Technology, Policy and Management
Delft University of Technology

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Project code P2127

Contents

Summary

Standard 1. Intended learning outcomes

The bachelor's programme Technische Bestuurskunde (TB) and the master's programmes Complex Systems Engineering and Management (CoSEM), Engineering and Policy Analysis (EPA) and Management of Technology (MOT) are strongly interdisciplinary, and contain transdisciplinary aspects. The programmes are at the intersection of technology, policy and management. They are well-aligned with current major societal challenges. The knowledge and skills taught in the programmes are valuable for companies, governments and other organization working on solutions, policies, products and services related to these challenges. The programmes are embedded in the strong external network of the Faculty of Technology, Policy and Management (TPM). The panel advises to formalize these connections for the continuous development of the programmes, for instance by creating an advisory board consisting of stakeholders and alumni. The intended learning outcomes of the programmes are fitting for academic bachelor's and master's programmes. To further define the positioning of the programmes on the boundary of engineering and social sciences, the panel recommends elaborating the level and skills expected of students in applying social science research methodologies in each programme.

Standard 2. Teaching-learning environment

All four programmes have adequately translated their intended learning outcomes into a coherent curriculum. The BSc TB offers an integrative curriculum that combines knowledge and skills from multiple disciplines in interdisciplinary courses, and teaches students to study complex sociotechnical systems using a combination of approaches. The MSc CoSEM combines engineering thinking with the domains policy, economics and law in an interdisciplinary approach, allowing students to learn methods and tools for designing solutions to real-world complex systems. The MSc EPA curriculum combines modelling and simulation courses with public policy courses, teaching students to integrate these two lines in studying societal challenges. The MSc MOT builds on the technological background of students with insights from business, economics and finance, and teaches them to study and understand technological innovation processes within their field.

The teaching methods in the four programmes are appropriate. All programmes combine lectures, self-study and practical exercises with group work, allowing students apply the knowledge and develop their skills in real-world challenges. The panel recommends a more deliberate mixing of project groups regarding educational backgrounds to improve onboarding and homologation in the master's programmes. Furthermore, the panel recommends investigating whether the skills courses and electives in the programmes need to be adapted to allow students to obtain the required level in social sciences methodology. The panel recommends additional support for concise writing in thesis preparation and supervision in order to reduce thesis length. The choice to teach the MSc programmes in English is well-substantiated and implemented.

Students are well-supported, both through formal structures and through the informal community within the programmes. The workload in the programmes is appropriate, with an important role for the restructured MSc graduation procedures that removed several causes for study delay in the programmes. The teaching staff is qualified for teaching in the programmes, both in terms of research background and didactic qualities. The panel advises to invest in developing didactic qualities related to interdisciplinary teaching in the onboarding of new core staff members. The panel highly appreciated the strong commitment towards the bachelor's and master's programmes expressed by the programme directors, the lecturers and the students.

The recent move of the MSc EPA to The Hague provides the programme with many opportunities to strengthen collaborations with the academic and professional side of public policy. The panel encourages the programme to keep exploring this. Due to the increased use of the Wijnhaven Campus, the facilities of the programme in the Hague are nearing its limits: the panel recommends investigating measures to address this.

Standard 3. Student assessment

According to the panel, the assessment system of the TPM programmes promotes valid, reliable and transparent assessment, with assessment methods that fit the intended learning outcomes of the programmes. The use of group projects and complex, open challenges is well-implemented with appropriate checks and balances in place to monitor the individual attainment of the learning outcomes. The Board of Examiners is in control and has a proactive role in the quality assurance of assessment in the programmes. Thesis assessment is insightful and transparent. Each thesis is graded by two examiners, using an elaborate rubric as well as qualitative argumentation. To further improve thesis assessment procedures, the panel recommends striving for consistency in the amount of qualitative feedback provided on the assessment forms, storing documentation related to all steps in the assessment procedure rather than only the final form, and providing clear documentation on all assessment procedures. For the BSc TB, the panel recommends adding the preproposals in the thesis reviews of the Board of Examiners and ensure that the grades for these preproposals are consistent with the thesis grades of BSc students.

Standard 4. Achieved learning outcomes

The panel concludes that the theses show that the intended learning outcomes are achieved for all four programmes. The theses are generally of a high quality, covering many complex challenges relevant to the goals of the respective programmes. The programmes prepare students for relevant MSc programmes (BSc) and for positions in the professional field, often related to complex, interdisciplinary challenges (MScs).

Score table

The panel assesses the programmes as follows:

BSc Technische Bestuurskunde

Standard 1: Intended learning outcomes	meets the standard
Standard 2: Teaching-learning environment	meets the standard
Standard 3: Student assessment	meets the standard
Standard 4: Achieved learning outcomes	meets the standard
General conclusion	positive

MSc Complex Systems Engineering and Management

Standard 1: Intended learning outcomes	meets the standard
Standard 2: Teaching-learning environment	meets the standard
Standard 3: Student assessment	meets the standard
Standard 4: Achieved learning outcomes	meets the standard
General conclusion	positive

MSc Engineering and Policy Analysis

Standard 1: Intended learning outcomes	meets the standard
Standard 2: Teaching-learning environment	meets the standard
Standard 3: Student assessment	meets the standard
Standard 4: Achieved learning outcomes	meets the standard
General conclusion	positive

MSc Management of Technology

Standard 1: Intended learning outcomes	meets the standard
Standard 2: Teaching-learning environment	meets the standard
Standard 3: Student assessment	meets the standard
Standard 4: Achieved learning outcomes	meets the standard
General conclusion	positive

Prof. dr. J. (Nico) Vandaele, chair

Peter Hildering MSc, secretary

Date: 10 March 2023

Introduction

Procedure

Assessment

On 14 and 15 December 2022, the programmes Technology, Policy and Management of Delft University of Technology were assessed by an independent peer review panel as part of the cluster assessment Industrial Engineering and Management. The assessment cluster consisted of 11 programmes, offered by the University of Groningen, Eindhoven University of Technology, the University of Twente and Delft University of Technology. The assessment followed the procedure and standards of the NVAO Assessment Framework for the Higher Education Accreditation System of the Netherlands (September 2018).

Quality assurance agency Academion coordinated the assessment upon request of the cluster Industrial Engineering and Management. Peter Hildering acted as coordinator and secretary in the cluster assessment. He has been certified and registered by the NVAO.

Preparation

Academion composed the peer review panel in cooperation with the institutions and taking into account the expertise and independence of the members as well as consistency within the cluster. On 22 July 2022, the NVAO approved the composition of the panel. The coordinator instructed the panel chair on his role in the site visit according to the Panel chair profile (NVAO 2016). The full panel was also informed on the assessment frameworks, the working method and the planning of the site visits and reports.

The programmes composed a site visit schedule in consultation with the coordinator (see appendix 3). The programmes selected representative partners for the various interviews. They also determined that the development dialogue would be organized in the form of thematic sessions during the site visit. A separate development report was made based on these sessions.

The programmes provided the secretary with a list of graduates over the period 2020-2022. In consultation with the secretary, the panel chair selected 15 theses per programme. He took the diversity of final grades and examiners into account, and made sure that all tracks were covered in the thesis selection.

Before the site visit, Academion received the relevant documentation from the programmes, consisting of an extensive set of current documentation pertaining to the four standards of examination that, together with a cover letter and SWOT analysis, served as self-evaluation report. This included a comprehensive analysis of the programmes' strengths and weaknesses, and a separate and independent student chapter along with the required appendices. Before and during the site visit, the panel studied the additional documents provided by the programmes. An overview of these materials can be found in appendix 4.

The panel members studied the information and sent their findings to the secretary. The secretary collected the panel's questions and remarks in a document and shared this with the panel members. In a preliminary meeting on 2 December 2022, the panel discussed the initial findings on the self-evaluation reports and the theses, as well as the division of tasks during the site visit.

Site visit

During the site visit, the panel interviewed various programme representatives (see appendix 3). The panel also offered students and staff members an opportunity for confidential discussion during a consultation

hour. No consultation was requested. The panel used the final part of the site visit to discuss its findings in an internal meeting. Afterwards, the panel chair publicly presented the preliminary findings.

Report

The secretary wrote a draft report based on the panel's findings and submitted it to a colleague at Academion for peer assessment. Subsequently, the secretary sent the report to the panel for feedback. After processing this feedback, the secretary sent the draft report to the programmes in order to have it checked for factual irregularities. The secretary discussed the ensuing comments with the panel chair and changes were implemented accordingly. The panel then finalised the report, and the coordinator sent it to Delft University of Technology.

Panel

The following panel members were involved in the cluster assessment:

- Prof. dr. J. (Nico) Vandaele, KU Leuven – chair
- Prof. dr. A. (Allan) Larsen, Technical University of Denmark – vice-chair
- Prof. Dr. E.M.M. (Emmo) Meijer
- Dr. Ir. J.C. (Jaap) Schouten
- Prof. em. Dr. ir. J.P.L. (Joos) Vandewalle, KU Leuven
- Prof. dr. H.J. (Erik-Jan) Hultink, Delft University of Technology
- Prof. dr. ir. G.H. (Gerrit) van Bruggen, Erasmus University Rotterdam
- Prof. dr. R.E.C.M. (Rob) van der Heijden. Radboud University Nijmegen
- Prof. dr. I.F.A. (Iris) Vis, University of Groningen
- Prof. dr. M.C.E. (Rietje) van Dam-Mieras
- Prof. dr. P. (Patricia) Wolf, University of Southern Denmark
- Dr. J.C. (Christine) Teelken, Vrije Universiteit Amsterdam
- L.P.F. (Lynette) Haksel BSc, Eindhoven University of Technology – student member
- I. (Ilse) Overvelde BSc, University of Groningen – student member

The panel assessing the Technology, Policy and Management programmes at Delft University of Technology consisted of the following members:

- Prof. dr. J. (Nico) Vandaele, KU Leuven – chair
- Prof. dr. A. (Allan) Larsen, Technical University of Denmark – vice-chair
- Prof. dr. M.C.E. (Rietje) van Dam-Mieras
- Prof. dr. P. (Patricia) Wolf, University of Southern Denmark
- Dr. J.C. (Christine) Teelken, Vrije Universiteit Amsterdam
- I. (Ilse) Overvelde BSc, University of Groningen – student member

