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BSc Technische Bedrijfskunde
MSc Industrial Engineering and Management
University of Groningen

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Summary

Standard 1. Intended learning outcomes

According to the panel, the profile and aims of the bachelor Technische Bedrijfskunde (international name: Industrial Engineering and Management Science or IEM) and MSc IEM are fit for academic bachelor's and master's programmes in the field of industrial engineering and management, with a strong focus on engineering through applying the full design cycle in technological business challenges. The goals of both programmes have been well-translated into two coherent sets of intended learning outcomes which are aligned with the requirements of the academic and professional fields. The programmes could work on further directing their narrative towards external stakeholders and prospective students. An interesting direction could be a focus on the preparation of students to guide companies in their transformations towards a sustainable society. This should then also be reflected in the ILOs of the programmes, for instance by adding transdisciplinary skills, transition management, innovation thinking and stakeholder analysis.

Standard 2. Teaching-learning environment

The intended learning outcomes of the BSc and MSc are well incorporated into the curricula. These reflect the focus on engineering and the design cycle and offer a good balance between theory and practice. The BSc IEM offers a solid foundation in engineering and management and teaches students how to integrate these aspects when working on multidisciplinary challenges. The MSc IEM further integrates engineering and management, allowing students to work on challenges related to Production Technology and Logistics or Sustainable Process Engineering. Both programmes offer students ample opportunity to tailor the programme to their own preferences. The choice to offer the programmes in English is well substantiated.

The focus of the programmes on learning communities, that is collaboration throughout learning and mentoring, is a strength and provides students with personal support and guidance. The teaching staff is well qualified and dedicated to the programme, bringing state-of-the-art research as well as connections to the professional field into the programme. The programme-specific facilities are impressive and fit the engineering focus of the programme.

Depending on the choices made regarding the further development of the programmes' profiles, the programmes could be adapted to expand multidisciplinary courses to include trans-disciplinarity aspects, teaching students to cross boundaries of disciplines and involve multiple stakeholders. Furthermore, attention to writing skills could be improved.

Standard 3. Student assessment

The panel is positive regarding the system of assessment in both programmes. The assessment methods are varied and fit the learning goals of the courses as well as the ILOs, with sufficient attention for individual performance in group work. The Board of Examiners operates in a professional way. It has checks and balances in place and plays an important role in the quality assurance of the programmes. The thesis assessment procedure is up to standard. The procedure could be further improved by including the two separate assessments of both examiners in the assessment file, and by ensuring that there is always one examiner that is not involved with supervision of the thesis.

Standard 4. Achieved learning outcomes

The panel concludes that the final products show that the intended learning outcomes of both programmes are achieved. The programmes prepare students for relevant master programmes (BSc) and relevant positions in the professional field (MSc).

Score table

The panel assesses the programmes as follows:

BSc Industrial 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 Industrial 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

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

Peter Hildering MSc, secretary

Date: 23-01-2023

Introduction

Procedure

Assessment

On 4 and 5 October 2022, the programmes Industrial Engineering and Management of the University of Groningen 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 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. 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 2016-2021. 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 ensured that all tracks were covered in the 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 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 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 22 September 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 the University of Groningen.

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 the University of Groningen consisted of the following members:

- Prof. dr. J. (Nico) Vandaele - chair
- Prof. dr. A. (Allan) Larsen
- Prof. dr. E.M.M. (Emmo) Meijer
- Dr. Ir. J.C. (Jaap) Schouten
- Prof. em. dr. ir. J.P.L. (Joos) Vandewalle
- L.P.F. (Lynette) Haksel BSc – student member

Information on the programmes

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

Programme name	Technische Bedrijfskunde (International name: Industrial Engineering and Management Science) *
CROHO number:	56994
Level:	bachelor
Orientation:	Academic
Number of credits:	180 EC
Specialisations or tracks:	Production Technology and Logistics Sustainable Process Engineering
Location:	Groningen
Educational minor:	Applicable
Mode(s) of study:	Fulltime
Language of instruction:	English
Submission date NVAO:	01-05-2023

* This report will use the common English name Industrial Engineering and Management for the BSc Technische Bedrijfskunde.

Programme name	Industrial Engineering and Management
CROHO number:	60029
Level:	master
Orientation:	Academic
Number of credits:	120 EC
Specialisations or tracks:	Production Technology and Logistics Sustainable Process Engineering
Location:	Groningen
Mode(s) of study:	Fulltime
Language of instruction:	English
Submission date NVAO:	01-05-2023

Description of the assessment

Organisation

The bachelor's and master's programmes Industrial Engineering and Management (IEM) are embedded in the School of Science and Engineering (SSE) and the Faculty of Science and Engineering (FSE) at the University of Groningen. SSE organizes 40 bachelor's and master's programmes in six disciplinary clusters: Biology, Chemistry, Pharmacy, Physics, Mathematics and Engineering. The IEM programmes are organized by the Engineering cluster, together with the Biomedical Engineering and Mechanical Engineering programmes. Education is organized on the cluster level, with the directors of the individual programmes forming (together with others) the programme board that heads the cluster. The BSc and MSc IEM have a joint Programme Committee, and share a Board of Examiners with the other programmes in the cluster.

