Industrial Engineering
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Contents

Summary

Standard 1. Intended learning outcomes

The profiles and aims of the bachelor Industrial Engineering (IE) and masters Operations Management and Logistics (OML) and Innovation Management (IM) are fitting for academic programmes in the field of industrial engineering, with the BSc IE focusing on a broad multidisciplinary base for understanding industrial engineering processes, the MSc OML on improving the efficiency and effectiveness of various types of operations in organizations, and the MSc IM on designing efficient and effective innovation processes. The panel recommends broadening the scope of the programmes to include sustainability and circularity, and to anchor this in the foundations of the programme through a broadening of its network towards societal stakeholders.

The goals of the programmes have been translated into three coherent sets of intended learning outcomes that are aligned with the requirements of the academic and professional fields. The Societal Council further strengthens the connection of the goals of the programmes to the professional field. The panel recommends expanding attention to sustainability in the ILOs of all three programmes.

Standard 2. Teaching-learning environment

All three programmes have adequately translated their intended learning outcomes into a coherent curriculum. The BSc IE offers a broad approach towards industrial engineering, with many connections to industry as well as the opportunity for students to adapt the curriculum using free elective space. The MSc OML offers a varied curriculum centred around improving operations in organizations, allowing students to specialize in a specific operational process through one of the four tracks, each of with has close connections to industry. Student can further customize their programme in the elective space and the master thesis project, which is often conducted in-company. The MSc IM provides students with knowledge and skills on how to further innovation in businesses, with specialization in innovative products and innovative processes. The curriculum is flexible with a substantive elective space, and the opportunity to work directly with innovative companies within the region.

The teaching methods as well as the facilities offered the programmes are appropriate. The panel considers challenge-based learning to be a very good fit for the programmes considering their multidisciplinary nature and many connections to industry. According to the panel, attention to sustainability could be expanded in the curricula of all three programmes. The panel recommends investigating opportunities to make this topic a core element of the curricula. Furthermore, attention to academic writing skills could be improved in the three programme. The BSc already made a start with this through the academic learning trajectory on this skill; the panel recommends monitoring the effect of this, and considering similar initiatives in both MScs.

Obtaining international experience in a semester abroad is a unique opportunity offered by both MScs. The dual degrees offered by both OML and IM offer additional opportunities for internationalization. All three programmes are offered in English, a choice that the panel considers to be well-substantiated considering the international orientation of the organizations in the professional field relevant to the programmes. The panel recommends further developing the international character of the programmes by a more explicit use of the possibilities of the international classroom.

The panel appreciates the flexibility of the curricula, and praises the personalized approach in both MScs, with mentors that discuss and compose a tailor-made curriculum with individual students. The MSc OML could consider an adjustment to the system of choosing a mentor, as finding a suitable mentor within four-weeks after starting the curriculum can be overwhelming, especially for students new to the TU/e. Guidance

in the three programmes is well-organized. Next to the mentor system in the MScs, this includes a buddy system in the first year of each programme, and student coaches during the bachelor end project. The curricula of all programmes are feasible, without structural elements that prevent timely completion.

The teaching staff associated with the programmes is well-qualified, and has relevant expertise in industrial engineering, as well as many connections to industry. The panel supports the planned improvement to the supervision structure of the bachelor end projects, and suggests a more uniform structure as well as mandatory training for PhD students involved in supervision.

Standard 3. Student assessment

The assessment system of all three programmes is valid, reliable and transparent. The assessment methods are varied and fit the intended learning outcomes. There are appropriate checks and balances to monitor the quality of exams as well as the thesis, with a constructive and proactive role for the Examination Committee. Thesis assessment is organized in an insightful and transparent way, with an independent assessor safeguarding the validity of the assessment. The panel recommends making participation in the master thesis defence mandatory for all assessors to further increase consistency of the thesis assessment.

Standard 4. Achieved learning outcomes

The panel concludes that theses of all programmes are generally of a good quality and show that the intended learning outcomes of all three programmes are achieved. Graduates of the bachelor programme continue successfully into a master programme. Graduates of the master programmes end up in relevant positions, and are very satisfied with their education.

Score table

The panel assesses the programmes as follows:

BSc Industrial Engineering

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 Operations Management and Logistics

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 Innovation 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

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

Peter Hildering MSc, secretary

Date: 3 February 2023

Introduction

Procedure

Assessment

On 19 and 20 October 2022, the programmes Industrial Engineering of Eindhoven 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, 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 20 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 and thematic sessions. They also determined that the thematic sessions would serve as the development dialogue for 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 and joint programmes were covered in the thesis selection. In order to select two theses for each of the dual degree programmes of the MSc Operations Management and Logistics, the list for this programme was expanded to cover the full six year period between 2017 and 2022.

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 programme's strengths and weaknesses, and a separate and independent student chapter along with the required appendices. Before and during the site visit, the panel studied 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 10 October 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 vice-chair publicly presented the preliminary findings.

The panel chair was present online for the major part of the site visit, and participated in all of the preparations and reporting afterwards. The vice-chair was responsible for chairing the interviews on-site, and stepped in as chair for the parts of the site visit where the chair could not attend, including the oral feedback at the end of the visit.

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 Eindhoven 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 Heijen. Radboud University Nijmegen
- Prof. dr. I.S.A. (Iris) Vis, University of Groningen
- Prof. dr. M.C.E. (Rietje) van Dam-Mieras
- Prof. dr. P.D. (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 Industrial Engineering and Management programmes at Eindhoven University of Technology consisted of the following members:

- Prof. dr. J. (Nico) Vandaele – chair
- Prof. dr. A. (Allan) Larsen, DTU – vice-chair
- Prof. dr. H.J. (Erik-Jan) Hultink, Delft University of Technology
- Prof. dr. ir. G.H. (Gerrit) van Bruggen, Erasmus University Rotterdam
- I. (Ilse) Overvelde BSc, University of Groningen – student member

Information on the programmes

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

Programme name	Industrial Engineering
CROHO number:	56994
Level:	bachelor
Orientation:	academic
Number of credits:	180 EC
Specialisations or tracks:	-
Location:	Eindhoven
Educational minor:	Applicable
Mode(s) of study:	Fulltime
Language of instruction:	English
Submission date NVAO:	01-05-2023

Programme name	Operations Management and Logistics
CROHO number:	66430
Level:	master
Orientation:	academic
Number of credits:	120 EC
Specialisations or tracks:	Services (since 2022) Supply Chains (since 2022) Manufacturing and Maintenance (since 2022) Transport and Mobility (since 2022) *Data-intensive Industries (until 2022)* *Capital Goods (until 2022)* *Consumer Goods (until 2022)* *Service Industries (until 2022)* *Transportation (until 2022)* *Manufacturing Systems Engineering (until 2022)* Free Track
Dual degrees:	Grenoble INP, France Korea Advanced Institute of Science and Technology (KAIST), South Korea
Location:	Eindhoven
Mode(s) of study:	Fulltime
Language of instruction:	English
Submission date NVAO:	01-05-2023

Programme name	Innovation Management
CROHO number:	60430
Level:	master
Orientation:	academic
Number of credits:	120 EC

Specialisations or tracks:	Business and Product Creation Managing Innovation Processes
Dual degree:	Lappeenranta University of Technology, Finland
Location:	Eindhoven
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

Profile
The BSc Industrial Engineering (IE) and the MScs Operations Management & Logistics (OML) and Innovation Management (IM) are organized by the School of Industrial Engineering, which is one of the ten departments of Eindhoven University of Technology (TU/e). The programmes aim for students to learn to understand business processes from various technological angles, with the ultimate aim of streamlining processes, performance and innovations in industry and service organizations.

The *BSc IE* provides students with a broad, multidisciplinary basis necessary to understand industrial engineering processes. Students study business processes from various perspectives: people, technology, data, information systems, economy, and organizations. They learn to use these insights to design solutions for bottlenecks in business processes, to improve product or service quality, and to increase production. The BSc IE places emphasis on the business practice: the programme has multiple connections to industry, and uses these to provide students with hands-on experience in industry. After graduation, students can pursue a master degree in a related programme, such as one of the three MScs where the School of Industrial Engineering participates in: IM, OML or the MSc Artificial Intelligence Engineering Systems (separately accredited).