Information on the programmes

Name of the institution:	Delft University of Technology
Status of the institution:	Publicly funded institution
Result institutional quality assurance assessment:	Positive

Programme name	Technische Bestuurskunde
CROHO number:	56995
Level:	bachelor
Orientation:	academic
Number of credits:	180 EC
Location:	Delft
Educational minor:	Applicable
Mode(s) of study:	Fulltime
Language of instruction:	Dutch
Submission date NVAO:	01-05-2023

Programme name	Complex Systems Engineering and Management
CROHO number:	60358
Level:	master
Orientation:	academic
Number of credits:	120 EC
Specialisations or tracks:	Energy Information & Communication Transport & Logistics
Location :	Delft
Mode(s) of study:	Fulltime
Language of instruction:	English
Submission date NVAO:	01-05-2023

Programme name	Engineering and Policy Analysis
CROHO number:	60179
Level:	master
Orientation:	academic
Number of credits:	120 EC
Specialisations or tracks:	-
Location:	Den Haag
Mode(s) of study:	Fulltime
Language of instruction:	English
Submission date NVAO:	01-05-2023

Programme name	Management of Technology
CROHO number:	66995
Level:	master
Orientation:	academic
Number of credits:	120 EC
Specialisations or tracks:	-
Location:	Delft
Mode(s) of study:	Fulltime
Language of instruction:	English
Submission date NVAO:	01-05-2023

Description of the assessment

Standard 1. Intended learning outcomes

The intended learning outcomes tie in with the level and orientation of the programme; they are geared to the expectations of the professional field, the discipline, and international requirements.

Findings

Mission and profile
The bachelor's programme *Technische Bestuurskunde* (TB) and the master's programmes Complex Systems Engineering & Management (CoSEM), Engineering & Policy Analysis (EPA) and Management of Technology (MOT) are organized by the Faculty of Technology, Policy and Management (TPM) of TU Delft. All four programmes focus on the interface of technology and society, studying socio-technical systems from the combined perspectives of governance, systems and values. Students are trained to become engineers who can apply technical and social science knowledge and skills in complex environments with a variety of stakeholders. They are equipped with technical skills and insights, as well as with in-depth knowledge of the management, government and policy context in which they will be working. In addition, they receive a thorough training in communication skills, ethical decision-making and entrepreneurship.

The *bachelor's programme TB* focuses on the analysis of so-called 'sociotechnical systems': systems that are technically, socio-economically and politically complex, such as large-scale infrastructure, the transport and energy sector and business information systems. Sociotechnical systems typically involve different parties with their own interests and goals. Students of the bachelor's TB are trained to analyse such systems over the course of the programme, as well as to develop and assess solutions to various problems in these systems. The programme is highly multidisciplinary: students learn to use methods from social as well as technical sciences, combining insights from various fields such as technology, economy, law, ethics, security, public administration and mathematical modelling. Part of this training is learning to identify actors and interests and working with the inherent limitations to all solutions.

The *master's programme CoSEM* is aimed at designing solutions for large and complex contemporary sociotechnical problems. Graduates are expected to be able to independently design solutions, reflect on the effectiveness of these solutions and manage the associated change processes. They are multidisciplinary engineers that see problems not only as a technical challenge but can also take into account the preferences of multiple stakeholders, as well as institutional and ethical considerations. Students specialize in designing solutions in one of three technological domains: Energy I, Information & Communication (I&C) and Transport & Logistics (T&L). Since 2016, the CoSEM has developed from the 'flow-through master' for the bachelor TB to a multidisciplinary master with inflow from many different bachelor programmes, including monodisciplinary engineering or natural sciences programmes.

The *master's programme EPA* is focused on using analytical methods to study public policy issues related to major societal challenges, such as the energy transition, climate change, cybersecurity, urbanization and the rise of AI in the public domain. These challenges have in common that they all have technological as well as social components, and thus require a systemic perspective. Students are equipped with analytical skills to model sociotechnical systems, and translate the resulting insights into policy advice. To this end, they are thoroughly trained in modelling and simulation, as well as policy and politics. Students are expected to

become multidisciplinary engineers that can for instance pursue a career as policy advisor on technology. EPA is an internationally oriented programme with students from all over the world, coming from a variety of engineering and natural sciences backgrounds. It is the only master's of TU Delft located in The Hague rather than Delft, close to real-life policy making, as well as to the educational and research activities in public administration and political science of Leiden University taking place at the Wijnhaven campus.

The *master's programme MOT* is targeted at students with a monodisciplinary engineering background. Students learn to combine their engineering knowledge with management principles in order to improve the overall quality of innovation and organizational processes in organizations. In the programme, they learn to analyze technologies and their commercial impact, and how to implement these in technology-oriented companies. This includes analyzing wider societal trends and potential markets for new products and services. Graduates can pursue careers as for instance technology managers, production engineers, technological market analysts or entrepreneurs. MOT is explicitly not intended for bachelor's graduates with a business or management ransdiscid: the programme wants its students to build their innovation management insights on an engineering foundation, and apply existing technological knowledge in a business context. Innovations are increasingly technology-based, and the programme believes that high-tech companies need employees that are able to both manage and understand these technologies.

The panel studied the mission and profiles of the four educational programmes and concludes that they offer a very attractive palette of interdisciplinary programmes at the intersection of technology, policy and management. The BSc TB provides students with a broad basis for analyzing complex socio-technical problems, and the skills and tools necessary to model, analyze and implement solutions. The master's programmes CoSEM and EPA offer students a coherent and integrated combination of technical and non-technical knowledge and skills, allowing students to further specialize in the analyzing and modelling of complex socio-technical challenges. The panel noted that both master programmes are often chosen as a follow-up programme to the BSc TB, but also attract students from other, often interdisciplinary backgrounds. Both programmes have a clear, distinct profile, that is also recognized by students. CoSEM is focusing on designing solutions related to major societal challenges in energy, ICT, and transport & logistics, whereas EPA has a predominant analytical character and teaches students to use modelling and simulation to analyze public policies. The master's programme MOT offers students from engineering bachelor's programmes the opportunity to obtain innovation management knowledge and skills, providing them with a unique combination of disciplinary and interdisciplinary skills to help businesses implement new technological products and services.

The panel notes with appreciation that the TPM programmes in Delft are designed as truly interdisciplinary programmes, with clear aspects of transdisciplinarity, where different disciplines jointly develop new concepts and ideas. This inter- and ransdisciplinary nature is very well aligned with contemporary society, which is faced with major complex socio-technical challenges related to climate, energy and security. The knowledge and skills that the programmes aim to provide students with are very relevant for companies, governments and other organizations that are confronted with these challenges. This alignment with the requirements of the professional field is further promoted by the large network of companies and organizations, through personal contacts of staff members and through alumni. The panel thinks that the programmes could further benefit from this network by creating a more formalized stakeholder basis that is used for feedback and further development of the programmes. This could for instance take the form of an advisory board with representatives from industry, public policy makers and alumni.

Intended learning outcomes
The intended learning outcomes (ILOs) of the programmes describe the domain knowledge and skills expected of graduates of the programme. These include skills related to research and design, cooperation and communication, and general attitudes and intellectual skills. The full sets of ILOs are included in appendix 1. The panel studied the ILOs of all four programmes and concluded that they form a well-structured overview of the main goals of each programme translated into knowledge and skills to be acquired by students of the programme. They clearly reflect the appropriate level and academic orientation.

The panel advises to describe more explicitly in the ILOs of the different programmes what level is expected of students regarding social science research methodologies, such as literature study, qualitative interviews and case studies. The panel noted that the way in which students describe these methodologies in the theses often differs from the way these are taught in social sciences educational programmes (see also Standard 4). The panel concludes based on the discussions during the site visit that the programmes are primarily embedded in an engineering context, and as a result, students are not as thoroughly trained in the formal aspects of social sciences research as a student on a social sciences programme would be. The panel understands this position and advises to make more explicit in the intended learning outcomes (or when appropriate in the objectives of the relevant courses) of each programme what research skills can be expected of students in this regard.

Considerations
The bachelor's programme TB and the master's programmes CoSEM, EPA and MOT are strongly interdisciplinary, and contain transdisciplinary aspects. The programmes are at the intersection of technology, policy and management. They are well-aligned with current major societal challenges. The knowledge and skills taught in the programmes are valuable for companies, governments and other organization working on solutions, policies, products and services related to these challenges. The programmes are embedded in the strong external network of TPM. The panel advises to formalize these connections for the continuous development of the programmes, for instance by creating an advisory board consisting of stakeholders and alumni. The intended learning outcomes of the programmes are fitting for academic bachelor's and master's programmes. To further define the positioning of the programmes on the boundary of engineering and social sciences, the panel recommends elaborating the level and skills expected of students in applying social science research methodologies in each programme.

Conclusion
The panel concludes that all programmes meet standard 1.

Standard 2. Teaching-learning environment

The curriculum, the teaching-learning environment and the quality of the teaching staff enable the incoming students to achieve the intended learning outcomes.

Findings

Curriculum: BSc TB
The curriculum of the bachelor's programme *Technische Bestuurskunde* is structured along six learning lines or clusters:

1) Analysis of sociotechnical systems
2) Mathematics and statistics
3) Programming and modelling

4) Governance of sociotechnical systems
5) Skills
6) Technical Specialization

Students follow three 5 EC courses per quarter, which are typically a mix of courses related to the first four clusters. The fifth cluster, containing the Skills learning line, is integrated into the other courses, and offers students training in skills such as project work, presenting, academic writing and interviewing in relation to the topic of the course. For the sixth cluster, students choose one out of three technology specializations (Information and Communication Technology, Transport and Logistics, or Energy and Industry) after the first semester, and follow 30 EC of courses in this specialization spread over the three years of the curriculum. Students complete the curriculum with a 30 EC minor, which can be any coherent package of courses offered by the TU Delft or another university, and a 15 EC bachelor final project. This final project is an individual research project conducted under supervision of one of the teaching staff members, consisting of a research proposal (5 EC) and a research report (10 EC). Some students choose the option to do a final project at an external organization, using part of the elective space to combine the project with an internship. A full overview of the curriculum is found in appendix 2.