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 Industrial Engineering and Management programmes at the University of Groningen aim to teach students to translate new industrial techniques into practical solutions, such as more sustainable production processes and new products. They prepare students for careers as industrial engineers, in which they will apply technological solutions in the business world. They learn to work on a complete design cycle, from problem definition and analysis to implementation and evaluation of design feasibility. The programmes have a relatively strong focus on technology and technical sciences compared to other IEM programmes in the Netherlands. Roughly, two-thirds of the curricula is oriented towards technology, with the other third oriented towards business and management.

The *BSc IEM* aims to teach students the elementary principles of IEM design engineering issues and prepares students for IEM or other engineering master's programmes. In the second half of the curriculum, students choose between two majors. The first major, Production Technology and Logistics (PTL), focuses on the logistics and automation of production processes at large factories, whereas the Sustainable Process Engineering (SPE) major covers the optimization of chemical and biochemical production processes in an industrial setting.

The *MSc IEM* aims to educate and train engineers to design solutions to technical problems in a specific industrial and business context from a strong technological and research perspective. The context depends on the track the students choose. At the start of the programme, students choose between the Production Technology and Logistics and the Sustainable Process Engineering tracks, which are comparable in focus to the majors in the BSc IEM.

The panel studied the profiles of the IEM programmes and discussed them with staff and students during the site visit. The panel learned from the content of the curricula as well as from the site visit that the programmes stand out through a strong engineering component comparable to similar IEM programmes. Students apply the full design cycle when dealing with challenges related to technology and technological

innovation in a broader business context. For instance, students work on design projects in the lab and follow engineering courses such as Fluid Dynamics and Materials and Molecules. The programme management and teaching staff explained to the panel that they envision IEM graduates becoming employees who oversee and manage technical processes or projects. Therefore, they need knowledge of technology. They also must be able to define which expertise and specialists to include. The panel appreciated this further clarification and thinks that the programmes have chosen a coherent profile and focus.

At the same time, the programmes could work on improving their narrative.The panel feels that the programme could benefit from an overarching story that binds the courses together, and demonstrates the nature and value of the programme to both internal and external stakeholders. Based on discussions with various programme representatives, the panel suggests that the main focus of this narrative could be preparing students to assist companies with large systematic changes and complex transitions towards a more sustainable society. Over the next decades, graduates will be part of transformations towards a sustainable society, and the programmes could play a significant role in assisting organizations and companies prepare for this transition. The panel recommends ensuring that the chosen narrative is fully implemented throughout the entire programme. This includes connecting this narrative to the content of the two tracks in both programmes to help students make curriculum choices based on their future career ambitions.

Stakeholders that could benefit from this narrative also include prospective students. The panel noticed through discussions that a considerable number of first-year bachelor students drop out of the programme. They often state as one of the reasons that the programme, particularly its strong engineering focus, did not meet their expectations. The MSc struggles to retain graduates from the BSc IEM as well as attracting BSc graduates from other universities. The panel realizes that there are many possible explanations for dropouts but thinks that a more elaborate and well-defined selling proposition for the programmes could help in better showcasing the programmes to the outside world. Altogether, this can help manage student and prospective student expectations and offer them a stimulating and attractive proposition.

In order to keep the mission and content of the programmes aligned with the expectations of the professional field, the programmes have an Industrial Advisory Board with representatives from various relevant companies, such as Philips, FrieslandCampina and Shell. This board meets with the programme directors once a year to discuss developments in the programme. The panel thinks that the Industrial Advisory Board is a valuable platform for collecting input from the professional field. According to the panel, the role of the Industrial Advisory Board would be even more valuable if it also included input from societal and governmental stakeholders. The panel advises that the programmes consider expanding the Board in this direction by including members from governmental and non-governmental organisations (NGOs). The panel thinks that this Board, as well as more intensive connections with the professional field in general (an ‘outside in’ perspective), could help the programme in reformulating its goals (see above).

Intended learning outcomes

Each programme has translated its aims into a set of eight intended learning outcomes (ILOs) which describe the knowledge, skills and attitudes that students are to obtain by the end of the programme (see Appendix 1). Based on the recommendations of the previous accreditation panel, the programmes have worked on a further differentiation between the ILOs of the BSc and MSc IEM. The programmes have reformulated the ILOs by further articulating the existing differences in level, profile and orientation between the bachelor’s and master’s programmes.

The panel studied the ILOs of both programmes and concluded that they form a well-structured overview of the main goals, translated into the knowledge and skills to be acquired by students. An overview provided by the programme demonstrates that the ILOs align with the Dublin descriptors for bachelor's and master's programmes, thereby 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 for IEM. The ILOs describe knowledge and skills relevant to the field of IEM (ILO 1–3), academic skills (ILO 4–5) and professional skills (ILO 6–8), reflecting their academic orientation as well as their alignment with the requirements of the professional field.