The *MSc OML* is focused on efficiency and the effectiveness of the operations in an organization. It teaches students how to analyze operational processes, both in manufacturing (industry) and service-oriented organizations. The programme provides theory, tools, and techniques for the management of operations. Students learn how to analyze the current operational performance of an organization, how to explain it in terms of quality, cost, and time, and how to improve this performance by redesigning business processes. Students can specialize in specific operational processes by choosing one of the tracks. Per 2022-2023, these are Services, Supply Chains, Manufacturing and Maintenance, and Transport and Mobility[1]. Alternatively, students can pursue a Free Track, where they compose a tailor-made curriculum, or pursue one of the dual degree opportunities with either Grenoble INP in France or the Korea Advanced Institute of Science and Technology (KAIST) in Daejeon, South-Korea.

The *MSc IM* is a multidisciplinary programme focusing on business innovation processes. Students learn how to help business to be more innovative, and to make innovative products and services more successful. They learn to analyze, model and (re)design innovation processes for maximum effectiveness and efficiency. Key elements of the programme are product development, strategic marketing, sales and after-sales management, business intelligence, open innovation and entrepreneurship. Students choose between two tracks, focused on either Business and Product Creation or Managing Innovation Processes, or compose a

[1] Prior to 2022-2023, the tracks were Data-intensive Industries, Capital Goods, Consumer Goods, Service Industries, Transportation and the selective track Manufacturing Systems Engineering (together with Mechanical Engineering). These six tracks were used as the basis for the thesis selection of the master OML.

tailor-made curriculum in the Free Track. Students can also choose to for a dual degree programme with Lappeenranta University of Technology (LUT) in Finland.

The panel studied the profile and aims of the three programmes, and concludes that they are relevant for bachelor and master programmes in the field of industrial engineering. Students in the BSc IE obtain a broad basis in understanding industrial engineering processes, and learn to implement solutions to business challenges in practice. In the MSc OML, students learn to analyze and optimize operational processes in a specific area. The MSc IM teaches students how to design effective and efficient innovation processes in companies. The aims of all three programmes are well-aligned with industrial challenges related to processes, operations and innovation. During the site visit, the panel learnt that the programmes have many connections to industry, and that students often encounter real-life challenges from companies.

During the site visit, the panel learnt that the School of Industrial Engineering is working on broadening the scope of the programmes to include more topics related to sustainability and circularity. The panel fully endorsed this, and thinks that societal challenges related to sustainability should be a core element of all modern-day industrial engineering programmes. It encourages the School to explore ways to broaden its network from predominantly industry-focused to also include societal stakeholders such as policy makers, governments and NGO's. Complex future challenges related to sustainability will include a joint effort from both societal and industrial stakeholders, and, according to the panel, this should become part of the DNA of the programme. This could for instance be reflected in a broader composition of the Societal Council, and by looking to expand the staff with researchers working on sustainability topics in collaboration with societal stakeholders.

The School could use its expanded vision and the positioning discussed above together with the strong elements of the curriculum to create a convincing narrative of the programme for prospective students as well as external stakeholders in general. Students consistently praise the flexibility of the curriculum, the opportunities for internships in industry and (in particular in the MScs) the full semester dedicated to studying abroad as unique and strong elements of the programmes.

Intended learning outcomes
The intended learning outcomes (ILOs) of all three programmes are divided into general ILOs, that are shared with the other programmes at TU/e, and domain-specific ILOs for the individual programmes. The general ILOs include academic qualifications in the domain of engineering and technology, research and design skills, judgmental skills, planning skills, cooperative and communicative skills and societal awareness. The domain-specific ILOs describe knowledge and skills related to the disciplines relevant for the programmes. The full sets of ILOs are included in Appendix 1.

The programmes benchmark their ILOs against the Domain-Specific Framework of Reference (DSFR) to keep them aligned with the general expectations for Industrial Engineering programmes. In order to align the aims and content of the educational programmes with the expectations of the professional field, the School of Industrial Engineering regularly consults its Societal Council. This Council consists of seven members from companies and government-related organizations, and meets three times per year to discuss research and education within the School.

The panel studied the ILOs of all three 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. In response to the recommendations of the previous panel, the programmes worked on further differentiation between the BSc and MSc ILOs, and adapted the ILOs to better reflect the programmes' profiles. The panel

notes with appreciation that this has led to well-defined ILOs tailored to the level and profile of the individual programmes. As demonstrated in an overview provided to the panel by the programmes, all elements of the Dublin descriptors for either bachelor or master programmes are clearly visible, demonstrating their level and academic orientation. Furthermore, the panel determined that the ILOs align well with the general knowledge, skills and attitudes described in the domain-specific framework of reference (DSFR) for IEM, demonstrating that the programmes meet the expectations of the discipline. The Societal Council provides an excellent benchmark for the expectations of the professional field, and safeguards that the goals of the programmes remain aligned with that of future employers of graduates. The broad field of application of the field of IEM allows for different focal points between the four universities that offer IEM programmes in the Netherlands. The Eindhoven programmes stand out through their focus on business processes, logistics and innovation.

The panel remarks that future shifts in the focus and profile of the programmes, such as the shift discussed under *Profile*, should also be integrated in the ILOs of the programmes. Sustainability in particular deserves a more prominent role in the ILOs of the programme. It is currently incorporated in the ILOs of the bachelor programme as a 'stakeholder need' in designing business processes, and not explicitly mentioned at all in the ILOs of both master programmes. The panel recommend adding sustainability and all related aspects explicitly to the ILOs in all three programmes.

Considerations

The profiles and aims of the BSc IE and MScs OML and IM are fitting for academic programmes in the field of industrial engineering, with the BSc IE focusing on a broad multidisciplinary base for understanding industrial engineering processes, the MSc OML on improving the efficiency and effectiveness of various types of operations in organizations, and the MSc IM on designing efficient and effective innovation processes. The panel recommends broadening the scope of the programmes to include sustainability and circularity, and to anchor this in the foundations of the programme through a broadening of its network towards societal stakeholders.

The goals of the programmes have been translated into three coherent sets of intended learning outcomes that are aligned with the requirements of the academic and professional fields. The Societal Council further strengthens the connection of the goals of the programmes to the professional field. The panel recommends expanding attention to sustainability in the ILOs of all three programmes.

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 IE

The bachelor programme Industrial Engineering is embedded in the framework of the Bachelor College. This means that the curriculum follows the same structure as other BScs in the TU/e: it consists of 95 EC in *major courses* (programme-specific), 25 EC in *basic courses* in mathematics, physics, ethics and history of

technology, engineering design and data analytics, 15 EC in courses in the societal *USE learning trajectory* on User, Society and Enterprise, and 45 EC of free elective space.

The *major courses* are grouped into three main learning trajectories: mathematics, (industrial) engineering, and integration courses that combine engineering and business subjects. It also includes 5 EC of professional and academic skills integrated into the other courses. Students follow the *basic courses* and the *USE learning trajectory courses* together with students from other BScs at the university. These courses are organized by the Bachelor College. They are organized in the first year of each programme and ensure that all TU/e students have sufficient foundation in engineering and develop a societal and entrepreneurial orientation. The free elective space can be used by students to broaden or deepen their knowledge. The department offers various coherent elective packages such as Business Economics, Healthcare Logistics, Advanced Operations Management and Data Science for IE, but it is also possible to choose university-wide packages, such as the educational package leading to a 'tweedegraads' teaching qualification in mathematics. The capstone of the programme is the 10 EC Bachelor End Project (BEP), which is an individual research project conducted in-company. The project is part of the major courses. Students can choose to expand the size of their bachelor thesis to 15 EC using free elective space. To prepare students for the BEP, the programme has identified an academic writing pathway throughout the courses, including training and peer coaching.