The panel studied the curriculum of the bachelor's programme TB, spoke with students and teaching staff, and studied the content of several courses. It concludes that the curriculum reflects the ILOs of the programme and is well-designed. It offers an integrated mix of elements from engineering and management sciences. This integration is found in the variation of courses, as well as within the courses, where students learn to use and combine knowledge and skills from different disciplines to study complex sociotechnical systems. These are often presented in the form of cases, such as studying the effects of different policies when developing wind farms, where there are technological challenges as well as multiple conflicting public and private interests. The courses focus on a combination of independent study and group work, with many practical exercises, especially for courses in mathematics, statistics and modelling. According to the panel, this didactic approach fits the goals of the programme. In particular, the fundamentally interdisciplinary nature of the programme is a strong aspect, offering students the opportunity to not only obtain knowledge and skills from different disciplines, but also use them in an integrated way that reflects the nature of the challenges that graduates are likely to encounter in their future career.

Students can tailor the curriculum to their own preferences through the choice of a technological specialization, as well as through the minor. The panel understood that there is an ongoing discussion between students and programme management whether the BSc TB should offer additional opportunities for an internship. According to the programme management, an internship is not necessary to realize the programme's ILOs. The panel agrees with this, but also understands that students would like to develop their professional skills further, especially considering the central position of societal challenges and stakeholder collaboration in the curriculum . The panel thinks that there could be additional internship opportunities, for instance by making in-company final projects more attractive for students. It suggests the programme to investigate such possibilities.

Curriculum: MSc CoSEM
The first year of the MSc CoSEM curriculum consists of seven mandatory core courses (30 EC), two constrained-choice methods courses (10 EC) and 20 EC track-specific courses. For the latter, students choose one of three tracks at the start of the curriculum: Energy, Information & Communication or Transport & Logistics. The second year has 25 EC electives (15 free and 10 track-specific), a 5 EC thesis preparation course and a 30 EC master thesis. The full curriculum is provided in appendix 2.

In the core and skills courses, students study the key content of complex systems engineering in interdisciplinary courses that cover both technical (e.g., methods and tools, design) and political, economic and social (e.g., law, institutional economics, change management) content. Students choose 2 out of 4 skills courses, depending on the research skills they expect to need for their master thesis. In the track-specific courses and electives, students learn to deal with complex systems in their chosen domain, dealing with the multi-actor socio-political context relevant to that domain. Students can further tailor the programme to their own interests with the 15 EC free electives, which can also be used to study abroad. The master thesis is preceded by a thesis preparation course, where students write a project plan and a scientific paper on their topic of choice. This is often a real-world challenge, where students execute their final project within an external organization. The didactic approach of CoSEM is based on combining theory and practice within the courses. Many courses contain projects, in which students apply theoretical content in real-world situation, allowing them to better understand the course contents, as well as practice professional skills. The core courses also include a 5 EC design project, a capstone project in which students design an intervention that allows stakeholders to implement a recent policy decision relating to energy, mobility, or digitalization.

The panel studied the curriculum of the MSc CoSEM and its contents, and interviewed students and staff associated with the programme. It concludes that the ILOs of the programme are clearly recognizable in the curriculum. The programme offers an attractive and unique curriculum that unites engineering thinking with the domains of policy, economics and law in an interdisciplinary approach. It is well-designed with an appropriate mix of fundamentals in the core courses, and tracks and electives for further deepening and broadening, allowing students to tailor the programme to their own interests. The teaching methods provide students with ample opportunity for self-study, group work and practical training.

Curriculum: MSc EPA
The first year of the MSc EPA has a core curriculum of 50 EC, where students are provided with the core content of the programme divided over two learning lines. *Modelling and simulation* (15 EC) is focused on methodological skills to analyze grand challenges, such as model building, simulation design, data analysis and analytics. *Policy and Politics* (25 EC) makes students familiar with policy analysis and policy-making from various approaches, including political science, sociology, ethics and economics. In addition, students follow 10 EC of integration courses, where they combine both learning lines in studying actual public policy issues. 10 EC in the first year are dedicated to alignment courses, where non-TB graduates can follow courses in TPM modelling and Policy Analysis, and both TB and non-TB-graduates can follow and additional course on Scientific Computing. Students are recommended after admission to the programme to follow one or more of these courses based on their educational background. Any remaining EC can be spent on additional electives in the modelling & simulation learning line. Woven through the courses in the first year is a Skills learning trajectory, where students practice academic and professional skills, such as writing, presentation and interviewing as part of the courses.

In the second year, students follow 25 EC of electives. As a part of this, they can opt for a 10 EC Societal Challenge Project, where students apply their knowledge to a real-life case provided by a policy maker from professional practice. For the remaining 15 EC, students can choose coherent course packages related to various specializations or compose an individual package. The curriculum is completed by a master thesis (30 EC), preceded by a Master Thesis Preparation course (5 EC), where students write a project plan and a scientific paper on their topic of choice. The thesis project is often a real-world challenge, where students execute their final project within an external organization.

Based on the structure and content of the curriculum, and the interviews with staff and students, the panel concludes that EPA reflects the ILOs of the programme and is well-structured. Students learn to study major

societal challenges from a technical as well as a public policy perspective and have the opportunity to use these insights in integrative projects as well as in the thesis. The alignment courses are an appropriate measure to address the diversity of inflow to the programme without impact on study duration, taking the different types of deficiencies into account.

The electives allow students to shape the curriculum to their own interests. The panel understood that the programme uses co-teaching for some courses, where teaching staff members with different disciplinary backgrounds together shape a course. The panel is very positive on this and thinks that this adds to the interdisciplinarity of the courses. The recent move of the programme to The Hague campus, where the public administration and political sciences programmes of Leiden University are also located, provides further opportunities for interdisciplinary collaboration. The panel understood from students and staff members that collaborations with both the academic and professional practice from public policy in The Hague could be expanded, and that the programme is working on this. The panel encourages the programme to keep working on making full use of the possibilities this location offers the programme.

Curriculum: MSc MOT
The curriculum of the MSc MOT is structured around four key themes in relation to technology and innovation management: Engineering Economics, Commercialization, Organization and Research and Reflection. In the first year, students follow 55 EC of mandatory courses on these four themes. Coming from a disciplinary engineering background, they learn to understand the language of business, economics and finance. They also gain insight into the way that technology firms operate, and how technical ideas transform into products and services, taking users, risks and corporate responsibilities into account. At the end of the first year, students follow the course Integration Moment (5 EC in total). In this course, they apply their new knowledge and skills through a consultancy assignment for MOT related business cases of organizations and companies.

In the second year, students follow specialization courses (15 EC) and electives (10 EC), prepare for their master thesis (5 EC) and execute their master thesis project (30 EC). For the specialization and electives, the programme offers a number of standard packages of courses, related to various topics for master thesis projects. Examples are Cyber Security, AI, Emerging Technology and Water and Delta Systems. Students can also compose individual specialization packages relevant to the individual curriculum of the student, or for studying abroad. They may also follow courses of these packages as part of their (10 EC) electives or choose any other master level courses. The thesis is usually executed externally at a company, where students investigate a specific technology management-related challenge.

The panel concludes based on the curriculum structure and content, as well as the interviews during the site visit, that MOT provides students with a solid understanding of business, economics and finance, and teaches them to use this understanding to study technological innovation processes. By offering integration between managerial content and the engineering background of the students, the programme educates multidisciplinary professionals that can work on innovation processes within their field. The specialization courses, electives and thesis allow students to specialize in a specific type of technological innovation. The panel understood from the interviews that the programme carefully guides students through the change in disciplines at the start, making them familiar with the concepts and principles of management science and the new research methods. Students often have tutorials where they can practice and do exercises in smaller groups. The panel appreciates this guidance at the start of the curriculum and thinks that this provides a solid basis for the rest of the curriculum.

Curricula: general observations
The master's programmes all have a very heterogeneous inflow of students. For the MSc MOT, this has always been a feature of the programme by design, but the MScs CoSEM and EPA are also increasingly populated by graduates from programmes other than the BSc TB, where most of its students originally came from. CoSEM has aimed for a more diverse inflow of students over the past years to become a more multidisciplinary master's programme, increasingly independent from the BSc TB. This has led to a new admission policy that does not only admit BSc graduates from multidisciplinary engineering programmes, but also from monodisciplinary programmes with a proven combination of electives in economics, law and policy of at least 30 EC. EPA has introduced two alignment courses in the first semester (see above) to level the skills of students.

The panel approves of this extension of the master's programmes, and thinks that both CoSEM and EPA could benefit from this heterogeneous inflow. At the same time, it understood from students that the gap in educational background is not always fully closed during the programme. In project groups, students sometimes tend to specialize in tasks they are familiar with rather than focus on developing new skills. Furthermore, students report that it is sometimes hard for non-TB students to mix in with their fellow students. The panel thinks that both issues could be tackled by a more deliberate composition of project groups in the MSc programmes. This includes the MSc MOT, which also has a very diverse inflow. Mixing students with various educational backgrounds and being more directive in the distribution of tasks in project groups could help with onboarding, as well as bridging skills gaps between students, especially at the start of the curriculum.

As discussed under standard 1, the panel thinks that the programmes could be more explicit in defining the required level of students regarding social science research methodology. Depending on the choices made, the skills courses of the programmes should be adapted to train students to achieve the required level. This could take the shape of additional training in social sciences research methodology for all students, or providing students interested in applying specific methodologies in their thesis with additional electives or thesis-specific coaching.

