Assessment report
NVAO Limited Framework Programme Assessment

**Master Data Science and Entrepreneurship (joint degree)**

Tilburg University/Eindhoven University of Technology

## *Contents of the report*

# 1. Executive summary

In this executive summary, the assessment panel presents the main considerations with respect to the assessment of the quality of the Master Data Science and Entrepreneurship programme (joint degree) of Tilburg University and Eindhoven University of Technology. The panel assessed the programme according to the limited framework for programme assessments of the NVAO Assessment framework for the higher education accreditation system of the Netherlands, taking into account the NVAO Protocol for Dutch Applications for Accreditation leading to a Joint Degree.

The programme organisation is solid. Both universities clearly support the programme. The cooperation between the two universities is productive and articulated well in the Cooperation Agreement. The added value of the cooperation between the two universities is clear, Tilburg University providing business, management and social sciences' expertise and Eindhoven University of Technology bringing in technical and entrepreneurial expertise.

The objectives of the programme meet the internationally accepted requirements for programmes in the data science, business and entrepreneurship domains. The intended learning outcomes of the programme correspond to the objectives, are articulated very well, and meet the master level.

The programme is firmly embedded in the Brainport region. The panel feels, however, the profile of the programme being of international relevance, stretching beyond this region. In the panel's opinion, programme management could consider these international dimensions. The interaction with industry on the Mariënburg Campus is favourable, but more systematic collection of feedback from the industry could help in further improving this interaction.

The panel endorses the English name of the programme and English as the language of instruction, as programme management brought forward convincing arguments in favour of English.

The panel agrees to changing the name of the programme to the new name *Master Data Science in Business and Entrepreneurship*, proposed by programme management. The panel agrees to the arguments put forward by programme management to change the name of the programme to this new, proposed name. Adding *Business* to the name of the programme makes the name match better the objectives and contents of the programme. Both in the intended learning outcomes of the programme and in the curriculum, business activities and business development in existing organisations are covered, although some strengthening of the business aspect in certain intended learning outcomes is recommended. Changing the name of the programme in this sense will better inform prospective students about the goals and the contents of the programme.

Programme management continued to improve the programme, although the previous assessment panel did not make any particular recommendations in this respect.

The panel supports the intentions of programme management to raise the inflow of students in the programme. The entry requirements of the programme are well-considered and assure admitting students, with the motivation and the capacities to complete the programme. The pre-master programme is well-defined and well-organised.

The contents of this curriculum are appropriate and the curriculum meets the programme intended learning outcomes. In both data science courses and entrepreneurial courses, the scientific, theoretical grounding is adequate and the literature to be studied is up to standard. The panel suggests to consider explicitly addressing data science implementation aspects (compiling elements and achieving working models). The curriculum ensures the interdisciplinary character of the programme, as the constituent disciplines are covered and are connected across and in courses. The coherence of the curriculum is appropriate, as courses are scheduled along the lines of the disciplines and the integration courses Data Entrepreneurship in Action and master thesis are scheduled in a logical sequence. In the Data Entrepreneurship in Action courses and in the master thesis, students are offered ample opportunities to relate to industry. Training in professional skills is addressed in the curriculum in a clear trajectory. The panel suggests to consider renaming the Data-Driven Decision Making courses (being Interactive Explainable AI Design, Super Cruncher, Data Visualization) to bring these rather technical names closer to the less technical contents of these courses. The panel recommends to do a careful analysis of the minors in the curriculum, in terms of the reasons to introduce minors, the nature and contents of the minors to offer, the added value of minors, and the alignment of the intended learning outcomes of the programme and the curriculum with minors included.

The panel appreciates the staff teaching in the programme and finds the staff members competent and enthusiastic teachers. The teachers have good credentials in terms of educational expertise, academic qualifications and research track records. The teachers having close relations to industry is fruitful for the programme. Teachers and programme management are approachable for students.

The educational concept and study methods are adequate for this programme, allowing students to apply their knowledge and skills to practice-oriented, real-life problems. The panel appreciates the small scale of the programme and notes this to be welcomed by students. Working with fixed teams in the first semester has both advantages and disadvantages. The study guidance in the programme is up to standard. The study success figures for the programme are appropriate.

Programme management took appropriate measures to account for education and examinations during the Covid crisis, to assure the quality of these, and to monitor the well-being of students.

The rules and regulations for the programme examinations and assessments are appropriate and effective. The new rules and regulations for examinations and assessments of Tilburg University may, however, conflict with the programme regulations. The panel recommends to continue assuring the alignment of these two sets of rules and regulations.

