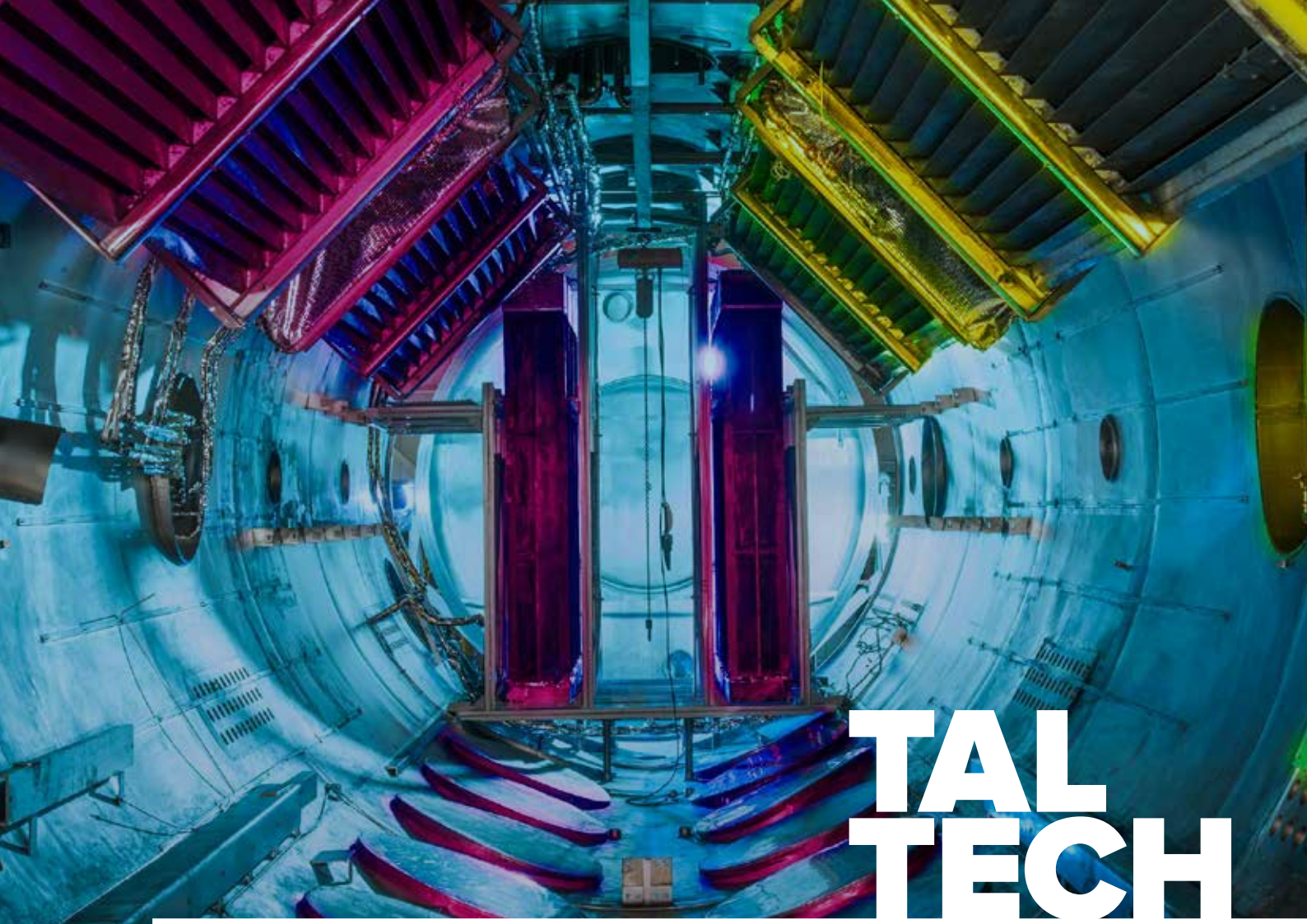

SELF-EVALUATION REPORT FOR INSTITUTIONAL ACCREDITATION 2021

TALLINN UNIVERSITY OF TECHNOLOGY

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ABBREVIATIONS

ADAPTER – Estonian business cooperation platform
APEL – Accreditation of Prior and Experiential Learning
ASTRA – Estonian institutional development programme for research and development and higher education institutions
BA – Bachelor's studies
BALTECH – Baltic Sea region university consortium for Science and Technology
BRICO – The Nordic Steel Bridge Competition
CCTV – Closed-circuit television
CESAER – Association of Universities of Science and Technology in Europe
EARB – Product Development and Robotics bachelor's study programme
ECTS – European Credit Transfer System credit points
EDTR – Telematics and Smart Systems professional higher education study programme
EFMD – European Foundation for Management Development
EIT – European Institute of Innovation and Technology
EKKA – Estonian Quality Agency for Higher and Vocational Education
EMERA – Estonian Maritime Academy
ENIC/NARIC – Academic Recognition Information Centre
ERC – European Research Council
EUA – European University Association
EuroTech – A universities Alliance/a strategic partnership of leading European universities of science and technology
EuroTeq - EuroTeQ Engineering University is a project that will establish joint engineering sciences study programmes
FP7 - Seventh Framework Programme
FTE – Full-time equivalent
GDP – Gross Domestic Product
H2020/Horizon 2020 - EU Framework Programme for Research and Innovation Horizon 2020
h-index – An author-level metric that measures both the productivity and citation impact of the publications of a scientist or scholar
IA – Institutional accrediation
IAAB – IT Systems Administration bachelor's study programme
IABM – Business Information Technology master's study programme
ICT – Information and communications technology
IGIP – International Society for Engineering Pedagogy
INT – Integrated Bachelor's and Master's study
ISO 9001 – the international standard that specifies requirements for a quality management system
KPI – Key performance indicator
LAAB – Applied Chemistry, Food and Gene Technology bachelor's study programme
MA – Master's study
MARM – Industrial Engineering and Management master's study programme
MEKTORY – Business and Innovation Centre at Tallinn University of Technology Modern Estonian Knowledge Transfer Organisation for You
NAEM – Industrial Ecology master's study programme
NAV – TalTech human resource database based on Microsoft Dynamics NAV
NORDTEK – Network of the Rectors and Deans of the Technical Universities in the Nordic-Baltic countries
OSKA – Applied Research Surveys on Sectoral needs for Labour and Skills
PDCA – Plan-Do-Check-Act
PhD – Doctoral studies
PHE – Professional higher education studies
R&D – Research and development
RDI – Research, development and innovation
ResTa – Support for R&D activities of resource valorisation
Robotex – An annual Robotics festival
Scopus – Abstract and citation database
SEFI – European Society for Engineering Education
SIS – Study Information System
TalTech – Tallinn University of Technology
THE – Times Higher Education University rankings
TRI*M index – The Customer Retention System.
TVTB, IBA – International Business Administration bachelor's study programme
TÕIS – Continuing education information system
UNICA – Network of Universities from the Capitals of Europe

1.

INTRODUCTION

1.1. SELF-DEFINITION, MISSION AND VISION

Tallinn University of Technology (hereinafter also “TalTech” or “the university”) is the second largest public university in Estonia and the flagship in engineering and IT science and education in Estonia, providing higher education at all levels in engineering and technology, information technology, economics, science, and maritime affairs. The university operates under the Tallinn University of Technology Act, the Higher Education Act, the Organisation of Research and Development Act, the Statutes of Tallinn University of Technology, the Strategic Plan of Tallinn University of Technology 2021–2025 and other legislation.

1.1.1. THE STORY OF TALTECH

Tallinn University of Technology is Estonia’s only university of technology. Its more than one hundred year history began at the dawn of the Estonian Republic, when the need for locally educated engineers was immediately recognised for gaining economic independence and prosperity. Ever since, the university has played a central role in educating engineers, technologists and economists. Our alumni have shaped Estonia’s society and economy , building the bridges and railways of a warn-torn state after Estonia first gained independence, and then founding the most innovative e-governance system in the world, following the end of Soviet occupation and now facing up to contemporary challenges such as fighting climate change.

Our historical motto „Mente et Manu“ fully reflects the university’s values, attaching equal importance to critical and creative analysis and to entrepreneurial and practical thinking. The staff and alumni of TalTech have always sought to put research into practice and create real benefits for society. Our teaching is based on the needs of Estonia’s society and economy. We value cooperation with industry and an entrepreneurial spirit, encouraging students and staff to apply their knowledge to real-world problems and transfer research results so to become practical, real world, solutions. Our graduates are in high demand on the labor market, enjoying incomes 25% higher than average, many fill the boards of Estonian most influential and successful companies and many others have become founders of successful Estonian startups (Estonia has the most unicorns per capita).

Throughout its history, Tallinn University of Technology has always recognized the importance of global reach and of international cooperation. The university’s founders and early professors had been educated in the best technology universities in Europe and the United States. During soviet occupation international cooperation became more difficult but academic staff found opportunities to study and work with the best scientists in Eastern-block countries. Now we are the most international university in Estonia (16-17% of students and academic staff). Our academic family includes members from more than 100 different countries. TalTech is now shaping a more supportive, encouraging and inclusive work culture and leadership to unite our diverse academic family. We were the first Estonia’n university to introduce a tenure-based academic career model 2017 in to provide better career perspectives for the academic staff and more stability for the university. This model has been now further revised to concentrate on growing the new generation of academic leaders.

In the past few years, the university’s structure has been fundamentally improved in order to improve efficiency and consolidate the work of schools and departments. We have defined five TalTech focus areas, all of which require interdisciplinary effort and so provide opportunities for cross-departmental collaborations. We are aiming for lean and efficient management of the university at all levels, supported by leading edge digital services (under the TalTechDigital initiative).

However, we wish to continue to develop further and move forward. Our new strategic plan emphasizes high quality standards in all aspects of our activities: excellent research, innovative teaching or management. Our ambition is to stand out, be noticed and measure up to the very best technology universities in Europe.

1.2. A BRIEF OVERVIEW OF HISTORY

Tallinn University of Technology was founded on 17 September 1918 as an educational institution of higher technical education, when the Estonian Technical Society, which united local technology intellectuals, started to organise special technical courses in Estonia. The university status was gained in 1936.

The outbreak of the Second World War interrupted the rapid development. In the wake of the war, the university lost numerous faculty and students, not to mention assets and infrastructure. During the Soviet occupation following the war, the university was named Tallinn Polytechnic Institute (TPI). Despite general mental downturn, the university continued to rise steadily. From the 1970s, liberal thoughts and ideas began to spread increasingly. The student body grew and the qualification of the teaching staff improved. TPI made significant advances in research, thus gaining the status of the leading technical university in the USSR. An important turning point was the beginning of the construction of the campus in Mustamäe in the early 1960s. The university participated actively in the ongoing social processes, making a significant contribution to the restoration of independence of the state. In 1989, the name Tallinn University of Technology was re-introduced. Over the next few decades, the study programmes expanded significantly, the student and teacher base became increasingly international, and working conditions improved. During the last couple of decades, several higher education and research institutions have been merged with/have joined TalTech (e.g. Institute of Geology, Institute of Cybernetics, Institute of Chemistry, Estonian Maritime Academy, IT College, Audentes University, etc.). Today, TalTech is one of the most recognised and largest universities in Estonia with more than 2,000 employees, including 1,200 teaching and research staff, and more than 10,000 students.

On its 100th anniversary in 2018, Tallinn University of Technology, the leader of Estonian science, technology, and innovation, officially introduced the short name TalTech alongside its full name. The essence of the university, however, remains the same – a technical university which serves the Estonian state and people through top-level international teaching and research with an aim to foster economic innovation in Estonia and to provide ideas for raising the standard of living throughout the world.

1.3. CAMPUS AND LEARNING ENVIRONMENT

TalTech campus is located on a nearly 60-hectare territory in Tallinn, Mustamäe. TalTech is the only campus-type university in the Baltic countries with an internationally high-level infrastructure for studies and research (classrooms, presentation equipment, research equipment, etc.) and one of the most modern libraries in the Baltic States. You can discover the campus on a virtual tour.

The student hostel accommodates nearly 2,200 persons. Most of its buildings are close to the university's study buildings. The study buildings are neighboring the beautiful green and forest areas of the district, including sports facilities for students and staff.

There are 135 classrooms on the campus. To make the learning environment more comfortable, there are rooms for individual and group work supplied with modern communication equipment designed to provide students an opportunity to study together. Some rooms for group work are accessible 24 hours a day.

TalTech has developed a modern digital campus with a digital learning environment that is mainly supported by the e-learning platform Moodle, TalTech Library, study information system (hereinafter also "SIS"), TalTech app and classrooms with hybrid learning/flexible learning capacity.

Studies also take place outside the campus: the Estonian Maritime Academy (hereinafter also "EMERA") operates in Kopli, the Department of Civil Engineering and Architecture of the School of Engineering partially in Tõnismägi, Kuressaare College in Saaremaa, Virumaa College in Kohtla-Järve, Tartu College in Tartu and Särghaua Earth Science Centre in Pärnu County.

1.4. MANAGEMENT AND STRUCTURE

The directing bodies of Tallinn University of Technology are the Council, the Senate and the Rector. **The Council**[1] is the highest decision-making body of the university which is responsible for the development of the university and for making important economic, financial and property decisions. In order to ensure the representation of the society in the strategical management, the Council has 11 members – five appointed by the university Senate, one (a non-member of the University) appointed by the Estonian Academy of Sciences, and five appointed by the Ministry of Education and Research after the Senate and the Academy of Sciences have made their choices. The ministry shall also make sure that at least half of the people they appoint to the Council are adept in the field of education. The Council elects the university's Rector who directs the activities of the university and is responsible for the general state of the university. The Rector, Vice-Rectors and the area directors form **the Rectorate**[2]. The academic decision-making body of the university is **the Senate**[3], which is responsible for the education, research and development activities of the university as well as for ensuring high academic quality. The Senate includes the Rector as the chairman, the vice-rectors, the deans, the representatives of the academic staff of the schools, the representative of the administrative and support units, the representatives of students. The Senate, with the term of office ending on 31 August 2022, has 26 members.

[1] Until 2019, the Council was called the Board of Governors.

[2] The members of the Rectorate are the Rector, the Vice-Rector for Academic Affairs, the Vice-Rector for Research, the Vice-Rector for Entrepreneurship, the Director for Finance, the Director for Administration and the Director for Facilities.

[3] Until 2019, the Senate was called the Council.

The university's structure (see Figure 1) is divided into academic and administrative and support structure. The academic structure consists of four Schools, the Estonian Maritime Academy and 21 departments. **The Schools** are:

- School of Information Technologies
- School of Engineering
- School of Science
- School of Business and Governance
- Estonian Maritime Academy

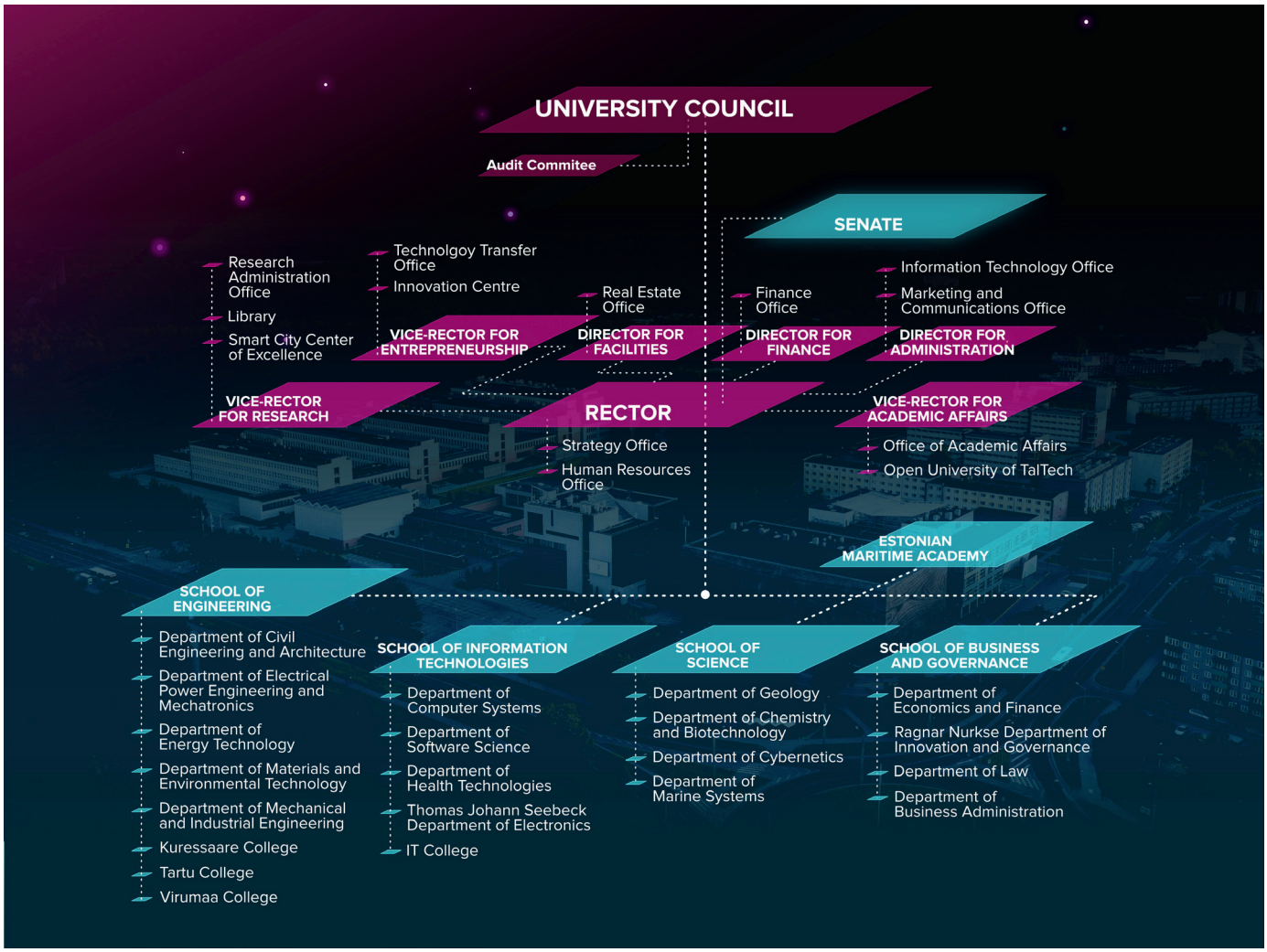


Figure 1. Structure of Tallinn University of Technology

The Rector is responsible for the university's general management, implementing the budget, the lawful and purposeful use of financial resources and decides matters related to the activities of the university that are not within the competence of the Council or Senate.

Vice-Rectors and area directors are area managers and members of the Rectorate, who manage the relevant areas of activity and are responsible for the operation and development of the units under their authority.