In line with the earlier discussion of the programmes' profiles, the panel recommends aligning the ILOs with the new narrative of the programmes, if necessary. This could, for instance, take the form of intended learning outcomes describing the preparation of graduates for playing a role in large systematic changes and complex transitions of the future. According to the panel, relevant knowledge, skills and attitudes include transdisciplinary skills, transition management, innovation thinking and stakeholder analysis. The panel suggests adding these to the programme objectives since they can help students prepare for this future role.

Considerations

According to the panel, the profile and aims of the BSc and MSc IEM are fit for academic bachelor's and master's programmes in the field of industrial engineering and management, with a strong focus on engineering through applying the full design cycle in technological business challenges. The goals of both programmes have been well-translated into two coherent sets of intended learning outcomes which are aligned with the requirements of the academic and professional fields. The programmes could work on further directing their narrative towards external stakeholders and prospective students. An interesting direction could be a focus on the preparation of students to guide companies in their transformations towards a sustainable society. This should then also be reflected in the ILOs of the programmes, for instance by adding transdisciplinary skills, transition management, innovation thinking and stakeholder analysis.

Conclusion

The panel concludes that both 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

Curricula

The curricula of the BSc and MSc IEM have been designed to teach students the complete design cycle, from problem definition and analysis to design/redesign, implementation and validation in a business context. The content of the curricula is highly multidisciplinary and combines mathematics, physics, chemistry and social sciences to provide students with all the knowledge and skills necessary for an academically trained IEM engineer. Students are trained to cross-disciplinary borders, with several courses in both programmes aimed at integration between disciplines. Students often work in teams on open-ended problems and challenges (problem-based learning) combined with individual capstone projects. The full curricula can be found in Appendix 2.

The *BSc IEM* defines three learning pathways: the mathematical-technical foundation, the business environment and engineering integration. The mathematical-technical foundation courses consist of core knowledge from relevant disciplines necessary for an IEM engineer, such as mathematics, fluid dynamics, programming, modelling and materials science. The business environment courses familiarise students with relevant elements from business sciences, such as management accounting, organizational behaviour marketing and innovation strategies. The third pathway integrates the other two pathways and offers courses that combine engineering and business insights, such as sustainable engineering design and systems dynamics. Woven through these pathways are three skills: reporting (which includes writing and presenting), teamwork and programming, which are covered by multiple courses.

In the first part of the BSc, students follow the core courses in either of the three pathways (90 EC). In the second part, students enter a phase with emphasis on individual choices, starting with a choice between the PTL and SPE majors (45 EC of major-specific courses) halfway through the second year and the choice of a 30-EC minor in the third year. For the minor, students can choose a package of courses aimed at either specialisation within the field of IEM or broadening into another field through one of the university-wide minors. Students can also opt to follow a minor elsewhere, at another Dutch university or abroad. Students complete their programme with the individual bachelor's integration project (15 EC). In this project, students combine the knowledge and skills obtained during the programme to investigate an often real-life engineering design challenge, which is frequently inspired by, or directly obtained from, a business context.

The *MSc IEM* introduces the PTL and SPE tracks right from the start, including 45 EC of track-specific courses and electives. In addition, all students follow three core IEM courses (15 EC), integrative courses that contain the main skills and knowledge required from all students. Students can further personalize their track by choosing sets of elective courses with a specific focus, such as control engineering and robotics or game theory and optimization in PTL or biotechnology and process engineering in SPE. The second year of the MSc is dedicated to two major individual projects: the master design project (25 EC) and master research project (30 EC), complemented by a 5-EC course on research methodology. The design project is an internship in an industrial setting, where students work on a specific design challenge at their internship company. The research project is considered the thesis of the programme and is a research project conducted under the supervision of one of the members of the associated IEM research groups.

The panel studied the structure and content of the curricula as well as the content of a selection of courses for both programmes and spoke to programme management, teaching staff and students. The panel found that the intended learning outcomes of both programmes are well incorporated into the curriculum, including content related to processes and products as well as academic and professional skills. The panel observed with appreciation that the curriculum is designed to teach students the complete design cycle, from problem definition and analysis to design/redesign, implementation and validation in a business context. From the interviews with staff and students, the panel learned that the programmes have a good balance between theory and practice and that there is plenty of space in the curriculum for both lab and project work. According to the panel, this balance reflects the programmes' focus on engineering and allows students to learn through both theory and practice.

The panel learned from the documents that the *BSc IEM* has a well-structured programme. The three learning pathways in the BSc IEM provide structure to the programme and help students build as well as integrate their knowledge and skills in core engineering and business sciences. The curriculum has sufficient room for individual choices by the students, showing that the recommendation of the accreditation in 2016 to bring more flexibility into the programme has been incorporated. This is particularly visible in the second part of the BSc, where students can select one of two majors, a minor and an individual bachelor's integration

project. From the interviews with staff and students, the panel got the impression that the IEM integration project provides students with the opportunity to integrate the knowledge and skills obtained during the programme. Students appreciate this setup, especially the opportunity to work on real-life challenges.