The Examination Board effectively and conscientiously monitors the quality of examinations and assessments of the programme. The panel welcomes the regular reviews of course examinations

and master theses by the Assessment Committee, acting on behalf of the Examination Board. The panel suggests to allocate sufficient time to the members of the Examination Board to carry out the tasks of this Board.

The assessment methods of the courses are aligned with the course goals and the intended learning outcomes of the programme, and appropriately test knowledge, insights and skills in these courses. The panel finds the proportion of group assignments within course assessments as well as the peer review procedures and the fraud and plagiarism regulations adequate means to effectively counter free-riding.

The master thesis supervision and assessment processes generally are appropriate. The process of the thesis assessment by two examiners as well as the thesis assessment form with elaborate and valid criteria assure the reliability of the assessment of the master theses. The panel, nevertheless, recommends to make explicit the process by which the examiners arrive at the final grade for the thesis on the basis of their separate grades. The panel also recommends to make explicit and formalise the contribution of the reflection paper, describing the societal or business impact of the thesis project, to the final master thesis grade.

The panel reviewed fifteen master theses of programme graduates with lower, average and higher marks. All the theses reviewed are considered by the panel to be at least satisfactory and to testify to the students having reached the intended learning outcomes of the programme. The panel found the theses to be up to standard and to be of good quality.

The panel welcomes students having many contacts with industry representatives and, this way, being well prepared for the labour market. The panel appreciates the positions students manage to secure and the proportion of students setting up their own companies.

The assessment panel conducted the assessment of the Master Data Science and Entrepreneurship programme (joint degree) of Tilburg University and Eindhoven University of Technology. The panel assesses this programme to meet the standards of the limited framework for programme assessments of the NVAO Assessment framework for the higher education accreditation system of the Netherlands, having taken into account the NVAO Protocol for Dutch Applications for Accreditation leading to a Joint Degree. The panel judges the outcome of the assessment for the programme to be positive and, therefore, recommends NVAO to grant this programme the accreditation of an existing programme.

Rotterdam, 13 September 2021,

Prof. W.E.A. Van Petegem PhD                                    W. Vercouteren MSc
(panel chair)                                                                (panel secretary)

## 2. Programme administrative information

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|---|---|
| Name programme in CROHO: | M Data Science and Entrepreneurship (joint degree) |
| Orientation, level programme: | Academic Master |
| Grade: | Master of Science |
| Number of credits: | 120 EC |
| Specialisations: | N.A. |
| Location: | 's-Hertogenbosch |
| Mode of study: | Full-time |
| Language of instruction: | English |
| Registration in CROHO: | 21PN-65018/21PG-65018 |

| | |
|---|---|
| Names of institutions: | Tilburg University and Eindhoven University of Technology |
| Status of institutions: | Government-funded (both institutions) |
| Institutions' quality assurance: | Approved (both institutions) |

# 3. Findings, considerations and assessments per standard

## 3.1 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*

The Master Data Science and Entrepreneurship programme is a joint-degree programme of Tilburg University and Eindhoven University of Technology. Both this programme and the joint-degree Bachelor Data Science programme are offered by the Jheronimus Academy of Data Science, which the universities have set up to give the programmes their organisational and educational foundation. The Academy and both programmes were initiated six years ago. The Province of North-Brabant and the City of 's-Hertogenbosch participate in the Academy. The two universities signed the Cooperation Agreement Joint Degrees to regulate the organisational and financial cooperation for both programmes. The Academy is managed by the Steering Committee, being composed of the Deans of the most closely involved Schools or Departments within the universities. The Tilburg School of Economics and Management has the prime responsibility for the Master programme. The Master programme is embedded in the Jheronimus Academy of Data Science Mariënburg Campus in 's-Hertogenbosch. Students take their courses on this Campus. The programme is managed on a day-to-day basis by the programme director. The Education Committee, being composed of students and staff members, advises programme management on the quality of the programme. The Examination Board has the authority to monitor the quality of examinations and assessments in this programme and the Bachelor Data Science programme.

The objectives of this interdisciplinary programme are to educate students in data science, business and entrepreneurship, allowing them to convert data science designs into business or societal value. Students are trained as Π-shaped professionals, having in-depth expertise in data science and entrepreneurship combined with broader expertise in social sciences and business. Students acquire knowledge and skills in data engineering and data analytics (data science part), and in data-driven decision making and data-driven business development (entrepreneurial part), embedded in legal and ethical contexts. Students are taught to combine knowledge of management and business models with knowledge of data science methods, and to understand human behavioural, legal and ethical constraints. Lecturers from five schools and departments of the two universities participate in the programme, bringing in the complementary expertise available in these two universities. Students are trained to become entrepreneurial data scientists, data entrepreneurs, business developers or consultants.