A school is an academic unit composed of departments engaged in teaching, research and development in similar scientific disciplines. A school is led by a Dean, who is appointed by the Rector. A Dean coordinates the activities of the departments of the school and is an immediate superior of the head of a department, ensures the preparation and implementation of the school's action plan and updating of study programmes in co-operation with the programme advisory boards and programme directors of degree studies.

A department is a central academic and administrative structural unit, which is engaged in teaching, research and development and which unites research groups with a similar profile. A college is a regional or sectoral academic unit, which is primarily engaged in teaching. A department organises research and development, conducts educational activities and performs other functions of the university in the department's field of activity.

The Student Union is the representative body of students, who stands for the quality of education, high-quality learning environment, and student life that is full of opportunities. The Student Union represents students and student organisations at Tallinn University of Technology and the student body in general outside of the university. The basis for the operation of the student body shall be laid down in the statutes of the student body adopted by the Student Union and approved by the Senate.

1.5. AREAS OF ACTIVITY

According to the administrative contract concluded between the Estonian Ministry of Education and Research and Tallinn University of Technology, TalTech is responsible for the organisation, quality, development and popularisation of high-level studies that meet the needs of society in the following study programme groups (fields of responsibility):

- architecture and building;
- business and administration;
- engineering, production and technology;
- informatics and information technology;
- physical science;
- transport services.

The share of students studying in TalTech's fields of responsibility has increased steadily (87.7% in 2015 as against 96.4% in 2020). Teaching is concentrated almost entirely on the study fields of responsibility (95% of the study programmes belong to TalTech's fields of responsibility). TalTech conducts studies in all three levels of higher education – bachelor's (hereinafter also „BA"), master's (hereinafter also „MA") and doctoral (hereinafter also „PhD"). There are also professional higher education (hereinafter also „PHE") and integrated bachelor's and master's (hereinafter also „INT") study programmes.

The fields of activity of most of the research groups are in line with the TalTech's strategic research and development (hereinafter also "R&D") areas laid down in the Academic Strategic Plan. The most important research projects of international importance by fields of activity:

- **smart and energy efficient environments**
  - o Horizon 2020 coordinated by TalTech:
    - Smart grid competence hub for boosting research, innovation and educational capacities for energy transition
  - o H2020, ERA Chair:
    - ERA Chair of Emerging Next-Generation Photovoltaics
  - o Estonian Centres of Excellence:
    - Zero energy and resource efficient smart buildings and districts
- **dependable IT solutions**
  - o H2020 projects coordinated by TalTech:
    - Integrated Modelling, Fault Management, Verification and Reliable Design
    - The Once-Only Principle Project
    - Sensors for LArge scale HydrodynaMic Imaging of ocean floor
  - o H2020, Twinning:
    - Twinning to Strengthen Tallinn University of Technology's Research and Innovation Capacity in Nanoelectronics Based Dependable Cyber-Physical Systems
    - Secure and Assured hardware: Facilitating ESTonia's digital society
  - o H2020, MSCA ITN training network:
    - Interdependent Challenges of Reliability, Security and Quality in Nanoelectronic Systems Design
  - o H2020 ERA Chair:
    - ERA Chair in Cognitive electronics
    - ERA Chair in Maritime Cyber Security
  - o Estonian Centres of Excellence:
    - Estonian Centre of Excellence in ICT Research
- **valorisation of natural resources**
  - o H2020 ERA Chair:
    - Excellent Tallinn University of Technology Research Chair in Green Chemistry and Technology
- **future governance**
  - o H2020, ERC grant:
    - Design Global, Manufacture Local: Assessing the Practices, Innovation, and Sustainability Potential of an Emerging Mode of Production
  - o H2020, MC individual grant:
    - The Political Economy of E-Residency
  - o H2020 Teaming project:
    - Establishment of Smart City Center of Excellence (FINEST TWINS)
- **innovative SME-s and digital economy**
  - o H2020, MC researcher exchange:
    - Institutions for Knowledge Intensive Development: Economic and Regulatory Aspects in South-East Asian Transition Economies
  - o H2020, Twinning:
    - Individual Behaviour and Economic Performance: Methodological Challenges and Institutional Context
    - Industrial Strategy and Competitiveness Studies

The university's Strategic Plan 2021–2025 sets the goal to increase the role of the university in servicing society, developing economy and increasing competitiveness. Through its focus areas, the university plans to contribute to national and global issues, shaping of strategies and improving the quality of research.

1.6. SELF-EVALUATION PROCESS AND WRITING THE REPORT

TalTech started with self-evaluation for institutional accreditation (hereinafter also "IA") and preparation of the report at the beginning of 2020, when the Rector initiated the quality system development project and the process for preparing for institutional accreditation. The Director for Administration was appointed general manager of the project and the Quality Manager was appointed coordinator of the project, who was responsible for preparing the draft development project. A steering committee was formed, which included the university's Vice-Rectors, the Director for Administration, the Head of International Cooperation and the Quality Manager.

In April 2020, the Rector approved the draft development project and formed seven working groups for institutional accreditation:

1. strategic management and resources (head of the working group: Director for Administration Joosep Kaasik)

2. quality culture (head of the working group: Quality Manager Kaja Kuivjõgi)

3. academic ethics (head of the working group: Vice-Rector for Research Prof. Maarja Kruusmaa)

4. internationalisation (head of the working group: Head of International Cooperation Reijo Karu)

5. research and development (head of the working group: Head of Research Administration Office Maia-Liisa Anton)

6. service to society (head of the working group: Vice-Rector for Entrepreneurship Sven Illing)

7. learning and teaching (head of the working group: Vice-Rector for Academic Affairs Prof. Hendrik Voll).

The task of the working groups corresponding to the standards of international accreditation was to perform self-evaluation of the respective topic, to prepare SWOT analyses, a self-evaluation report and to suggest areas for improvement in the sector. To ensure the equal representation the working groups included the members of the university's management board, heads of academic units, members of academic staff, alumni, employers, support staff and students. The programme directors of eight study programmes chosen to be evaluated were given a separate task to prepare the self-evaluation reports of the study programmes based on the guide of the Estonian Quality Agency for Higher and Vocational Education (EKKA).

In April 2020, a two-day online training of EKKA was organised for the members of the working groups and interested parties (a total of 80 employees and student representatives participated). In addition, regular discussions took place in the steering committee and working groups, separate meetings were held with programme directors.

A separate webpage was created for institutional accreditation on the intranet, to where information regarding accreditation (minutes, working groups, analyses, videos of the meetings) was gathered. In addition, a Microsoft Teams group was created for the involved parties to manage, exchange information on and discuss matters related to the self-evaluation report.

The period of preparation of the self-evaluation report coincided with the period of planning the new Strategic Plan 2021–2025. The new Rector Professor Tiit Land, who assumed office in September 2020, decided to join the processes of drawing up a new strategic plan and preparing for institutional accreditation. The new rectorate could take the recommendations for improvement given by the working groups into account in drawing up and implementation of the new strategic plan. When the new Rector took office, some changes were made in the rectorate and management (e.g. the Vice-Rector for Research and the Head of the Research Administration Office were replaced) and in the composition of the working groups. The further task of the steering committee was to prepare the Strategic Plan.

In order to ensure that the self-evaluation reports of the standards and study programmes prepared by the working groups and programme directors reflect the situation at the university as accurately as possible and that the statements are supported by examples and facts, the self-evaluation report was reviewed in two stages. The eight self-evaluation reports of study programmes were reviewed in November 2020, the reports of the standards were reviewed in February 2021. Each self-evaluation report of a standard and study programme was reviewed by two to three experts from the university, incl. representatives of students. The reports were reviewed by members of university staff (both academic and support staff) who have experience in external evaluations as an evaluee and evaluator, who are recognized experts in the field and interested in contributing to the development of the university. In order to involve more staff, discussions on the self-evaluation report were held in March 2021 at joint meetings of committees of the university's Senate[4]. At three meetings, the heads of the working groups provided an overview of the strengths of the areas related to the standards, the areas for improvement and the planned development activities, the recommendations of the reviewers were heard, the members of the committees had the opportunity to express their opinion. The second stage of the review of the self-evaluation report took place in April and May 2021, when feedback on the English version of the report was provided by an additional round of internal reviews by university members with prior experience in academic management and evaluations and by Prof. Alar Karis (former Rector of University of Tartu and previous Auditor General of Estonia) as an external expert.

The self-evaluation report was finalised, approved by the Senate and submitted to EKKA in June 2021. The self-evaluation report is available to university staff and students on the intranet. According to the internal communication plan, after completion of the self-evaluation report the members of the university will be additionally informed through various channels (newsletter, interactive seminar-trainings, etc.).

1.7. TALTECH IN NUMBERS

Table 1. TalTech in numbers in 2016-2020

	2016	2017	2018	2019	2020
Revenue from the rendering of education services (million euros)	48.5	49.7	53.1	53.1	54.4
Total revenue from research and development (million euros)	25.3	34.1	38.3	45.5	47.3
Total number of employees (headcount)	1,930	1,837	1,847	1,846	1,897
Number of research publications	1,362	1,221	1,209	1,289	1,382
Number of defended doctoral theses	75	62	77	66	55
Total number of students	11,070	11,208	10,852	10,282	10,024
incl. international students	13.3%	13.4%	14.8%	16.2%	13.5%
Study programmes opened for admission	106	93	86	81	83
incl. study programmes taught in English	33	33	32	31	31

[4] The committees of the university's Senate are the Academic Committee, the Committee for Academic Affairs and the Committee for Research.

1.7.1. STUDENTS

The number of students in Estonian higher education has significantly decreased in the last decade (65,000 in 2010 → 45,000 in 2019[5]), which has been caused by the general demographic situation and the resulting decrease in applicants. Over the last five years, the number of TalTech students and admission rates have decreased by about 10%. In addition to demograhic changes, the number of applicants has also been affected by the transition to threshold-based admission and the strategic choice to regularly raise the admission thresholds to ensure the applicants' more uniform level and to improve quality (see Chapter 3.8). However, in the years 2017–2019, the number of upper secondary school graduates increased from 6,000 to 6,800 which means that the number of applicants for bachelor's level will gradually increase. At the same time the general graduation rate is not showing an increasing trend, the number of graduates has increased only at master's level. At the same time, the dropout rate shows a declining trend – in the academic year 2016/2017 1,992 students discontinued their studies, while in the academic year 2019/2020 the number was 1,558, i.e. 30% less than four years ago. The university pays constant attention to reducing the dropout rates and increasing the graduation efficiency (for more details see Chapter 3.10). Table 2 provides aggregated data about the students by study level – number of students[6], number of students enrolled[7], number of early leavers/dropouts[8], number of graduates[9].

Table 2. Aggregated data about the students by study level in the academic years 2016/2017–2020/2021. Source: SIS

Study level		2016/17	2017/18	2018/19	2019/20	2020/21
Bachelor's studies	Number of students	4,146	3,915	3,931	3,788	3,868
	Number of students enrolled	1,336	1,333	1,439	1,204	1,242
	Number of dropouts	801	801	707	601	N/A
	Number of graduates	840	746	769	711	N/A
Professional higher education studies	Number of students	1,734	2,309	2,015	1,646	1,414
	Number of students enrolled	498	502	421	340	336
	Number of dropouts	408	398	366	312	N/A
	Number of graduates	323	340	367	301	N/A
Integrated studies	Number of students	914	866	883	909	919
	Number of students enrolled	182	210	235	200	202
	Number of dropouts	136	116	115	116	N/A
	Number of graduates	142	116	87	98	N/A
Master's study	Number of students	3,632	3,521	3,489	3,435	3,298
	Number of students enrolled	1,338	1,320	1,308	1,242	1,186
	Number of dropouts	566	594	499	480	N/A
	Number of graduates	896	850	903	927	N/A
Doctoral studies	Number of students	644	597	534	504	525
	Number of students enrolled	71	90	99	88	124
	Number of dropouts	81	89	62	49	N/A
	Number of graduates	57	76	66	57	N/A
TOTAL	Number of students	11,070	11,208	10,852	10,282	10,024
	Number of students enrolled	3,425	3,455	3,502	3,074	3,090
	Number of dropouts	1,992	1,998	1,749	1,558	N/A
	Number of graduates	2,258	2,128	2,192	2,094	N/A

[5] Source: Estonian Education Database Haridussilm

[6] As of 10 November.

[7] The number of students enrolled between 11 November and 10 November of the following year.

[8] Number of students exmatriculated for reasons other than graduation between 1 October and 30 September of the following year.

[9] Between 1 October and 30 September of the following year.

1.7.2. STAFF

Table 3. Aggregated data about university staff in the years 2017–2020. Source: NAV

	2017	2018	2019	2020
Number of academic staff [10]	1,019	985	987	1,028
incl. male employees	639	621	626	651
incl. female employees	380	364	361	377
Academic staff (FTE)[11]	817	788	791	838
Share of academic staff[12]	55.5%	53.3%	53.5%	54.2%
Number of academic staff with a PhD	576	599	622	624
Share of academic staff with a PhD	57%	61%	63%	61%
Average age of academic staff	46.4	46.1	45.5	45.2
Number of international teaching staff	153	169	205	239
Number of non-academic staff	830	870	859	869
Members of administrative and support staff calculated on a full-time basis[13]	715.9	751.2	743.7	764.6
in academic units	380.2	410.6	409.8	424.3
in support units	335.7	340.6	334	340.3
Voluntary turnover[14]	4.9%	2.7%	4.2%	3.7%

Table 4. Aggregated data about staff by School in the years 2017–2020. Source: NAV

School of Information Technologies				
	2017	2018	2019	2020
Number of academic staff[15]	227	222	232	245
incl. male employees	171	174	179	191
incl. female employees	56	48	53	54
Number of academic staff with a PhD[16]	144	148	150	145
Share of academic staff with a PhD	63%	67%	65%	59%
Average age of academic staff[17]	45.1	45.7	44.3	43.6
Number of international teaching staff[18]	38	48	65	85
Number of support staff[19]	91	104	112	115

[10] Number of persons in academic positions as of 31 December. In 2017 and 2018, the number of persons at the university and the corresponding total number in the structural units are different, as the employees may have had several employment contracts and held several positions. In 2019 and 2020, also academic positions outside the academic structure are included.

[11] Filled academic staff positions (FTE, rounded to the nearest whole number) as of 31 December.

[12] Ratio of the total number of staff to the number of academic staff as of 31 December.

[13] Filled non-academic staff positions (full time equivalent, rounded to the nearest whole number) as of 31 December.

[14] Voluntary turnover: the number of employees who left on their own initiative divided by the average number of employees in the year. From 2020, the raw data processing logic has changed. The average number of employees used to calculate the turnover rate is calculated as the number of persons, in previous years the average number of employees was calculated as FTE.

[15] Number of persons in academic positions as of 31 December.

[16] Number of academic staff, who have a valid employment contract as of 31 December and who have a PhD or an equivalent qualification.

[17] Average age of academic staff as of 31December, age in completed years.

[18] Persons, who have a valid employment contract as of 31 December and who do not have Estonian citizenship, but hold the citizenship of another state, are considered international teaching staff.

[19] Number of persons in non-academic positions as of 31 December.

School of Engineering				
	2017	2018	2019	2020
Total number of academic staff	350	332	334	349
incl. male employees	238	225	222	231
incl. female employees	112	107	112	118
Number of academic staff with a PhD	199	196	211	217
Share of academic staff with a PhD	57%	59%	63%	62%
Average age of academic staff	45.0	45.1	44.7	44.5
Number of international teaching staff	53	50	55	60
Number of support staff	190	193	199	199
School of Science				
	2017	2018	2019	2020
Total number of academic staff	237	222	195	204
incl. male employees	129	119	108	109
incl. female employees	108	103	87	95
Number of academic staff with a PhD	163	165	150	147
Share of academic staff with a PhD	69%	74%	77%	72%
Average age of academic staff	45.0	44.9	45.1	44.4
Number of international teaching staff	26	37	34	36
Number of support staff	121	133	108	108
School of Business and Governance				
	2017	2018	2019	2020
Total number of academic staff	163	157	163	169
incl. male employees	71	65	72	78
incl. female employees	92	92	91	91
Number of academic staff with a PhD	74	86	96	99
Share of academic staff with a PhD	45%	55%	59%	59%
Average age of academic staff	45.5	46.2	46.1	46.2
Number of international teaching staff	36	34	47	54
Number of support staff	36	41	49	54
Estonian Maritime Academy				
	2017	2018	2019	2020
Total number of academic staff	62	62	62	59
incl. male employees	43	44	44	41
incl. female employees	19	18	18	18
Number of academic staff with a PhD	10	13	14	14
Share of academic staff with a PhD	16%	21%	23%	24%
Average age of academic staff	57.7	57.4	54	54.9
Number of international teaching staff	0	0	4	4
Number of support staff	41	42	43	37

2.

MAIN CHANGES CARRIED OUT FROM PREVIOUS INSTITUTIONAL ACCREDITATION

In recent years, TalTech has undergone several changes and renewals based on recommendations on the management and operation, teaching and learning, research and development and service to society given by the assessment committee of IA conducted in 2014.

Strategic management. The IA assessment committee recommended that the ambition expressed by the leadership – that in the future the university will be among the top universities in the world – be incorporated into the university's strategic plans. The committee advised the university to increase international benchmarking and best practice learning.

The organisational performance of the university has been most affected by the structural reform that took place in 2016 and 2017 (see Chapters 3.1 and 3.2), the study programmes reform in the years 2016-2018 (see Chapter 3.7) and reorganisation of the academic career system (see Chapter 3.6). Reforms were led by the previous rector prof. Jaak Aaviksoo. The strategic management of the university was also affected by the change in the structure of the University Council, which is the highest decision-making body. Since 2015, the University Council has largely consisted of members from outside the university, which has resulted in strengthening of coherence with Estonian society and economy. Reference universities[20] have been agreed upon and the best international practices have been studied in the course of planning subsequent reforms. While the university has fallen in international rankings, the strategic performance indicators approved by the Council have improved and the rise in indicators has been faster than the decline in rankings. The decline in rankings is partly caused by the mergers with professional higher education institutions and increase in the number of universities participating in the rankings (see Chapters 3.1 and 3.5). The aim of the extensive structural reform, which involved both academic and administrative and support units, was to improve interdisciplinary cooperation and synergy, streamline the management model, clarify the fields of responsibility and harmonise the service standards of administrative and support activities. As a result of the structural reform eight faculties were merged into four schools and the Estonian Maritime Academy and more than 60 departments were merged into 20 departments (incl. Virumaa College, Tartu College and IT College). In 2019, in the Academic Strategic Plan the R&D focus areas were agreed upon (see also Chapter 3.11).

Resources. In order to better manage resources, the university was recommended to develop a strategy for funding models to cope with economic and political uncertainties.