Language and internationalization
The BSc is offered in Dutch, while the three MScs are offered in English. The BSc is in Dutch in order to be able to teach students about the Dutch professional practice, and provide them with language skills relevant to the Dutch technology management context. The MScs are in English, as English is the dominant language in the field, both in academia and in an increasingly international professional context. TU Delft therefore requires all teaching staff to have at least low level C1 proficiency in the English language. A package of tests and courses has been developed to ensure that the teaching staff attain and maintain the desired level of proficiency. Every new member of the academic staff (professors, associate professors, assistant professors and lecturers) must take a language test within one year of them starting to work at the university. Their language level is determined on the basis of this test and they are then given personal advice on whether they need to take a course.

The panel considers the choice for the use of English for the master's programmes to be well motivated. Next to the academic context, the field of technology management and the sociotechnical context of societal challenges is increasingly international. An English language programme prepares students for this internationally oriented field. An additional benefit is connecting international staff of the faculty to the master's programmes. Students are positive on the quality of the education in English, and there is sufficient attention to the language skills of the teaching staff. The panel learnt that the BSc increasingly offers English language content and education over the course of the curriculum, allowing students to practice their

English language skills before entering a master's programme. Even though this is enough for most students, there are some students from a Dutch-language BSc that initially struggle with English-language writing in the master's programmes. The panel recommends investigating whether extra English writing courses can be offered to students when necessary.

The MSc programmes are increasingly international. In 2021, 18% (CoSEM), 36% (EPA) and 36% (MOT) of the incoming students had an international background. Beyond the international character of the programmes itself, further opportunities for internationalization are provided through student mobility and the international network of teaching staff members. For instance, students can work on projects with international stakeholders, follow electives abroad or consult international experts during their thesis project. The panel approves of these options and encourages the programmes to keep investing in such opportunities, as the majority of the societal challenges graduates will be working on have a clearly international character.

Guidance and feasibility

The Faculty TPM aims for a personal study environment, where students feel ownership for their learning process. This includes the frequent use of smaller project groups, where students work on exercises or projects, and the possibility to individually compose part of the curriculum in the MSc programmes. First year bachelor's and master's students are paired with a student mentor in the first semester. This student mentor is an older student from the same programme that helps students find their way at the university, in the faculty and in their programme. The student mentors are trained by the academic counsellors of the programme, whom they also can report to in case of issues with their mentored student. The academic counsellors also proactively monitor the progression of students, and contact them in the case of delays or other suspected issues. Next to this TPM has an active student association called Curius, which helps students integrate into, and become embedded in, the student community. It offers an extensive set of activities and support. Two board members of the student association are members of the education management team as education officers.

In order to compose their largely individual curriculum in their second year, MSc students can consult an online student portal to view their options for electives and specializations, and consult an academic counsellor if they need help making a choice. The selected package is sent to the Board of Examiners for approval. For the MSc CoSEM, the track coordinator helps students select a coherent package of courses, following the guidelines for each of the tracks. In the first half of the second year, MSc students select a graduation supervisor depending on their envisioned master thesis project. This supervisor can also help students find a suitable external organization in case of an externally executed thesis project.

The panel approves of the measures and regulations that the four programmes have in place to provide students with guidance and improve the feasibility of the curricula. Mentoring and support are well-embedded in the programme. Both the BSc and the MSc students that the panel interviewed reported that they found the workload in the programmes manageable, and that they feel well supported. They appreciate the support provided by the programme, and report that in addition, there is an informal structure of mentoring through the smaller tutorial and project groups by teaching staff members, teaching assistants and fellow students. Some MSc students reported that they very much appreciated the community aspect of their programmes in the first year of the curriculum and regretted losing much of this in their more individual second year. The panel suggests expanding the role of the thesis circles (see below) to improve this. They could for instance be broadened to include all students, without the requirement that they work on a similar subject.

The MSc programmes recently invested in streamlining the graduation process in order to prevent study delay. Students in the MSc programmes often took more time than the dedicated 21 weeks to finish the theses. The programmes found this to be related to delays in finding a thesis supervisor on the one hand, and too ambitious thesis projects on the other hand. The latter was also concluded by the 2016 accreditation committee, which found that the theses for the MSc programmes were often extensive and reflected much more work than 30 EC. The faculty tackled both issues by revising the master graduation process. The MSc final project is now shaped as a fixed-duration project similar to the BSc final project, with the option to join thesis circles of 3-5 students that work on similar subjects. To help students find a supervisor, the faculty annually publishes a list of all available thesis supervisors and their research fields, and has appointed a faculty graduation coordinator that assists in matchmaking between students and supervisors. An additional benefit is that this creates a better distribution of workload among the supervisors, as it creates a better visibility of all supervisors rather than only the core teachers in the MSc programmes. Furthermore, the faculty invested in setting realistic expectations for a 30 EC thesis through the Thesis Preparation Course. Information provision for the thesis is also improved: all information related to the thesis is collected in a dedicated Graduation Portal.

The improved thesis graduation procedures and the clear communication thereof help students with the timely completion of their final projects. The panel understood that since the implementation of the new regulations, students report fewer problems in finding a thesis supervisor. A sharp drop in projects with a long duration (1 year or longer) has been observed, for which the panel praises the programmes. The management of the programmes are still not completely satisfied. They conclude that notwithstanding the regulations, the master theses still tend to be very long reports. Based on the theses that it studied (see standard 4), the panel thinks that this is not so much related to the length of the research projects itself, as was the case in 2016, but rather to lack of concise writing. According to the panel, otherwise very good research projects can lose some of their strength if their packaging is overdone. Finally it recommends complementing the thesis preparation and supervision with training in and feedback on writing skills., the panel supports the implementation of a maximum length for a thesis (which the panel understood is a strong debate within the programmes), as long as this is combined with additional support in concise writing.

Teaching staff

The programmes are offered by the staff of the Faculty TPM. Almost all the teaching staff members are active researchers and hold a PhD. Teaching assistants (often higher-year bachelor or master students) are employed under supervision of tenured staff, and assist in tutorials and projects in the BSc and in some of the projects in the first MSc year. Regarding professionalization of teachers, the programmes require all new teaching staff to obtain the University Teaching Qualification (UTQ). At the moment, the large majority of teaching staff have obtained an UTQ or is in the process of obtaining it.

The panel finds that the teaching staff is well-qualified for teaching in the programme, both in terms of research background and didactic qualities. The research fields covered by the staff are very diverse, fitting the interdisciplinary character of the programme. Students report that they are satisfied with the expertise of their teachers, as well as the support they receive from them. The panel was happy to learn that the faculty is currently in the process of recruitment and onboarding of new staff to replace several retiring core staff members. The panel underlines the importance of professionalization regarding interdisciplinary teaching, which requires specific didactic qualities. It advices the programmes to explicitly pay attention to this element in the onboarding and training trajectory. Especially the new staff members with education as their primary focus should be given the opportunity to develop themselves as specialists in interdisciplinary teaching.

Facilities

The BSc TB, the MSc CoSEM and the MSc MOT are located in the faculty building of TPM, where the majority of the teaching staff of the programmes have their offices. The panel had the opportunity to take a small tour of the faculty. It appreciated the facilities offered there, including many small spaces for project work and dedicated rooms for the study association Curius. Due to the growth of the BSc in the past five years (from roughly 200 to 300 enrolments per year), BSc courses are increasingly scheduled in the larger educational buildings of TU Delft. The panel understands the students' regret that this limits opportunities for community-forming between teaching staff members and students, but also understands that this is a natural consequence of programme growth.

The MSc EPA is located on the Wijnhaven Campus in The Hague, where it shares a building with the political science and governance programmes and departments of Leiden University. The panel understood from students and staff members that this is a well-equipped building with good facilities. At the same time, the Leiden programmes in The Hague are experiencing major growth issues, which puts pressure on available facilities. For instance, students report that they have trouble finding project rooms. In addition, the EPA teaching staff has very limited options for using offices in The Hague. As all their other duties and facilities are in Delft, this means that they usually only visit The Hague for lectures before going back to Delft. The panel thinks that this is a missed opportunity, as the relatively small scale of the EPA programme (approximately 100 students per year) would be well-suited for close community forming between staff and students. It understood from the faculty that there are on-going discussions for a more permanent presence of TU Delft in The Hague, including independent facilities. The panel supports these developments and thinks that this would be a natural next step for the MSc EPA, as the current set-up is nearing the limit of its growth. On the short term, the panel supports any measures to improve access of students to existing facilities in The Hague.

Considerations

All four programmes have adequately translated their intended learning outcomes into a coherent curriculum. The *BSc TB* offers an integrative curriculum that combines knowledge and skills from multiple disciplines in interdisciplinary courses, and teaches students to study complex sociotechnical systems using a combination of approaches. The *MSc CoSEM* combines engineering thinking with the domains policy, economics and law in an interdisciplinary approach, allowing students to learn methods and tools for designing solutions to real-world complex systems. The *MSc EPA* curriculum combines modelling and simulation courses with public policy courses, teaching students to integrate these two lines in studying societal challenges. The *MSc MOT* builds on the technological background of students with insights from business, economics and finance, and teaches them to study and understand technological innovation processes within their field.

The teaching methods in the four programmes are appropriate. All programmes combine lectures, self-study and practical exercises with group work, allowing students apply the knowledge and develop their skills in real-world challenges. The panel recommends a more deliberate mixing of project groups regarding educational backgrounds to improve onboarding and homologation in the master's programmes. Furthermore, the panel recommends investigating whether the skills courses and electives in the programmes need to be adapted to allow students to obtain the required level in social sciences methodology. The panel recommends additional support for concise writing in thesis preparation and supervision in order to reduce thesis length. The choice to teach the MSc programmes in English is well-substantiated and implemented.

Students are well-supported, both through formal structures and through the informal community within the programmes. The workload in the programmes is appropriate, with an important role for the restructured MSc graduation procedures that removed several causes for study delay in the programmes. The teaching staff is qualified for teaching in the programmes, both in terms of research background and didactic qualities. The panel advises to invest in developing didactic qualities related to interdisciplinary teaching in the onboarding of new core staff members. The panel highly appreciated the strong commitment towards the bachelor's and master's programmes expressed by the programme directors, the lecturers and the students.

The recent move of the MSc EPA to The Hague provides the programme with many opportunities to strengthen collaborations with the academic and professional side of public policy. The panel encourages the programme to keep exploring this. Due to the increased use of the Wijnhaven Campus, the facilities of the programme in the Hague are nearing its limits: the panel recommends investigating measures to address this.