Programme management drafted the Benchmark Statement, based upon international IEEE (Institute of Electrical and Electronics Engineers) and ACM (Association for Computing Machinery) frameworks. The Benchmark Statement was updated in 2021 to account for current trends in the field. The programme has been compared to programmes in the Netherlands and

abroad. This programme distinguishes itself through the interdisciplinary approach, combining data science with entrepreneurship and business.

The intended learning outcomes of the programme include fundamental and advanced knowledge and understanding of data engineering, data analytics, data-driven decision making, data-driven business development, and data science-related law and ethics; knowledge and skills to conduct scientific research in the data science and entrepreneurship domains; knowing how to critically reflect upon this research; knowing how to design, implement and market data-centred products and services; knowing how to critically evaluate sustainability of business activities in the data science domain; skills to communicate orally and in writing on data science and entrepreneurship activities and research; and knowing how to pursue further, doctoral studies in the programme domain. Programme management demonstrated the intended learning outcomes to meet the Dublin descriptors for the master level.

The programme is embedded in the North-Brabant Brainport region. The Jheronimus Academy of Data Science concluded a substantial number of partnerships with organisations in industry and non-profit organisations. The Mariënburg Campus offers students, teachers, researchers, and industry representatives ample opportunities to meet and to work together. This interaction with industry on the Campus contributes to research by lecturers, is at the basis of PhD projects and provides real-world assignments for students in the programme.

The programme's name is in English, and the programme is taught in English as well. The reasons for English are the following. Students are equipped for the international labour market. English is the common language in many organisations in the Brainport region and beyond. Data science is an international domain of study and most research in this domain is done in English. Experts from abroad may be recruited as teachers, while the programme staff already includes many international teachers.

Programme management proposes to change the name of the programme from the current name *Master Data Science and Entrepreneurship* into the new, proposed name *Master Data Science in Business and Entrepreneurship*. The reasons of programme management to change the name of the programme and to propose the new name mentioned are the following.

- Students in the current programme are not only trained in entrepreneurship, which may be said to refer to newly developed organisations, but they are also educated in business development and business activities of existing organisations. Including *Business* in the name of the programme, therefore, more accurately reflects the contents of the programme.
- Business development is one of the core disciplines the programme is focused on. Business activities and business development are listed prominently in the intended learning outcomes of the programme. Adding *Business* to the name of the programme does, therefore, do justice to the intended learning outcomes of the programme.
- Among other courses, the courses in the current curriculum *Data Entrepreneurship in Action I*, *II* and *III*, *Servitization and Data-driven Innovation*, and *Entrepreneurial Marketing* cover business development and business activities. The curriculum in its present set-up, therefore, justifies mentioning *Business* in the name of the programme.

- Including *Business* in the programme name informs prospective students more adequately about the programme contents. As the programme not only addresses *Data Science* and *Entrepreneurship*, but also covers business activities and business development, prospective students will be better informed about the objectives and the contents of the programme by adding *Business* to the name of the programme.

The new, proposed name has been approved by the Jheronimus Academy of Data Science Steering Committee.

In 2016, the programme was evaluated conditionally positive in the initial accreditation procedure. The conditions imposed referred to the strengthening of the entrepreneurial competencies in the programme. These conditions were fulfilled in 2017, as the programme was judged positive by the assessment panel. This panel did not add any recommendations for improvements. Programme management, nevertheless, continued improving the programme by, among other things, clarifying the programme profile.

*Considerations*

The panel regards the programme organisation to be solid. Both universities clearly support the programme, which the panel considers to be important. The cooperation between the two universities is productive and articulated well in the Cooperation Agreement. The added value of the cooperation between the two universities is clear to the panel, Tilburg University providing business, management and social sciences expertise and Eindhoven University of Technology bringing in technical and entrepreneurial expertise.

The panel considers the objectives of the programme to meet the requirements for programmes at master level in the data science, business and entrepreneurship domains. The objectives correspond to the Benchmark Statement, which is regarded by the panel as an adequate, internationally validated description of the programme domain.

The programme's intended learning outcomes correspond to the objectives of the programme and articulate very well the requirements students should meet at completion of the programme. As the panel established, the intended learning outcomes of the programme correspond with the master level.