In 2017, new financial regulations were established and activity-based budgeting was introduced. The university prepares its budget in the 1+4-year perspective, which means that upon preparing a new budget for the subsequent year the activities are planned with a five-year perspective. Budgets are prepared by broad involvement – the university management meets the representatives of the structural units and ambitious goals for the next and subsequent years are discussed and agreed upon jointly. This practice has helped to increase the university's operating revenue. The amount of operating revenue has been increased from 91.3 million euros in 2015 to 117.2 million euros in 2020 (growth of 28.4%), which is comparable to the nominal gross domestic product (GDP) growth in Estonia. This is noteworthy, because although state funding for higher education increased at a significantly slower pace compared to the growth of economy and state budget, TalTech was able to find possibilities to increase its revenue at a rate consistent with the overall economic growth. The increase in revenue was mostly due to improvement of the key performance indicators of teaching and learning as well as enhancement of research and development and business activities (the capacity to attract competitive funding has increased, about 1/3 of the university's budget funds come from competitive grants). The state budget funds form over 50% of TalTech's budget revenue. For example, in 2020 the university received a to-

[20] TalTech Council has approved the reference universities: Aalto University in Finland, Chalmers University of Technology in Sweden and Technical University of Denmark.

tal of 57.6 million euros of financial resources related to activity support for higher education and baseline funding of R&D from the state budget under the funding agreement signed with the Ministry of Education and Research. At the same time, the university's total budget revenue amounted to 117.2 million euros. Thus, the share of state budget resources in 2020 was 49.1%. In 2021, the corresponding share is 53.4%. In addition, the university applies for competitive grants and participates in various public procurements. Other state agencies to whom the university provides various services and conducts applied research may also use state budget funds to pay for services ordered from the university. Thus, considering both direct and indirect state measures of funding, over 50% of the budget revenue is received from state budget funds. In order to better organise the financial management and reporting of research and development projects, the Project Accounting and Reporting Division was established (see Chapter 3.2). In order to better plan and organise the implementation of the university's financial activities, in the framework of the TalTechDigital initiative a new business software was introduced in 2018. A significant number of purchase and sales documents, which were still processed on paper during the previous accreditation, have been digitized. Several supporting IT solutions have been developed and introduced, which enable the electronic processing of purchase and sales invoices, expense documents, documents related to business trips, etc. In 2020, the university's Accounting Policies and Procedures were updated and the university's chart of accounts was harmonised with the national chart of accounts in order to simplify and speed up the exchange of data and reporting between the university and the government.

Human resources management. The IA assessment committee recommended the university to increase focus on ensuring young successors as older generations retire and to make funds available for that purpose. The committee also advised the university to encourage international mobility of students and staff.

TalTech's human resources policy was most affected by the reform of the administrative and support structure in 2016, the reform of the academic units in 2017 and reorganisation of academic career management (transition to the tenure-based system). As a result, the sustainability of the university's academic staff has improved – the age structure of the teaching staff has become younger (the share of academic staff under the age of 50 has increased), the share of international staff and the share of academic staff with a PhD have also increased (see Table 3). In addition, the fact that most of the PhD students are employed at the university as Early Stage Researchers helps to ensure young successors. Moreover, leadership is constantly developed and valued (a reserve of young leaders has been created and a leadership programme has been developed to train them). In addition, the Assistant Professor post has been established to provide young researchers with high potential an opportunity to prepare for pursuing tenure. In order to facilitate appointment to Professor Emeritus/Emerita status, remuneration is granted to the persons who have resigned from Professor or Associate Professor post. There has been great interest in applying for academic positions, and the average salary of TalTech academic staff is also the highest in Estonian universities (see Table 23 and Figure 16). The renewed academic career management system has served as an example for other universities in developing their career management systems (see Chapters 3.2 and 3.6). As the number of international staff is increasing, more attention is paid to supporting them – an International Staff Centre has been established. To encourage staff and student mobility, the volume of agreements for exchange studies supporting mobility has been increased (mainly in the framework of the Erasmus+ programme) and the strategic cooperation project EuroTeQ Engineering University has been launched. Efforts will continue to be made to raise students' awareness of study abroad opportunities. Student mobility has been stable over the last five years (about 2% outgoing students and 4% incoming students of the total number of students). In order to foster staff mobility, the university has expanded international mobility opportunities in particular by joining the Erasmus+ global mobility programme, the effectiveness of which is difficult to assess due to the restrictions imposed because of the SARS-CoV-2 pandemic. The procedure for submitting applications for staff mobility has also been made more flexible: instead of two application rounds, the staff can now apply for mobility all year round (see also Chapter 3.5).

It was also pointed out that the opportunities for in-service professional development of academic staff should be improved.

The Good Lecturer Development Programme has been launched to improve the effectiveness of teaching and organisation of studies and develop the teaching competencies of the academic staff (see Chapter 3.6.3.2). In 2021, a didactics experts network will be developed. The development and training activities for university staff (incl. academic staff) are organised in compliance with the Rules for Organisation of Staff Training. The Human Resources Office identifies and analyses the need for training, sets the training goals, evaluates the results and manages the training plan and calendar, which is available to the university staff on the intranet. For example, the training plan includes, in addition to training on didactics of higher education, an onboarding programme for new employees, the development of management, digital and social skills, language training and the development of other special skills (see Chapters 3.2.1 and 3.8).

In the field of **teaching and learning**, the committee underlined the need for reducing the number of study programmes in order to facilitate focusing and interdisciplinarity in all university activities.

One of the main goals of the university's Strategic Plan 2016–2020 was the study programmes reform, which was guided by the principle that graduates should receive diverse and competitive preparation for their professional careers. As a result of the reform, the number of TalTech study programmes decreased by 18%, by about 30% in the first study level[21]. Conducting of studies is concentrated on the fields of responsibility which means that the university can contribute to the fields, where it has top-level expertise and for which it bears national responsibility. In addition, a new study programme management system is applied, where the programme director has the central role and responsibility and is advised by the programme advisory board (see Chapter 3.7). In order to respond quickly and flexibly to the expectations of the labour market, the requirements for making changes in the study programmes were simplified (e.g. certain changes can be made by a decision of the school council, previously a Senate's decision was required).

The committee also recommended that the university should more efficiently collect feedback from different stakeholders and further develop its feedback system to increase the response activity and produce a more systematic implementation of the feedback received. In order to promote cooperation between the university and internship enterprises, it was recommended to develop a web-based application to support the feedback system.

TalTech's feedback system collects feedback from various stakeholders: 1) the student feedback survey on the content and organisation of studies, which is conducted once a semester in the SIS, 2) the graduate satisfaction survey, which provides a comprehensive overview of the entire study period, 3) the alumni survey, which provides an overview of the activities of the alumni, their labour market performance and assessments of the quality of studies,

[21] In the professional higher education studies, bachelor's studies and integrated studies.

4) employer feedback is collected regularly through programme advisory boards, practitioners involved in teaching and internship enterprises. From the academic year 2015/2016, students are required to give the feedback via a web-based survey in SIS once a semester (response rate 75%). Implementation of the feedback results is governed by the Rules for Requesting and Taking into Account Feedback on Teaching and Courses, according to which the schools shall analyse the results of the feedback surveys and questionnaires and submit a feedback report of the academic year (see Chapters 3.3 and 3.7).

One of the areas for improvement pointed out by various external evaluation committees has been the need to take steps to reduce dropout rates. This has been a challenge, partly because of the overheated Estonian labor market that attracts students away from studies to early employment (see Figures 20 and 21). Various measures (including scholarships) have been developed to support students' progress. Admission is threshold-based in order to attract applicants with the best academic abilities. Thresholds are reviewed regularly and have been raised in most of the study programmes. Since 2018, TalTech has had a year-round admission process, which enables the establishment of contacts with candidates before the commencement of studies and improving their awareness of the study programme. A monitoring system has been developed to track the progress of students to enables the programme director to detect students at risk of dropping out, based on the mid-term results in the e-learning environment. An important measure to support students' progress is the system of counselling which is provided both at school level and centrally by the Student Counselling Office. In addition, pre-session courses (incl. language studies and mathematics) are offered to applicants. Following the implementation of these measures, dropout rates have been steadily decreasing (see Chapter 3.10).

In the field of **research and development**, the IA assessment committee recommended addressing the effectiveness of R&D (to promote visibility and to publish results of all research areas in high-ranking journals; to restructure research groups so as to involve more young top-talent). It was pointed out that the university should also focus on resources and support processes (invest in research-based teaching, and recruit researchers with pedagogical competencies; seek research funding from as many different sources as possible; increase research funding from the European Union and other international sources, increase contract work with industry and perform more joint projects with international universities and companies). It was also pointed out that the university should create centres of excellence or interdisciplinary teams, which are focused on both teaching and research, and include staff as well as students.

In the last few years, the field of R&D has been most affected by the reforms of the academic structure and academic career management. One of the results of the academic reform is that the central academic structural unit at the university is the department, which joins research groups engaged in R&D with a similar profile and critical mass. The performance of research groups is monitored regularly and an analysis is prepared annually (the Research Group Atlas). This gives a compact overview of the main characteristics - the composition of the group, published publications, number and volume of projects etc. This enables better monitoring of of research groups' development and provides data for R&D governance decisions. The tenure-based academic career model established in 2017 is also an important move towards the establishment of new research directions and attracting new top-talent. Strong teaching competence is one of the selection criteria for tenured professors. To increase scientific capabilities and to develop R&D excellence, TalTech has established the FinEst Twins Smart City Center of Excellence through the Horizon 2020 Teaming project, 4 ERA Chair projects (including FP7 and H2020 programmes) and is leading two national Centres of Excellence (one in ICT and the other in zero energy and resource efficient smart buildings and districts).

The average number of research articles in scientific journals per academic staff member with a PhD has increased from 0.67 in 2015 to 0.94 in 2020 and the share of articles published in Q1 journals out of the total number of articles published in the respective year (%) has increased from 46,9% to 55,3% in the same period. So far TalTech has participated in 74 Horizon 2020 projects with a total grant financing of 35.89 million euros. This is an increase of over 200% compared to FP7 funding of 11.73 million euros, and more project participations are expected from the final H2020 calls.

TalTech's total revenue from research and development in 2020 amounted to 47.3 million euros, which is an increase of 28.5% compared to 2015 (36.8 million euros), demonstrating an improving ability of research groups to successfully apply for research funding from national and international support measures and to carry out R&D and innovation-intensive cooperation with companies and the public sector both in Estonia and abroad. This more active cooperation with companies has resulted in revenue from R&D business agreements increasing by 96% over the 2015-2020 period. The aim of mitigating risks and diversify funding resources is reflected in the share of international R&D revenue which was 20% in 2015 but has increased to 25,5% as an average figure for the period of 2016-2020.

In 2019, the university adopted its Academic Strategic Plan, which approved the strategic R&D areas and set the focus on the promotion of horizontal and interdisciplinary cooperation and the launching of joint sectoral projects. In order to implement R&D projects more successfully, the Rules for Project Administration were updated in 2018 and a new Project Writing Team was established in the Research Administration Office at the beginning of 2020. In addition, a comprehensive renewal project was launched in 2020 for project management to ensure better regulatory compliance throughout the life cycle of a project and to support this process with the necessary IT solutions. This means that both the pre-award and post-award services have been improved in order to provide better assistance in administrative and bureaucratic matters (see Chapter 3.11).

TalTech successfully passed the regular R&D evaluation. A positive evaluation decision was received for all six research fields evaluated. The most important points raised in the observations concerning the research fields evaluated were related to insufficient funding, publication in low-impact journals, inefficient use of research equipment and low visibility of research groups. Currently, most doctoral students are employed as Early Stage Researchers, the quality of publications has improved (the number of international co-authored publications, publishing in Q1 journals), an overview of the up-to-date research equipment and information on the most important equipment is available in the Estonian Research Information System (ETIS); information on the activities of research groups is on the university website. The need for a better link between research and teaching is acknowledged and addressed via targets that will be set for each study level specifying a compulsory contribution from teaching staff with a doctoral degree to teaching. The concept of mission-based or problem-based teaching will be developed further.

In order to improve the quality of **doctoral studies**, the IA assessment committee recommended that the university should seek ways to increase the number of doctoral students and annual defences of theses, strengthen teaching and research project supervision and encourage collaboration among doctoral students as well as among different faculties.

Several changes have been made in the organisation of doctoral studies since 2014 in order to improve the quality of doctoral studies. In 2014-2015, more emphasis was placed on the quality of supervisors. They must now must meet a set threshold in order to obtain supervision rights. At the same time, changes were made to the attestation requirements so that attestations would be more objective (external members in the attestation committee) and more broad-based. In 2016, a new admission system for doctoral students was introduced, according to which admission takes place by public competition to given thesis topics or based on industrial doctorate principles, with three admission periods each academic year. Doctoral students are guaranteed a job with the supervisor's research group and remuneration for research work is paid by the department (see Chapter 3.8.2.3). In 2017, new attestation requirements and criteria were established in order to better support the development of doctoral students and improve the quality of their studies and research. In 2020, the requirements for doctoral theses were updated (see Chapter 3.9.4).

TalTech's focus on quality over quantity in doctoral studies initially decreased admission rate significantly, but admission rates has begun to rise again in the last few years. As a result, the target set (10% increase in graduation numbers each year) has not been fully met but graduations are expected to increase in the coming years as the full effects of the reforms become more apparent (see Chapter 3.10.2.1)

Collaboration among doctoral students is supported by joint general studies courses and through Doctoral Schools.

As regards **service to society**, the IA assessment committee noted that the university must find balance between the needs of society and business, and the interests affecting its own competitiveness. Thus, the university gains the opportunity to acquire a leading position in restructuring Estonian economy.

To improve cooperation with business, an ecosystem supporting technology transfer and business cooperation is being created: entrepreneurship cooperation coordinators have been recruited at schools alongside intellectual property rights specialists and technology transfer experts, a legal officer and a marketing specialist are employed at the Technology Transfer Office. Moreover, a programme better supporting university start-ups is under development. Technologies developed at the university, the intellectual property portfolio and good examples of cooperation with companies and public sector organisations are featured on the university website.

In order to strengthen cooperation between the university and businesses, the innovation centre Mektory has been revampred – a new demo centre will promote the focus areas and development projects of the university, there are prototyping laboratories and collaborative areas for businesses, workspaces for start-ups and innovative projects, a conference hall, XR centre specialising in virtual and augmented reality technologies, etc. Through a number of student projects (e.g. Robotex, Iseauto (self-driving car), formula car) and public events (e.g. TalTech Entrepreneurship Academy, ADAPTER Cooperation Festival, Researchers' Night Festival), knowledge transfer and the dissemination of new practical skills to the business sector and society at large take place.

University researchers are actively involved in shaping different development policies and contributing to the preparation of a number of sectoral strategies, policies and legislation. Several leading figures at the university are opinion leaders in R&D, entrepreneurship, innovation and education (e.g. Tarmo Soomere, Tiit Land, Maarja Kruusmaa, etc.). Strong strategic partnerships have been developed with several private, public and third sector companies and organisations (e.g. Eesti Energia, ABB, Starship Technologies, Utilitas, City of Tallinn, Eesti Pank, the North Estonia Medical Centre). University researchers also actively participate in shaping the innovation ecosystem through various national councils, supervisory boards and boards of professional associations, societies and foundations (see Chapter 3.12.2).

The committee recommended that upon planning **in-service training, lifelong learning and retraining activities** the university enter into a more permanent dialogue with Estonian companies, promote cooperation with the Education Technology Centre and balance the programmes of in-service training and retraining between purely academic single courses and more practical, problem-solving courses.

TalTech's Open University has involved several institutional partners with whom cooperation is being developed, including, based on the university's fields of responsibility, the Estonian Association of Civil Engineers, the Estonian Association of Construction Entrepreneurs and several construction companies, for whom specialised continuing education courses have been provided. Long-term partners also include the North Estonia Medical Centre (PERH) and the Information System Authority; last year courses were provided also to Kaubamaja (an Estonian retailer) and the postal service company Omniva. Cooperation with the TalTech's Education Technology Centre has strengthened and this year in cooperation with the Centre preparation courses were developed for final exams in mathematics for 12th and 9th grade students, which turned out to be very popular. TalTech Open University is seeking a balance between academic courses and more practical and problem-based courses. In the last few years the volume of continuous education courses developing practical skills has considerably increased in response to labour market needs, especially in the IT sector, which has been facilitated by close cooperation of the Open University with TalTech's IT College. Several specialized continuing education courses are also provided by the Schools according to their strategic plans (see also Chapter 3.12.3).

3.

SELF-EVALUATION ACROSS STANDARDS

3.1. STRATEGIC MANAGEMENT

The strategic management of the university is based on the Strategic Plan of Tallinn University of Technology 2021–2025, which is guided by the university's mission and vision. The university's Strategic Plan has been approved by the university Council and both stakeholder and interest groups were involved in its preparation. The key values, goals and indicators of the core activities are defined in the Strategic Plan and its implementation documents. Impact is assessed using key performance indicators (hereinafter also "KPI"). Each unit has its own action plan, the implementation of which is monitored at an annual review. The strategic management process has also been described in the university's process manual.

Strategic Plan → Implementation plan → Action plan of academic units → Action plan of support units

The strategic areas of research and development (R&D) and other academic activities have been further defined in the Academic Strategic Plan which sets out the university's strategic R&D areas. (see also Chapter 3.11). The Plan is implemented by the total of 124 research groups (as of the end of 2020) in the departments. The strategic areas correlate with the strategy "Estonia 2035", the Estonian Research, Development, Innovation and Entrepreneurship Strategy for 2021-2035 and the focus areas of the Research and Development Council of the Government of the Republic. The Strategic Plan of TalTech 2021–2025 takes more account of the global trends (see also Chapter 3.3). The self-evaluation period coincides with the periods of two Strategic Plans (2011-2015 and 2016–2020). This report focuses mainly on the period of the last Strategic Plan.

3.1.1. OVERVIEW OF THE PREVIOUS PERIOD

The Strategic Plan of Tallinn University of Technology 2020 laid down the university's goals, for the fulfilment of which was elaborated the Management Action Plan (in Est). The Action Plan defined the specific persons responsible for achieving the goals at the strategic level by their fields of responsibility and the key performance indicators were defined. Implementation of the Action Plan was monitored regularly through appraisal interviews and discussions held by the management. The implementation level of the key performance indicators was also reviewed annually. Based on the Strategic Plan, significant changes have been carried out in the management of the university during the last five years.

By the beginning of 2017, **the structural reform of academic units** was complete, consolidating eight faculties and separate educational and research institutions into four Schools (School of Information Technologies, School of Engineering, School of Science and School of Business and Governance) with the Estonian Maritime Academy remaining a separate structural unit. The Schools comprise departments, which are the main academic units supplied with competencies required for teaching and research (see Figure 1). As a result, sectoral co-operation and synergies have improved, management was better structured and areas of responsibilities have been more clearly defined.