The panel studied the curriculum of the BSc IE, and concludes that the programme has successfully translated its intended learning outcomes into a coherent curriculum. The programme offers a broad range of courses and subjects, and enables students to adapt the curriculum to their own preferences through the large number of ECs in the free elective space. During the site visit, the panel learnt that students value this freedom very much, and see it as one of the key selling points of the programme. Another element that is appreciated by students are the opportunities to connect with industry. Projects in courses are often inspired by actual industrial challenges, and the BEP is conducted in-company by the large majority of students.

Curriculum: MSc OML
The MSc Operations Management and Logistics offers a coherent programme in operations management, with the tracks guiding students towards a specific operational process (Services, Supply Chains, Maintenance & Manufacturing, and Transport and Mobility) to specialize in. These four tracks are the result of a recent revision of the curriculum, and have replaced the former six tracks per 2022-2023. The curriculum of the master Operations Management & Logistics is structured into core courses (15 EC) for students in all tracks, track courses (20 EC) specific to each of the four tracks, track electives (10 EC) to be chosen from the courses offered within the track, free electives (40 EC), a literature survey (5 EC) and the thesis project (30 EC). The free electives are generally used by students to study one semester abroad in the second year of the programme. Students who choose the Free Track design an individual programme in close collaboration with a personal mentor, and submit this for approval to the programme chair. The Free Track is used as an honours programme, and is typically followed by a handful of excellent students selected by the programme each year. The dual degree (see below) is also considered to be part of the Free Track.

The *core courses* are two compulsory courses (Performance Enhancement, and Implementing and Adapting to AI in Organizations), and a choice between either Business Analytics for IT Systems and Design of Service Operations. The core courses contain knowledge relevant for all OML students, as well as the necessary master level research skills. The *track courses* are 1-3 common courses, depending on the track, supplemented by restricted choice courses chosen out of a list of 2-4 courses. These courses contain the core content of the operational processes central to the track. Students can further specialize through the track electives and free electives, which they often use to broaden or deepen their knowledge with regard to the

intended thesis project. The free elective space is used by the majority of students to go abroad and obtain international experience at another university. Students complete their curriculum with a literature survey and the thesis project, which is considered to be the final project of the programme. The literature survey requires students to study a specific topic (often related to the thesis project) from scientific literature. The thesis project is a larger research project conducted either at the university or in-company, with most students choosing a company project.

After studying the curriculum, the panel concludes that the intended learning outcomes of the master OML have been translated into a well-structured curriculum. The four tracks cover relevant operational processes, whereas the core courses as well as the curriculum structure provide sufficient coherence the curriculum overall. The programme has many opportunities for customization by students through the tracks, electives and thesis. The programme is well-connected to companies in the region (and beyond): many course assignments come from practice, and a large number of students do their thesis project in industry.

Curriculum: Master IM
The master Innovation Management has a common core of 35 EC, and 25 EC of track-related electives. Students choose between the track Business and Product Creation (PBC) and Management Innovation Processes (MIP) for 25 EC in courses. Furthermore, students can choose 30 EC of free electives, and complete the programme with a thesis project of 30 EC.

The common core is followed by all students, and consists of 7 courses offered in the first year, containing the general knowledge and skills related to innovation management. For the track electives, students choose five out of nine courses offered within the track. The free electives are situated in the first semester of the second year, and allow students to tailor the curriculum to their individual preferences. As in the master OML, students often choose a so-called international semester, where they study abroad for half a year. The thesis project is a larger research project conducted either at the university or in-company, with most students choosing a company project. Students have the opportunity to choose a literature review course. A select number of excellent students can choose the Free Track, where they design an individual programme in close collaboration with a personal mentor, and submit this for approval to the programme director. Students can also choose to pursue a dual degree programme with Lappeenranta University of Technology (LUT) in Finland.

Based on the content and structure of the curriculum, the panel concludes that the curriculum reflects the ILOs of the master IM in an appropriate way. The common core reflects the core content of the programme, whereas the two tracks allow students to specialize in either innovative products or innovation processes. The curriculum is very flexible and can be adapted to the preferences of students. As in the master OML, students particularly value this flexibility, the opportunity for an international semester, and the many connections of the programme to industry.

Curricula: general remarks
The full curricula of all three programmes can be found in Appendix 2. Following the discussion under standard 1, the panel thinks that content related to sustainability could be expanded in the curricula of all three programmes. Although already several courses are offered integrating elements related to sustainability, particularly in the master IM, the panel thinks that this topic should be promoted to becoming one of the core elements of all three programmes. Sustainability and related societal challenges such as the circular economy and the energy transition are key elements that graduates will encounter throughout their career, and should be integral to industrial engineering programmes. According to the panel, this could take

many forms in the curricula, ranging from separate courses to an overarching learning trajectory. The individual programmes should choose the approach that best fits their goals.

The panel observed in the BSc as well as the master theses that the writing skills of students as well as the way in which theses are presented on paper could often be improved. It recommends investing in additional training on this aspect, as well as additional supervision during the thesis trajectory in all three programmes. In this context, the panel approves of the introduction of the academic writing pathway in the BSc IE. It recommends monitoring whether the extra training has the desired result, and if not, offer extra support to help students develop their academic writing skills.

Teaching methods
The programmes offer a variety of teaching methods, including lectures, tutorials, and group and individual project work. The programmes frequently use challenge-based learning (CBL) in their courses, an approach that TU/e is increasingly adopting in all of its programmes. The Bachelor College will be redesigned from 2023 onwards to provide more room for such courses in the TU/e bachelor programmes. In CBL-courses, students work on real-life cases, often offered by industrial partners in the region. By studying open-ended problems, students learn to apply knowledge and skills on real-life cases, and how to obtain new knowledge and skills relevant to the problem. To further promote interdisciplinary working, TU/e is planning to introduce multidisciplinary CBL-courses, where students from different programmes work together in project groups. The programmes offer student workplaces and facilities for project work, that the panel had the opportunity to visit during a tour of the facilities.

The panel approves of the teaching methods as well as the facilities for project work in the programmes. It thinks that the CBL-approach fits the IE programmes very well. The multidisciplinary nature of the three programmes, as well as the strong connections to industry provide a good context to engage in CBL, which will give students additional opportunities to practice their multi- and interdisciplinary skills. The programmes are still in an early stage of investigating and adopting CBL, but the panel has full confidence that the programme will be successful in finding a suitable approach that aligns with the learning goals of the programmes.

Since the COVID-19 pandemic, all three programmes increasingly make use of digital and blended learning techniques. Investments made in educational methods and tools during this period have considerably increased the opportunities for doing so, and have given these teaching methods a permanent place in the programmes. At the same time, the panel found out during the site visit that the programmes are very aware of keeping sufficient opportunities for collaboration among students and student-teacher interaction. The programmes make an effort to schedule regular mandatory educational activities on-campus. The panel thinks that the programmes have found an appropriate balance in the use of on-campus and online activities, especially since interaction and teamwork are important elements of the programmes.

Dual degree programmes
Both master programmes have agreements with a university abroad for pre-defined exchange programmes of five semesters, resulting in double diploma's from the participating universities. A small number of students opts for this possibility. Students of OML can follow a dual degree programme with either the Korea Advanced Institute of Science and Technology (KAIST) in Daejeon, South Korea, or with Grenoble INP in France. Students IM can pursue a dual degree programme with Lappeenranta University of Technology (LUT) in Finland. The dual degree curriculum take the form of an extended international exchange of up to 60 EC instead of the usual 30 EC. During the extra 30 EC, students follow courses and/or work on an extended

thesis, meeting the criteria of the partner universities. After completing the programme, students receive a diploma of both participating universities.

KAIST and TU/e have formulated a list of curricular requirements that satisfy the requirements of both universities. Students follow half of the courses at TU/e and half of the courses at KAIST, and write a thesis at their home university. After approval by both universities, this serves as the final project for both programmes. Grenoble INP and TU/e have a similar agreement, with the difference that the order in which students study at both universities is fixed: students first study at TU/e, and then at Grenoble INP. With LUT, both universities defined a coherent 120 EC curriculum composed of the courses offered by both universities, which is completed by a 45 EC final project supervised at the home university and graded by both TU/e and LUT.