The core courses of the *MSc IEM* provide a solid foundation for all students, after which students can specialize in one of two tracks. Students can further personalize their track by choosing sets of elective courses with a specific focus. The panel appreciates this room for electives since it allows individual students to tailor the programme to their own interests. The combination of an internship in an industrial setting and a research project creates a strong balance between theory and practice in the final part of the curriculum.

The panel advises both programmes to further develop trans-disciplinarity in the curriculum. There is a growing need in industry and society for experts who can work on complex industrial challenges by integrating various disciplines and viewpoints. In order to contribute to this need, graduates require skills that allow them to combine insights from both technology and management, while incorporating the demands and interests of various stakeholders. The programmes could begin training students for such a trans-disciplinary perspective as early as in the bachelor programme. Since the programmes already contain several courses with a multidisciplinary focus, the panel thinks that IEM is in a good position to extend this focus to trans-disciplinarity. According to the panel, possible directions to explore are, for instance, co-teaching of courses by lecturers with different disciplinary backgrounds and projects where students work with students from other programmes on a multidisciplinary challenge. As there is an extensive network of companies among the teaching staff, actual cases from industry could be used for this. This could help students experience the broader societal context in which technological challenges are embedded.

Attention to writing and reporting skills could be expanded in both programmes. In the theses that the panel read (see Standard 4), there were several instances of informal use of language and inconsistencies in layout. In its discussion with the Board of Examiners, the panel found that the Board came to similar conclusions based on its latest thesis check and already made remarks regarding this to the programme management. The panel seconds this and advises that increasing attention be paid to scientific writing and reporting in the skills courses in both programmes as well as in thesis supervision and grading.

Language and internationalization
In line with the policies of the RUG, both programmes are offered in English. According to the programmes, English is the dominant language in academia and in the professional field. The job market is highly international. This means that the English language is essential for participation in the international professional environment where graduates of the programmes can be expected to work. As the staff in the faculty is very international, the use of English means that all staff members can participate in education. Due to this international context, the entire teaching staff works and communicates in English on a day-to-day basis. For new staff members, language proficiency is one of the selection criteria. Additionally, the university offers courses to improve language proficiency of all staff members.

The panel considers the choice of the use of English to be well motivated. The programme is offered in an international environment regarding both the field of Industrial Engineering and Management and the staff of the faculty. An English language programme prepares students for an internationally oriented field. Students are positive about the quality of the English education. Sufficient attention is paid to the language skills of the teaching staff.

Guidance and feasibility

At the start of the BSc IEM, students are enrolled in a learning community, typically consisting of around 20 students and coached by one of the IEM staff members. This method gives students a sense of belonging to a smaller involved community throughout the courses and stimulates collaborative learning and teaching. In the first and second years, these learning communities meet on a weekly basis, following a dedicated programme linked to the curriculum. Students are coached on, for instance, effective studying, academic writing, presenting and other skills relevant to the course components that run parallel to their meeting. The focus of the learning community is on practicing and coaching; students are never assessed in the context of the learning community.

Guidance in the second half of the BSc and in the MSc IEM is increasingly focused on individual choices and needs. The master programme helps students select a coherent curriculum through suggested specialization options and provides close supervision by staff members throughout the individual research and design projects. The final research projects in the BSc and MSc are conducted within the research groups and supervised on an individual basis by one of the researchers associated with the programme. For the design projects in the MSc, which are conducted in-company, students are assigned a daily supervisor within the company, with a formal supervisor at the university who is responsible for the academic quality and assessment of the project. If necessary, the supervisor of the design project can also help students find a suitable internship position.

The panel is positive towards student support in the programmes. The focus on coaching in small groups and individual supervision provides students with personalized guidance, helping them find their way in the programme and fully develop themselves. An example of personal support is that the programmes – in individual cases or in special circumstances – offer rapid retakes for failed exams rather than waiting for the official exam week for retakes, allowing students to minimize study delay. The panel learnt from staff and students that this personal approach was also very helpful in supporting students during the COVID-19 pandemic.

Based on the interviews with students and staff, the panel considers the curricula to be feasible for students. The average study duration is approximately 3.5 years for the BSc and 2.5 year for the master, which the panel understood to be mainly related to personal choices of students, such as engaging in extracurricular activities and having part-time jobs. Students experience the workload as sometimes high but manageable. There is a substantial number of dropouts (up to 40%) in the first bachelor year, but as the panel found out during the site visit, these are mainly related to mismatches in expectations (see Standard 1) and not curriculum related.

Teaching staff

The majority of the teaching staff in the programmes are researchers at the Engineering and Technology Institute Groningen (ENTEG). The management-related courses are taught by teaching staff from the Faculty of Economics and Business. Over 90% of all teaching staff members hold PhDs, and a similar percentage holds a University Teaching Qualification (UTQ) or are in the process of obtaining one. All new staff members have a UTQ. Further professionalization is possible through Senior Teaching Qualification (STQ), which is meant for teaching staff at the programme management level. The annual retreats (*heidagen*) with staff members provide additional opportunities for teaching staff to professionalize and discuss educational developments in the programmes. In the BSc programme, the teaching staff is supported by Teaching Assistants (TAs), higher-year students who assist students in later cohorts in courses and projects. TAs are employed by the university and are required to follow a dedicated training programme.