By the middle of 2018, the reform of the first and second level **study programmes** was completed, as a result of which the number of first level study programmes decreased by one third. Duplication of courses also decreased and interdisciplinarity increased (for more details see chapter 3.7). In addition, the position of programme director was established in each of the Schools and external partners were involved in new programme advisory boards.

In 2017, TalTech was the first in Estonia to implement a **tenure-based academic career model**. Tenure professors allow better planning of long-term strategy to increase the university's academic capacity (see Chapter 3.6).

Within the framework of the TalTechDigital initiative launched in 2017, information systems have been developed which improve capabilities for monitoring University operation. A data warehouse and a Power BI based business analysis solution were created, which support management analysis and monitoring (see also Chapter 3.2). In addition, a document management system was deployed more widely, allowing processes to be digitized, creating a more comprehensive view and largely eliminating the need for paper documents.

In 2016, **support units were consolidated** with the aim to harmonise the service standards of administrative and support activities and to improve coordination among smaller divisions and offices. The number of structural units decreased and transparency and clarity in management improved.

3.1.1.1. MONITORING AND SELF-ASSESSMENT

The Rector provides to the Council an annual overview of the fulfilment of the goals and achievement of the performance targets laid down in the Strategic Plan. A general summary of the university's activities and results is provided in the Annual Report. In addition, sectoral reports are prepared on educational activities, research and development activities and service to society. Besides the agreed indicators (see Annex 1), a number of other indicators are monitored. The university's figures and reports are available both on the external website and on the intranet (incl. as a Power BI report).

The goals set out in the Strategic Plan 2020 have been partially achieved. The analysis of the key performance indicators for teaching and learning showed stable and solid development, but the targets were not fully achieved in some aspects. The key performance indicators for research indicated rapid development in the field and most of the targets were achieved or exceeded. A more detailed analysis with explanations is provided in Annex 1.

One lesson learned from the implementation of the Strategic Plan and an area for improvement is the need to communicate the goals more widely and organise better monitoring. The Schools did not feel their association with the Management Action Plan on the one hand due to insufficient involvement and on the other hand due to lack of engagement in academic activities. The indicators were monitored mainly at the management level. In the course of the SWOT analysis, besides internal factors, also external factors that influence the strategic development of the university were identified. The new Strategic Plan places more emphasis on policy-making, the development of strategic management, increasing of own revenue and the development of cost-effective support services fostering academic development.

3.1.2. PREPARATION OF THE NEW STRATEGIC PLAN

The lessons of the previous period have been taken into account in the preparation of the university's Strategic Plan 2021–2025. The starting point was the proposals presented by the university's Council to the Rector who assumed office in 2020. A much larger membership was involved in the preparation of the Plan and its implementation plan, and everyone has had the opportunity to express their opinion. The Strategic Plan steering committee organised the preparation, involvement in, and communication of, the Strategic Plan and its implementation plan. Sectoral expert groups were established for this, involving representatives of all the Schools and students. Experts in the field (e.g. Vice-Deans for Academic Affairs, student representatives, programme directors, researchers, companies' representatives) participated in the work of expert groups. Information sessions were held for employees and an online discussion forum was created so that everyone could express their opinion. Two seminars were held for managers, joint meetings took place with the Council and the Senate, separate discussions were held with students and alumni, ideas were collected from the essay and idea competition "What kind of role will TalTech have in the future?". All materials are available on the university's intranet. In addition, the international TalTech Development Conference 2021 was held to introduce the new Strategic Plan and the management's goals. Based on the Council's proposals, a steering committee was set up by an order of the Rector, the expert groups of which prepared the Strategic Plan and its KPIs. The developing versions of the Strategic Plan were discussed through several cycles of involvement before the Rector submitted the Strategic Plan to the Senate's committees for discussion. TalTech's Strategic Plan 2021–2025 was approved by the Senate and the Council in February 2021 (see Figure 2).

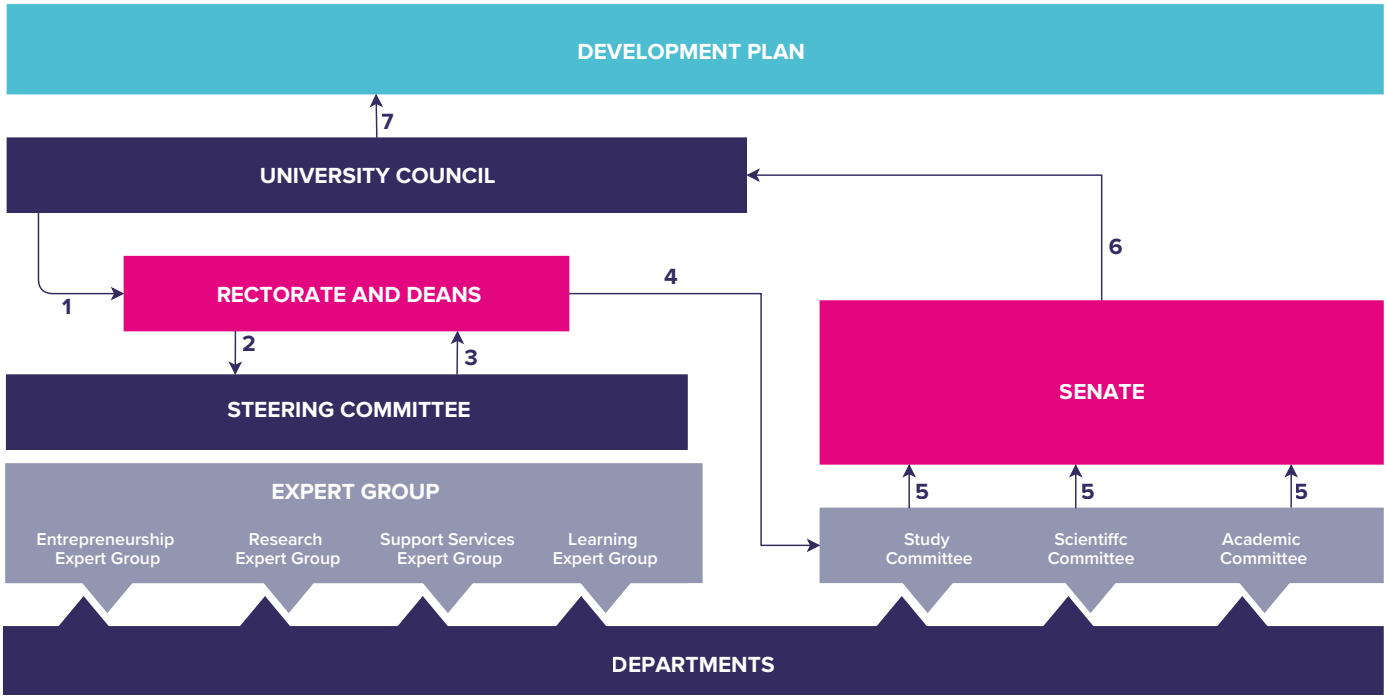


Figure 2. The process of preparing the Strategic Plan 2021–2025. The numbers in the figure indicate the progression of the process.

A similar process was also carried out for the development of KPIs and the implementation plan. The Council approved the key performance indicators in March 2021. The implementation plan was prepared in parallel with the preparation of the Strategic Plan.

In order to improve clarity and transparency of management and provide high-quality services to support the university's core activities the principles of process-based management were implemented and the the quality system was developed further (see Chapter 3.3.). In the future, it is planned to involve, besides the management team, also departments and horizontal networks in the annual review of the Strategic Plan and implementation projects. The overarching message of the university's Strategic Plan is quality in research, teaching and service to society. The relationship between the goals of the Strategic Plan and key performance indicators, the university's processes and the metrics of the implementation plan are described in Annex 2).

In the new Strategic Plan, some key performance indicators applied are as in the previous period, the share of qualitative indicators has been increased and there are new people-centred indicators measuring soft values.

3.1.3. THE NEW STRATEGIC PLAN 2021–2025

According to the new Strategic Plan, TalTech graduates should have an evidence-based mindset, practical engineering skills, good self-management and cooperation skills and entrepreneurial spirit. They are ready to take responsibility for the development of the Estonian economy and should be in high demand in the international labour market. At TalTech, high-level research is conducted, which serves as the basis for applications, studies and research-intensive innovation and drives the Estonian economy. The university practises inclusive, value-based management and management decisions are adopted in order to foster high-level studies and research.

In order to execute those plans, a goal has been set in the new Strategic Plan to monitor the selected key performance indicators **for teaching and learning** that focus on evidence-based learning, reduction of the dropout rate, graduation within the nominal duration of study and the competitiveness of the graduates (KPIs for teaching and learning) (see also Chapter 3.10). Special attention is paid to teaching staff with a doctoral degree and the quality of teaching and supervision (see Table 5 and Chapter 3.6).

Table 5. Key performance indicators for teaching and learning 2021–2025.

Teaching and Learning KPIs	Baseline	Target
Share of students graduating within the nominal period of study	50%	60%
Ratio of the average income of the graduates of master's studies to the average salary in Estonia	1.53	1.65
At least 75% of the volume of the master's programme is taught by academic staff members with a PhD or an equivalent qualification	46%	100%
Total annual income from educational activities (million euros)	54.4	70.9

The key performance indicators for **research** are an increase of the share of high-level publications and competitiveness (prioritising the number of citations and the ability to compete for international financing measures). The focus remains on raising the next generation of researchers as the prerequisite of strategic sustainability – and because the targets were not achieved in the previous period, a whole package of measures is introduced in the implementation plan to raise the next generation of PhD holders (see Table 6 and Chapter 3.11).

Table 6. Key performance indicators for research 2021–2025.

Research KPIs	Baseline	Target
Number of articles published in Q1 journals per academic staff member per year	0.47	0.70
Number of defended doctoral theses	55	97
The amount of R&D project proposals per FTE of an academic staff member with a PhD (thousand euros)	60.2	72

In the field of **entrepreneurship**, greater emphasis than previously is placed on commercialisation of science, knowledge transfer and being an engine of Estonian economy (see Table 7 and Chapter 3.11).

Table 7. Key performance indicators for entrepreneurship 2021–2025.

Entrepreneurship KPIs	Baseline	Target
Annual income from R&D contracts and services (million euros)	10.9	13
Number of established spin-off and start-up companies	4	10
Income from sales of licenses and patents (euros)	189	50,000
Number of licence agreements	3	10
Number of patents per year	10	13
Number of filed patent applications per year	12	20

In addition to the above, traditional, metrics, the focus is on developing a sustainable and **climate-smart university**, aiming to be a role model in a broader sense. The university's goal is to become climate-neutral by 2035. The target of the key performance indicators will be agreed in 2022.

After major reforms and changes, it is important to pay attention to the most valuable asset - students and employees. Therefore, the aim is to improve reputation, satisfaction, visibility, equal treatment as well as international competitiveness (see Table 8 and Chapter 3.2).

Table 8. General key performance indicators 2021–2025.

General KPIs	Baseline	Target
Reputation index (TRI*M)	85	95
Share of voice on media in the comparison of 3 largest universities (TalTech, the University of Tartu and Tallinn University)	18%	30%
Integration of gender equality into professional activities (SAI)	0.827	0.900
Employee satisfaction index (TRI*M)	61	68

The Strategic Plan places a strong emphasis on serving society, being an engine of the economy and improving international competitiveness in the core fields of activity. More attention will also be paid to the well-being of employees and TalTech's reputation as an employer.

A new Strategy Office has been established under the direct subordination of the Rector to drive progress towards the Strategic Plan's goals and improve strategic management. The office will systematically monitor and analyse the university's activities, and develop forecast models and a new quality system (see also Chapter 3.3)

In recent years, the university has dropped in international rankings, now in the 801-1000 range in the Times Higher Education (THE) ranking. This is partly due to mergers with professional higher education institutions (the Estonian Maritime Academy and the Estonian Information Technology College) in 2015 and 2016. These professional higher education organisations had lower research indicators and so the mergers decreased the overall ratio of TalTech's academic staff. In addition, the overall number of universities participating in the rankings has grown rapidly during the period. TalTech is committed to rising back up the rankings and a thorough analysis will be conducted as an early step.

Looking at the research indicators of the reference universities in Figure 3, which are in higher positions in the ranking, it can be seen that the baseline of TalTech is lower, but the rise has been faster. The percentages indicate the growth rate, which is 83% in case of TalTech.

Figure 3. Number of Q1 (Top 25%) publications compared to reference universities in the period of 2016 to 2020. Growth rate expressed by % compared to year 2016. Source: Scopus

The university's new Strategic Plan has a significantly stronger focus on improving the quality of its teaching and research. The Strategic Plan also aims to improve the university's reputation and increase its visibility through the KPIs and metrics of the implementation plan. This is likely to help TalTech move up in university rankings.

Over the past seven years, the university has significantly reorganized its structures and management, to become more process-based and clearly targeted. These structural changes have been challenging and resulted in several setbacks, which is why in the period of the new Strategic Plan, besides its strong emphasis on quality improvement, also attaches much greater importance on soft values such as inclusion and work or study satisfaction – this is also reflected in the performance indicators.

SUMMARY OF STRENGTHS AND AREAS FOR IMPROVEMENT

Strengths

• In order to better serve society's needs and concentrate on the focus areas, study programmes reform and other structural reform have been carried out. As a result the operation of the university has improved, course duplication has been reduced and interdisciplinarity increased.

• Information systems have been upgraded and a data warehouse established to enable more strategic management.

• A transition to process-based management has begun with clearer responsibilities and management chains.

• The university's new Strategic Plan was prepared with extensive involvement so that there is more consistency with stakeholders' expectations and needs.

Areas for improvement and planned development activities

• To systematically and continuously communicate the goals and values of the university to the staff and connect them with the various different level action plans.

• To develop a monitoring system using the current information systems in order to support the university's progress towards its goals.

• To improve cross-disciplinary management and tackle external challenges, the Rector's Strategy Office, established in 2021, will systematically monitor and analyse the university's activities, develop a quality system, devise policies and improve the strategic position.

3.2. RESOURCES

The strategic goals for staff development and resource management are defined in the newly prepared university's Strategic Plan and its implementation plan. Fulfilling the goals ensures further sustainable development of TalTech. According to the Tallinn University of Technology Act the university is the owner of its assets and has the right to possess, use and dispose of its assets ensuring the purposeful, expedient, economic and prudent use of the assets. The management of financial resources and budgeting are governed by the university's Financial Regulation and the plan approved for each financial year (see Figures and Reports).

3.2.1. PEOPLE

The university's human resources policy is guided by the objective to develop professional potential of its employees, which shall be based on the employees' motivation, international openness and well-targeted selection of staff. The university expects the academic staff to have international work experience, regularly engage in self-improvement and actively participate in international research and development and teaching.

Aggregated data about the university staff in 2017-2020 is shown in Table 3. The reform of the administrative and support structure carried out in 2016 and the structural reform of the academic units in 2017 led to a slight reduction in staff numbers, but in several sections the numbers are now back at the pre-reform level. Positive trends include an increase in the share of academic staff under 50 years old by 10 percentage points and an increase in the share of international employees from 11% in 2015 to 23% in 2021. Positive developments can also be seen in the share of academic staff with a doctoral degree (excluding early stage researchers, many of whom are PhD students) from 73% in 2018 and 78% in 2020). TalTech's voluntary staff turnover has remained stable (see Table 3).

The university's human resources development system includes staff recruitment and development principles and procedures. Upon recruitment the university takes into account the principles laid down in the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers[23], which ensures an open and transparent recruitment process and equal treatment of candidates. Competitions for academic positions are organised in compliance with the Regulation on the Academic Career Management. In order to ensure a fair and transparent recruitment process, recruitment for all academic and non-academic positions is coordinated by the Human Resources Office. After implementation of the new career management system, the number of candidates for academic positions has reached new levels. Instead of the previous competition of 1-2 candidates per position, there are now 3-4 candidates per position, mainly at competitions for tenured professor and postdoctoral positions (see Chapter 3.6).

The Regulation on Academic Career Management established in 2017 and revised in 2021 and its "Academic Evaluation Matrix" Annex form the basis for the development of competencies and of performance improvement of academic staff. The academic career management of TalTech and in particular the implementation of the tenure system sets an example for other universities and for establishing national rules. Individual goals are set and responsibilities are agreed upon in individual job descriptions. Employees' skills and performance are assessed against the requirements set out in the career management and the evaluation matrix at annual interviews, upon attestation carried out in every 5 years and upon applying for a post (see also Chapter 3.6). The goals for non-academic staff are set, their performance is analysed and development needs are agreed upon at annual interviews, in individual job descriptions and in summaries of annual interviews.

In developing the staff, the university is guided by the expectations set out in the academic evaluation matrix, the competence model for lecturers, the competence model for managers and the job descriptions of non-academic staff. The training calendar is available on the university's intranet. Besides centrally organised trainings, the structural units themselves assess the need for professional training and find suitable solutions. The volume of centrally organized trainings is characterized by Table 9. Although the number of trainings decreased in 2020 due to SARS-CoV-2 pandemic, use of electronic means led to a clear increase in the number of participants.

Table 9. Employees participating in the trainings. Source: NAV and TÕIS training database

	2016	2017	2018	2019	2020
Total number of internal trainings (source: TÕIS)	56	71	57	65	41
Number of participants	1,120	1,642	904	1,006	1,519

In order to improve the qualification of lecturers and develop the assessment system, a study was conducted in 2017 on the pedagogical competencies of lecturers teaching at TalTech, based on which the lecturer's online self-assessment questionnaire, guidelines for preparing an academic portfolio, guidelines for lesson observations and a university-wide model for the development of the knowledge, skills and attitudes of academic staff members were prepared.

In the years 2016-2019 the international mobility of employees, driven by self-development goals and providing self-improvement opportunities in international organisations where TalTech is involved, in international education conferences, coordinated cooperation events and various project seminars, increased exponentially with the help of support funds. The volume of trainings provided, number of participants in trainings and mobility suffered a setback in the years 2020 and 2021 due to the SARS-CoV-2 pandemic (see Chapter 3.6).

Employees are remunerated and rewarded in accordance with the Rules for Remuneration in force. The university determines the remuneration of employees with an aim to pay a competitive salary and to be the top-paying Estonian university as regards academic posts - the goal which the university has successfully achieved (see Chapter 3.6). The gross salary increased significantly from 2016 to 2020 and has regularly been ca 10% higher that the gross salary at the University of Tartu (see Table 10).