The panel appreciates the programme being firmly embedded in the Brainport region. The panel finds, however, the programme profile also of international relevance, stretching beyond this region. In the panel's opinion, programme management could consider more these international dimensions. The interaction with industry representatives on the Mariënburg Campus is favourable. The panel, nevertheless, suggests to collect feedback from industry more systematically.

The panel endorses the English name of the programme and English as the language of instruction, as programme management brought forward convincing arguments in favour of English.

The panel agrees to changing the name of the programme into the new name *Master Data Science in Business and Entrepreneurship[1]*, proposed by programme management. The panel agrees to the arguments put forward by programme management to change the name of the programme into this new, proposed name. Adding *Business* to the name of the programme makes the name match better the objectives and contents of the programme. Both in the intended learning outcomes of the programme and in the curriculum, business activities and business development in existing organisations are covered, although some strengthening of the business aspect in certain intended learning outcomes is recommended. Changing the name of the programme in this sense will better inform prospective students about the goals and the contents of the programme.

The panel was pleased to hear programme management having continued with improving the programme, although the previous assessment panel did not make any particular recommendations in this respect.

*Assessment of this standard*
These considerations have led the assessment panel to assess the programme to meet Standard 1, Intended learning outcomes.

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[1] The panel uses the current name of the programme throughout this report. Considerations and assessments of the panel also apply in case the programme name changes to the new, proposed name.

## 3.2 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*
The intake of the programme rose in previous years from 27 students in 2016/2017 to 116 students in 2018/2019. The years after the inflow decreased to 81 students in 2019/2020 and 37 students in 2020/2021. Programme management wants to raise the intake to around 100 to 130 students in the coming years by intensifying the communication about the programme among students in both universities, and by promoting the transfer of Bachelor Data Science students to this master programme. The inflow of the latter students is currently very limited.

The entry requirements for the programme are bachelor degrees with sufficient backgrounds in mathematics, statistics, and data science or computer science. Incoming students should have entrepreneurial mind-sets. Students who have satisfactory mathematics and statistics backgrounds, but lack data science or computer science knowledge and skills, are invited to take the 30 EC pre-master programme. Programme management has made the entry requirements stricter, to attract better qualified students for this challenging programme.

The Master Data Science and Entrepreneurship programme carries in total 120 EC of study load and takes two years to complete. Programme management demonstrated the curriculum to meet the intended learning outcomes of the programme. All of the courses in the curriculum carry 6 EC of study load, except for the thesis which is 24 EC. Each of the courses belong to one of the four disciplines the curriculum is founded upon. These disciplines are *Data Engineering* (data architecture, data integration), *Data Analytics* (machine learning, artificial intelligence, data mining), *Data-Driven Decision Making* (interaction between models and human decision making) and *Data-Driven Business Development* (business opportunities, competitive strategies, business models). Societal and business context courses are also offered, which focus on legal and ethical aspects of data science and entrepreneurship, including intellectual property. In three *Data Entrepreneurship in Action* courses, which are scheduled in each of the first three semesters, students integrate the programme disciplines, work in teams on assignments covering the whole data cycle and are required to come up with results in terms of data-driven business development. In the *Professional Skills Journey and Coaching* trajectory, which runs in parallel to the courses over the entire curriculum, students work on their professional development in, among others, presentation skills, consulting and advising skills, creative thinking, and negotiation skills. Students select six out of eight professional skills. Students draft and execute their individual development plan and are offered coaching sessions. In the second, third and fourth semesters, students are offered electives (30 EC in total), which they select from pre-determined lists. The electives allow students to delve deeper into subjects within the programme domain. Assembling specific electives, students may compile minors (12 EC). Minors in food and agriculture, and in crime and safety are currently offered. A minor in health and vitality is considered for the future. At the end of the curriculum, students draft and complete their *Master Thesis*. The thesis may be considered to be the

extension of the Data Entrepreneurship in Action courses and is nearly always carried out in industry. Students are offered extra-curricular opportunities to develop their ideas and plans for start-up companies on the JADS Playground, being part of the Mariënburg Campus. They may also create their own companies and become self-employed data scientists in the MKB Datalab, this also being part of the Campus. Students may go on an international exchange. This often leads to half a year of extra study time, as the curriculum is intensive and does not leave much time for such an exchange.

More than 50 teachers are involved in the programme, coming from the five participating schools and departments of the two universities. About 88 % of the teachers in the programme have PhDs. Teachers are active researchers in their field of study. About 67 % of them are University Teaching Qualification certified, testifying to their educational abilities. In addition to the academic staff, practitioners present the industry perspective in courses. Teachers meet twice per year to discuss the programme. Students appreciate the expertise and the teaching skills of teachers. They find programme management and teachers very approachable. The Mariënburg Campus offers an interesting learning and working environment, where students, teachers, entrepreneurs, researchers, and others meet informally.