During the site visit, the panel got the impression that the teaching staff is very engaged, enthusiastic and passionate about teaching in the programme. Students find the teaching staff accessible and engaged and are positive regarding the amount of feedback teachers provide to students on assignments, which they feel adds to their learning process. The teaching staff is involved in state-of-the-art research as well as in collaborations with companies and societal organizations, which brings research and professional practice into the classroom. Teaching assistants are very valuable to the programme, allowing for smaller-scale education. Furthermore, the position offers higher-year students a valuable opportunity to develop themselves. The panel observed that the gender balance in the teaching staff could be improved. It learnt that FSE is aware of this but that they need time to remedy the situation. It encourages the programmes and FSE to keep up their efforts in this respect.

Programme-specific facilities
During the site visit, the panel had the opportunity to take a tour of several programme-specific facilities, including the student labs and workspaces. The panel concluded that the facilities of the programmes are impressive. Students have the opportunity to work on design projects using state-of-the-art hardware and software. The panel got the impression that there is a good atmosphere for studying, community forming and joint working on projects. It learnt that IEM will move to a new building in the coming years, which is expected to present even more opportunities.

Considerations

The intended learning outcomes of the BSc and MSc are well incorporated into the curricula. These reflect the focus on engineering and the design cycle and offer a good balance between theory and practice. The BSc IEM offers a solid foundation in engineering and management and teaches students how to integrate these aspects when working on multidisciplinary challenges. The MSc IEM further integrates engineering and management, allowing students to work on challenges related to Production Technology and Logistics or Sustainable Process Engineering. Both programmes offer students ample opportunity to tailor the programme to their own preferences. The choice to offer the programmes in English is well substantiated.

The focus of the programmes on learning communities, that is collaboration throughout learning and mentoring, is a strength and provides students with personal support and guidance. The teaching staff is well qualified and dedicated to the programme, bringing state-of-the-art research as well as connections to the professional field into the programme. The programme-specific facilities are impressive and fit the engineering focus of the programme.

Depending on the choices made regarding the further development of the programme's profiles, the programmes could be adapted to expand multidisciplinary courses to include trans-disciplinarity aspects, teaching students to cross boundaries of disciplines and involve multiple stakeholders. Furthermore, attention to writing skills could be improved.

Conclusion

The panel concludes that both programmes meet Standard 2.

Standard 3. Student assessment

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

Findings

System of assessment

Both programmes follow the assessment policies of FSE, which aim to assure that assessments are valid, reliable, effective, fair and transparent. The programmes aim to provide a variety of assessment methods based on the nature of each course, and they include written exams, essays, reports, presentations and projects. To this end, the programme directors of each programme annually draw up an assessment plan detailing the relation between the programme ILOs and the curriculum as well as the relation between the course goals and teaching and assessment methods of each course. Furthermore, each course has a course unit assessment overview (CUAO) describing the course goals and assessment in relation to the programme ILOs. The programmes review the assessment plans and CUAOs each year. They constitute an important instrument for the Board of Examiners (BoE) in quality control of assessment. The panel is positive about the system of assessment in both programmes. The assessment methods are varied and fit the learning goals of the courses. The assessment plans ensure that course assessment covers all knowledge and skills described in the ILOs of the programmes. During the COVID-19 pandemic, the programmes used online assessment for a short period of time but switched back to on-site assessment as soon as this was allowed.

Due to the prominence of group work in the programmes, particularly in the BSc, the balance between individual and group assessment is an important element in the assessment policy of the programmes. The programmes ensure that in the assessment plans there are no ILOs, which are only assessed through group work throughout the curricula. Group projects are assessed on group performance level through reports and presentations and supplemented with feedback on individual performance obtained through peer feedback and group process monitoring. The BSc uses the CATME web-based assessment tool, which offers state-of-the-art software for peer assessment of students. The panel concludes that the programmes have solid procedures in place to ensure that all students individually obtain the learning objectives in group projects.

Board of Examiners

The IEM BSc and MSc share a Board of Examiners (BoE) together with the other Engineering programmes at the Faculty. The BoE monitors the quality of assessment in the programmes by annually checking the assessment of a selection of course units throughout the programmes and a selection of recent bachelor integration projects and master research projects, eight in total. The Board checks the level of the projects and theses as well as the reliability and transparency of the assessments. In case of shortcomings, the Board reports its findings to the examiners or to the programme management in case of more structural or serious issues. Additionally, the Board checks that all individual curricula of bachelor and master students cover the ILOs of the BSc and MSc, respectively.