Conclusion

The panel concludes that all programmes meet standard 2.

Standard 3. Student assessment

The programme has an adequate system of student assessment in place.

Findings

Assessment system

The assessment policy of the TPM faculty is based on the principle that assessment is a learning activity, helping students to understand the course materials, and ultimately to achieve the ILOs of the programme. To this end, the programmes ensure through constructive alignment that all ILOs are sufficiently covered in both summative and formative tests throughout the courses. Next to exams and assignments associated with single ILOs, the programmes also explicitly design assignments that integrate various ILOs. These are often challenges resulting from real-life cases: complex problems with many stakeholders for which there is no single solution. Student learning then arises from interaction and collaboration between students, lecturers, the material and the authentic context.

Due to the high prevalence of project work in the programmes, the faculty has developed specific policies to safeguard that all students can individually demonstrate the achievement of the ILOs of the various programmes. Each course has individual assessment elements, and the programme management of each programme, advised by the Board of Examiners, checks on a curriculum level whether all ILOs are assessed individually. Furthermore, assessment of group work is often accompanied by peer review or peer assessment. Students are required to log the contributions of individual group members. The lecturers, and the students in the case of peer assessment, use this in their assessment. On top of that, students are trained and assessed in the way they engage in peer feedback and peer assessment, which the programmes consider an essential professional skill.

The panel studied the system of assessment in the programmes and concludes that this is well-structured. It had the opportunity to review the assessment matrices for each programme, which detail the alignment of assessment as well as assessment methods with the programme's ILOs. The panel concludes that this alignment is well-designed, and that the assessment methods are diverse and fit the goals of the individual

programmes. The panel praises the programmes for their elaborate use of project work. It allows the students to obtain the programme's ILOs in an integrated way, with appropriate checks and balances to prevent freeriding. Students and teaching staff members that the panel interviewed indicated that these procedures work well in practice.

Board of Examiners
The Board of Examiners of the programmes covers all degree programmes in the faculty TPM. The Board is made up of seven staff members from the different programmes, including an external member of the faculty of Industrial Design Engineering. Each degree programme has at least one representative on the Board. The Board of Examiners is responsible for the quality and organisation of the assessments. It draws up the requirements of assessment and advises the management of the programmes in implementing these. The Board also conducts regular reviews of course as well as thesis assessment through evaluation and sampling.

The panel interviewed the Board of Examiners and studied a number of its reports. It concludes that the Board fulfils all of its duties in a proactive way and is in control of quality assurance of assessment within the Faculty. It has several mechanisms in place to monitor the quality of assessment of individual courses, the overall programme and the exit level of students.

Thesis assessment
The BSc and MSc theses are assessed by at least two examiners. For BSc theses, the first examiner is the supervisor of the student, and an independent examiner acts as second reader. For MSc theses, the graduation committee consists of a minimum of two examiners, of which one takes the role of first supervisor. One of the examiners takes the role of chair. The chair is usually the first or second examiner, and is required to be a full or associate professor. The graduation committee can be expanded to include co-supervisors or daily supervisors, who are not formal examiners but have an advisory role, particularly regarding the assessment of process and research skills. Each examiner independently grades the thesis and the examiners jointly formulate a final assessment after discussing their findings. For MSc theses, the chair of the graduation committee is responsible for setting the final grade in consultation with the other committee members. The examiners grade the thesis on three main criteria (Process and Independency, Reporting Quality, and Research Quality) for the BSc, and four main criteria for the MScs (Research Quality, Research Skills, Reporting Quality, and Quality of the Oral Defence). Each criterion is split into several elements that are separately graded using an elaborate rubric. The final grade does not follow automatically from the subgrades but has to be substantiated with qualitative arguments per main criterion.

As part of its preparation for the site visit, the panel studied the final work of 15 students from each programme, including the accompanying assessment forms. It found the assessment forms as well as the rubrics to be insightful and transparent. The extensive rubric used in grading the thesis is very insightful and ensures that the grades are valid and reliable. The requirement to determine the final grade per criterion using qualitative arguments keeps the assessment procedures flexible and improves the transparency of the process. The panel noted that the amount of qualitative feedback that graduation committees provide on a thesis is variable, with some providing extensive feedback and others just a short clarification. The panel recommends striving for consistency in this to ensure that all students receive a comparable amount of feedback.

The panel noted that only the final assessment form is stored, and that any preceding steps, including the separate grading by the two examiners and any rejections and resubmissions are not part of the final dossier. It understood that this is partly related to the ICT systems the faculty is using. Nevertheless, the panel thinks

that storing the full documentation related to the assessment process would further improve the transparency of the process, and supports any improvements to the systems that makes this possible.

Furthermore, the panel found that whereas the information related to graduation for students is very clearly communicated through the Graduation Portal (see also standard 2), assessment procedures for examiners could be more clearly documented. Although the panel learnt through the interviews that thesis assessment procedures are well-structured, this was not immediately apparent from the documentation. The panel recommends expanding the assessment policy of the faculty with all procedures, such as requirements for the two examiners (e.g., that the second examiner cannot be one of the co-supervisors, the steps for reaching a final grade, and resubmission procedures).

For the BSc theses, 70% of the final grade is determined by the BSc thesis itself, and 30% by the grade for the pre-proposal that students write as part of the preparatory course, with the requirement that both need to be graded at least 6 or higher. The panel thinks that such a pre-proposal is a very good method to help students formulate a robust and realistic research project for their final project. At the same time, it found that the grades for these pre-proposals are usually high, and often lead to a higher final grade than students would have received based on the BSc thesis alone. It advises the programme to investigate whether this is desirable. Furthermore, the panel advises the Board of Examiners to include the pre-proposals in their annual thesis reviews. This is currently not the case, but would be appropriate according to the panel due to their contribution to the final grade.

Considerations

According to the panel, the assessment system of the TPM programmes promotes valid, reliable and transparent assessment, with assessment methods that fit the intended learning outcomes of the programmes. The use of group projects and complex, open challenges is well-implemented with appropriate checks and balances in place to monitor the individual attainment of the learning outcomes. The Board of Examiners is in control and has a proactive role in the quality assurance of assessment in the programmes. Thesis assessment is insightful and transparent. Each thesis is graded by two examiners, using an elaborate rubric as well as qualitative argumentation. To further improve thesis assessment procedures, the panel recommends striving for consistency in the amount of qualitative feedback provided on the assessment forms, storing documentation related to all steps in the assessment procedure rather than only the final form, and providing clear documentation on all assessment procedures. For the BSc TB, the panel recommends adding the preproposals in the thesis reviews of the Board of Examiners and ensure that the grades for these preproposals are consistent with the thesis grades of BSc students.

Conclusion

The panel concludes that all programmes meet standard 3.

Standard 4. Achieved learning outcomes

The programme demonstrates that the intended learning outcomes are achieved.

Findings

Thesis quality

Prior to the site visit, the panel studied 15 BSc theses, and 15 theses for each of the MSc programmes. The panel took care that all specializations and tracks were sufficiently covered in the selection. The panel was very impressed by the high quality and interdisciplinary nature of the theses in all four programmes.

The bachelor theses clearly showed that students are capable of defining a relevant research problem, and derive new insights and recommendations from systematically collected information. The theses are empirically strong and generally well written. The panel felt that the final grades seemed generous in some cases, but found this to be related to the high grades for the pre-proposals (see standard 3). The master theses dealt with many interesting challenges, on the boundaries of engineering, social science and business, with a high relevance to the goals of the individual programmes. Students demonstrated to be capable of developing a complex research question, motivate it with literature and define an appropriate research approach. They demonstrate being able to make sense of large amounts of data and communicate complex results.

One thing that the panel noted from the theses is that in all four programmes, notwithstanding the overall high quality of the theses, students regularly do not adhere to the formal standards of scientific research in the social science. Examples are the presentation of methods for data collection and data analysis, and providing the parameters for conducting literature reviews. The panel advises the programmes to reflect on the extent to which they want to educate students in the formal aspects of social science research methodologies, and adapt the curricula according to the results of this reflection. This is further discussed under standard 1 and 2.

Alumni

According to a recent alumni survey, graduates of the BSc TB usually continue with a related master's programme at the TUD (82%), with the majority going to either CoSEM or EPA (respectively 32% and 21% of the total number of students). BSc graduates that the panel interviewed reported that these two programmes are well-aligned with the BSc TB. Some students initially struggle with an English-language programme (see also standard 2), but they grow accustomed to this during their first year. The MSc graduates that the panel interviewed during the site visit were very satisfied with their education and feel that particularly the conceptual and interdisciplinary thinking and the working on complex challenges prepared them very well for their careers. Based on information provided through alumni surveys and the faculty's many informal contacts, graduates usually quickly find a suitable position in either governance, NGOs or companies, often working on topics on the intersection of engineering and societal and management/innovation challenges.

The panel noted that the MSc programmes have a rather incomplete view of where their graduates end up. Alumni surveys sent out by the programmes 1, 4 and 8 years after graduation typically have a very low response rate. It supports efforts by the programme to improve this, such as the recent introduction of surveys when students are still working on their thesis. Furthermore, the panel found that the faculty's alumni network could be better exploited. It learnt that the faculty is planning on organizing additional activities that make it more attractive for alumni to return to the university, and including alumni in a new professional field committee. The panel supports these efforts and thinks that they would not only provide the programmes with better insights on the experiences of graduates with the programmes, as well as their future career, but would also expand their professional network.

Considerations

The panel concludes that the theses show that the intended learning outcomes are achieved for all four programmes. The theses are generally of a high quality, covering many complex challenges relevant to the goals of the respective programmes. The programmes prepare students for relevant MSc programmes (BSc) and for positions in the professional field, often related to complex, interdisciplinary challenges (MScs).

Conclusion

The panel concludes that all programmes meet standard 4.

General conclusion

The panel's assessment of the BSc Technische Bestuurskunde is positive.
The panel's assessment of the MSc Management of Technology is positive.
The panel's assessment of the MSc Complex Systems Engineering and Management is positive.
The panel's assessment of the MSc Engineering and Policy Analysis is positive.