[23] European Commission 2006

Table 10. Average salary (gross) at TalTech compared to the average salaries of the University of Tartu and Estonia from 2016 to 2020. Source: Universities Estonia, University of Tartu

	2016	2017	2018	2019	2020
Average salary TalTech (gross)	1,726	1,850	1,978	2,162	2,232
Average salary University of Tartu (gross)	N/A	1,567	1,691	1,813	1,939
Average salary of academic staff TalTech	2,052	2,205	2,273	2,501	2,544
Average salary of academic staff University of Tartu	1,797	1,918	2,020	2,185	2,310
Average salary of academic staff Estonia	1,779	1,903	2,008	2,181	2,282

An employee's salary is agreed based on the salary grade corresponding to the employee's position and the minimum salary rate, the specific sectoral nature of the relevant position and the salary rate of equivalent positions in the labour market, the average salary paid in equivalent positions at the university, the employee's personal contribution to exceeding the requirements set for the post and the employee's qualifications and their uniqueness. The categories and principles for recognizing the achievements of staff and members of the university are set out in the Regulations on Acknowledgement and Insignia. Regular cooperation regarding the working conditions and salary terms is carried out with the Academic Professionals Union of Tallinn University of Technology. So far, everything agreed in the collective agreement has been extended to all university employees.

The university regularly conducts employee satisfaction surveys with the help of the independent market research and consulting company Kantar Emor. Besides conducting surveys, Kantar Emor also provides comparative data regarding European universities. The survey was conducted in this form for the first time in the spring of 2018, the next one in the autumn of 2019, and from then on the survey has been conducted in every two years. The modest results of the first survey (TRI*M employee engagement index 53) were likely to be affected by the structural reform carried out at the university in 2017, however, it revealed significant bottlenecks in information flow and in involvement of the members of the university in management. An action plan was drawn up and implemented to improve the situation. The results of the second survey (TRI*M index 61) provided assurance that the activities undertaken were steps in the right direction. According to the employees, the issues that require attention the most are the reliability of central management and remuneration. The results of the survey have been used to improve the flow of information, enhance employees' development and career opportunities and attention has been paid to introducing the principles of inclusive management at the university. The next survey will be conducted in the autumn of 2021. The goal is to reach at least the average level of European universities by 2025 (TRI*M index 68).

3.2.2 INFRASTRUCTURES

The university has developed a compact and comprehensive campus at Mustamäe in Tallinn, which is connected to the nearby Science Park Tehnopol. In addition, the university operates at Kopli and at Tõnismägi in Tallinn, as well as in Tartu, Kohtla-Järve, Kuressaare and Särghaua. One of the biggest investments made in recent years is the construction of the new study and research building on Mäepealse street in Tallinn, which is planned to be taken into use in 2021. The academic goals have been taken into account in the development of infrastructures. The infrastructure management process has been described. The university's major investments are presented in budget plans and annual reports.

3.2.1.1. DEVELOPMENT OF THE EDUCATION AND RESEARCH INFRASTRUCTURE

In 2016-2020, approximately 20 million euros were invested in the education and research infrastructure (see Table 11).

Table 11. Investments in education and research infrastructure. Source: Finance Office

	2015	2016	2017	2018	2019	2020
Investments in education and research infrastructure (million euros)	5.9	1.4	3.7	3.9	2.9	2.0

The support received under "The institutional development programme ASTRA for research and development and higher education institutions" funded with European Regional Development Fund support during 2014-2020, helped to fund the development of the university infrastructure. More than 4.2 million euros under the ASTRA measure and 6.8 million euros under the Structural Funds measure "Support for Research Infrastructures of National Importance based on the National Research Infrastructures Roadmap" have been invested in the development of education infrastructure and research laboratories. At the end of 2020, a 1.8 million euro project was started to renew the infrastructure of the Small Craft Competence Centre in Saaremaa and to build a smart design centre. In 2017-2020, several R&D projects were additionally funded from the Rector's Fund (in the total amount of approximately 2.65 million euros), which include also infrastructure developments. Examples include the development of the self-driving car Iseauto, the Student Satellite, the Laboratory of Wood Technology.

The university has fulfilled its goal to develop education infrastructure by focussing on e-learning assets. In the development of the learning environment, the focus has been on enhancing

e-learning and hybrid learning/flexible learning capacity (i.e. the updated e-learning environment Moodle has been adopted, classrooms have been supplied with video recording devices and lecturers can use tools which support distance learning). E-learning capacity has made it possible, among other things, to cope with the rapid changes in the organization of studies caused by the spread of SARS-CoV-2 (see also Chapter 3.10). In order to increase the digital competence of employees, an online course Digital Wisdom has been developed, for which 667 university employees had registered as of 9 March 2021, of these 239 have successfully completed the course.

The university has set a goal to improve the availability of the research infrastructure. This goal has been partially fulfilled. For example, almost 600 laboratory services have been entered into the Estonian Research Information System ETIS and the relevant information is also displayed to companies on the website adapter.ee, and information on laboratory services of each department is also available on the university's website. Unfortunately, this information is not centrally managed or easy to find. The updating of the data fields of the Estonian Research Information System ETIS needs to be linked to annual inventory of assets.

Within the framework of the university's new Strategic Plan for 2021-2025, it has been agreed that the overview of the infrastructures will be managed by the Director for Facilities, who shall involve the Vice-Rector for Academic Affairs and the Vice-Rector for Research and representatives of the academic units. An important goal is to provide a comprehensive overview of the infrastructures and their life-cycle based development needs and to encourage cross-usage of assets. This goal has not yet been fully realized, but developments are moving in the right direction. The resources necessary for renewal must be planned more systematically in the university budget and additional funding must also be obtained from external sources. The implementation plan of the new Strategic Plan sets the goal to prepare life-cycle based development and investment plans for the infrastructures.

3.2.1.2. REAL ESTATE

Besides the unique campus at Mustamäe that supports studies and research and provides accommodation and leisure opportunities and where most of the buildings and premises used are concentrated, the university has also real estate situated elsewhere in Tallinn and Estonia. In 2013, the campus of TalTech won a prestigious international competition (the competition "Science and Education" organized by the Club of the Rectors of Europe, which brings together the leaders of the universities from 30 countries). The modern and innovative touch of the Mustamäe campus of TalTech and its close ties with high-tech companies were pointed out.

In order to manage real estate more efficiently, the activities related to the field have been consolidated in the Real Estate Office and the main relationships are described in the real estate management process map. The possibilities for students' group work were expanded significantly in 2016-2020 by providing cross-usage opportunities and opening classrooms with innovative IT possibilities, incl. rooms open 24/7. In order to make the buildings more energy-efficient, LED lights with smart controllers have been installed in the public areas of the Mustamäe buildings. Waste is sorted and a separate collection system is used in the whole university. The significant new buildings include reconstruction of the hostel at 5A Akadeemia tee (in 2017) and construction of the new study and research building at 3 Mäepealse street (in 2021) as nearly zero energy buildings. Renovation work has been carried out and the functionality of the courtyard at 5 Ehitajate tee has been expanded (incl. an amphitheatre has been built). The lobby of the university's main building has been renovated and in cooperation with the city of Tallinn, a smart intersection was developed on Raja Street. Due to the SARS-CoV-2 pandemic, the operation of the indoor climate systems was changed very quickly and cost-effectively and the functionality of several rooms was altered. The difficulty so far has been to ensure long-term sustainability of the real estate. The university aims to become the first climate-neutral university in Estonia by 2035. In connection with this, a real estate development vision document is being prepared, which addresses the development needs of the university's real estate and physical environment at both the conceptual level and the level of buildings. A long-term strategy for the development and management of the university's real estate will be drawn up, and detailed work plans will be prepared in compliance with the objectives set out in the Strategic Plan and the university's financial capacity. Energy consumption analysis has begun and optimization options are being mapped.

3.2.1.3. IT INFRASTRUCTURE AND DIGITAL SOLUTIONS

An important focus in recent years has been on continual development of appropriate IT infrastructure and digital solutions to support the university's core and support activities, keeping them secure, up-to-date and user-friendly. The function of IT operations management, IT architecture, IT development and administration, IT infrastructure and IT helpdesk have been consoli- dated as Information Technology Services. Beginning in 2017, a greater focus has been placed on the digitization of core and support activities. The TalTechDigital initiative has included several projects for upgrading digital infrastructure (new business management software, document management system, data warehouse, e-learning environment, external website, intranet, self-service solutions, TalTech's mobile application, etc.). During 2018-2019, all 1500 compulsory courses were provided with e-support in the Moodle environment. Between 2017-2020, approximately 3.2 million euros were additionally invested in these projects. In addition, internal competence has been developed and new necessary posts have been manned (IT development manager, IT architect, business and IT project managers). The university has also set a goal in the new Strategic Plan to be a leader in the digital revolution and a long-term IT architecture roadmap is under preparation to better assess the development needs of the IT infrastructure (information systems, applications, integrations, physical infrastructure) arising from the process goals and stemming from the emerging technology opportunities. An IT investment plan will then be prepared, to ensure up-to-date and consistent development. The investment needed for central IT systems development required by the needs of the Strategic Plan 2021–2025 is estimated at 0.8–1.5 million euros per year.

3.2.3. FINANCIAL MANAGEMENT

The underlying documents for the university's financial management, budgeting and business management are the university's Strategic Plan and the Budgetary Strategy . In addition, the State Budget Act, the state budget strategy and the economic forecasts shall be taken into account. Budgeting and implementation of the budget shall be carried out in compliance with the applicable Financial Regulation, which lays down the general basis for the preparation, approval, amendment, implementation of and reporting on the university's annual budget. The accounting of the university is governed by the Accounting Policies and Procedures.

A number of changes and updates have been made in the university's financial management process to support more effective organization of teaching and research. TalTech was one of the first Estonian higher education institutions, to move from cash-based to accrual-based budgeting. A new Financial Regulation was prepared, and the financial accounting of the university's structural units has been harmonized which enables better comparability between units. In 2018 and 2019, the financial and human resource management was transferred to the Microsoft Dynamics NAV business platform, which enables better cross-usage and analysis of data via the data warehouse. The university was among the first to develop a total cost model for study programmes to analyse the cost-effectiveness of teaching activities. Expense document management workflows have been digitized. The new solutions have made reports available to all members of the university; e.g. every university employee can view the budgets of structural units and their implementation (and source documents) in the budgeting module on the intranet. In 2020, Accounting Policies and Procedures were updated to harmonize the university's chart of accounts with the national chart of accounts. This simplifies and speeds up data exchange and reporting between the university and the state. The university's business accounts and correctness of accounts are regularly audited by independent auditing firms. The university's Internal Audit Office conducts internal audits of budgeting, asset accounting, public procurements and other issues related to financial management.

The main economic indicators of the university have improved in recent years (see Table 12). The annual revenue base has increased from 91.3 million euros (2015) to 117.2 million euros (2020). Since 2017, the university's operating profit has been positive, residual long-term debt has been reduced year by year, etc. The audited annual reports are available on the university's website.

Table 12. TalTech key financial performance indicators of TalTech 2015–2021. Source: Finance Office

PERFORMANCE INDICATORS (consolidated)	2015 (actual)	2016 (actual)	2017 (actual)	2018 (actual)	2019 (actual)	2020 (actual, not validated)	2021 (budget)	GRAPH
Operating revenue, incl. revenue from grants related to assets (million euros); incl.:	91.3	80.3	92.9	103.6	111.0	117.2	119.0	
revenue from the rendering of education services (million euros)	43.1	48.5	49.7	53.1	53,1	54.4	58.4	
revenue from research and development (million euros)	36.8	25.3	34.1	38.3	45.5	50.5	53.2	
research and development contracts and services provided (million euros)	5.6	5.1	5.4	7.1	10.6	10.9	8.9	
EBITDA (million euros)	12.7	7.1	13	12.7	14.0	17.7	9.8	
Depreciation costs (million euros)	13.3	13.2	11.2	10.9	9.7	8.7	8.5	
Operating profit/loss, minus financial expenses and depreciation costs (million euros)	-0.3	-6.5	1.6	1.8	4.2	8.9	1.2	
Loan balance (million euros)	35	27.5	26.1	20.2	18.9	17.6	15.8	
Balance of funds at the end of the period (million euros)	16.6	12.9	17.6	15.4	22.7	36.4	26.5	
Current ratio	1.5	1.4	1.4	1.5	1.6	1.7	1.8	
Investments in fixed assets (million euros)	11.1	2	8.3	6.6	6.3	9.6	6.2	

Despite the fact that the financial volume of the National Higher Education Programme has not increased at the same pace as Estonia's gross domestic product (GDP), TalTech have managed to increase total operating income at the same rate as economic growth. This has been facilitated by the increase in R&D and business-related revenues and the improvement of performance indicators. It should be pointed out that although significant annual investments were made in renewal of the fixed assets and infrastructures of the university, the depreciation costs still exceeded the investment amounts in 2015-2019. In 2020, however, investments exceeded the annual depreciation costs. The major goals of the university's economic activities for 2021–2025 are to increase revenue faster than Estonia's GDP growth, to prepare long-term development and investment plans related to infrastructure, to continue the automation of accounting and to create more visual analytics solutions. The Financial Regulation will also be updated in 2021 in order to further support efficient contribution to teaching, research and entrepreneurship and society and also to find additional funding sources for the development of university infrastructure.

3.2.4. COMMUNICATION, TRANSPARENCY AND INFORMING THE PUBLIC

Marketing and communication management is important for TalTech and is undergoing a renewal process so as to increase international visibility and highlight the university's research activities. Public Communications is focused on explaining the university's admission and study programmes, research news and participation of researchers in areas of social importance. The use of e-channels is analysed, and development is based on the user needs. Information on evaluation of the university's activities is available both on the intranet and on the external website. The results of the annual university reputation surveys showed an

improvement of reputation between 2015 and 2019 (see Table 13). A strong position was achieved after the renewal of the university's brand and visual identity (TalTech) on the 100th anniversary, which significantly improved the university's reputation and likeability among young people. The new visual identity was also favourably assessed by marketing experts. Systematic training of spokespersons in the university's priority areas has begun.

In 2020, the reputation index fell somewhat. According to the market research and consulting company Kantar Emor this was related to the Rector's elections that was taking place at the same time as the survey and an investigation into the financial reporting details of a specific research project attracted wider attention (leading to negative articles in the media). At the same time, the admission campaign for new students remained positively evaluated by young people in Estonia (the clarity of the messages, modernity and good visibility of the ads were pointed out) and the admission numbers were good – more students applied to study programmes than expected. The admission campaign of 2020 was awarded the title of the best digital campaign in Estonia at the competition "Best Digital Advertising Campaign in 2020".

Table 13. Reputation of universities in Estonian society (TRI*M index). Source: Kantar Emor survey 2020

University	2015	2016	2017	2018	2019	2020
TalTech	86	87	90	90	92	85
Tallinn University	N/A	73	N/A	57	60	N/A
University of Tartu	94	95	100	100	103	103
Estonian Academy of Arts	N/A	66	N/A	N/A	64	N/A
Estonian University of Life Sciences	63	68	66	63	70	70
Estonian Academy of Security Sciences	N/A	64	64	N/A	N/A	72

In the period 2019–2021, inclusive digital formats were developed for briefings, public debates and conferences and a CCTV solution has been developed to improve internal communication. A newsletter covering the most important news of the week is sent to employees weekly. Employees and students were involved in the preparation of the Strategic Plan on the university-wide forum. The university attaches great importance to the development of a new and modern communication environment (the intranet and external website, the student portal). The university's external website was renewed in the spring of 2020, migration of data from the old to the new platform was completed and the old platform closed by May, 2021. The new web platform allows fast updates and flexible creation of new areas of information and content (e.g. to increase the visibility of research information). The aim is to move towards a uniform and clearly recognizable digital identity for the university and increase the visibility of the university's research. At the same time, the development of the new external website was more difficult than expected and a lack of specific technical competences in the beginning resulted in several setbacks. Lessons have been learned from this experience and the development team has been empowered and experts from the School of Information Technologies have been involved.

SUMMARY OF STRENGTHS AND AREAS FOR IMPROVEMENT

Strengths

• The campus, which is unique in the Baltic States, is compact and has a good development perspective.

• The reorganization of the academic career system, including the establishment of a tenure system, has set an example to other Estonian universities.

• The university has a competitive average salary compared to other Estonian universities.

• In recent years, the university has significantly developed and integrated its IT systems, digitized many internal work processes and introduced new, improved services.

• The university has a strong and modern brand, recognized as such by experts.

Areas for improvement and planned development activities

• The goal of the university is to become a climate-neutral university by 2035. To this end, a long-term real estate development and investment plan will be prepared and implemented. The real estate development must be able to respond to changes in society (e.g. the situation caused by the SARS-CoV-2 pandemic may make it necessary to change the physical environment for teaching and research).

• The management of the university's fixed assets must be life-cycle based. To this end, long-term plans for the sustainable development and management of fixed assets related to teaching and research and university-wide information systems need to be drawn up and implemented. Project management software must be more widely used for different projects to ensure better management and more cost-effective management.

• The visibility of the university as well as proactive academic attention to topics resonating in society must be increased. To this end, a comprehensive communication plan including various initiatives from different units of the university needs to be prepared and implemented.

• The university's support activities need to be standardized. To this end, service passports will be drawn up and service quality levels recorded, and service performance and user satisfaction must be reviewed regularly. The quality of support services will be improved based on the feedback received. The abovementioned development target has also been set out in the implementation plan of the university's Strategic Plan 2021-2025.

3.3. QUALITY CULTURE

3.3.1. QUALITY IS A WAY OF THINKING

The mission of TalTech is to be a leading provider of engineering and economic education, a leader in engineering sciences and smart technologies. Being Estonia's only technological university, it is the most innovative and enterprising university. TalTech is a research university where research, studies, innovation and contribution to society are equally valued, balanced and interconnected. The university's general approaches for quality assurance are in line with the requirements set for several external evaluations, the Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG) as well as the Standards of EKKA. Cooperation between Estonian universities led by the non-profit association Universities Estonia, which was established by public universities and which has contributed to major changes in higher education, research and development, plays an important role in the development of the quality system. Uniform quality standards in various key areas have been established in the Quality Agreement of Estonian Public Universities (in Est) and the Quality Agreement for Doctoral Studies (in Est).

The development of a quality system is an ongoing systematic process. In 2001, Tallinn University of Technology approved the quality management principles in education and the implementation guides thereof. Based on these, the quality system has been improved consistently and attention has been focused on quality in general. The university has successfully passed the external evaluations of study programmes and study programme groups, as well as the evaluations of different fields of research and development and the previous institutional accreditation. In 2014,[24] the first version of the Management System Manual (in Est) was completed, which has been developed further. There has been a step forwards from the printed version of the manual towards an interactive solution. The intermediate stages in this work include the mapping and manual of the university's processes, continuous monitoring of the university's performance indicators, regular overviews and annual reports. The Management Board of the university also reviews implementation of the Strategic Plan and its implementation plan annually. All materials are available to members of the university on the university's intranet.