The panel concludes that the Board of Examiners has checks and balances in place to monitor the quality of assessment as well as the exit level of the programmes. The interview with the BoE showed the panel that the Board is very aware of its responsibilities. Through its checks as well as its role in safeguarding the coherence of the individual curricula in the programmes, the Board plays an important role in the quality assurance of the programmes. The sampling of theses by the Board of Examiners is well designed for both BSc and MSc programme, although the panel found the sample size a bit low compared to the total numbers of theses per year. It suggests increasing the sample number to obtain a more detailed overview of thesis

quality and assessment.

Thesis assessment
The bachelor integration projects are evaluated by two independent assessors who separately assess the project and afterwards discuss their findings. The first assessor provides a grade and substantiation for all criteria, taking the assessment of the second assessor into account, after which both assessors sign the form. A third assessor is involved if there is a major disagreement on the score. The assessment criteria include design quality (70%), management of the integration project (10%), final presentation (10%) and final report (10%). Students can graduate if they receive a satisfactory (5.5 or higher) score for each of the four aspects. The master research project follows a similar procedure but with different assessment criteria, namely research quality (50%), management of research (25%), final presentation (12.5%) and final report (12.5%). Again, all four criteria are required to obtain a satisfactory score before students can graduate.

As part of its preparation for the site visit, the panel studied the 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. It observed that the contribution of the second examiner to the assessment was not always explicitly visible on the assessment forms. In some cases, the second examiner only signed for agreement with the overall assessment. The programme explained that both examiners independently assess the theses, decide upon a joint assessment afterwards and write this down on the assessment form. The panel approves of this procedure in principle and thinks that using two assessors who separately evaluate the theses adds to the validity and reliability of the assessment. In addition the panel thinks that the assessment process could be made more transparent by including the two separate assessments of both examiners to the assessment file for quality assurance purposes. This would make the contribution of both examiners visible and could provide insights into differences in judgement between the supervisor and second examiner. Furthermore, the panel noted that in some cases, particularly in strongly multidisciplinary work, both examiners are involved in supervision of the thesis. The panel thinks that a fully external view of an examiner not involved in supervision would further improve the validity of the thesis assessment. It recommends investigating ways to implement this, for instance by adding a third independent examiner for co-supervised theses, or having only one of the co-supervisors act as formal examiner.

Considerations
The panel is positive regarding the system of assessment in both programmes. The assessment methods are varied and fit the learning goals of the courses as well as the ILOs, with sufficient attention for individual performance in group work. The Board of Examiners operates in a professional way. It has checks and balances in place and plays an important role in the quality assurance of the programme. The thesis assessment procedure is up to standard. The procedure could be further improved by including the two separate assessments of both examiners in the assessment file, and by ensuring that there is always one examiner that is not involved with supervision of the thesis.

Conclusion
The panel concludes that both 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 integration projects of 15 bachelor graduates as well as 15 master research projects. The panel took care that all majors and tracks of the programmes were sufficiently covered in the selection. For the BSc IEM, the panel found that the topics are relevant and that their academic and technical content is of good quality. Students integrate current insights, methods and tools into their work, including up-to-date references, methods and software tools. For the MSc IEM, the panel found the thesis topics to be relevant both academically and professionally. In general, the panel found that the theses could be improved regarding writing and reporting skills (see Standard 2). It also noted that some theses could reflect more on the impact of the results on various stakeholders as well as on sustainability and techno-economic analysis. In some cases, the techno-economical sections of the theses required more input from industrial experts to make them more realistic. In general, the theses convincingly showed that the intended learning outcomes for both programmes are achieved by its graduates.

Alumni

Graduates of the BSc programme generally continue with a master's programme, either at the University of Groningen (51%) or elsewhere (41%), or directly enter the industrial sector (8%); 65% of students staying in Groningen choose the MSc IEM. A recent alumni survey of the master programme showed that the majority of the graduates find a relevant job within five months after graduation, in several cases at the company where they conducted their design project. The panel therefore concludes that the programmes prepare students for relevant master programmes (BSc) and relevant positions in the professional field (MSc). According to the panel, a more regular and extensive survey among employers and alumni could be a helpful tool to discover and monitor how graduates function in the professional field and integrate these insights in the curriculum (see also Standard 1). The panel advises setting this up.

Considerations

The panel concludes that the final products show that the intended learning outcomes of both programmes are achieved. The programmes prepare students for relevant master programmes (BSc) and relevant positions in the professional field (MSc).

Conclusion

The panel concludes that both programmes meet Standard 4.

General conclusion

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

Development points

1. Further develop the narrative of the programme for internal and external stakeholders and prospective students, for instance by showcasing the role of students as guides in companies in their transformations towards a sustainable society.
2. Depending on the choice made for the programmes to further develop their profiles, the programmes could be adapted to expand multidisciplinarity to include trans-disciplinarity, teaching students to cross boundaries of disciplines and involve multiple stakeholders.
3. Increase attention on academic writing and reporting in the curricula.
4. Improve the thesis assessment procedure by including the two separate assessments of both examiners in the assessment file, and by ensuring that co-supervised theses are also assessed by an examiner not involved in supervision.
5. Set up a more regular and extensive survey among employers and alumni to discover and monitor how graduates function in the professional field.