Development points

1. Describe the level and skill expected of students in applying social sciences methodologies in each programme, such as the presentation of methods for data collection and data analysis, and the parameters for conducting literature reviews. Investigate whether the skills courses or electives in the programmes need to be adapted to allow students to obtain the required level in social sciences methodology.

2. Provide additional support for concise writing in thesis preparation and supervision to reduce thesis length.

3. Invest in developing didactic qualities related to interdisciplinary teaching in the onboarding of new core staff members to the programmes.

4. Further improve assessment procedures by striving for more consistency in the amount of qualitative feedback provided on the thesis assessment forms, storing documentation related to all steps in the assessment procedure rather than only the final form, and clearly documenting all assessment procedures.

5. *MSc programmes:* Work on more deliberate mixing of project groups regarding educational backgrounds to improve onboarding and homologation in the master's programmes.

6. *BSc TB*: Ensure that the grades for the thesis preproposals are consistent with the thesis grades of BSc students and include these pre-proposals in the thesis reviews of the Board of Examiners.

7. *MSc EPA:* Explore opportunities to make better use of the location in The Hague, both on the content-side by strengthening collaborations with the academic and professional side of public policy, and on the organizational side by investigating opportunities to improve access to facilities in The Hague.

Appendix 1. Intended learning outcomes

BSc Technische Bestuurskunde

Algemeen

Afgestudeerden van de Bachelor opleiding Technische Bestuurskunde zijn in staat om analytisch:

- te bepalen welke factoren binnen complexe socio-technische systemen relevant zijn voor verschillende actoren binnen deze systemen;
- de waarden van deze factoren te verklaren vanuit de institutionele* en technische structuren en processen binnen deze systemen, en de omgeving van deze systemen;
- te beredeneren hoe deze processen en (waarden van) factoren veranderen als gevolg van veranderingen in de institutionele of technische structuren in deze systemen;
- te beredeneren voor welke besluitvormingsdilemma's actoren binnen deze systemen zich geplaatst zien.

* Onder institutionele structuren worden verstaan: stelsels van formele en informele regels die het gedrag van actoren mede bepalen.

De analyses worden goed gestructureerd en beargumenteerd uitgevoerd op basis van een zorgvuldig onderbouwde selectie van modellen en resultaten.

De student heeft specifieke kennis op minstens een van de volgende technische domeinen:

- Energie & Industrie
- Informatie & Communicatie
- Transport & Logistiek
- Bouwen & Ruimtelijke ontwikkeling (mogelijk voor studenten van cohort 2017-2018)

Kennis en vaardigheden
(op basis van Meijers et al. (2005)

Kundig in een of meer wetenschappelijke disciplines

- Begrijpt de kennisbasis en methodologie van het interdisciplinaire vakgebied van de technische bestuurskunde, dat zich richt op de analyse en het management van complexe socio-technische systemen.
- Kan deze kennis toepassen op complexe socio-technische problemen in een van de volgende technische domeinen: Bouwen & Ruimtelijke ontwikkeling, Energie & Industrie, Informatie & Communicatie, en Transport & Logistiek, en kan adequaat communiceren met experts uit het betreffende domein.
- Begrijpt de structuur van de relevante vakgebieden en de samenhang tussen deelgebieden, in het bijzonder systeemanalyse, wiskundige modellering, beleidskunde, institutionele economie, recht, en de genoemde technische domeinen.
- Heeft inzicht in de wijze waarop besluitvorming plaatsvindt door binnen deze vakgebieden relevante actoren.
- Bezit inzicht en enige vaardigheid in de werkwijze met betrekking tot waarheidsvinding, theorievorming en modelvorming in de relevante vakgebieden.
- Bezit inzicht en enige vaardigheid in de werkwijze met betrekking tot interpretaties (van teksten, data, problemen, resultaten) in de relevante vakgebieden.
- Bezit inzicht en enige vaardigheid in de werkwijze met betrekking tot experimenten, gegevensverzameling en simulaties in de relevante vakgebieden.
- Is zich bewust van de vooronderstellingen van standaardmethoden en van het belang daarvan.
- Is in staat eigen kennishiaten te signaleren en door studie kennis te herzien en uit te breiden (onder begeleiding).

Bekwaam in onderzoeken

- Is in staat om slecht gestructureerde onderzoeksproblemen te herformuleren. Betrekt daarbij ook de systeemgrenzen. Kan deze nieuwe interpretatie verdedigen tegenover de betrokken partijen.
- Is opmerkzaam en heeft de creativiteit en het vermogen om in ogenschijnlijk triviale aangelegenheden bepaalde verbanden en nieuwe gezichtspunten te ontdekken.
- Kan een onderzoeksplan maken en dit uitvoeren (onder begeleiding).
- Kan op verschillende abstractieniveaus werken.
- Ziet in dat een interdisciplinaire benadering essentieel is voor een goede analyse van socio-technische systemen.
- Is zich bewust van de veranderlijkheid van het onderzoeksproces door externe omstandigheden of voortschrijdend inzicht.
- Is in staat onderzoek binnen de eigen interdiscipline op bruikbaarheid te schatten.
- Is in staat op één of enkele deelgebieden van de eigen interdiscipline een bijdrage te leveren aan de ontwikkeling van wetenschappelijke kennis (onder begeleiding).

Bekwaam in analyseren [1]

- Is in staat om slecht gestructureerde problemen te herformuleren. Betrekt daarbij ook de systeemgrenzen. Kan deze nieuwe interpretatie verdedigen tegenover de betrokken partijen.
- Kan voor een slecht gestructureerd probleem de relevante systeemniveaus benoemen en daarbij geschikte abstractieniveaus te kiezen.
- Ziet waar nodig het belang in van andere disciplines (interdisciplinariteit).
- Is zich bewust van de veranderlijkheid van besluitvormingsprocessen door externe omstandigheden of voortschrijdend inzicht.
- Kan bestaande kennis en methoden toepassen in een analyse.
- Heeft de vaardigheid methodologische keuzes te maken en deze te rechtvaardigen en te evalueren op systematische wijze.

Een wetenschappelijke benadering

- Is nieuwsgierig en heeft een houding van levenslang leren.
- Heeft een systematische aanpak, gekenmerkt door de ontwikkeling en het gebruik van theorieën, modellen en samenhangende interpretaties.
- Bezit de kennis en de vaardigheid voor het gebruiken, rechtvaardigen en op waarde schatten van modellen. Kan modellen voor eigen gebruik opstellen.
- Heeft inzicht in de eigen aard van wetenschap en technologie (doel, methoden, verschillen en overeenkomsten tussen wetenschapsgebieden, aard van wetten, theorieën, verklaringen, rol van experiment, objectiviteit, enz.).
- Heeft inzicht in de wetenschappelijke praktijk (onderzoeksysteem, relatie met opdrachtgevers, publicatiesysteem, belang van integriteit, enz.).
- Is in staat de resultaten van onderzoek adequaat te documenteren met de bedoeling bij te dragen aan de kennisontwikkeling in het vakgebied en daarbuiten.

Intellectuele basisvaardigheden

- Kan kritisch reflecteren (met ondersteuning) op eigen denken, beslissen en handelen en dit daarmee bijsturen.
- Kan logisch redeneren in het vakgebied en daarbuiten, zowel 'waarom' als 'wat-als' redeneringen.
- Kan redeneerwijzen (inductie, deductie, analogie, enz.) in het vakgebied herkennen.
- Kan adequate vragen stellen en heeft een kritisch-constructieve houding bij het analyseren en oplossen van problemen in het vakgebied.
- Kan een beredeneerd oordeel vormen in het geval van incomplete of irrelevante data.
- Kan een standpunt innemen ten aanzien van een wetenschappelijk betoog in het vakgebied.
- Beschikt over numerieke basisvaardigheden en heeft besef van grootte-ordes in het gekozen technische domein.

Bekwaam in samenwerken en communiceren

- Kan schriftelijk communiceren over de resultaten van leren, denken en beslissen, met vakgenoten en niet-vakgenoten.
- Kan mondeling communiceren over de resultaten van leren, denken en beslissen, met vakgenoten en niet-vakgenoten.
- Kan debatteren over het vakgebied en de plaats van het vakgebied in de maatschappij.
- Kenmerkt zich door professioneel gedrag. Dit houdt in: drive, integriteit, betrokkenheid, nauwkeurigheid, vasthoudendheid en zelfstandigheid.
- Kan projectmatig werken: bezit pragmatisme en verantwoordelijkheidsbesef; kan omgaan met beperkte bronnen; kan omgaan met risico's; kan compromissen sluiten.
- Is in staat om in een multidisciplinair team te werken.
- Heeft inzicht in en kan omgaan met teamrollen en sociale dynamiek.

Houdt rekening met de temporele en maatschappelijke context

- Is in staat de maatschappelijke consequenties (economisch, sociaal, cultureel) van nieuwe ontwikkelingen in relevante vakgebieden te analyseren en te bespreken met vakgenoten en niet-vakgenoten.
- Is in staat de consequenties van wetenschappelijk denken en handelen op milieu en duurzame ontwikkeling te analyseren.
- Is in staat de ethische en normatieve aspecten van de gevolgen en aannamen van wetenschappelijk denken en handelen te analyseren en te bespreken met vakgenoten en niet-vakgenoten.
- Heeft oog voor de verschillende rollen van professionals in de samenleving.