The programme has been founded upon the educational principles of challenge-based learning and problem-based learning. These educational principles imply students integrate theory and practice and apply scientific theories and methods to real-life challenges and problems. These principles are most evident in the Data Entrepreneurship in Action courses and in the master thesis. The other courses provide the theoretical and methodological knowledge and understanding to address the challenges and problems. Teaching methods in the programme include lectures, group work and individual work. In the first semester, the group composition is fixed. In later semesters, students are free to compose their own groups. The class size in the lectures tends to be between 40 and 80 students. The group size of student groups working on assignments and in the professional skills trajectory is rather small. The education support team and the study advisor of the programme assist students in study-related issues and problems and refer students to other university services, if needed. Feedback by students on the quality of the programme is adequately dealt with by programme management. Drop-out rates vary considerably across the years, being 7 % to 8 % on average. The study success rates of the programme are about 60 % of the students completing the programme in two years and about 86 % of them finishing in three years. As the programme is relatively new, figures currently available are limited.

Programme management has taken proper measures to organise education in the Covid crisis and to monitor the quality of the education. On campus education often proved not to be feasible, due to government regulations. Therefore, teachers were forced to change learning activities to online lectures or other alternatives. They adequately did so, being assisted by programme management and online education teams. Programme management and the academic advisor contacted students and assisted them in overcoming obstacles in their studies. This way, students' well-being was actively monitored and taken care of.

*Considerations*

The panel supports the intentions of programme management to raise the inflow of students in the programme.

The panel approves of the entry requirements of the programme. These are well-considered and assure admitting students, with the motivation and the capacities to complete the programme. The panel finds the pre-master programme to be well-defined and well-organised.

The curriculum meets, so the panel established, the programme intended learning outcomes. The contents of this curriculum are appropriate and the courses offered are solid. In both data science courses and entrepreneurial courses, the scientific, theoretical grounding is adequate and the literature to be studied is up to standard. The panel suggests to consider explicitly addressing data science implementation aspects (compiling elements and achieving working models) in the curriculum in either existing courses or new courses. The curriculum ensures the interdisciplinary character of the programme, as the constituent disciplines are covered and are connected across and in courses. The coherence of the curriculum is appropriate, as courses are scheduled along the lines of the disciplines and the integration courses Data Entrepreneurship in Action and master thesis are scheduled in a logical sequence. In the Data Entrepreneurship in Action courses and in the master thesis, students are offered ample opportunities to relate to industry. Training in professional skills is addressed in the curriculum in a clear trajectory. The panel suggests to consider renaming the Data-Driven Decision Making courses (being Interactive Explainable AI Design, Super Cruncher, Data Visualization) to bring these rather technical names closer to the less technical contents of these courses. The panel recommends to do a careful analysis of the minors in the curriculum, in terms of the reasons to introduce minors, the nature and contents of the minors to offer, the added value of minors, and the alignment of the intended learning outcomes of the programme and the curriculum with minors included.

The panel appreciates the staff teaching in the programme and finds the staff members competent and enthusiastic teachers. The teachers have good credentials in terms of educational expertise, academic qualifications and research track records. The panel sees teachers having close relations to industry as being fruitful for the programme. The panel appreciates teachers and programme management being approachable for students.

The educational concept and study methods are adequate for this programme, allowing students to apply their knowledge and skills to practice-oriented, real-life problems. The panel appreciates the small scale of the programme and notes this to be welcomed by students. Working with fixed teams in the first semester has both advantages and disadvantages. The study guidance in the programme is up to standard. The study success figures for the programme are appropriate.

In the panel's view, programme management took measures to provide adequate education during the Covid crisis, to assure the quality of this education, and to monitor the well-being of students.

*Assessment of this standard*
These considerations have led the assessment panel to assess the programme to meet Standard 2,
Teaching-learning environment.

## 3.3 Standard 3: Student assessment

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

*Findings*
The rules and regulations with respect to examinations and assessments of the programme are laid down in the Education and Examination Regulations for the programme, the Rules and Guidelines of the Examination Board and the Master Data Science and Entrepreneurship Assessment Policy. For the Master Data Science and Entrepreneurship the Tilburg University rules and regulations are leading.