One of the most important changes made at the university since the last institutional accreditation was the structural reform carried out in 2016 (see also Chapter 3.1), one of the aims of which was to harmonise service standards of administrative and support activities and to improve coordination among smaller divisions and offices. In 2018, process mapping software was introduced and a schematic description of the processes was started and extensive training was provided to the process managers involved from support units. In 2020, optimisation of the management processes began to improve synergy, clarity and transparency in the organisation. The next challenge is to improve synergy between different units and provide support services and orient management information to a more user-oriented approach. Integration of information systems and data quality is another challenge to be addressed. As a result of process mapping, a dynamic and up-to-date interactive organisation manual based on the university's quality management system concept has been completed providing an overview of university operations. In addition to the quality of the core processes, attention is paid to optimising support services. The interactive manual contains the regulations, key performance indicators, outputs and risks related to the university's core activities, management and support processes in the relevant field.

The major changes made after the previous institutional accreditation:

• A qualitative leap took place in the collection of student feedback (voluntary feedback was not representative). Feedback has been integrated into the learning process and now engages at least 80% of the students (see Chapter 3.8).

• Academic career management is clearer and more transparent as a result of the implementation of the Academic Evaluation Matrix.

• Mapping and monitoring of the capacity and performance of research groups (valuable information for strategic management) is carried out centrally at the university.

• In the organisation of doctoral studies great attention is paid to inspection of quality.

The university's systematic activities in organising processes and developing management was confirmed by success in coping with the SARS-CoV-2 and the resulting crisis in 2020 (see also Chapters 3.2 and 3.8).

The diagram of the university's quality management system presented in Figure 4 shows the interconnections between the Strategic Plan and the key performance indicators, inputs for the quality requirements and evaluations and monitoring. At each level of the quality system, the plan-do-check-act (PDCA) cycle is regularly applied. The appropriate intervals and focuses of the university's monitoring system are under continuous review.

[24] Process mapping was started in 2011.

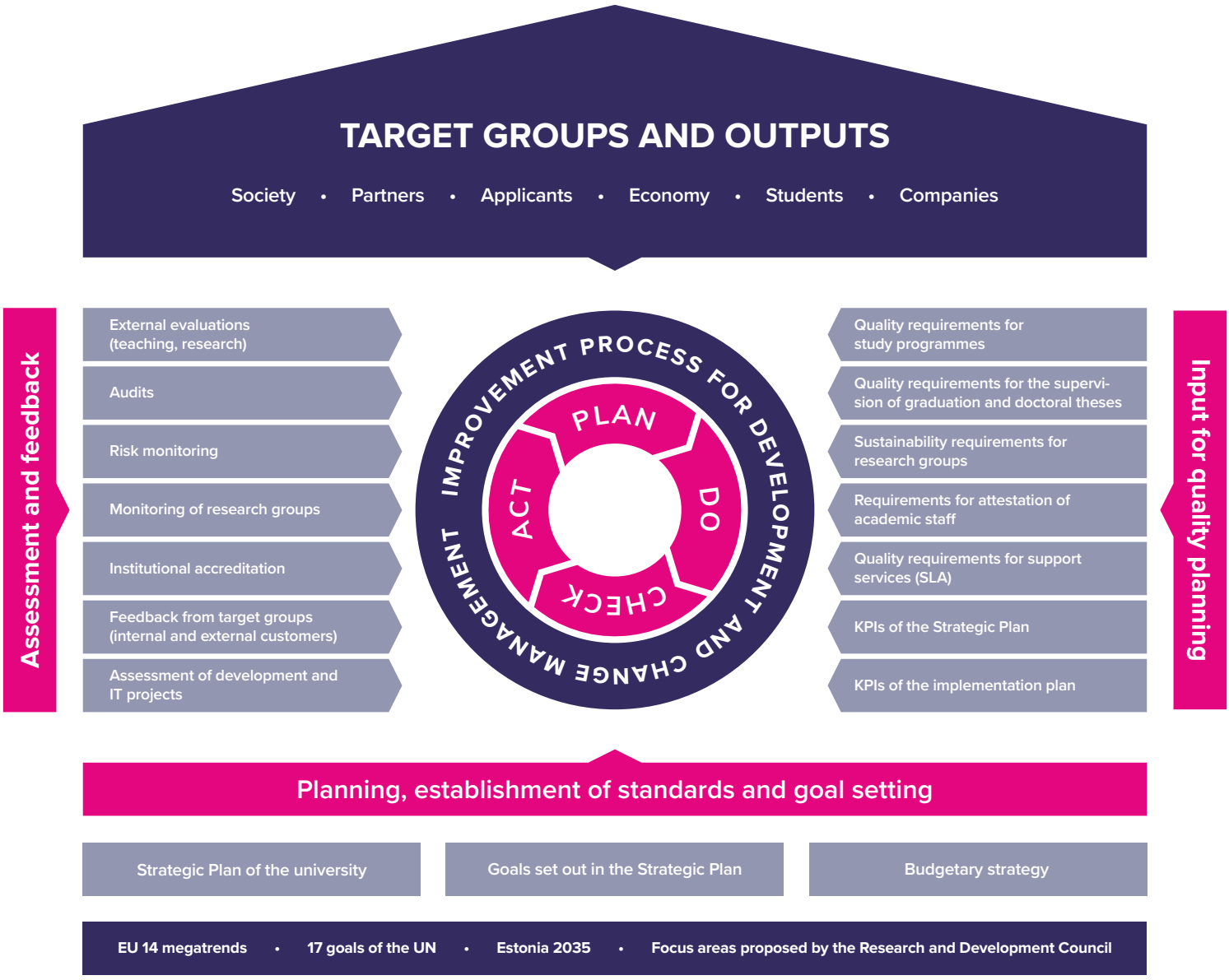


Figure 4. Quality management system of Tallinn University of Technology

3.3.2. THE QUALITY SYSTEM IS MULTILAYERED

The university's quality management system comprises the following key components:

1) **the quality definitions for study programmes**, which are undergoing an academic debate and will be supplemented. In 2021, the quality requirements and indicators will be agreed, based on which the existing study programmes will be developed or closed and new study programmes will be opened. The key performance indicators for study programmes are the number of students admitted per main speciality, the graduation efficiency, the share of professors in teaching, the share of teaching staff with a doctoral degree, the salary level of alumni, graduates' satisfaction with their studies. For all quantitative indicators, a baseline and a target will be set, the progress of which will be monitored annually (for more details see Chapter 3.7);

2) **the quality definitions for research**[25], which are closely linked to internationally accepted criteria. All researchers are aware of the requirements set out in the career matrix, based on which each member of academic staff is regularly evaluated at attestations. The university aims to be a competitive research university among the top ranked technical universities. The quality requirements for research articles, research projects and research activities in general must be comparable with those of the reference universities (share of articles published in Q1 journals and number of citations, the ratio of students to teaching staff, etc.). The following criteria are important in case of research groups: their financial sustainability (volume of projects funded by competitive project funding) and raising the next generation of researchers (number of defended doctoral theses), contribution to teaching (lectures, practical training, exercise classes, supervision) and business cooperation (business cooperation agreements, patents, start-up companies, licence agreements);

3) **requirements for, and monitoring of, sustainability of the research groups**, which provide a regular review of the viability of the research. The university monitors the academic capacity of research groups and effectiveness of their R&D using the Research Group Atlas. The Atlas includes a brief overview of the activities of each research group, its members and other characteristics (e.g. the h-index of the head of the research group, the number of citations received by the head of the research group, the number of papers published by the members of the research group, the number and volume of projects carried out by the research group, the number of patent applications filed and the number of patents owned by the research group). The evaluation period is a calendar year, whereas the development (performance dynamics) of the research group over the last three years is analysed. The methodology for compiling the atlas has been approved by the Senate's Committee for Research and the atlases are available on the intranet for university staff;

4) **the quality of doctoral studies** is key in raising the next generation of researchers and ensuring sustainability. The requirements for the level of the supervisors, the requirements for doctoral theses and attestation of doctoral students are of primary importance in ensuring the quality of doctoral studies (see also Chapter 3.8). The requirements for, and the assessment of conformity of, doctoral theses pose a challenge for all universities. TalTech's requirements are established and assessment is carried out in compliance with the Quality Agreement for Doctoral Studies of Universities Estonia. Doctoral students undergo regular attestation once an academic year (see also Chapter 3.9);

5) **guiding the development of academic staff through the academic career system**, the key process of which is regular evaluation. The requirements for the qualification and performance of academic staff have been defined from 2017 in the Regulation on Academic Career Management. The career matrix is used as a basis for evaluating the qualification and skills of academic staff upon both recruitment and attestation (see also Chapter 3.6).

3.3.3. CONSISTENT MONITORING AND DEVELOPMENT

The development of the university is ensured by regular and consistent self-analysis and internal audits. The Council and the Management Board as well as the structural units and schools perform regular inspections at the university. In addition to the fact that the university has been successful in regular and targeted evaluations of study programmes, study programme groups as well as research and development, several units of the university have initiated voluntary external evaluations and certifications. For example, TalTech Estonian Maritime Academy has implemented an internal quality management system complying with the ISO 9001 Quality Management System standard. The bachelor's study programme International Business taught at the School of Business and Governance (see Chapter 4.5) successfully passed the international accreditation for business and management degrees and courses and received EFMD accreditation. Out of the university's 74 laboratories, 11 testing laboratories are accredited, which shows that the members of the university are aware of the essence of quality systems in various areas. Accredited testing laboratories enable improved cooperation with the business sector. In addition, seminars are organised at the departments, conferences are held at the schools, annual reports are presented and experience gained from attestations is shared. In 2020, a seminar series was launched for programme directors to share the best practices; in the previous year the teaching staff who had been granted an award or recognition shared their experiences.

Figure 5 illustrates the annual calendar of the TalTech monitoring system. Regular dialogues between the university's Management Board and the Schools have become an annual tradition, the formats thereof have changed. Each School prepares its own action plan based on the university's Strategic Plan and key performance indicators. The attainment of the targets is monitored regularly at different levels (see Chapter 3.1).

[25] For the purposes of this report, the term "research" means all research and development activities, i.e. basic research, applied research and experimental development.

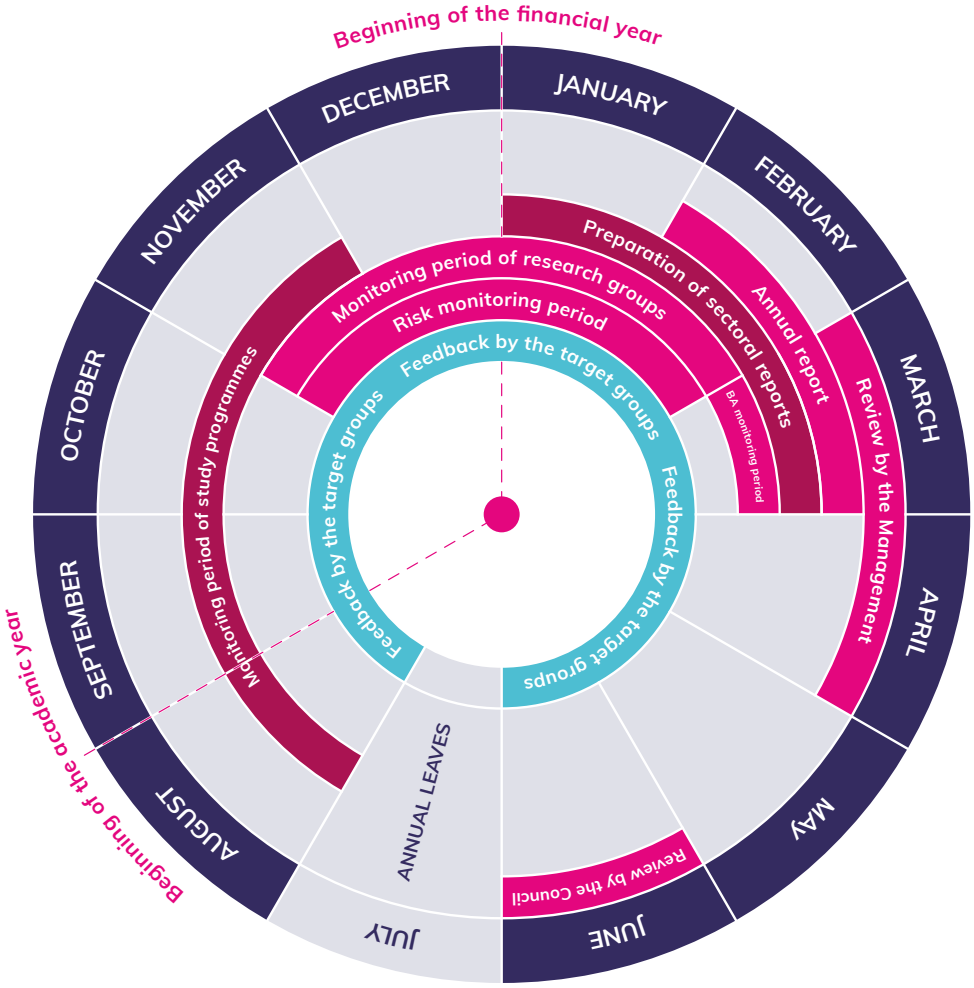


Figure 5. Annual calendar of the monitoring system of TalTech.

The university values feedback from different target groups and stakeholders, on the basis of which activities are initiated to improve study programmes, teaching, support services and expand development opportunities and increase staff satisfaction. The most important regular feedback surveys and questionnaires are the following:

1) student feedback survey on teaching, courses and organisation of studies, conducted once a semester in SIS with the aim to obtain input to different aspects of teaching and learning and thereby provide an opportunity for students to be involved in the development of the field. Students are informed about development activities through the programme advisory boards and the annual feedback report, which is a part of the internal evaluation of study programmes (the report is available to students in SIS);

2) the graduate satisfaction survey, seeks feedback on the completed study programme, the quality of teaching, organisation of studies and supervision;

3) the alumni employment and satisfaction survey, conducted every two years by the Ministry of Education and Research with the aim to obtain feedback on the after-graduation activities of the university's alumni who have graduated up to 3 years ago, their competitiveness and how knowledge and skills acquired at the university meet labour market requirements;

4) feedback and input from employers for development is received from the programme advisory boards, which include representatives of various interest groups (incl. relevant companies and professional associations) (see also Chapter 3.7). The supervisors at internship host organisations provide feedback on the level of the knowledge and skills of their interns. Previously an employer satisfaction survey was also conducted, but this is no longer used due to the establishment of the programme advisory boards, from where more operative, substantial and high-quality feedback can be obtained.

5) the employee job satisfaction survey is conducted every two years (see Chapter 3.2) and it is similar to those conducted in other universities and organisations.

The services that support the workflow and the main processes, have been mapped and the majority of the services (e.g. ICT, human resources, marketing, real estate maintenance services) have been made available to the staff via intranet. In the coming years, the focus will be on raising the quality level of the support services and making them more user-friendly: the intention is to create quality standards for the support services, define indicators for assessing compliance and create a methodology for collecting feedback on user experience and satisfaction with each service in order to meet user expectations.

3.3.4. SELF-ANALYSIS AND FEEDBACK IMPROVE THE UNIVERSITY

Feedback systems and surveys play an important role in the development and management of the university. Based on the input obtained from them, several processes have been improved:

• **the mapping and optimisation of management processes** has helped streamline the management model, adjust areas of governance, reduce fragmentation and fix broken value chains (e.g. to integrate marketing and communication processes, bring similar activities of lifelong learning for different target groups under common management, consolidate R&D and business processes);

• **internal audit reports** are important in initiating improvement activities to facilitate and improve the quality of processes. The management regularly monitors actions taken on the recommendations made in audit reports. As a result of these recommendations, changes have been made to the student recruitment process, the procedure for admission to doctoral studies, organisation of public procurements and management of R&D and IT projects. The implementation of R&D projects has also been improved: the Project Accounting and Reporting Division was established under the Finance Office, the team of project proposal writers was created, the team of project advisors was established at the Research Administration Office. In order to improve cooperation within the university in project and financial management new project management software has been adopted (see also Chapter 3.2);

• **students' semester-based feedback** on courses and study materials provided in SIS is regularly monitored and, if necessary, changes are made (e.g. the workload of a course has been adjusted if feedback has consistently indicated that the work performed during the course does not correspond to the amount of credit points; the Educational Technology Centre has helped improve Moodle courses to provide better e-support for courses);

• in the course of the **internal evaluation of study programmes**, each programme director analyses the dynamics of various performance indicators and stakeholder feedback his/her study programme and makes adjustments regarding courses, teaching staff and the study programme. Based on the results of internal evaluation, changes have been made to admission requirements, teaching staff have been replaced and main specialities have been closed in study programmes with low student numbers. The programme advisory boards also propose amendments and provide feedback to improve study programmes (e.g. in the bachelor's study programme Business Information Technology, the number of points for state examinations required for applying is planned to be increased in order to ensure the applicants' more uniform level in mathematics) (see also Chapter 3.7 and Chapter 4.2).

SUMMARY OF STRENGTHS AND AREAS FOR IMPROVEMENT

Strengths

• Systematic internal evaluation is carried out based on regular feedback on the study programmes (provided by students, employers) and the experience of the reference universities.

• Annual monitoring of research groups provides a good overview of the viability of their R&D activities and the areas for improvement, and enables making reasoned decisions.

• Open, inclusive, knowledge-based and fact-based management creates the preconditions for substantial academic dialogue and helps to communicate expectations transparently - the necessary management data are available on the Power BI platform on the intranet.

• The university's Strategic Plan 2021–2025 focuses on quality in teaching and research, service to society and organisational culture as a whole.

Areas for improvement and planned development activities

• To agree on quality definitions in order to provide better and more user-friendly support services (target groups in and outside the university depending on the support service).

• To improve data quality in databases and synchronise data management with actual processes.

• To reduce the administrative burden and duplication of work to improve synergy between processes and services. This requires interoperable user-centred processes and supportive information systems (automated data collection).

• To increase the share of data-based analysis in the decision-making process, to create a convenient desktop solution for managers and better share good practices.

3.4. ACADEMIC ETHICS

3.4.1. GENERAL COORDINATION OF MATTERS OF ACADEMIC ETHICS

General guidelines for understanding academic culture and raising awareness of the values related to academic ethics and the general basis for working practices and academic activities at the university are provided by the European Charter for Researchers and Code of Conduct for the Recruitment of Researchers and the European Code of Conduct for Research Integrity. The fundamental principles of research ethics support researchers in everyday circumstances and help to solve practical, ethical and intellectual problems arising in the course of research.

The university's quality system concept provides that all the management and operating principles shall be regularly reviewed, risks shall be assessed and improvements made in compliance with the university's Principles of Academic Ethics (Code of Academic Ethics) and Estonian Code of Conduct for Research Integrity. The basic documents underlying the practices are presented in the scheme of management and handling of matters of ethics. The Vice-Rector for Research has the leading role in resolving matters related to academic ethics; general coordination takes place in cooperation between the heads of different areas of responsibility. In each area of responsibility, the processes are supported by a set of regulations and uniform, transparent and understandable principles of academic ethics are applied throughout all processes. It is often difficult to draw clear lines between different areas of ethics, so there are general procedures that ensure a quick and clear processing of complaints and appeals. Information related to academic ethics is consolidated on one page on the intranet; relevant legislation on ethics is available to employees and students in Estonian and English (see TalTech Legislation).