The panel concludes that the dual degrees are designed in such a way that students can realize the intended learning outcomes of the respective master programmes in Eindhoven. The curriculum requirements help students compose a coherent curriculum, and the dual supervision of the master thesis solidifies the connection of the final projects to the learning outcomes of the Eindhoven programmes.

Language and internationalization
In line with the policies of TU/e, all three programmes are offered in English. The programmes aim to prepare students for an international career in academic research/design or in companies operating in an international context. The programmes have taken several measures to improve the English-language proficiency of their staff. For new staff, including educational support staff, sufficient command of English is one of the selection criteria. Existing research staff usually have years of experience in an international research environment. The university offers a wide range of language courses through which teachers can improve their English language proficiency. These can be followed out of a teacher's own initiative, or upon recommendation of the programme management, for instance when students express serious dissatisfaction with the level of English used in courses. Students in the MSc OML that opt for the dual degree with Grenoble INP are expected to follow their courses in Grenoble partly in French. This is clearly communicated to students, is included in the admission criteria for this dual degree. In practice, this means that the dual degree is usually chosen by students originating in Grenoble INP.

The panel supports the programmes' decision to offer their curriculum in English. This provides students with the opportunity to get acquainted with an international atmosphere and interact with the increasingly international research staff at the School. It also prepares students for an international career in in the professional field. The Brainport Eindhoven region, where many graduates of the programmes become employed, is highly internationally oriented and requires students to be able to work and communicate in English. The programme has taken sufficient measures to safeguard the quality of the use of English in courses.

The international context of the programmes is furthered by the international student population at the School: in 2021-2022, approximately a quarter of the student population had an international background. Furthermore, most master students follow a semester abroad. The resulting international classroom provides students with a culturally diverse educational context. The panel thinks that this is a very valuable experience for students, and has the impression that the programmes could enhance this experience by emphasizing this during the curriculum. The programmes could for instance aim for more deliberate mixing of Dutch and international students in project groups, something the panel understood is not always the case. Furthermore, the programmes could consider offering a workshop on internationalization and cultural

sensitivity at the start of the semester, in order to prepare students for the international classroom as well as (for the MScs) the international semester.

Guidance and feasibility
As recommended by the previous panel, the programme has invested in guidance for students to help them find their way in the programme. All first-year bachelor students are coupled with a senior student, who helps them find their way in Eindhoven, in the TU/e and in the programme. In regular sessions, they discuss the choice of electives, study planning, and (mental) well-being. All first-year master students coming from an hbo or international university are assigned a buddy, a fellow student that helps them feel at home at the TU/e campus, and offers advice and support in practical matters. This support network for first-year students was especially important during the COVID-19 lockdowns in 2020 and 2021, where it was utilized to monitor the well-being of students within the programme. A comparable system is used at the end of the BSc, where students work on their Bachelor End Project. Students regularly meet in a group with other students working on their BEP, and are coached by a master student. The coaches are supported through intervision meetings with the BEP coordinator and a trainer. This buddy system provides students with structure and support during the BEP period.

The panel is positive on the attention paid to guidance and support, and noted during the interviews that students also value this aspect of the programmes. Combined with the mentor system in the MScs, the guidance structure in the programmes creates a learning environment that feels personal and supportive. Although students often take longer to complete the curriculum, the panel learnt from management as well as students that these delays are usually self-inflicted due to taking extra courses, part-time jobs or prolonging the time spent abroad for travelling in the MScs, and that there are no structural elements in the three programmes that prevent timely completion.

The programmes have multiple opportunities for students to tailor the programme to their own preferences. The BSc IE has 45 EC of elective space, whereas master students can choose between tracks and can have up to 50 EC (OML) and 55 EC (IM) of elective space with the track and free electives combined.

Where in the BSc the free elective space is mainly used for broadening, the elective space in the MScs is a core part of the curriculum. To help students compose a coherent curriculum that aligns with the individual interests of the student, each master student is assigned a mentor shortly after the start of the programme. The mentor is preferably a staff member with expertise in the area in which a student is interested for specialization, and helps the students making choices for electives and the development of professional skills. The mentors are trained and have regular intervision sessions with the academic advisors.

The panel learnt that students generally very much appreciate this personalized approach to the programme. It allows students flexibility in composing their curriculum, and adds to the small-scale feeling of the MScs by offering students personal contact with a member of the teaching staff in regular meetings. The panel praises the master programmes for this, and considers the mentor system a key element of the MScs.

The timeline for finding a mentor is different for the two MScs. In the MSc IM, students choose a mentor in the second quarter of the first year, after having followed three core courses. In the MSc OML, specialization starts as early as the first quarter. Students therefore have to choose a mentor within the first six weeks of their first year. The panel learnt from students in OML that this can sometimes be overwhelming for students, especially for international students who are unfamiliar with the university. This could negatively affect

equal opportunities for mentors associated with popular research topics. The panel recommends investigating whether this system can be adjusted to prevent this.

Teaching staff
The teaching staff in the programmes comprises the academic staff of the School of Industrial Engineering, amounting to 143 lecturers in total. The majority of the teaching staff (53%) is active as either full, associate or assistant professor. Another large (44%) part is PhD student, and mainly involved in the daily supervision of BEPs in the BSc IE. The remaining 3% are dedicated lecturers associated with the programme. The teaching staff of several courses in each programme is complemented by so-called 'hybrid teachers': part-time researchers who also have a job in industry. Other courses use guest lecturers from industry. Of the current teaching staff (not counting PhD students), 71% has a University Teaching Qualification (UTQ), or is in the process of obtaining one. All new academic staff is required to follow the UTQ programme.

The panel is positive on the quality and quantity of the teaching staff. The lecturers are experts in their respective fields, and bring their research expertise as well as their connections to industry into the classroom. The teaching staff is balanced in terms of gender, and approximately half of the teaching staff member has an international background. Considering the recommended development of the programmes towards sustainability and societal challenges, the panel thinks that the School should aim for an increase in teaching staff members affiliated with those topics in order to build expertise and a more expansive network in this area.

The previous panel found that the teaching load in the programmes was too heavy, particularly the MSc OML. The School has invested in taking measures to reduce this, including an increase in staff. Based on the interviews during the site visit, the panel concludes that, notwithstanding the general high workload in academia in the Netherlands, the high teaching load is not the pressing issue it was six years ago.

During the site visit, the panel spoke with several representatives of the BSc IE on the role of PhD students in the supervision of bachelor projects. PhD students act as daily supervisor of the BEP, on behalf of a permanent staff member that also acts as examiner. From the student chapter as well as the student interviews, the panel understood that there are varying experiences on the quality of supervision in this system. According to students, the supervisors have a large amount of freedom in shaping the supervision, leading to large variations in the frequency of contact with both the daily and formal supervisor. Also, students report variation in the quality of supervision, as PhD students are often not equally equipped for a supervisory role. The panel understood that the programme has initiated a project group tasked with improving BEP supervision. It approves of this, and suggests considering measures such as a more uniform structure for supervision and a mandatory training for all PhD students involved in BEP supervision.

Considerations
All three programmes have adequately translated their intended learning outcomes into a coherent curriculum. The *BSc IE* offers a broad approach towards industrial engineering, with many connections to industry as well as the opportunity for students to adapt the curriculum using free elective space. The *MSc OML* offers a varied curriculum centred around improving operations in organizations, allowing students to specialize in a specific operational process through one of the four tracks, each of with has close connections to industry. Student can further customize their programme in the elective space and the master thesis project, which is often conducted in-company. The MSc IM provides students with knowledge and skills on how to further innovation in businesses, with specialization in innovative products and innovative processes. The curriculum is flexible with a substantive elective space, and the opportunity to work directly with innovative companies within the region.

The teaching methods as well as the facilities offered the programmes are appropriate. The panel considers challenge-based learning to be a very good fit for the programmes considering their multidisciplinary nature and many connections to industry. According to the panel, attention to sustainability could be expanded in the curricula of all three programmes. The panel recommends investigating opportunities to make this topic a core element of the curricula. Furthermore, attention to academic writing skills could be improved in the three programme. The BSc already made a start with this through the academic learning trajectory on this skill; the panel recommends monitoring the effect of this, and considering similar initiatives in both MScs.