The Examination Board is the authority to monitor the quality of examinations and assessments and to ensure students reaching the intended learning outcomes. Representatives from both universities sit on the Board. The Board also appoints examiners for the courses. The examiners have to assure the contents and level of the examinations and assessments and the assessment methods being in line with the course goals and contents, and adequately contributing to the intended learning outcomes of the programme. On behalf of the Examination Board, the Assessment Committee on a regular basis reviews course examinations and assessments as well as master theses. Examinations and assessments of each of the courses are reviewed every three years. The results of the reviews are communicated to programme management and teachers.

The assessment methods for courses are individual written examinations and individual or group assignments. Course examinations may consist of various components to arrive at the course grade. Group work assessments in courses are always accompanied by individually graded examinations and assessments. In most courses, the share of group assignments does not surpass 40 %, In the Data Entrepreneurship in Action courses, the share of group assignments is 50 %. Peer reviewing procedures in student groups have been adopted to counter free-riding. Students are informed about the rules for fraud and plagiarism. Written assignments are automatically checked for plagiarism.

The master thesis projects are usually carried out in external organisations. Students can either take their own business ideas as the subject for the thesis or elaborate on previous work done in the Data Entrepreneurship in Action courses. The master thesis is an individual research project. In drafting and completing their thesis, students are supervised by their supervisor. When master theses address subjects in related fields, students working on these theses may come together in thesis circles. The master thesis manuscript does not always address the societal or business impact. This is, however, covered in a reflection paper. The reflection paper is an integral part of the thesis portfolio, along with information on data used and programming code. The thesis portfolio is formally the final project of the programme. Both the thesis and the reflection paper are assessed by the supervisor and the second assessor, who use the standardised thesis assessment form. The societal or business impact are explicit criteria in this form. These aspects are assessed on the basis of the reflection paper. The examiners assess the thesis portfolio apart from each other and meet to discuss the final, shared grade. They do so prior to the oral defence by the student. The oral defence may change the grade for 0.5 points at most.

Programme management has taken measures to organise examinations and assessments in the Covid crisis and to monitor their quality. In the Covid crisis, all examinations were transferred to online examinations. Requests for alternative, online assessment methods were submitted to the Examination Board for approval. The Board ruled on these assessment methods, verifying whether these met the course goals and consequently the programme intended learning outcomes.

*Considerations*
The panel regards the rules and regulations for the programme examinations and assessments as appropriate and effective. The new rules and regulations for examinations and assessments of Tilburg University may, however, conflict with the programme regulations. This results from new rules and regulations being recently implemented by Tilburg University. Adaptation of programme regulations may, therefore, be needed. The panel recommends to continue assuring the alignment of these two sets of rules and regulations.

The position and the activities of the Examination Board are up to standard. The Board effectively and conscientiously monitors the quality of examinations and assessments of the programme. The panel welcomes the regular reviews of course examinations and master theses by the Assessment Committee, acting on behalf of the Examination Board. The panel suggests to allocate sufficient time to the members of the Examination Board to carry out the tasks of this Board.

The assessment methods of the courses are aligned with the course goals and the intended learning outcomes of the programme, and appropriately test knowledge, insights and skills in these courses. The panel finds the proportion of group assignments within course assessments as well as the peer review procedures and the fraud and plagiarism regulations adequate means to effectively counter free-riding.

The panel regards the master thesis supervision and assessment processes generally as appropriate. The process of the thesis assessment by two examiners as well as the thesis assessment form with elaborate and valid criteria assure the reliability of the assessment of the master theses. The panel, nevertheless, recommends to make explicit the process by which the examiners arrive at the final grade for the thesis on the basis of their separate grades. The panel also recommends to make explicit and formalise the contribution of the reflection paper, describing the societal or business impact of the thesis project, to the final master thesis grade.

The panel considers the measures programme management has taken to organise examinations and assessments in the Covid-crisis and to monitor the quality of these examinations and assessments to be appropriate.

*Assessment of this standard*
These considerations have led the assessment panel to assess the programme to meet Standard 3, Student assessment.

## 3.4 Standard 4: Achieved learning outcomes

The programme demonstrates that the intended learning outcomes are achieved.

*Findings*
Students are to demonstrate their ability to formulate a research question in on of the programme four disciplines, to analyse and answer the research question using adequate data science methods and to present critical conclusions. Students have to complete the whole data cycle in the master thesis. On top, students have to provide evidence of the societal or business impact of their master thesis. The average grade for the theses was 7.8 for the last four cohorts. The Examination Board regards the master theses to be up to standard.