The academic ethics matters at TalTech are managed as follows:

1) research ethics (area of responsibility of the Vice-Rector for Research),

2) academic honesty (area of responsibility of the Vice-Rector for Academic Affairs),

3) business ethics (area of responsibility of the Vice-Rector for Entrepreneurship),

4) conflict of interests (area of responsibility of the Director for Administration and the Head of Human Resources),

5) equal treatment (area of responsibility of the Head of Human Resources).

3.4.2. RESEARCH ETHICS

The basis of research ethics are the university's Principles of Academic Ethics and the Code of Conduct for Research Integrity. The university organises its everyday research and resolves disagreements in adherence with these documents. The basic documents and the basic principles of academic ethics are also introduced at the admission to doctoral studies and it is planned to cover these topics in more detail in the trainings of new employees. In order to raise the awareness of academic staff and doctoral students about ethical issues, the courses Ethics and Engineering Ethics have been integrated into the teacher training continuous education study programme of the Estonian Centre of Engineering Pedagogy.

Cases of misconduct are handled according to the presented process diagram. The university actively participates in the development of the new Organisation of Research and Development Act, thereby influencing, along with with other universities, the content and enforcement of research ethics legislation.

The university's Academic Ethics Committee is a statutory body that resolves academic ethics disputes, including authorship, plagiarism, targeted use of research funding and other matters. The Committee is also responsible for evaluating, if necessary, the compliance of research and development projects applied for by university members with the principles of research ethics. To provide information and feedback on the evaluation, a corresponding technical solution is being developed on the intranet in the Jira services environment, which will be a part of the project management software in future.

The Statute of the Academic Ethics Committee sets out the objectives and tasks of the activities, the rights and obligations of the members, the rules of procedure and decisions, and the procedure for handling of matters. In order to ensure transparency in the resolution of matters, the Committee reports regularly to the Senate on the conclusions made in the cases handled in the Committee. The process for referring matters to the Ethics Committee is described and available online. The Committee has no obligation to conduct training, but the Chairman of the Committee has organized studies for PhD students for years and the members of the Committee have introduced the principles of academic ethics in the Schools. Work is carried out in compliance with the Statute and the Code of Academic Ethics. The procedure for archiving confidential materials of the Academic Ethics Committee will be reviewed and supplemented in the future. The new composition of the Committee will, where necessary, specify the procedure for handling cases of misconduct and evaluation of research ethics in its rules of procedure.

Since 2017, the number of cases handled by the Ethics Committee has increased, which shows an increase in the general awareness (from 2 cases in 2017 to 13 cases in 2019).

3.4.3. ACADEMIC HONESTY

Academic honesty and fraud are covered in the Academic Policies, which regulate plagiarism checks of graduation theses, exmatriculation, violation of good academic practice and appealing against study related decisions. All Schools have established citation and formatting guidelines for written papers, including graduation theses. The Curriculum Statute, requirements that bachelor's, professional higher education, master's and integrated study programmes should include courses that foster scientific thinking and the acquisition of good scientific practice and implementation of professional research methodology, and help raise students' awareness of academic honesty. The university has the right to check graduation theses regularly with plagiarism detection systems and currently uses Ouriginal (previous name Urkund) for this. If plagiarism is detected, the chairman of the defence committee has the right not to allow the thesis to be defended. Due to the increase in distance learning, it is planned to introduce the Proctorio solution, which allows proctoring of the exams and assignments. In addition, a guide has been prepared for students and lecturers for conducting online exams.

The number of documents uploaded into the Ouriginal system has increased steadily and significantly since 2017, which shows an increased awareness of the importance of plagiarism checks (see Figure 6).

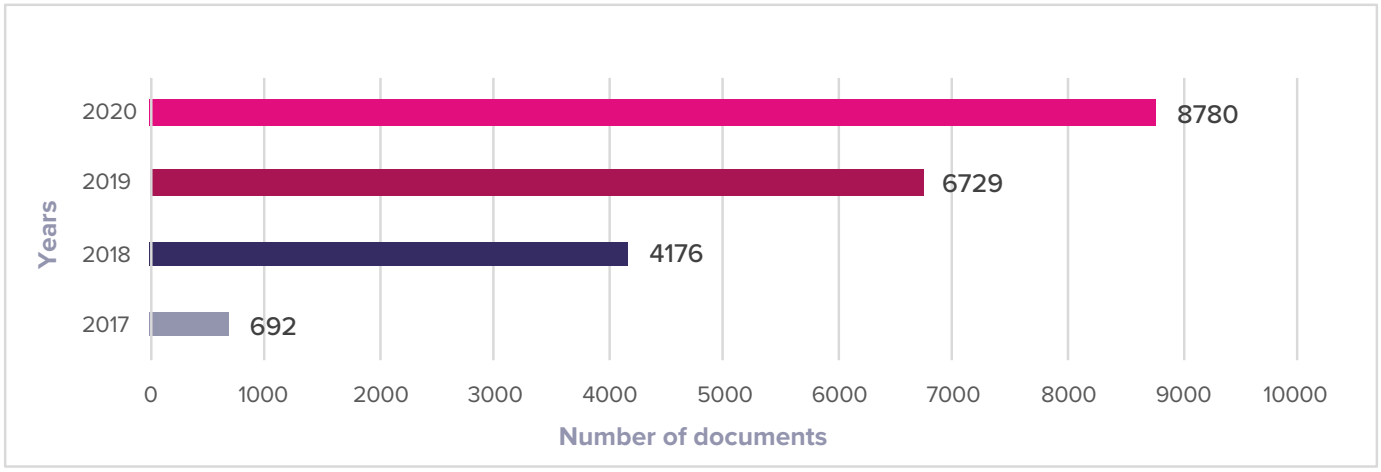


Figure 6. Documents uploaded into the Ouriginal system in 2017–2020. Source: Educational Technology Centre.

All Schools have established a procedure for processing violation of good academic practice and misconduct (e.g. see the relevant procedure established by the School of Business and Governance). A student can be exmatriculated due to contemptible conduct (the cases are defined in more detail in § 35 of the Academic Policies). The number of reprimands issued by a dean characterises the cases of students' misconduct in the Schools that were resolved at the level of the dean. The main reasons for these for 2017–2021 were plagiarism in a graduation thesis, an essay or an internship report and making use of help from others at an exam (see Table 14).

Table 14. Reprimands issued by a dean by School in the period 2017–2020. Source: dean's offices of the Schools[26].

Academic year	School of Information Technologies	School of Engineering	School of Business and Governance	Estonian Maritime Academy	School of Science
2017/18	12	4	3	1	0
2018/19	2	9	6	0	0
2019/20	8	5	11	0	0
2020/21	2	5	3	0	0
TOTAL	**24**	**23**	**35**	**1**	**0**

[26] In the smaller Schools (EMERA and School of Science) with few or no cases the issues are solved case-by-case mostly between the lecturer and the student.

3.4.4. BUSINESS ETHICS

Research and development carried out with business partners is in line with the principles set out in the regulations on research ethics. In undertakings in which TalTech holds shares, the representatives of the university are obliged to inform the university about unethical conduct or threat to the university's reputation. In addition, the university conducts background research with the help of the Business Register and other databases and media monitoring, which helps to avoid cooperation partners with questionable ethical backgrounds. However, the university staff have no control over the ethical views and practices of their partners. In order to better respond to changing external regulations (incl. the General Data Protection Regulation and inconsistent practices, the university has established the Procedure for Processing and Protection of Personal Data. The university is seeking, together with the University of Tartu, suitable and viable solutions for Estonian universities to ensure ethical and legal conduct in participatory policy framing, incl. the establishment of start-up and spin-off companies; the Ministry of Justice and the Estonian Internal Security Service will also be involved in the work. The subsidiaries shall be managed in adherence to the university's goal to contribute to the development of society. As regards the companies established by students, the university can direct students to take the ethical path. The university can also refuse to fund establishment of unethical companies, e.g. through the non-profit organisation Prototron.

3.4.5. CONFLICT OF INTERESTS

To prevent conflicts of interest, the university's management and members of the Council make declarations of their interests once a year in compliance with the Accounting Standards Board's guideline (ASBG 15). Transactions concluded with related parties are mapped and verified based on the submitted reports and the university's accounting data. In order to avoid conflicts of interests in the university's public procurement processes, all employees participating in the work of procurement committees shall sign the declaration of no conflict of interest, which is preserved in the university's document register. An online course "Preventing corruption and conflicts of interest in the public sector" is available for university employees, which provides an opportunity for employees in charge of the university's assets to acquire basic principles regarding the prevention of corruption and of conflicts of interest.

Conflicts of interests are governed by Work Procedure Rules and its Annex 1 "Procedure for Avoiding a Conflict of Interests and for Prevention of Corruption", which sets out the principles for avoiding conflicts of interest and the prevention of corruption, but leaves it up to the management to decide how individual cases are handled. The Guidelines for Resolving Conflicts Regarding Academic Ethics and Labour Relations prepared in 2018 define the principles and the bases of the proceedings, but do not regulate procedures in detail. In 2019, the Procedure for Whistleblowing and Verification of Whistleblowers' Complaints was annexed to the Work Procedure Rules, which provides an opportunity for the members of the university to report anonymously on an offence or misdemeanor or circumstances that can cause damage to the university's property or reputation. Between November 2019 and February 2021, 3 complaints have been processed, which can be considered a low number. In February 2021, the Rector approved the Conciliation Procedure for resolving labour disputes, which regulates the settlement of cases in a two-instance system. At first instance, cases are resolved within the structural unit. If the parties are not satisfied with the decisions made at first instance, the case can be referred to the Conciliation Committee appointed by the Rector. If a case concerns the principles of academic ethics, the parties may refer the case to the Academic Ethics Committee for further evaluation of the facts at any instance.

3.4.6. EQUAL TREATMENT

The university's Guidelines for Equal Treatment describe the principles of equal treatment, encourage employees to react to and notify cases of unequal treatment and provide example cases regarded as discrimination. The guidelines are available to all employees on the intranet. One of the metrics set out in the new Strategic Plan is the measure of occupational segregation based on gender (Duncan Segregation Index). According to the survey conducted in 2019, there was a gender wage gap of 24.20% to the disadvantage of women. A study on the wage gap of employees with a doctoral degree conducted by the Department of Economics and Finance pointed out the reasons behind the lower pay of women: their academic careers are shorter compared to men, while maternity leave is an important contributor to their career breaks, and there is a higher share of women involved in teaching, which is less well paid than research and development. Men have a higher share of management roles at the university, only 21% of the 43 heads of structural units are women. Both the lack of women in management roles and the size of the pay gap mean that the university should adopt measures in the near future to improve the situation and to establish a gender equality procedure that will set out the principles and metrics needed to progress towards gender balance.

SUMMARY OF STRENGTHS AND AREAS FOR IMPROVEMENT

TalTech follows the principles of academic ethics in compliance with the established standard. The university has defined the principles of academic ethics, there is a system for disseminating them among the members of the university and a code of conduct for handling cases of infringement of the principles. The university has a functioning complaint handling system. The principles of academic ethics are the basis of daily work organization, research and development and smooth progression of studies. However, there are some areas that need to be further developed in order to increase the general awareness of the members of the university in the field.

Strengths

• The European and Estonian code of conduct for research integrity and the basic documents on academic culture provide the general basis for working practices and academic activities at TalTech.

• The Code of Academic Ethics prepared by the Academic Ethics Committee is one of the foundations of research and teaching activities; matters regarding academic ethics are managed in cooperation with the heads of the areas of responsibility.

• Guidelines for Equal Treatment have been prepared, the Conciliation Procedure and the related documents have been prepared, the relevant referral schemes are available online.

Areas for improvement and planned development activities

• In order to raise awareness of the topics and basic documents of academic ethics, it is planned to:

o enhance internal communication on academic ethics issues in order to increase the overall visibility and awareness of ethics issues among members of the university at all levels. Relevant materials will be available in both Estonian and English;

o to organize training on academic ethics for international staff and students in order to prevent problems that could arise due to different cultural backgrounds and differences in ethical principles.

• In order to enhance the skills of structural units to detect problems and address them appropriately at an early stage, it is planned to train administrative staff with an aim to embed the practice of solving a potential problem at the level of the persons or academic units in conflict.

• In order to mitigate the risks of violating academic ethics in the digital era, it is planned to train lecturers and inform students of the principles of academic ethics and good practice of complying with the principles in (digital) studies.

3.5. INTERNATIONALISATION

The Strategic Plan of TalTech 2016–2020 addressed internationalisation as a horizontal enabler for achieving the goals in four main areas: 1) organisation and management, 2) studies, 3) research and innovation, 4) partnership with society. The university's Strategic Plan 2021–2025 also views internationalisation as a horizontal process that supports the achievement of goals as an enabler for development. In order to develop services supporting internationalization and to manage the process, it is planned to analyse the need to develop a sectoral sub-strategy based on the focus area profiles.

3.5.1. ORGANISATION AND MANAGEMENT

TalTech's goal is to improve its international reputation by 2025, incl. through cooperation with reputable universities and research-intensive companies in the world. One of the most important planned activities is to lay the foundation for the most influential European centre for engineering and economics education together with the universities[27] belonging to the EuroTeQ Engineering University. So far, as regards organisational management, the main activities supporting internationalisation have been aimed at creating a work and study environment that promotes cross-border cooperation.

The university has contributed to the establishment and development of relations with foreign partner universities; the number of cooperation agreements has increased from 521 to 722[28] in the last five years, strategic cooperation has been initiated with the universities belonging to the EuroTech Universities Alliance[29] and reference universities have been designated from among top universities of technology in the Nordic countries in order to monitor institutional development.

Besides sectoral networks, significant attention has been paid to cooperation with institutional academic networks, involving, in addition to the former partners (UNICA, CESAER, EUA, SEFI, BALTECH and HERITAGE), also the network of the technical universities in the Nordic and Baltic countries NORDTEK and the global network of education, research and innovation Science Business Network. In 2021, TalTech joined the global network for quality enhancement in engineering education CDIO, the aim of which is to create an innovative framework of study programmes supporting engineering education. The main goal of participating in them is to increase contacts through international networking of the members, to improve the international reputation of the university, to increase visibility and to participate in the development of sectoral policies.

In order to provide a comprehensive information and counselling service to the international members of the university (international staff and students) related to their working and studying in Estonia, the International Staff Centre and the Student Counselling Office (see also Chapter 3.10) have been established. So far the International Staff Centre has provided support to some 90 foreigners who have joined TalTech.

The international competitions for the posts of the tenure system launched in 2017 contribute to the share of international academic staff to a significant extent (see Chapter 3.6). In the last five years, the number and share of international employees has increased by about 70% (see Table 15).

Table 15. Number and share of international staff in 2016–2020. Source: NAV

	2016	2017	2018	2019	2020
Number of international staff (headcount)	171	187	207	245	297
Number of international academic staff (headcount)	141	153	168	204	239
Share of international academic staff in the total number of academic staff	13.3%	15%	17.1%	20.7%	23.3%

Due to the internationalisation of the composition of the university staff, the Language Policy has been renewed, which lays down the principles that support the involvement and participation of all the members in the daily operation and development of the university (internal communication, document translations, opportunities for the development of language skills).

The main strengths are the continuing increase in the share of international academic staff and the strategic partnerships launched with the universities of the EuroTech network. One of the bottlenecks is the capacity to manage the continuously increasing portfolio of partner universities, for the resolving of which it is planned to analyse the quality, feasibility and potential of cooperation carried out under agreements, thereby reducing the number of contract partners in order to focus on strategically important cooperation.

[27] TalTech participates as a partner university in the three-year pilot project EuroTeQ Engineering University of the EuroTech alliance, the aim of which is to develop engineering education across Europe.

[28] Data of the International Cooperation Division as of 31.12.2020.

[29] a joint application for the support action of the Eramus+ European Universities and the strategic cooperation project EuroTeQ Engineering University.

3.5.2. INTERNATIONALISATION IN STUDIES

In order to develop and increase the quality of studies, one of TalTech's goals has been to internationalise the student body. The effectiveness of internationalisation in the university's studies is assessed mainly on the basis of four indicators: 1) the share of international students in the total number of students, 2) the number of study programmes taught in English 3) the mobility of students and teaching staff, 4) the share of international graduates in the total number of graduates.

3.5.2.1. INTERNATIONAL STUDENTS

The total number and share of international students[30] increased every year until the academic year 2020/2021 (see Figure 7). In the academic year 2019/2020, the share of enrolled international students accounted for 20% of the total of all the students enrolled. Due to the university's threshold-based admission system, no target has been set for the number of international students to be admitted. In the academic year 2020/2021, students from one hundred different countries are studying at TalTech. The share of international students is the highest in doctoral studies (39%); 27.23% of the graduates of doctoral studies have experience of studying abroad (for at least one semester). Both indicators show an upward trend. In the academic year 2020/2021, the decrease of the total number of international students to the level of 4 years ago was caused by the SARS-CoV-2 pandemic, due to which the university postponed the enrolment of students from third countries with high infection rates admitted to I and II level study programmes to the next year. The share of international students in doctoral studies has increased with each academic year and this trend has been constant in recent years. The admission of international students in future will largely depend on the epidemiological and national situation.

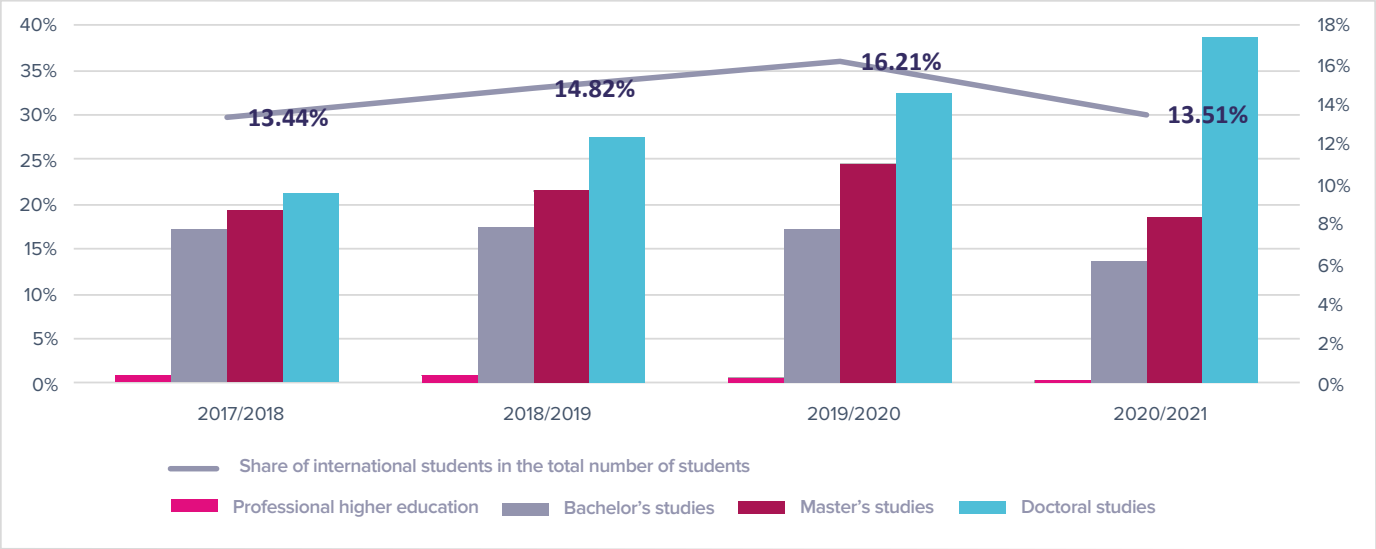


Figure 7. Share of international students in the total number of students by type of study in 2017/2018–2020/2021. Source: SIS

In the last five years, the share of international graduates in the total number of graduates has increased, amounting to an average of 21% of the total number of graduates in the academic year 2019/2020 (see Figure 8).