Obtaining international experience in a semester abroad is a unique opportunity offered by both MScs. The dual degrees offered by both OML and IM offer additional opportunities for internationalization. All three programmes are offered in English, a choice that the panel considers to be well-substantiated considering the international orientation of the organizations in the professional field relevant to the programmes. The panel recommends further developing the international character of the programmes by a more explicit use of the possibilities of the international classroom.

The panel appreciates the flexibility of the curricula, and praises the personalized approach in both MScs, with mentors that discuss and compose a tailor-made curriculum with individual students. The MSc OML could consider an adjustment to the system of choosing a mentor, as finding a suitable mentor within four-weeks after starting the curriculum can be overwhelming, especially for students new to the TU/e. Guidance in the three programmes is well-organized. Next to the mentor system in the MScs, this includes a buddy system in the first year of each programme, and student coaches during the bachelor end project. The curricula of all programmes are feasible, without structural elements that prevent timely completion.

The teaching staff associated with the programmes is well-qualified, and has relevant expertise in industrial engineering, as well as many connections to industry. The panel supports the planned improvement to the supervision structure of the bachelor end projects, and suggests a more uniform structure as well as mandatory training for PhD students involved in supervision.

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 programmes follow the assessment policy of the School of Industrial Engineering & Innovation Sciences. Important principles are the alignment of ILOs and assessment methods, assessment as a tool for learning, and transparency. The various learning goals of each course are matched with a fitting assessment method. Lecturers have the primary responsibility for designing the assessment of a course. Prior to an examination, exams and answer models are checked by a second teaching staff member. For assignments and projects (including the thesis), rubrics are used and shared with students at the start of the assignment. For every new or significantly adapted course, the Programme Committee discusses the alignment between learning goals, teaching methods and assessment methods. During the COVID-19 pandemic, the School used online assessment for a short period of time, but switched back to on-site assessment as soon as this was allowed.

The three IE programmes share a Examination Committee. To safeguard the quality of assessment, the Examination Committee has appointed an Assessment Committee that annually checks the assessment in a sample of courses, and a Thesis Assessment Committee that takes annual samples of bachelor and master projects to examine the exit level of the programmes, as well as the quality of thesis assessment within the programmes.

The panel is positive in the system of assessment in the three programmes. The assessment methods are varied and fit the intended learning outcomes of the programmes. Most courses have multiple types of assessment, allowing students to use feedback from one assignment in the next one. There are several separate tests for skills, in particular for the BSc IE, which ensure that students master all relevant professional and academic skills individually. The assessment system promotes reliable, valid and transparent assessment, both for course assessment and the theses. Based on the interviews during the site visit, the panel concludes that the Examination Committee is very involved in the programmes and has a good working relationship with the faculty. It has its checks and balances in place and monitors the quality of assessment in each of the programmes.

The panel learnt that the programme management, teaching staff and Examination Committee are currently discussing the consequences of adopting challenge-based learning. CBL is associated with group work, which will provide the programmes with the challenge to assess students individually based on group projects. The panel praises the programmes for tackling this issue proactively, and has full confidence that the programmes are aware of the challenges and will find fitting solutions. The panel suggests student peer review and individual elements in courses with group work as possible solutions.

Thesis assessment
Students carry out their thesis project under the guidance of one (BSc) or two (MSc) supervisors. The first supervisor is a staff member of the School, and acts as the first point of contact for students throughout the project. He or she helps the student find a suitable company or other external organization, and helps negotiating a research project that fit the goals of both the programme and the company. If a student conducts the project within an external organization, an external supervisor will be sought for the student for daily supervision within the organization. This external supervisor is no formal assessor, but has an advisory role regarding the daily functioning of the student in the organization. The second supervisor in the master thesis project contributes to various feedback moments in the process by giving a second opinion regarding the student's work. The independent assessor is only involved at the end of each bachelor or master project, and is tasked with safeguarding that the project and its assessment is conducted according to the intended goals of the assessment. He or she assesses the Research Proposal at the beginning of the process and the written thesis at the end, but is in no way involved in the supervision and execution of the project. For the master thesis, the independent assessor usually also attends the presentation and participates in thesis defence. For the dual degrees in the MScs, each thesis is assessed by two examiners, one from each participating university. The examiners from TU/e check whether the thesis complies with the criteria and quality standards set by the School.

Bachelor students are assessed on four criteria related to research quality: Problem Identification and Theoretical Framework, Research Strategy, Research Execution and Conclusion and Discussion, with each criterion contributing 25% to the final grade. Furthermore, students are scored on the professional skills of Writing and Information, Planning and Organizing, Collaboration, Reflection and Presentation. These do not contribute to the grade, but if a student receives an Exceptional score for one or more skills, the assessors can jointly decide to give the student a 0.5 grade point bonus. The assessment of the master thesis projects in both programmes is formed by a weighed average of thesis grade (70%) and a process grade (30%). The

thesis grade is an overall score in which Scientific Quality and Scope, Research Method, Quality of Solution and Written Communication are considered, and the process grade includes Project Management and Planning, Cooperation, Academic Attitude, Societal Awareness and Oral Communication. The two (BSc) or three (MSc) examiners separately complete an assessment form and provide a grade. Due to his or her role, the independent assessor only focuses on the thesis quality, and does not contribute to the skills and process criteria. After that they engage in discussion with each other, and jointly decide upon the final grade, which they substantiate on a separate assessment form. The full thesis assessment file consists of the separate assessment forms of the examiners, and the final joint assessment form.

The panel approves of the thesis assessment procedures in all three programmes. The use of an independent assessor not associated with the project is a valuable instrument to safeguard the validity of the assessment. The fact that for in-company projects, external supervisors have an advisory role but do not grade, ensures that the programmes can grade the projects according to academic quality standards, without losing sight of the functioning of students in daily practice. The master programmes monitor the quality of the theses conducted in the dual degrees through direct involvement in assessment.

Prior to the site visit, the panel studied 15 thesis assessment files per programme to determine the quality of thesis assessment. It concludes that the theses for all three programmes have been assessed in an insightful and transparent way. The grades on the various criteria are matched on a rubric, adding to the consistency of grading between assessors. Using separate assessment forms for each examiner as well as a joint form for the resulting final assessment is a transparent way to show how the final grade was determined. The panel observed that participation in the thesis defence by the independent assessor is mandatory for the BSc, but not for the master thesis defence. This leads to a situation where some third assessors hand in their written assessment and skip the defence. This creates differences in the role of the third assessor, depending whether he or she participates in the assessment of the thesis defence and the discussion afterwards. The panel recommends streamlining this procedure. Since the defence as well as the deliberation among assessors is a central part of the thesis assessment, they should be mandatory for all assessors.

Considerations

The assessment system of all three programmes is valid, reliable and transparent. The assessment methods are varied and fit the intended learning outcomes. There are appropriate checks and balances to monitor the quality of exams as well as the thesis, with a constructive and proactive role for the Examination Committee. Thesis assessment is organized in an insightful and transparent way, with an independent assessor safeguarding the validity of the assessment. The panel recommends making participation in the master thesis defence mandatory for all assessors to further increase consistency of the thesis assessment.

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 the Bachelor End Projects of 15 bachelor graduates and 15 master thesis projects for both MScs. The panel took care that all tracks and variants of the master programmes

were sufficiently covered in the selection, including the Free Track in the MScs and the international dual degrees. As the current four tracks of the MSc OML have been introduced in 2022-2023, the theses were chosen from the former six tracks of the programme (see Standard 1).

The panel concludes that the theses were all of sufficient quality for academic bachelor and master programmes. The panel was impressed with the quality of the bachelor theses. They show a high variation of relevant topics, executed in companies from various different fields, reflecting the broad nature of the programme. The master theses OML show that students have had the opportunity to specialize in a specific area throughout their personal curriculum, which results in-depth theses on many different topics related to operations management, using solid analyses and methodologies. The master theses IM show a good mixture of theory and application, often combining literature and data analysis to provide insights into innovation processes in companies. In several cases throughout the programmes, the panel found that the writing skills of students could be improved (see Standard 2).