In the programme, activities are undertaken to prepare students for the labour market or to equip them to start their own businesses. Guest lectures by industry representatives and assignments for companies bring students into contact with the professional field. In addition, students may engage in activities on the JADS Playground and in the MKB Datalab to develop their ideas for start-up companies, and to become self-employed data scientists. Programme management and the study association schedule yearly events to inform students about career perspectives and to bring them into contact with company representatives. In addition, students have access to programme alumni to inform them about career opportunities.

Recently, programme management conducted a survey among alumni. Students tend to find suitable positions shortly after graduation. Most students are employed in the private sector, either by large companies or by small- or medium-sized enterprises. Most students find jobs as data analyst, data scientist, or consultant. About 10 % to 15 % of the programme graduates start their own companies. And less than 10 % starts a PhD.

*Considerations*
The panel reviewed fifteen master theses of programme graduates. The theses were selected from all of the theses of graduates of the last four years. In the selection, theses with lower, average and higher marks were represented. All the theses reviewed are considered by the panel to be at least satisfactory and to testify to the students having reached the intended learning outcomes of the programme. The panel found the theses to be up to standard and to be of good quality.

The panel welcomes students having many contacts with industry representatives and, this way, being well prepared for the labour market. The panel appreciates the positions students manage to secure and the proportion of students setting up their own companies.

*Assessment of this standard*
These considerations have led the assessment panel to assess the programme to meet Standard 4, Achieved learning outcomes.

# 4. Overview of assessments

| Standard | Assessment |
|---|---|
| Standard 1. Intended learning outcomes | Programme meets Standard 1 |
| Standard 2: Teaching-learning environment | Programme meets Standard 2 |
| Standard 3: Student assessment | Programme meets Standard 3 |
| Standard 4: Achieved learning outcomes | Programme meets Standard 4 |
| Programme | Positive |

# 5. Recommendations

In this report, a number of recommendations by the panel have been listed. For the sake of clarity, these have been brought together below:

- To collect feedback from industry more systematically, in addition to the interaction with industry representatives on the Mariënburg Campus of the programme.
- To strengthen the business aspect in certain intended learning outcomes to align these somewhat more with the new, proposed name of the programme.
- To consider explicitly addressing data science implementation aspects (compiling elements and achieving working models) in the curriculum in either existing courses or in new courses.
- To consider renaming the Data-Driven Decision Making courses (Interactive Explainable AI Design, Super Cruncher, Data Visualization) to bring these rather technical names closer to the less technical contents of these courses.
- To carefully analyse minors in the curriculum, in terms of reasons to introduce minors, added value of minors, nature and contents of the minors to offer, and alignment of the programme intended learning outcomes and the curriculum with minors included.
- To continue assuring the alignment between the new rules and regulations of examinations and assessments of Tilburg University and the programme rules and regulations.
- To allocate sufficient time to the members of the Examination Board to carry out the Board's tasks.
- To make explicit the process by which the examiners arrive at the final grade for the thesis on the basis of their separate grades.
- To make explicit and formalise the contribution of the reflection paper, describing the societal or business impact of the thesis project, to the final master thesis grade.

## Appendix: Assessment process

Certiked VBI evaluation agency was requested by Tilburg University and Eindhoven University of Technology to support the limited framework programme assessment process for the Master Data Science and Entrepreneurship (joint-degree) of these two universities. The objective of the programme assessment of this programme was to establish whether the programme would conform to the standards of the limited framework, as laid down in the NVAO Assessment framework for the higher education accreditation system of the Netherlands, September, 2018 (officially published in Stcrt. 2019 no. 3198, 29 January 2019), having taken into account the NVAO Protocol for Dutch Applications for Accreditation leading to a Joint Degree, 7 June, 2010.

Management of the Master Data Science and Entrepreneurship programme drafted the list of panel candidates. Having conferred with programme management, Certiked invited candidate panel members to sit on the assessment panel. The panel members agreed to do so.

The panel composition was as follows:
- Prof. W.E.A. Van Petegem PhD, Associate Professor, Faculty of Engineering Technology, KU Leuven, Belgium (panel chair);
- Prof. M.R. van Steen PhD, Full Professor in Computer Science, University of Twente, the Netherlands (panel member);
- Prof. J. van Hillegersberg PhD, Full Professor of Business Information Systems, University of Twente, the Netherlands (panel member);
- Prof. I. Velegrakis PhD, Full Professor in Computer Science, Utrecht University, the Netherlands (panel member);
- Prof. P. Andries PhD, Associate Professor of Entrepreneurship and Strategy, Ghent University, Belgium (panel member);
- L. Weedage MSc, PhD Candidate in Mathematics, University of Twente, the Netherlands (student member).