Final attainment levels of the Master programme CoSEM

A master's graduate in CoSEM

1. **Is competent in one or more scientific disciplines / fields:**
   - Is a multi-disciplinary scholar, mastering theories and methods from the fields of systems engineering, institutional economics, law and management, with the ability to combine and/or switch between them to deal with complex problems;
   - Can apply this body of knowledge when creating insight in the multi-actor complexity and can anticipate the dynamics of socio-technical systems;
   - Is an expert in a specific technical domain (built environment and spatial development; energy; information and communications technology; transport and logistics), with regard to the engineering, management and governance of socio-technical systems and the related policy designs;
   - Is able to reflect on the choice of methods and assumptions in scientific disciplines / fields, can identify knowledge gaps and decide how these need to be addressed by means of self-study or teamwork;

2. **Is competent in doing research:**
   - Is able to formulate research questions and write a research proposal on complex issues in a highly interconnected world;
   - Is able to choose appropriate quantitative and/or qualitative methods for conducting research on socio-technical systems;
   - Can evaluate research and identify threats to the validity of scientific research, understand how these threats may affect the application of the research, and suggest possible remedies;
   - Can contribute to the body of scientific knowledge through independent work;

3. **Is competent in design:**
   - Is proficient in design methodologies for technical artefacts and institutional arrangements as well as able to develop innovative, integrative and effective interventions in real-world decision-making processes to establish a coherent combination of institutional arrangements and technical systems designs;
   - Is able to identify dilemmas arising during the design process and can reflect on these in a systematic way and make justifiable design choices;
   - Is able to structure and redefine complex problems from a multi-actor and socio-technical systems perspective;
4. **has a scientific approach:**
   - Is able to cope with the uncertainty involved in multi-actor system behaviour, system context and futures, and can justify methods choices, while taking into account these uncertainties;
   - Is able to critically reflect on existing theories and methods, and has skills to develop and validate these;
   - Is able to report on the results of research and design processes in a scientifically sound way;
5. **Possesses intellectual skills:**
   - Is competent in reasoning, reflecting and forming a judgment, and is able to recognize fallacies;
   - is able to ask adequate questions and take a critical-constructive attitude when presented with complex real-life problems in the socio-technical realm;

6. **Is competent in co-operating and communicating:**
   - Is able to work with and for others and has a sense of responsibility;
   - Is able to work and take a leading role in international and interdisciplinary teams, in an academic, public or business environment;
   - Is able to effectively communicate in writing or verbally and to use social media efficiently for research and communication;

7. **Takes account of the temporal and the social contexts:**
   - Is familiar with the state-of-the-art knowledge, and with engineering, management and governance challenges in a specific technical domain;
   - Is familiar with institutional factors that structure engineering and policy outcomes;
   - Is able to analyse the societal and ethical consequences of scientific and technological developments, and to integrate this knowledge into their own (scientific) work;
   - Takes into account the temporal context of the past and the future.

Final attainment levels of the Master programme EPA

A Master's graduate in EPA

1. **Is competent in one or more scientific disciplines**
   - An EPA graduate has a thorough mastery of policy and politics, is skilled and experienced in intercultural management, and has a basic understanding of economic theories.
   - An EPA graduate is skilled in (both quantitative and qualitative) modelling and simulation methods aimed at addressing global societal challenges following engineering principles and a multi-actor perspective.
   - An EPA graduate apprehends the relationship of science and technology with governance and societal values.
2. **Is competent in doing research**
   - An EPA graduate is able to formulate research questions on complex issues at the interface between natural and engineered systems, institutionalised values and social behaviour.
   - An EPA graduate is proficient in the application of modelling and simulation methodologies in scientific research.
   - An EPA graduate can design multi-methodological approaches to research that is fit for purpose.
   - An EPA graduate can evaluate research within their discipline and identify threats to the validity of scientific research, suggest how these threats may confound the application of the research, and suggest possible remedies to address these threats.
   - An EPA graduate can contribute to the body of scientific knowledge through independent work that has the potential for scientific publication.
3. **Is competent in design**
   - An EPA graduate is able to develop engaging, innovative, integrative and adaptive, problem solving strategies and policies on the interface between natural and engineered systems, institutionalised values and social behaviour.
   - An EPA graduate is able to structure and redefine complex societal issues from a multi-actor systems perspective.
   - An EPA graduate is able to design and develop models and simulations for a wide range of engineering and societal challenges.
   - An EPA graduate is able to design and develop strategic policy advices on the basis of analytical and modelling information
4. **Has a scientific approach**
   - An EPA graduate has a systematic, multi-method approach characterised by the development and use of theories, models and domain knowledge.
   - An EPA graduate knows the possibilities and limitations of a range of analysis and modelling techniques, and is able to select the appropriate methods for the problem.
   - An EPA graduate has insight into the nature of science and technology, and their interrelations with governance and societal values.
   - An EPA graduate is a reflective practitioner able to review and evaluate both theory and practice and able to learn and improve upon his or her own practice.

5. **Possesses basic intellectual skills**
   - An EPA graduate is able to ask adequate questions and take a critical-constructive attitude when presented with complex real-life problems in the socio-technical realm.
   - An EPA graduate can deconstruct policy arguments, thereby revealing the frames and assumptions that shape public debate.
   - An EPA graduate is familiar with argumentation structuring techniques and can apply these for building convincing argumentations

6. **Is competent in co-operating and communicating**
   - An EPA graduate is a catalyst of change and is able to work with and for others. He or she creates commitment for action, has a sense of responsibility, and demonstrates leadership.
   - An EPA graduate is able to participate effectively in the scientific and public debate.
   - An EPA graduate is able to work in an international, intercultural and interdisciplinary environment.
   - An EPA graduate is capable in translating disciplinary and technical knowledge into actionable findings, practical policy advises and social understanding.

7. **Takes account of the temporal and the social context**
   - An EPA graduate is familiar with the grand challenges that shape the future of our natural and built environments.
   - An EPA graduate is familiar with the cultural and institutional factors that structure engineering and policy outcomes, and understands how these factors differ across the world.
   - An EPA graduate is able to analyse the ethical and societal consequences of scientific and technological developments, and integrates this knowledge into their own work.

A Master's graduate in MOT

1. **Is competent in one or more scientific disciplines, in particular the management sciences, and is able to adapt and apply the concepts of these sciences in a high-tech engineering environment.**
   - Has a thorough mastery of parts of the relevant fields (as named in article 3) extending to the forefront of knowledge (latest theories, methods, techniques and topical questions).
   - Looks actively for structure and connections in the relevant fields, and the connections between subfields.
   - Has knowledge and skills in the way in which....
     - truth-finding and the development of theories and models
     - interpretations (texts, data, problems, results)
     - experiments, gathering of data and simulations
     - decision-making

     ... take place in the relevant fields.
   - Is able to reflect on standard methods and their presuppositions; is able to question these; to propose adjustments and to estimate their implications.
   - Is able to spot gaps in his/her own knowledge, and to revise and extend it through study.

2. **Is competent in doing research**
   - Is able to reformulate ill-structured research problems. Takes account of the system boundaries in this. Is able to defend the new interpretation against involved parties.
   - Is observant, and has the creativity and capacity to discover in apparently trivial matters certain connections and viewpoints and put these into practice for new applications.
   - Is able to produce and execute a research plan.
   - Is able to work at different levels of abstraction. Given the process stage of the research problem, chooses the appropriate level of abstraction.
   - Is able, and has the willingness to draw upon other disciplines in his or her own research.
   - Is flexible in dealing with changes in the research process.
   - Is able to assess research within the discipline on its scientific value.
   - Is able to contribute to the development of scientific knowledge.

3. **Has a scientific approach**
   - Is able to identify and take in relevant scientific developments.
   - Is able to critically examine existing theories, models or interpretations in the area of his or her graduation subject.
   - Has skills in, and affinity with the use, development and validation of models; is able consciously to choose between modelling techniques.
   - Has insight into the nature of and differences between management and technical sciences and is able to distinguish and combine scientific fields.
   - Is able to document adequately the results of research and thereby contribute to the development of the knowledge in the field, and is able to publish these results.

4. **Possesses basic intellectual skills to reflect and decide**
   - Is able to critically reflect on his or her own thinking, decision making, and acting and to adjust these on the basis of this reflection
   - Is able to reason logically within the field and beyond; both 'why' and 'what-if'-reasoning.
   - Is able to recognize modes of reasoning (induction, deduction, analogy etc.) within the field. And is able to apply these modes.
   - Is able to ask adequate questions, and has a critical yet constructive attitude towards analyzing and solving real life problems in the field.
   - Is able to form a well-reasoned decision (and adopt effective strategies) in the case of incomplete or irrelevant data.
   - Is able to take a standpoint with regard to a scientific argument in the field, and is able to assess this critically as to its value.
   - Possesses numerical skills, and has an understanding of orders of magnitude.

5. **Is competent in co-operating and communicating in an intercultural and multi-disciplinary environment**
   - Is able to communicate in writing in English about research and solutions to problems with colleagues, non-colleagues and other involved parties.
   - Is able to communicate verbally in English about research and solutions to problems with colleagues, non-colleagues and other involved parties.
   - Is able to debate about both the field and the place of the field in society.
   - Is characterized by professional behavior. This includes: drive, reliability, commitment, accuracy, perseverance and independence.
   - Is able to perform project-based work: is pragmatic.
   - and has a sense of responsibility; is able to deal with risks; is able to compromise.
   - Is able to work within an interdisciplinary and intercultural team.
   - Is able to assume the role of team leader.

6. **Takes account of the temporal, market and the social context**
   - Understands relevant developments in the history of the fields. This includes the interaction between the internal developments (of ideas) and the external (social) developments, and integrates this in scientific work.
   - Is able to analyse and to discuss the social consequences (economic, social, cultural) of new developments in relevant fields and integrates these consequences in scientific work.
   - Is able to analyse the consequences of scientific thinking and acting on the environment and sustainable development and integrates these consequences in work.
   - Is able to analyse and to discuss the ethical and the normative aspects of the consequences and assumptions of scientific thinking and acting and integrates these ethical and normative aspects in work.