Alumni

Graduates of the BSc IE generally continue with a master programme, either at the TU/e or elsewhere, with a small number of graduates directly entering the industrial sector. Bachelor students staying in Eindhoven often choose either the MSc OML or IM. Graduates of the master programmes find a position in a wide variety of companies (89% has a job within 4 months after graduation), either in the Eindhoven Brainport Region or beyond. Several master graduates find their first job in a company where they executed their thesis project. Graduates of the programme are highly relevant to the professional field, as is demonstrated by the high involvement of industry in the programmes. A recent alumni survey shows that 97% of alumni from the programmes is satisfied or very satisfied with their education. From the documentation as well as the interviews during the site visit, the panel got the impression that graduates feel well-prepared for their future career. In particular, the external thesis projects provide students with hands-on experience in the professional field.

Considerations

The panel concludes that theses of all programmes are generally of a good quality and show that the intended learning outcomes of all three programmes are achieved. Graduates of the bachelor programme continue successfully into a master programme. Graduates of the master programmes end up in relevant positions, and are very satisfied with their education.

Conclusion

The panel concludes that all programmes meet standard 4.

General conclusion

The panel's assessment of the BSc Industrial Engineering is positive.
The panel's assessment of the MSc Operations Management and Logistics is positive.
The panel's assessment of the MSc Innovation Management is positive.

Development points

1. Broaden the scope of the programmes to include sustainability. This includes adding it more explicitly to the intended learning outcomes. It also includes broadening the programmes' ecosystem with societal stakeholders and teaching staff members with an expertise in sustainability, and making sustainability one of the core elements of the curricula.

2. Increase attention paid to academic writing skills in all three programmes, both in the curriculum and in feedback provided during the thesis process.

3. Exploit the international character of the programmes through a more explicit use of the possibilities of the international classroom, for instance by deliberate mixing of project groups and intercultural training.

4. Consider an adjustment to the system of choosing a mentor in the MSc OML, allowing new students more time to get familiar with the programme before making their choice.

5. Further streamline the thesis supervision of the Bachelor End Product by providing a more uniform structure for BEP supervision and introduce a mandatory training for PhD students involved in BEP supervision.

6. Make participation in the master thesis defense mandatory for all assessors to further increase consistency of the thesis assessment.

Appendix 1. Intended learning outcomes

BSc Industrial Engineering

General learning outcomes

Bachelor of Science graduates:

- are academically qualified to degree level within the domain of engineering science and technology,
- are competent in the relevant domain-specific discipline(s) at the level of a Bachelor of Science, as specified in the second paragraph,
- are able to conduct research and design under supervision,
- are aware of the significance of other disciplines,
- take a scientific approach to non-complex problems and ideas, based on current knowledge,
- possess intellectual skills and are able to reflect critically, reason and form opinions under supervision,
- Have the ability to communicate the results of their learning, thinking, acts and decision-making processes,
- can plan and execute their activities,
- are aware of the temporal and societal contexts of science and technology (understanding and analysis),
- in addition to a recognizable domain-specific profile, possess a sufficiently broad basis to be able to work or collaborate in an interdisciplinary and multidisciplinary context. Here, multidisciplinary means focusing on other relevant disciplines needed to solve the design or research problem in question.

Domain-specific learning outcomes of BSc IE

The relevant domain-specific disciplines, as referred to in the previous paragraph, second bullet, The BSc IE graduate can scientifically identify, understand, analyze and describe (the performance of) business processes. This involves a correct identification, understanding, description, assessment, application, and integration of the existing scientific knowledge for relevant business problems arising within industrial and service organizations. The scientific nature of the analysis means that the analysis is carried out in a structured and reproducible manner, using a careful and well-founded selection of theoretical models and research methods. Graduates of the BSc IE base their choices on academic knowledge of Mathematics, Modeling and Design, Information Systems, Operations Management, Work and Organizational Psychology, Innovation Management, and Business Economics.

Graduates of the BSc IE program:

- D1. identify, understand, analyze and describe (the performance of) business processes in a structured and reproducible manner, using a careful and well-founded selection of theoretical models and research methods. In this way, the graduates can design and conduct experiments, and analyze and interpret (quantitative and qualitative data).
- D2. determine and quantify how the performance of business processes changes as a function of changes in the input. The BSc graduates can apply this multidisciplinary knowledge and insight under supervision to optimize (operational) business processes systematically.
- D3. base their choices in conducting research on scientific knowledge from several disciplines. The graduate can integrate existing knowledge, modeling techniques, and research results, explicitly acknowledging the multidisciplinary nature of business processes.

- D4. produce (under supervision) recommendations for (re) design and/or improvement of these business processes. Graduates recommend (re)design directions considering the desired stakeholder needs within realistic constraints, such as economic, environmental, ethical, manufacturability, and sustainability aspects.

Graduates of the BSc IE program have an academic attitude, design skills, and a set of communicative and social skills. This makes them capable of:

- G4. Reflecting, thinking, and acting systematically, i.e. they have the skills to develop and use theories, models, and coherent interpretations and do so in a critical manner.
- G5. Communicating (in writing and speaking) clearly, unambiguously, and professionally in different contexts.
- G6. Operating independently as well as in interdisciplinary teams (in national and international contexts), drawing on self-management and project management skills.
- G7. Analyzing the ethical aspects and social and environmental consequences of (changes in) business processes.

MSc Operations Management and Logistics

General learning outcomes

Masters of Science graduates of this degree program:

- are academically qualified to degree level within the domain of 'science engineering & technology',
- are competent in the relevant domain-specific discipline(s) at the scientific Master's degree level, as indicated in paragraph 2,
- are able to conduct research and design independently,
- have the ability and attitude to include other disciplines in their research, where necessary,
- have a scientific approach to complex problems and ideas,
- possess intellectual skills that enable them to reflect critically, reason and form opinions,
- have the ability to communicate the results of their learning, thinking and decision-making processes at an international level,
- are aware of the temporal and social context of science and technology (comprehension and analysis) and can integrate this context in their scientific work,
- in addition to a recognizable domain-specific profile, possess a sufficiently broad basis to be able to work or collaborate in an interdisciplinary and multidisciplinary context. In this context, multidisciplinary means being focused on other relevant disciplines needed to solve the design or research problem in question,
- have the ability and attitude to seek new potential applications, taking the social context into consideration.

Domain specific learning outcomes:

Domain-specific disciplines as intended by the previous paragraph, second point:

Graduates of the MSc Operations Management & Logistics program are engineers who:

- Have state-of-the art scientific knowledge of the design, behavior, planning, and enhancing performance of operational processes in industrial and service organizations. For this purpose graduates have multidisciplinary knowledge and insights stemming from the following disciplines: artificial intelligence, engineering economics, information systems, operations research, and work & organizational psychology.

- Have the research skills needed to independently conduct studies meeting academic standards in the domain of Operations Management and Logistics.
- Are well-capable of modeling and (re)designing complex business processes, based on the results of a study, including specifications and required information. Are capable of applying this knowledge and insight into operational, consulting, and managerial jobs in industry.

Graduates of the MSc Operations Management & Logistics program are engineers who have academic skills, design skills, and communication and cooperation skills. They:

- are capable of applying their knowledge and insight into research & development jobs in academia;
- are capable of applying their knowledge and insight into operational, consulting, and managerial jobs in industry;
- are capable of operating independently and in teams, at an academic level;
- can critically reflect on their own thinking, decisions and actions and behave systematically;
- operate effectively and efficiently in a multidisciplinary context;
- communicate clearly and unambiguously, both in industry and in academia, with non-specialists
- and specialists in the domain;
- are aware of the relative importance of knowledge of scientific disciplines and the societal
- impact of scientific knowledge (and vice versa);
- possess the necessary learning skills to enable them to enter subsequent programs requiring
- substantial independence, such as PhD programs or postgraduate professional programs or
- courses;
- are capable of independently identifying and supplementing any lack of knowledge.

