

Quality Criteria in the Technological Sciences

Recommendations for Assessing
Research Success

acatech (Ed.)



There is a consensus in academia that every field and discipline needs its own quality criteria for evaluating its work. These quality criteria should be established by the corresponding scientific community and must set out the standards required to deliver world-class research. Inappropriate criteria that are not specifically geared towards the discipline in question have a detrimental impact on research quality.

Appropriate quality criteria have yet to be formulated for the technological sciences. Although a German Council of Science and Humanities working group produced a valuable set of recommendations, these were confined to the disciplines of electrical engineering and IT. In keeping with its mission to act as the “voice of the technological sciences”, acatech has now developed the first ever set of quality criteria for the technological sciences as a whole.

The criteria are the result of a broad consultation process. Nevertheless, it should be stressed that quality criteria will never simply be the product of research findings alone – they reflect certain preferences that are themselves an expression of particular value systems. Furthermore, quality criteria will vary over time and across different cultures. Accordingly, they must be continuously discussed, reviewed and informed by research practice.

This acatech POSITION PAPER is first and foremost directed at the technological sciences themselves. It provides universities and other research institutions, research policymakers and research funding agencies with a set of criteria designed to maintain and improve quality in the technological sciences. Technological scientists are encouraged to apply these criteria whilst at the same time rejecting and opposing criteria that are inappropriate.

Scope of the quality criteria

The quality criteria recommended below apply to the technological sciences as a whole. Individual sub-disciplines may wish to

add specific criteria or weight the criteria. The selection and weighting of criteria will also depend on the specific context and goals. While the quality criteria are aimed at universities, they are also valid for non-university research and – with the appropriate modifications – for technical colleges engaged in research. They primarily relate to research, including the

At a glance

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They are directed at universities and other research institutions, research policymakers and research funding agencies.

The key criteria are as follows:

- Publications are only of limited value for quantitative performance evaluation in the technological sciences.
- No distinction should be drawn between public and private funding when it comes to successfully secured third-party funding.
- Doctorates – often in collaboration with industry – account for a significant proportion of research. A high number of doctorates and postdoctoral qualifications should be evaluated positively.
- Licences are an indication that innovations have been successfully marketed and should therefore receive a higher weighting than patents.
- Participation in large, established research partnerships should be promoted.
- Innovation prizes indicate that the research in question has practical relevance.



development of young researchers and technology transfer. They are unweighted and free to use.

It is not the intention of this acatech POSITION PAPER to prescribe which criteria are best suited to maintaining and improving the quality of the technological sciences in each specific case. Researchers and research institutions must set their own priorities for the individual quality criteria.

Recommended quality criteria for the technological sciences

(1) Publications

Publications are only of limited value for quantitative performance evaluation in the technological sciences. The h-index and impact factor may perhaps have some importance for certain individual sub-disciplines. However, they should not be the deciding factor in the appointment of professors with industry experience to their first university post, since most of these individuals will have had limited opportunities to publish while they were working in industry.

In the technological sciences, it is important to consider the value and impact of publications not only as far as academia is concerned, but also for the national innovation system. Reference works, textbooks, monographs and significant contributions to conference reports or to standardisation work and regulation drafting should all be taken into account, rather than concentrating solely on articles for scientific journals. Until this happens, the assessment of publications should be carried out by experts on a qualitative basis.

English is the lingua franca of global research. Nevertheless, publications in other languages aimed at national innovation system actors also play a prominent role in the technological sciences. It is important not to lose sight of this fact.

The overriding importance attached to articles in English-language journals as a performance criterion results in research findings being split up and published in several parts. This is at odds with the quality requirements for the technological sciences.

(2) Third-party funding measured in terms of the number of posts funded

The ability to successfully secure third-party funding indicates that the applicant is able to deliver the desired project goals, whether these involve expanding our theoretical knowledge or

developing know-how with practical applications. Consequently, especially in the technological sciences, no distinction should be drawn between public and private funding (e.g. from the German Research Foundation or industry), provided that partnerships with industry serve to generate or apply new knowledge. The material resources required to carry out a project vary from one discipline to another. To prevent any resulting bias, material resources should be excluded and only human resources should be taken into account when using these criteria.

(3) Number of doctorates and postdoctoral qualifications

Doctorates account for a significant proportion of the research carried out in the technological sciences. They often involve collaboration with industry and thus also equip people for the labour market. The postdoctoral "Habilitation" qualification helps to develop young academics. In principle, a high number of doctorates and postdoctoral qualifications should therefore be evaluated positively. However, it is important to ensure high supervision standards.

(4) Leadership of and involvement in research partnerships

Modern research questions call for collaboration between scientists from different disciplines. Since this is a time-consuming process, participation in large, established research partnerships should also be promoted.

(5) Patents and licences

Patents are a measure of innovation and the fundamental desire to translate innovations into practical solutions. Licences, on the other hand, document the cases where these solutions are successfully delivered. Accordingly, licences are a more important quality criterion than patents in the technological sciences.

(6) Spin-offs

Spin-offs are indicative of an effort to translate research findings into practical solutions. To quantify spin-offs, it would be necessary to employ parameters such as number of employees or turnover.

(7) Organisation of prominent scientific events

The organisation or contracting of scientific events (e.g. conferences or summer schools) is an indication of the status and recognition that researchers and research institutions enjoy within the scientific community.

(8) International research exchanges

Research quality is also reflected in international recognition. This should be evaluated using parameters such as the number



of long-term visiting researchers in both directions (i.e. visiting German technological scientists abroad and visiting foreign scientists at German institutes).

(9) Posts/appointments in scientific organisations and research funding bodies

Posts and appointments reflect the status of researchers within the scientific community. These roles include e.g. the editorship of scientific journals and positions in scientific societies, science

and engineering associations, standards bodies, science self-regulation bodies or funding bodies.

(10) Science and innovation prizes and awards

Prestigious prizes and awards show that researchers are held in high esteem by the scientific community. Innovation prizes in the technological sciences also indicate that the research has practical relevance.

Methodological approach

The quality criteria set out in this acatech POSITION PAPER are the result of a broad consultation process within the technological sciences. As well as representatives of the key technological science fields, the project group also included social scientists and humanities scholars engaged in research into the technological sciences. The interim findings were discussed by a wide group of experts and stakeholders from academia and industry.

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