in research, teaching and innovation. • What is the role of the leadership of a university in promoting a culture of change towards contributing to sustainability? • What are the mechanisms to assess and reward contributions to sustainability?	Leadership is needed to provide for the new narrative to students, learners, researchers, other staff and society, to safeguard commitment at all levels and to promote cultural change within their universities. In essence, it is about promoting universities as autonomous agents of great transformation towards ecological, economic and social sustainability.
Integration of sustainability into university strategy and policies	Existence of sustainability strategic plan, targets and reporting. • Does the university set targets and goals for sustainability actions by means of a plan? Are they tracked and measured? • Does the university report about sustainability actions? • How many UN SDG are addressed?	While several routes may be taken, such as a dedicated and targeted strategy for sustainability, or one whereby sustainability is integrated in the overall strategy and planning of a university, the essence is whether sustainability is at all present in the strategy and planning of a university.
Internal structures dedicated to sustainability	Existence of a board, vice-rector, delegate, or other organisation in charge of coordinating contribution to sustainability. • How is the university organised in order to face sustainability issues? • Is there central coordination concerning contribution to sustainability?	Again, many different designs for such structures exist varying from specialised and dedicated bodies and functions to more integrated approaches whereby existing university bodies and functions have been attributed specific responsibilities and tasks concerning the university´s contribution to sustainability.
Ethical frameworks and values	Existence and application of ethical frameworks and values. • What values does the university and its researchers, teachers and learners adhere to? • What generic (i.e. not specific for discipline) ethical frameworks are established within the university? • What collaborative and team-based approaches for defining and solving important complex societal problems are taken? • How are responsible research, education and innovation taught and how are they applied by the university and its researchers, teachers and learners? • How does the university deal with external pressures and challenges on key values such as democracy, human rights, freedom of speech and so forth? • How does the university and its researchers, teachers and learners defend academic freedom, institutional autonomy and other key values?	The rapid and vast developments in science and technology (think of artificial intelligence, quantum technology and biotechnology) raise ethical issues in many respects (think of privacy, democracy and safety). Addressing ethical frameworks and values allows to design new functionality expanding the set of obligations that can be satisfied. This means that values can and will shape design. Design can then accommodate and solve conflicting values and moral overload. The above mentioned intrinsic internal dimension to responsible research, education and innovation is however also dependent on the broader political and societal context in terms of the academic freedom and institutional autonomy actually granted to universities. It is thus also important to look at the way in which a university deals with external pressures and challenges on key values.

ANNEXE III - LIST OF ABBREVIATIONS

ABBREVIATION	MEANING
AUTM	Association of University Technology Managers
DORA	Declaration on Research Assessment
EC	European Commission
EOSC	European Open Science Cloud
ETER	European Tertiary Education Register
FAIR	Findable, Accessible, Interoperable, and Reusable
ISCN	International Sustainable Campus Network
IR	Institutional Research
JIF	Journal Impact Factor
NPM	New Public Management
OECD	Organisation for Economic Cooperation and Development
PIAAC	Programme for the International Assessment of Adult Competencies
RFO	Research Funding Organisations
S&T	Science and Technology
SSH	Social Science and Humanities
STEAM	Science, Technology, Engineering, Arts and Mathematics
STEM	Science, Technology, Engineering and Mathematics
THE	Times Higher Education
UI	University of Indonesia
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
UN SDG	United Nations Sustainable Development Goals

ANNEXE IV - LITERATURE LIST

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