MSc Innovation Management

General learning outcomes

Masters of Science graduates of this degree program:

- are academically qualified to degree level within the domain of 'science engineering & technology',
- are competent in the relevant domain-specific discipline(s) at the scientific Master's degree level, as indicated in paragraph 2,
- are able to conduct research and design independently,
- have the ability and attitude to include other disciplines in their research, where necessary,
- have a scientific approach to complex problems and ideas,
- possess intellectual skills that enable them to reflect critically, reason and form opinions,
- have the ability to communicate the results of their learning, thinking and decision-making processes at an international level,
- are aware of the temporal and social context of science and technology (comprehension and analysis) and can integrate this context in their scientific work,
- in addition to a recognizable domain-specific profile, possess a sufficiently broad basis to be able to work or collaborate in an interdisciplinary and multidisciplinary context. In this context, multidisciplinary means being focused on other relevant disciplines needed to solve the design or research problem in question,
- have the ability and attitude to seek new potential applications, taking the social context into consideration.

Domain specific learning outcomes:

Domain-specific disciplines as intended by the previous paragraph, second point:

Graduates of the MSc Innovation Management program are engineers who:

- have state-of-the art scientific knowledge of the design, behavior, planning and enhancing performance of innovation processes in technology-intensive and knowledge-intensive organizations. For this purpose graduates have multidisciplinary knowledge and insights stemming from the following disciplines: Engineering economics, information systems, operations research, organization sciences, and work & organizational psychology;
- have research skills to independently conduct studies meeting academic standards, in the domain of Innovation Management;
- are well-capable of modeling and (re)designing a complex business process, based on the results of a study, including specifications and required information.

Graduates of the MSc Innovation Management program have an academic attitude, design skills, and a set of communicative and social skills. Because of this they are capable of:

- reflecting and creatively solving problems. They understand their own (and the organizational) learning process and have skills in this domain;
- communicating clearly and unambiguously both in industry and in academia, with non-specialists and specialists in the domain. Therefore, they have adequate social and communication skills;
- operating independently as well as in (multidisciplinary) teams;
- being aware of the social context they work in and social impact of their work.

Appendix 2. Programme curriculum

BSc Industrial Engineering

Year 1							
Q1		Q2		Q3		Q4	
Calculus 2 2WBB0 (1)	A	Physics 3INABO/3INBB0 (1)	B	Data Analytics for 2IABO (1)	A	USE-Basic 0SABO (1)	A/C/E
Fundamentals of Work & Organizational Psychology 1JV00 (1)	C	Statistics for IE 2DD80 (2)	C	Fundamentals of Operations Management 1CV00 (1)	C	Fundamentals of Product Innovation 1ZV50 (1)	B
Mathematics 1 2DD40 (1)	D	Fundamentals of Algorithmic Programming 1BK60 (1)	E	Fundamentals of Business Information Systems (IS1) 1BV00 (1)	B	Elective	

Year 2							
Q1		Q2		Q3		Q4	
Engineering Design 4WBB0 (2)	C	Fundamentals of Financial and Management Accounting 1CV10 (1)	D	Marketing Perspectives on Product Innovation 1ZV20 (2)	D	Design of Business Information Systems 1BV10 (2)	D
Methodology for IE Research including Professional Skills 1ZV60 (2)	E	Mathematics 2 2DD50 (3)	E	Stochastic Operations Management 1CV60 (3)	E	Manufacturing Integration Course (Integration2) including Professional Skills 1CV50 (2)	E
Elective / USE		Elective / USE		Elective / USE		Elective / USE	

Year 3							
Q1		Q2		Q3		Q4	
Organisational Behaviour for IE 1JV10 (3) WOP2	B	**Choose 2 out of 3 **Supply Chain Mgt. (OM3) 1CVK00 (3) **Business Analytics & Decision Support (IS3) 1BVK00 (3) **Strategic and Organizational Perspectives on Product Innovation (IM3) 1ZVK00 (3)	B D C	Bachelor End Project 1BEPO including professional skills 1BEPIE (3)		Bachelor End Project 1BEPO including professional skills 1BEPIE (3)	
Quality and Reliability Engineering (OM4) 1CV40 (3) OM4	C	**Choose 2 out of 3 **Supply Chain Mgt. (OM3) 1CVK00 (3) **Business Analytics & Decision Support (IS3) M. Firat 1BVK00 (3) **Strategic and Organizational Perspectives on Product Innovation (IM3) 1ZVK00 (3)	B D C	Elective		Elective	
Elective / USE		Recommended Elective IM3 / OM3 / IS3 (not chosen)		Elective / USE		*Restricted Elective for* External Bachelor End Project 1BEPIEX (3)	

MSc Operations Management and Logistics

Compulsory Core courses OML

Quarter A1	Quarter A2	Quarter B3	Quarter B4
1JM110 Research Methods (E)	One out of 2 1JM50 Implementing and Adapting to AI in Organizations (C1)	1BM110 Data Driven AI (C2)	
		One out of 2 1JM11Performance enhancement (E)	

SERVICES

Quarter A1	Quarter A2	Quarter B3	Quarter B4
Track core courses			
	1BM20 Business Analysis for IT Systems (E2, E3)		1BM100 Design of Service Operations (B2)
One out of 2 1BM140 Engineering Knowledge-Intensive Business Processes (B2, B3 Wed 3e+4e h + Thu 9e+10e h)			
	One out of 2 1BM05 Business process management (B1)		
	One out of 3 1CM120 Advanced Maintenance and Service Logistics (A)	One out of 3 1CM100 Multi-Echelon Inventory Management C1)	
	One out of 3 1CM10 MAMS (D)		
Track specialization courses (mimimum of 10 ects)			
1CM22 Integrated fin & operations mgt (B Mon 5e t/m 8eh + Wed 1e + 2eh)	1CM190 Health Care Operations Management (A1) (2,5 ECTS)	1JM40 Behavioral Operations Management (A)	1BM10 E-business A2-A3
1CM40 Retail operations (C-Tues 1e t/m 4e h)	1CM200 Warehouse Operations Management (B2, B3) (2,5 ECTS)	1ZM65 System Dynamics (D2)	1BM120 Decision making with artificial and computational intelligence (C)
1ZM31 Multivariate statistics (A)	1CM220 Robust Policies for Operation Management Problems (E1) (2,5 ECTS)	2DI66 Advanced simulation (B)	1BM130 Design of AI-Driven Business Operations (B1 Mon 5e+6e h)
	1JM30 Managing team dyn & team perf (C2)		1JM21 Designing effective performance (A1)
	1ZM55 Service innovation management (E1)		

SUPPLY CHAINS

Quarter A1	Quarter A2	Quarter B3	Quarter B4
Track core courses			
		1CM100 Multi-Echelon Inventory Management (C1)	1CM140 Design of oper Plan & contr systems (B2)
	one out of 2 1CM10 MAMS (D)		
	one out of 2 1BM05 Business process management (B1)		
one out of 2 1CM40 Retail operations (C-Tues 1e t/m 4e h)	one out of 2 1BM20 Business Analysis for IT Systems (E2, E3)		
Track specialization courses (mimimum of 10 ects)			
0LM120 Perspectives on Medical Technology (C)	1CM110 Decision Making in Transport and Logistics (A)	1CM240 Artificial intelligence for logistics and its interfaces (D1)	1BM120 Decision making with artificial and computational intelligence (C)
1BM140 Engineering Knowledge-Intensive Business Processes (B2, B3 Wed 3e+4e h + Thu 9e+10e h)	1CM120 Advanced Maintenance and Service Logistics (A)	1JM40 Behavioral Operations Management (A)	1BM130 Design of AI-Driven Business Operations (B1 Mon 5e+6e h)
1CM22 Integrated fin & operations mgt (B Mon 5e t/m 8e h + Wed 1e + 2e h)	1CM200 Warehouse Operations Management (B2, B3) (2,5 ECTS)	1ZM65 System Dynamics (D2)	1CM36 Game theory (D)
1CM150 Advanced Planning and Scheduling Systems (C Friday 5e t/m 8e)	1CM220 Robust Policies for Operation Management Problems (E1) (2,5 ECTS)	2DI66 Advanced simulation (B)	1CM170 Sustainable supply chains (E)
1ZM31 Multivariate statistics (A)	1JM30 Managing team dyn & team perf (C2)		1JM21 Designing effective performance (A1)