Appendix 1. Intended learning outcomes

Bachelor	Master
1. The required knowledge to describe elementary technological products and processes within a business context. 2. The required understanding to determine and assess the functionality and performance of these products and processes in a multidisciplinary way (e.g. from technological and business perspectives as well as those of a variety of stakeholders). 3. The required skills to design, redesign, implement and subsequently validate these products and processes. 4. The required knowledge and understanding of technology, business studies, mathematics and natural sciences to successfully complete a Master's degree programme in Industrial Engineering. 5. An academic attitude, i.e. the required knowledge, understanding and skills to conduct elementary academic research. 6. The required knowledge, understanding and skills for 'Life-Long Learning' (including finding information and using IT applications) to function largely autonomously. 7. The required skills to communicate effectively about ideas and solutions with both engineers and managers. 8. Basic knowledge in the field of leadership, socially and ethically responsible behaviour in order to apply technology.	1. The knowledge to describe complex and advanced technological processes and products in a managerial/business context. 2. The understanding to diagnose the functionality and performance of such processes and products in a multi-disciplinary way (e.g. technological, managerial and from viewpoint of various stakeholders). 3. The skills to (re)design, implement and then evaluate such processes and products. 4. The knowledge and understanding of advanced technology, managerial/business sciences and mathematics to do research and to enter a PhD-program in Industrial Engineering or a related discipline 5. The knowledge, understanding and skills for doing research, i.e. applying industrial engineering methodologies in research. 6. The knowledge, understanding and skills for life-long learning (including information retrieval and ICT-use) needed to function autonomously. 7. The skills to think critically and communicate scientifically about ideas and solutions with engineers and managers. 8. Professional skills for managerial, societal and ethical behaviour when applying technology.

Appendix 2. Programme curriculum

BSc Industrial Engineering and Management

Bachelor IEM year 1 2022-2023

Ia	Ib	IIa	IIb
Global Supply Chain (WBIE007-05)	Organizational Behaviour and Group Dynamics (WBIE012-05)	Management Accounting (WBIE022-05)	Industrial Marketing (WBIE050-05)
Programming, Modelling and Simulation (WBIE008-05)	System Dynamics (WBIE016-05)	Materials and Molecules (WBIE023-05)	Fluid Dynamics (WBIE004-05)
Calculus 1 (for IEM) (WBIE003-05)	Linear Algebra (for IEM) (WBIE009-05)	Calculus 2 (for IEM) (WBIE017-05)	Statistics and Stochastics (WBIE041-05)

Bachelor IEM year 2 2022-2023

Ia	Ib	IIa	IIb
Operations Research (WBIE005-05)	Fluid Dynamics (WBIE004-05)	Mechanics for IEM (WBIE024-05)	Computer Aided Design and Manufacturing (WBIE033-05)
Outlining and implementing innovation strategy (WBIE013-05)	Production Planning and Quality Control (WBIE014-05)	Modelling and analysis of complex networks (WBIE025-05)	Control Engineering (WBIE034-05)
Research and Design Methodology (WBIE015-05)	Sustainable Engineering Design (WBIE052-05)	Signals and Systems (WBIE030-05)	Production Techniques (WBIE040-05)
		Industrial Biotechnology (for IEM) (WBIE051-05)	Gas-Liquid Mass Transfer (WBIE036-05)
		Reactor Engineering (WBIE029-05)	Process Design and Equipment (WBIE039-05)
		Technical Thermodynamics (IEM) (WBIE031-05)	Transport Phenomena 2 (WBIE042-05)

Bachelor IEM year 3 2022-2023

Ia	Ib	IIa	II
15 ECTS free room for approved specialisation package	15 ECTS free room for approved specialisation package	Design and Construction for IEM (WBIE018-05)	Design Science (WBIE019-05)
		Digital and Hybrid Control Systems (WBIE020-05)*	Integration Project IEM (PTL) (WBIE902-05)
		Materials Selection for Engineering Design (WBIE044-05)*	Integration Project IEM (SPE) (WBIE901-05)
		Capita Selecta SPE (WBIE046-05)	
		Product Technology (IEM) (WBIE028-05)	

*Students choose either Digital and Hybrid Control Systems or Materials Selection for Engineering Design

MSc Industrial Engineering and Management

	Core IEM – both tracks
	Core track
	Core track – non IEM courses
	Elective track
	Elective track - non IEM courses