Appendix 2. Programme curriculum

BSc Technische Bestuurskunde

Eerste jaar

Eerste kwartaal	Tweede kwartaal	Derde kwartaal	Vierde kwartaal
TB111b Probleemanalyse Projectwerk & Presenteren	**TB112c** Systeemmodellering 1: modelleerprincipes Feedback geven	**TB133c** Inleiding in programmeren in Python	**TB113b** Systeemmodellering 2: complexe systemen Informatievaardigheden 2
TB131b Differentiaalvergelijkingen en Lineaire Algebra	**TB132b** Multivariabele Analyse en Lineaire Algebra	**TB134a** Statistiek en data-analyse	**TB135c** Besliskunde
TB121b Bestuur en recht 1	**TB122b** Micro- en markteconomie Informatievaardigheden 1	Technologiespecialisatie (een van de vakken beneden)	Technologiespecialisatie (een van de vakken beneden)
		TB141Eb Introductie in Energie- en Industriesystemen	**TB142Ea** Analyse van energiesystemen
		TB141Ib I en C in organisaties	**TB142Ib** Computer and Information Systems
		TB141Tb Transport system analysis	**TB142Ta** Logistiek 1

Tweede jaar (2021-2022)

Eerste kwartaal	Tweede kwartaal	Derde kwartaal	Vierde kwartaal
Technologiespecialisatie (een van de vakken beneden)	Technologiespecialisatie (een van de vakken beneden)	**TB211a** Analyse van multi-actorsystemen	Technologiespecialisatie (een van de vakken beneden)
TB221b Economie van infrastructuren	**TB222a** Bestuur en recht 2	**TB223c** Organisatie en management Interviewtechniek	**TB212a** Ethiek en veiligheid
TB231c Systeemmodellering 3: simulatiemethoden	**TB234b** Multivariate data-analyse	**TB233b** Systeemmodellering 4: project simulatiemethoden Academisch schrijven	**TB232b** Onderzoek en data-analyse
TB241Ea Fysische transportverschijnselen	**TB242Eb** Processen in de energiesector		**TB243Ea** Analyse van industriële systemen
TB241Ia I and C-systeemanalyse	**TB242Ia** Intelligente data-analyse		**TB243Ia** Interconnected World
TB241Tb Logistics 2	**TB242Tb** Verbeteren van het transportsysteem		**CTB1420** Transport en planning

Derde jaar (2022-2023)

Eerste kwartaal	Tweede kwartaal	Derde kwartaal	Vierde kwartaal
MINOR		**TB321D** Governance specialisatie Debattechniek	**TB323a** Governance van sociotechnische systemen
		Technologiespecialisatie (een van de vakken beneden)	**TB351d** Bachelor Eindproject
		TB351d Bachelor Eindproject	**TB351d** Bachelor Eindproject
		TB341Ec Prestatieanalyse in Energie en Industrie	
		TB341Ic I and C Risk and Control	
		TB341Tc Quantitative Models for Transport	

KLEURENLEGENDA

Analyse van socio-technische systemen
Bestuur van socio-technische systemen
Wiskunde & statistiek
Technologiespecialisatie
Programmeren & modelleren
Vaardigheid

MSc Complex Systems Engineering and Management

First Year

	First Period	Second Period	Third Period	Fourth Period
*	SEN112 (5 EC) Complex Systems Engineering (F.M. Brazier)	SEN114 (5 EC) Managing Multi-actor Decision-making (M.L.C. de Bruijne)	SEN115 (5 EC) Law and Institutions (J.M. Kooijman)	SEN116 (5 EC) Design Project (M.P.M. Ruijgh-van der Ploeg)
*	SEN113 (3 EC) Institutional Economics for Designing in Socio-technical Systems (R.W. Kunneke)	METHODS (5 EC) (one of the two courses below)	METHODS (5 EC) (one of the two courses below)	SEN131 (5 EC) CoSEM Research Challenges (J. Ubacht)
*	TRACK (5 EC) (see below)	TRACK (5 EC) (see below)	TRACK (5 EC) (see below)	TRACK (5 EC) (see below)

* SEN111 (EC: 2 EC) Introduction to Design in Complex Systems (M.P.M. Ruijgh-van der Ploeg)

		SEN121 (5 EC) Agent-based Modelling (I. Nikolic)	SEN123 (5 EC) Mixed Research Methods for Multi-actor Systems (G. Bekebrede)	
		SEN122 (5 EC) Statistical Analysis of Choice Behaviour (C.G. Chorus)	SEN124 (5 EC) Design in Networked Systems (M.E. Warnier)	
E	SEN151 (5 EC) Engineering Optimization and Integrating Renewables in Electricity Markets (Z. Lukszo)	SEN152 (5 EC) Electricity and Gas: Market Design and Policy Issues (L.J. de Vries)	SEN153 (5 EC) Design of Integrated Energy Systems (E.J.L. Chappin)	SEN154 (5 EC) Sociotechnology of Future Energy Systems (D.J. Scholten)
I&C	SEN161 (5 EC) I&C Architecture Design (M.F.W.H.A. Janssen)	SEN162 (5 EC) I&C Service Design (Y. Ding)	SEN163 (5 EC) Fundamentals of Data Analytics (T. Fiebig)	SEN164 (5 EC) Digital Platform Design (J. Ubacht)
T&L	SEN171 (5 EC) Advanced Evaluation Methods for Transport Policy Decision-making (N. Mouter)	SEN172 (5 EC) Travel Behaviour Research (M. Kroesen)	SEN173 (5 EC) Analysis and Design of Freight and Logistic Systems (L.A. Tavasszy)	SEN174 (5 EC) Innovations in Transport and Logistics (J.A. Annema)

Second Year

First Period	Second Period	Third Period	Fourth Period
Electives Package (15 EC)	SEN232 (5 EC) Master Thesis Preparation (J. Ubacht)	SEN233 (30 EC) CoSEM Master Thesis (I. Bouwmans)	
Track Electives (10 EC)			

COLOUR LEGEND

Fundamentals	Methods	Research	Track	Thesis

MSc Engineering and Policy Analysis

First Year

First Quarter	Second Quarter	Third Quarter	Fourth Quarter
EPA1316 Introduction to Data Science	EPA1144 Actor and Strategy Models	EPA1341 Advanced System Dynamics	EPA1361 Model-Based Decision Making
EPA1102 Understanding International Grand Challenges	EPA1434 Intercultural Relations and Project Management EPA7021 Academic Writing	EPA1424 Political Decision Making EPA7030 Interviewing Techniques	EPA1133 Ethics and Impacts of Global Interventions
Alignment (one of the two courses below)	Alignment (one of the two courses below)	EPA1352 Advanced Simulation	EPA1223 Macro Economics for Policy Analysis

EPA1124 Policy Analysis of Multi-Actor Systems EPA7010 Oral Presentation	EPA1324 Introduction to TPM Modelling
EPA1333 Computer Engineering for Scientific Computing	Technology

(Students with BSc TB follow EPA1333 and a Technology course; others follow EPA1124 and EPA1324, and optionally EPA1333.)

Second Year

First Quarter	Second Quarter	Third Quarter	Fourth Quarter
Electives	EPA2934 Master Thesis Preparation	EPA2942 EPA Master Thesis	
Electives	Electives		
EPA2112 Societal Challenge Project (or electives)	EPA2112 Societal Challenge Project (or electives)		

COLOUR LEGEND

Policy & Politics	Modelling & Simulation	Integration	Skill

MSc Management of Technology

First Year

First Quarter	Second Quarter	Third Quarter	Fourth Quarter
MOT1524 Leadership and Technology Management	MOT2312 Research Methods	MOT1531 Digital Business Process Management	MOT1452 Inter- and intra-organisational decision making
MOT1412 Technology Dynamics	MOT1442 Social and Scientific Values	MOT1435 Technology, Strategy and Entrepreneurship	MOT2421 Emerging and Breakthrough Technologies
MOT1461 Financial Management	MOT1421 Economic Foundations	MOT1534 High-Tech Marketing	MOT1003 Integration Moment

Second Year

First Quarter	Second Quarter	Third Quarter	Fourth Quarter
Elective Courses	MOT2004 Preparation for Master Thesis	MOT2910 MOT Master Thesis	
Elective Courses	Elective Courses		
Master Specialisation	Master Specialisation		

COLOUR LEGEND

Technology, Innovation & Engineering Economics
Technology, Innovation & Commercialisation
Technology, Innovation & Organisation
Research & Reflection

Appendix 3. Programme of the site visit

Wednesday 14 December 2022

09.45	**Arrival of audit committee**
10.00-10.15	**Welcome**
10.15-11.00	**Preparatory meeting committee**
11.00-12.00	**Education management team (EMT)**
12.00-12.45	**Lunch**
13.45-14.30	**Lectures B TB**
14.30-15.00	**Panel discussion**
15.00-15.45	**Students M Complex Systems Engineering & Management (CoSEM)**
16.00-16.45	**Lecturers M Complex Systems Engineering & Management**
16.45-17.00	**Panel discussion**
17.00- 17.45	**Alumni**
18.30-21.30	**Diner audit committee**

Thursday 15 December 2022

8.30	**Arrival of audit committee**
8.45-9.15	**Preparatory meeting committee**
9.15-10.00	**Members Board of Examiners**
10.00-11.00	**Students M Engineering and Policy Analyses**
11.15-12.00	**Lecturers M Engineering and Policy Analyses**
12.00-12.45	**Panel discussion (incl. lunch)**
12.45-13.30	**Students M Management of Technology**
13.45-14.30	**Lecturers M Management of Technology**
14.30-15.00	**Panel discussion**
15.00-15.45	**Final meeting management**
15.45-17.45	**Meeting audit committee, first findings**
17.45-18.00	**Plenary presentation first findings**
18.00	**Drinks**

Appendix 4. Materials

Prior to the site visit, the panel studied 15 theses per programme. Information on the theses is available from Academion upon request. The panel also studied other materials, which included:

- Profiles & SWOT analysis
- Reading guide information file
- Student chapter
- Report previous accreditation 2016
- Organization of the Faculty and administrative information
- Final attainment levels
- Curriculum overview and learning lines
- Programme study guides
- Matrix of final attainment levels and course content
- Inflow and success rate
- Overview Teaching team
- Annual reports TPM, Board of Studies and Board of Examiners
- Examples of course evaluations
- Faculty quality assurance handbook
- TU Delft Global Engagement Framework 2018-2024
- Teaching and Examination regulations
- Graduation Portal for students
- Faculty assessment policy
- Examples of quality assurance of examination
- Examples of assessment and thesis reviews
- Alumni policy and alumni survey
- The content of a selection of courses (13) through Brightspace