On behalf of Certiked, W. Vercouteren MSc served as the process coordinator and secretary in the assessment process.

All panel members and the secretary confirmed in writing being impartial with regard to the programme to be assessed as well as observing the rules of confidentiality. Having obtained the authorisation by the University, Certiked requested the approval of NVAO of the proposed panel to conduct the assessment. NVAO has given its approval.

To prepare for the assessment process, the process coordinator met with programme management to discuss the planning of the preparatory activities, the documents to be presented to the assessment panel, and the site visit schedule. In the course of this process, programme management and the process coordinator regularly had contact to monitor the process. The activities prior to the site visit were performed as planned. Programme management approved of the site visit schedule.

Well in advance of the site visit date, programme management sent the list of master theses of programme graduates of the four most recent years. Acting on behalf of the assessment panel, the process coordinator/secretary selected fifteen theses from this list. In the selection, master theses with lower, average and higher marks were evenly represented.

The panel members were forwarded in time the documents, prepared by programme management. These documents consisted of the self-evaluation report, the appendices to the self-evaluation report and additional documentation. The student chapter was part of the self-evaluation report. The appendices to the self-evaluation report included, among other, the Cooperation Agreement Joint Degrees of Tilburg University and Eindhoven University of Technology, Benchmark Statement, intended learning outcomes and Dublin descriptors, examination programme overview, teaching staff overview, alumni information, assessment policy, Education and Examination Regulations, rules and guidelines of Examination Board, thesis guidelines and forms, and list of staff and committees. The additional documentation consisted of, among other, course information, examples of assignments and examinations, minutes of Education Committee, assessment plan, impact of Covid-19, organogram and students' experiences.

To assist panel members in assessing the programme, they were presented the Trained Eye Limited Framework Joint Degrees document of Certiked evaluation agency, this document being the elaboration of the NVAO Assessment framework and the NVAO Protocol for Dutch Applications for Accreditation leading to a Joint Degree.

Prior to the site visit date, the assessment panel chair and the process coordinator/secretary met to discuss the assessment process procedures. In this meeting, the panel chair was informed about the profile of panel chairs as drafted by NVAO. The panel chair agreed to work in line with the profile of panel chairs.

Due to the continuing spread of Covid-infections in the Netherlands and the measures taken by Dutch government to counter the spread of infections, programme management proposed the site visit to be organised online. All panel members agreed to the online visit.

Prior to the date of the online visit, panel members sent in their preliminary findings, based upon their studying of the programme documents, and sent in questions to be put to the programme representatives on the day of the visit. The panel secretary summarised this information, and compiled a list of questions to serve as the starting point for the discussions with the programme representatives during the visit.

Shortly before the visit date, panel members met to prepare for the site visit. Panel members discussed the procedures to be adopted during the visit, the preliminary findings about the programme, the panel reviews of the theses studied, and the questions to be put to the programme representatives.

On 4 June, 2021, the panel conducted the online visit. The visit schedule was in accordance with the schedule as planned.

The visit schedule included the following meetings:
09.00 – 09.45   Deans, Academy Board representatives, and programme director
10.00 – 11.00   Programme management, core lecturers, and study advisor
11.15 – 12.00   Examination Board
12.00 – 13.00   Panel lunch (closed session), with 12.00 – 12.30 Open office hours
13.00 – 14.00   Lecturers and final project examiners
14.15 – 15.00   Students (with Programme Committee student member) and programme alumni
15.00 – 16.30   Deliberations panel (closed session)
16.30 – 16.45   Main findings presentation by panel chair to programme representatives
16.45 – 17.15   Development dialogue

In all of the meetings with management and staff, representatives of both universities were present. Open office hours were communicated timely by programme management to staff and students. No persons presented themselves during these open office hours.

In a closed session at the end of the visit, the assessment panel considered the findings, weighted the considerations and arrived at conclusions with regard to the quality of the programme. After these internal deliberations, the panel chair presented in broad outline the findings, considerations, conclusions and recommendations to programme representatives.

At the end of the site visit, panel members and programme management met to discuss further improvements of the programme in the development dialogue.

The assessment draft report was finalised by the secretary, having taken into account the findings and considerations of the panel. The draft report was sent to the panel members, who studied this draft and made a number of changes. The secretary included these changes and edited the report. This report was presented to programme management to be corrected for factual inaccuracies. Programme management were given time to respond. Having been corrected for the factual inaccuracies, the Certiked bureau sent the final report to the University Boards of Tilburg University and Eindhoven University of Technology to accompany their request to grant this programme the accreditation of an existing programme.