MANUFACTURING and MAINTENANCE

Quarter A1	Quarter A2	Quarter B3	Quarter B4	
Track core courses				
	one out of 2 1CM10 MAMS (D)*			
	one out of 2 1CM120 Advanced Maintenance and Service Logistics (A)*		1CM140 Design of oper Plan & contr systems (B2)	* choice 1 out of 2 and 1 out of 4 should be different
one out of 4 1CM160 Manufacturing technology (D)*	one out of 4 1CM120 Advanced Maintenance and Service Logistics (A)*	one out of 4 1CM100 Multi-Echelon Inventory Management (C1)*		
One out of 2 1BM140 Engineering Knowledge-Intensive Business Processes (B2, B3 Wed 3e+4e h + Thu 9e+10e h)	one out of 4 1CM10 MAMS (D)*	one out of 4 1CM160 Manufacturing technology (E)*		
	one out of 2 1BM05 Business process management (B1)			
Track specialization courses (mimimum of 10 ects)				
1CM22 Integrated fin & operations mgt (B Mon 5e t/m 8e h + Wed 1e + 2e h)	1BM20 Business Analysis for IT Systems (E2, E3)	1JM40 Behavioral Operations Management (A)	1BM120 Decision making with artificial and computational intelligence (C)	
1CM150 Advanced Planning and Scheduling Systems (C Friday 5e t/m 8e)	1CM200 Warehouse Operations Management (B2, B3) (2,5 ECTS)	2DI66 Advanced simulation (B)	1BM130 Design of AI-Driven Business Operations (B1 Mon 5e+6e h)	
1ZM31 Multivariate statistics (A)	1CM220 Robust Policies for Operation Management Problems (E1) (2,5 ECTS)		1CM36 Game theory (D)	
	1JM30 Managing team dyn & team perf (C2)		1CM170 Sustainable supply chains (E)	
			1JM21 Designing effective performance (A1)	

TRANSPORT AND MOBILITY

Quarter A1	Quarter A2	Quarter B3	Quarter B4
Track core courses			
	1CM110 Decision Making in Transport and Logistics (A)		1CM130 Design for Transport and Logistics (B Mon 7e+8e h and Wed 1e t/m 4e h)
	1BM20 Business Analysis for IT Systems (E2, E3)		
one out of 2 1CM260 Large-scale optimization in transportation and mobility (D)		one out of 2 1CM240 Artificial intelligence for logistics and its interfaces (D1)	
Track specialization courses (mimimum of 10 ects)			
1CM22 Integrated fin & operations mgt (B Mon 5e t/m 8e h + Wed 1e + 2e h)	1BM05 Business process management (B1)	1CM100 Multi-Echelon Inventory Management (C1)	1BM120 Decision making with artificial and computational intelligence (C)
1CM40 Retail operations (C-Tues 1e t/m 4e h)	1CM10 MAMS (D)	1JM40 Behavioral Operations Management (A)	1BM130 Design of AI-Driven Business Operations (B1 Mon 5e+6e h)
1ZM31 Multivariate statistics (A)	1CM200 Warehouse Operations Management (B2, B3) (2,5 ECTS)	2DI66 Advanced simulation (B)	1CM36 Game theory (D)
	1CM220 Robust Policies for Operation Management Problems (E1) (2,5 ECTS)		1CM170 Sustainable supply chains (E)
			1JM21 Designing effective performance (A1)

1ML05	
International Semester and/or Electives	*Graduation Project 1.M96*

MSc Innovation Management

Q1	Q2	Q3	Q4	
1ZM16 (D) Management of Product Development	Track Elective	**1ZM11 (E)** Marketing and Innovation	**1ZM130 / 1ZM140 (B)** Design Science Methodology and Project	35 ECTS
1JM06 (C) Human Aspects of Innovation	Track Elective	**1BM110 (C)** Data driven AI	Track Elective	
1ZM31 (A) Multivariate Statistics	Track Elective	1ZM65 (D2) System Dynamics	Track Elective	
5 OUT OF 9 TRACK ELECTIVES				
	1BM20 (E2) Business Analysis for IT Systems **E2**		1ZM60 (E1-E3) Selling new products	25 ECTS
	1JM50 (C1) Implementing and Adapting to AI in Organizations		1ZM70 (E) Entrepreneurial finance	
	1ZM20 (A) Technology entrepreneurship		1ZM90 (A) Open innovation	
	1ZM120 (B) Entrepreneurial marketing		DBM160 Data-enabled design (A1-A2)	
	0EM160 (B2, B3) Innovation and Intellectual Property Rights			
Q1	**Q2**	**Q3**	**Q4**	60 ECTS
Free elective / International	Free elective / International	Master thesis		
Free elective / International	Free elective / International			
Free elective / International	Free elective / International			

Appendix 3. Programme of the site visit

Tuesday 18 October

17.00h – 18.30: Preparatory panel meeting
Including open consultation hour

Wednesday 19 October

09.00h – 09.15h: Welcome.
09.15h – 10.15h: Interview Management
10.15h – 10.30h: Break
10.30h – 11.15h: Interview BSc IE students
11.15h – 11.30h: Break
11.30 – 12.30h: BSc IE (part 1) Teaching and Learning Environment. How can we improve the BSc IE program further in the future in terms of content (synergy) and organization? How is the panel looking into the increased use of online material and how do you think the program can benefit?
Participants: Programme management, programme committee, teaching staff
12.30h – 13.15h: Lunch break
13.15h – 14.15h: BSc IE (part 2) Assessment. How does the committee evaluate the BEP setup? What improvements can/should be considered?
Participants: Programme management, programme committee, examination committee, teaching staff
14.15h– 14.45h: Guided tour Atlas and Auditorium
14.45h – 15.30h: Interview MSc OML students
15.30h – 16.30h: MSc OML (part 1) Teaching and Learning Environment. How does the committee view the advantages and disadvantages of the (current) mentoring system? Does the committee see substantive points for improvement in the MSc OML program (more specifically: The general OML profile in relation to the distinction in tracks)?
Participants: Programme management, programme committee, teaching staff
16.30h – 17.30h: MSc OML (part 2) Assessment. How does the committee evaluate the MSc thesis assessment (i.e., balance between transparency and objectivity, and enough expert freedom to cover the wide range of different thesis projects? Does the committee see opportunities for improvement regarding "Quality and possible overlap in international semester?
Participants: Programme management, programme committee, examination committee, teaching staff
17.30h – 18.00h: Internal discussion panel

Thursday 20th October

09.00h – 09.30h: Preparation panel
09.30h – 10.15h: Interview MSc IM students
10.15h – 10.30h: Break
10.30h – 11.30h: MSc IM (part 1) Teaching and Learning Environment. How does the committee advise on our ambition to grow: How can we scale up without sacrificing quality and without putting even more strain on teachers? Can we scale up with CBL, blended learning? How can we further stimulate the influx of international students?
Participants: Programme management, programme committee, teaching staff
11.30h – 12.30h: MSc IM (part 2) Assessment. How to differentiation between individual and group components in CBL courses? What is the vision of the committee on innovative assessment methods, with specific emphasis on individual learning paths, as noted in the 2030 TU/e strategy?
Participants: Programme management, programme committee, examination committee, teaching staff
12.30h – 13.30h: Panel discussion (lunch included)
13.30h – 14.15h: Interview management
14.15h– 16.00h: Drafting intended advice
16.00h – 16.30h: Public feedback of the intended advice

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:

- SWOT analysis
- Reading guides
- Student chapter
- Report previous accreditation 2016
- Intended learning outcomes
- Domain Specific Framework of Reference
- Schematic overview of the curriculum
- Study guides
- Composition and minutes Societal Council
- Programme and Examination Committee reports
- Internal Evaluation Reports
- List of lecturers
- Content and assessment of a selected number of courses from each programme
- Assessment policy
- Assessment plan
- Examination Regulations
- Thesis manuals
- Consortium agreements dual degrees