Master IEM year 1, track PTL 2022-2023

Ia		Ib		IIa		IIb	
Technology Based Entrepreneurship (WMIE006-05)		Simulation of Logistic Systems (WMIE012-05)		Analysis and Control of Smart Systems (WMIE015-05)		Sustainable Industrial Practice (WMIE027-05)	
Foundations of Logistics Systems Engineering (WMIE002-05)		Surface Engineering and Coating Technology (WMIE013-05)		Advanced Digital and Hybrid Control Systems (WMIE014-05)	SSCA	Systems Engineering (WMIE021-05)	
Robotics for IEM (WMIE005-05)		Engineering Design Integration (WMIE029-05)	APE/ PLE/ SSCA	Characterization of Materials (WMPH021-05)	APE	CFD for Engineers (WMCE013-05)	APE/ SSCA
Introduction to optimization (for IEM) (WMIE031-05)	SSCA	Fitting Dynamical Models to Data (WMIE007-05)	SSCA	Compressible Flows (WMCE008-05)	APE/ SSCA	Data-driven Optimization (WMME011-05)	PLE/ SSCA
		Game Theory with Engineering Applications (WMIE009-05)	PLE	Device Physics (MSc) (WMPH050-05)	APE	Introduction to Stochastic Programming (WMIE019-05)	PLE
		MEMS, NEMS and Nanofabrication (WMIE010-05)	APE/ SSCA	Optimization in Engineering Systems (WMIE026-05)	PLE/ SSCA	Numerical Mathematics 1 (for IEM) (WMIE032-05)	APE/ SSCA
		Multiscale Contact Mechanics and Tribology (WMIE011-05)	APE/ SSCA	Mechanical Properties (WMPH023-05)	APE	Mathematical Modelling (for IEM) (WMIE033-05)	SSCA
				Modelling and Control of Complex Nonlinear Engineering Systems (WMMA020-05)	SSCA		
				Product Design by the Finite Element Method (WMIE003-05)	APE		

APE = Advanced Production Engineering specialisation
SSCA = Smart Systems in Control and Automation specialisation
PLE = Production Logistics Engineering specialisation

Master IEM year 1, track SPE 2022-2023

Ia		Ib		IIa		IIb	
Technology Based Entrepreneurship (WMIE006-05)		Microfluidics (WMME020-05)	CE/ BT	Advanced Product Engineering (WMCE007-05)		Sustainable Industrial Practice (WMIE027-05)	
Bioprocesses for Engineers (WMIE028-05)		Advanced Instrumentation and Analytics in Biotechnology (WMIE023-05)	BT	Circular Polymers (WMCE017-05)		Systems Engineering (WMIE021-05)	
Interfacial Engineering (WMCE003-05)	CE	Food Pharma Products (WMIE008-05)	BT/ CE	Product Focused Process Design (WMCE011-05)	CE	Advanced Process and Energy Technologies (WMCE012-05)	
Catalysis for Engineers (WMCE002-05)	CE	Particulate Products (WMCE004-05)	CE	Advanced Polymer Processing (WMCE006-05)	CE	CFD for Engineers (WMCE013-05)	CE
Bio-based Products (WMCE001-05)	CE/ BT	Engineering Design Integration (WMIE029-05)	BT/ CE	Compressible Flows (WMCE008-05)	CE		
				Design of Industrial Catalysts (WMCE009-05)	CE		
				Bioprocess Technology (WMIE018-05)	BT		

CE = Chemical Engineering specialisation
BT = Biotechnology specialisation

Master IEM year 2

Research Methodology (WMIE025-05)	Master's Research Project (WMIE901-30)	Master's Design Project (WMIE901-25)

Research Methodology is offered twice per year; in semester Ia and IIa.

Appendix 3. Programme of the site visit

Day 1: 4 October 2022

11.00-11.15	Welcome
11.15-12.30	Panel preparation & consultation hour (incl. lunch)
12.30-13.30	Interview daily programme management
13.45-15.30	Student sessions - Tour of facilities - Interview with panel members
15.30-16.00	Break
16.00-17.00	Interview teaching staff
17.15-17.45	Interview Board of Examiners

Day 2: 5 October 2022

09.00 - 09.30	Panel preparation
09.30 - 12.00	Thematic sessions - Narrative - Inclusion - Future steps
12.00 13.00	Internal panel session (incl. lunch)
13.00 13.30	Final interview formal programme management
13.30 15.30	Internal panel session
15.30 16.00	Oral report panel

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:

- Short self-evaluation report
- SWOT analysis
- Student chapter
- Report previous accreditation 2016
- Quickscan BSc and MSc IEM
- Learning outcomes and Domain Specific Framework of Reference
- Minutes of meetings with Advisory Board
- Schematic overview of the curriculum
- Midterm report BSc IEM
- Curriculum Committee MSc IEM - Report
- Information sessions before and after enrollment
- Education monitor BSc and MSc IEM 2020-2021
- Survey on why students don't continue to MSc in IEM
- Information on UTQ of staff members
- Assessment plans 2021-2022
- Performing quality controls
- Labor Market Search for graduates of the IEM MSc programme
- Educational Vision and Learning Paths
- BoE activities during the Pandemic
- BoE Annual Reports IEM-ME 2019-2020, 2020-2021
- Appendix R - Programme ranking Keuzegids BSc and MSc
- FSE education monitor 2022
- FSE quality assurance policy
- Assessment forms thesis (BSc Integration Project, MSc Design Project, MSc Research Project)
- Online learning environments, course documents and evaluations of four courses of each programme