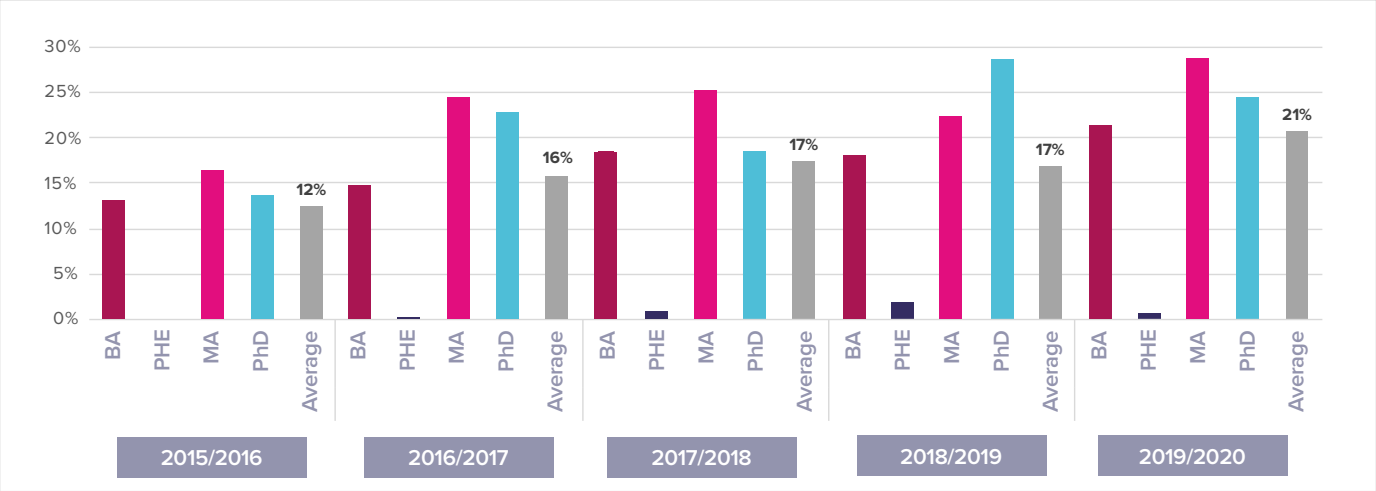


Figure 8. Share of international graduates in the total number of graduates by type of study in 2015/2016–2019/2020. Source: SIS

[30] "An international student" means a student whose country of residence is not Estonia and who does not have a permanent right of residence or hold a long-term resident's residence permit in Estonia and who does not have Estonian citizenship.

3.5.2.2. STUDY PROGRAMMES TAUGHT IN ENGLISH

In the academic year 2020/2021, admission took place to 31 study programmes taught in English (4 bachelor's, 18 master's and 9 doctoral programmes) accounting for 37% of all the study programmes. The largest number of English-taught study programmes are conducted in the School of Engineering and the School of Business and Governance (see Figure 9). Six of the master's study programmes are joint study programmes, including one international study programme. International joint studies also take place in other forms - mainly in the framework of the double degree study programmes[31]. The goal of the university is to expand international joint study opportunities in the field of engineering, in particular through the strategic cooperation launched in 2020 together with the universities of the EuroTech Alliance, the long-term objective of which is to develop a common learning environment, starting with integrated elements of modular learning and joint study programmes. The initiative fosters significantly student mobility, in particular with partner universities and their associates.

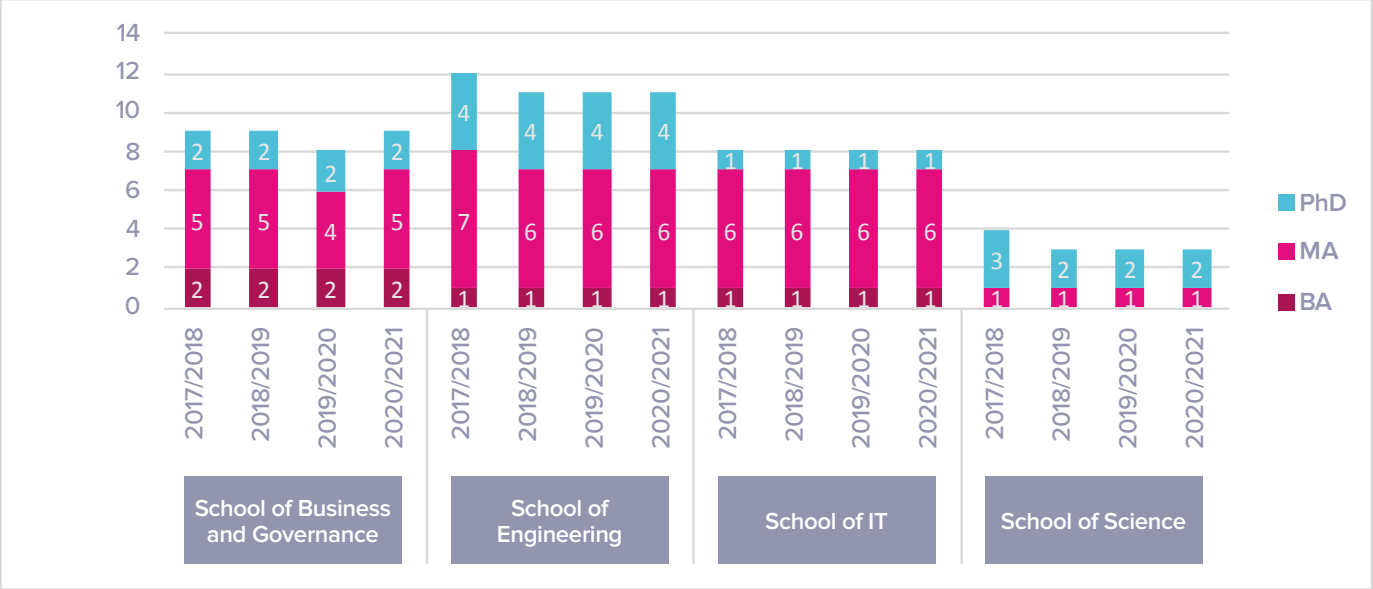


Figure 9. Number of study programmes taught in English 2017/2018–2020/2021 by School and type of study Source: SIS

3.5.2.3. MOBILITY OF STUDENTS AND TEACHING STAFF

The university measures student mobility by exchange studies at partner universities and internships in foreign companies. Short-term mobility (summer and winter schools) and virtual mobility are not coordinated across the university, and takes place on individual initiative.

Student mobility has reached a stable level over the last five years: 2% of outgoing students and 4% of incoming students (see Table 16). In the academic year 2019/2020, the opportunity to study abroad was most actively used by the students of the School of Business and Governance (56), followed by the students of the School of Engineering (53), the School of Information Technologies (23) and the School of Science (11). Students attended studies abroad in the total of 88 universities in 25 countries. In the academic year, the largest number of international students studied at the School of Business and Governance (229) and the School of Engineering (140). International students tend to choose the autumn semester for their exchange semester at TalTech, when there is a greater choice of courses taught in English compared to the spring semester. In order to increase the number of international students, it is necessary to increase the total number of courses taught in English, in particular at the School of Engineering, the School of Information Technologies and the School of Science.

In the academic year 2019/2020, the opportunity to study abroad was most actively used by the students of the School of Business and Governance (56), followed by the students of the School of Engineering (53), the School of Information Technologies (23) and the School of Science (11). Students attended studies abroad in the total of 88 universities in 25 countries.

Table 16. Student mobility. Source: SIS

	2015/16	2016/17	2017/18	2018/19	2019/20
Number of international exchange students at TalTech	428	425	386	408	464
Number of students in short-term student mobility in exchange studies	199	227	225	200	193

[31] For example, various joint study programmes funded under Erasmus+/Erasmus Mundus programme in the fields of engineering, economics and social affairs. The EIT joint study programme is under development at the School of Information Technologies.

In recent years, the volume of agreements for exchange studies supporting mobility has exhibited an upward trend and the majority of mobility for studies takes place within the framework of the Erasmus+ programme (see Table 17). Since the aim is to focus future cooperation more on quality (incl. the possibilities of the partners to organise studies in English), the number of partnership agreements is likely to decrease.

Table 17. Number of student exchange partnership agreements in 2016-2020

	2016	2017	2018	2019	2020
Number of TalTech's student exchange partnership agreements per academic year	496	536	574	617	601
incl. Erasmus+ agreements	462	503	533	575	581
incl. bilateral agreements between the universities	34	33	41	42	20

Regardless of the large number of mobility agreements, the volume of credits transferred from studies abroad has remained marginal in the total volume of credit points of the courses completed during a study period (see Figure 10).

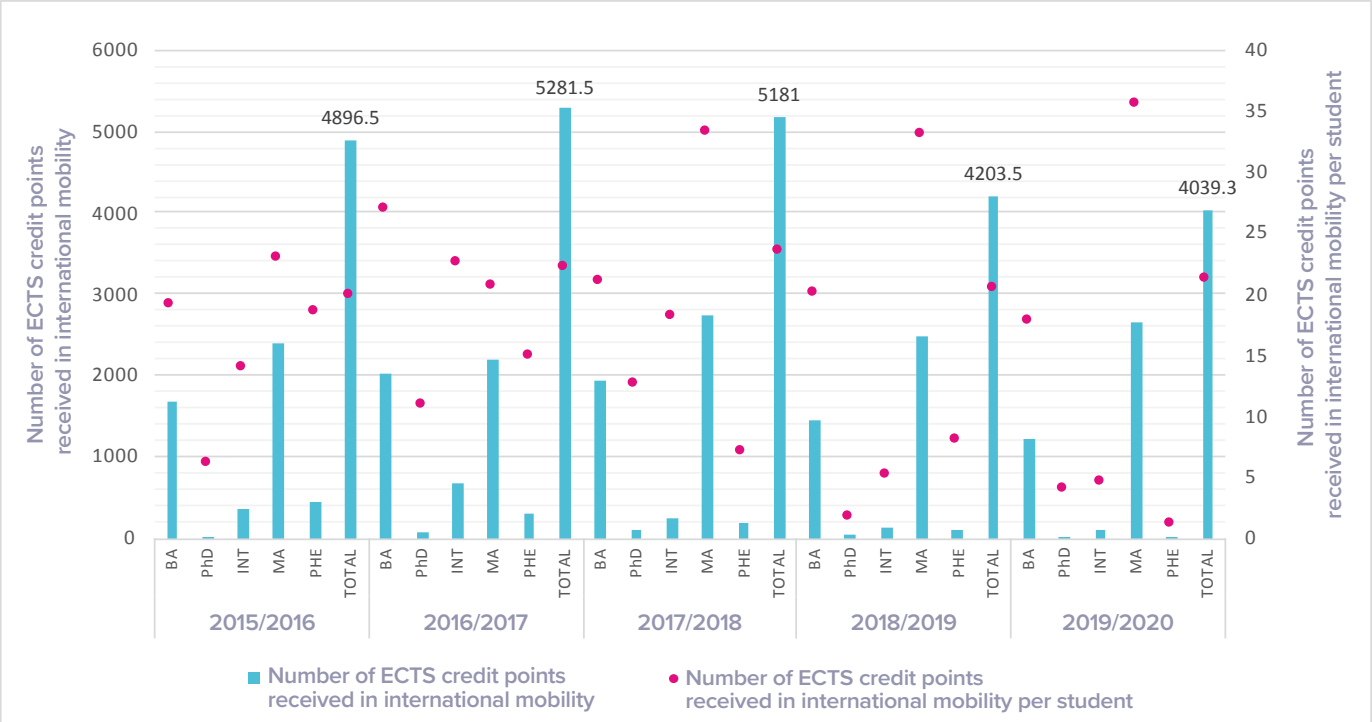


Figure 10. Number of ECTS received in international mobility in 2015/2016–2019/2020. Source: SIS

Besides the traditional mobility window, new options are being added to expand international learning opportunities: joint project-based learning, joint interdisciplinary modules, various combinations of e-learning, hackathons, joint summer and winter schools and joint course catalogues in the open studies system. TalTech has set a strategic direction to develop international studies primarily with the EuroTech partners. Within the framework of the EuroTeQ Engineering University cooperation project, new forms of problem-based learning with partner universities will be developed and, in addition, a joint catalogue of subject courses will be developed through the open university and joint study programmes will be developed.

An increasing number of European universities are moving towards internationalisation in studies at home, as a result of which local mobility is becoming more important. TalTech students, who cannot or do not want to study abroad for some reason, can gain international learning experience through international students and international visiting students. Local students are offered this opportunity through several TalTech study programmes taught in English. For example, the courses of International Business (taught in English) and Business (taught in Estonian) have both been included in the bachelor's studies of the School of Business and Governance.

The international mobility of teaching staff takes place within the framework of various grant programmes and projects mostly between European universities. In recent years, both intra-European and global mobility for studies has increased thanks to the support mechanism of the Erasmus+ programme, which in addition to increasing the amount of budgetary resources, has expanded the possibility of funding mobility for studies outside Europe (see Figure 11). In addition to studying abroad with Erasmus+, the teaching staff also use other forms of mobility (e.g. Dora+, Mobilitas+, bilateral agreements) for self-development and teaching. There was a steep decrease in the mobility figures in the second half of the academic year 2019/2020 resulting from travel restrictions imposed due to the spread of SARS-CoV-2. The mobility of employees for studies has not recovered in the academic year 2020/2021, but the first steps have been taken towards practising virtual mobility.

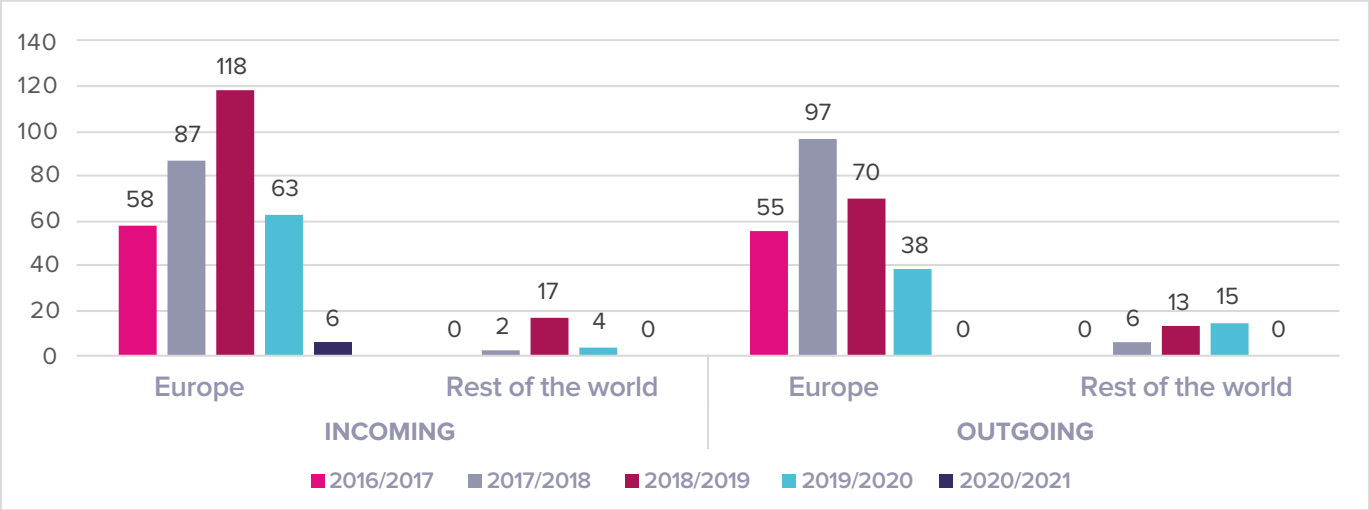


Figure 11. Number of academic staff participating in Erasmus+ and Erasmus+ International mobility in 2016/2017–2020/2021.

The main strengths are the large share of international students, including international visiting students, and strategic cooperation in the development of international joint study formats with EuroTech partner universities. A weakness is the low activity of students in participating in international mobility. To tackle the challenge, it is planned to strengthen the partners portfolio of exchange agreements and develop cooperation in the EuroTeQ Engineering University project, the goal of which is to create at least 18 new and flexible joint learning formats in cooperation with the world's top technical universities within three years.

3.5.3. RESEARCH AND INNOVATION

The effectiveness of internationalisation in the field of research and innovation at the university is monitored and evaluated mainly using three indicators: 1) the share of international students in doctoral studies, 2) international co-authorship, 3) external projects and contractual cooperation.

In the last five years, internationalisation of doctoral studies has reached a level, where the share of international PhD students has grown to almost 38.8% and is expected to continue to rise in the coming years. A prerequisite for internationalisation has been the provision of all doctoral studies in English, which has opened up global competition for all study places (see Table 18).

Table 18. Share (%) of international PhD students in the total number of PhD students Source: SIS

Share of international PhD students, %					
2015	**2016**	**2017**	**2018**	**2019**	**2020**
14.5	17.4	20.4	27.9	33.7	38.8

The main indicator of internationalisation of research, the international co-authorship rate, has increased in the last five years both in terms of the number and share of publications (Table 19).

Table 19. The share of international co-authorship in research in 2016–2019. Source: Scopus

	2016	**2017**	**2018**	**2019**	**2020**
Number of publications	868	880	884	1,090	1,151
Share of international co-authored publications	50.3%	52.2%	59.2%	62.5%	65.7%

Internationalisation in research and development and innovation is shown also by the share of external funding, the volume of projects and contractual cooperation (see Chapter 3.11).

The university's main strength in the sector is the international academic network resulting in an increasing share of international co-authored publications, the number of international projects and partners. Academic networking is also supported by the university's membership in the EIT Raw Materials consortium, which unites a total of 120 partners from countries in Europe.

Over the last five years, several important international R&D projects have been launched, which, besides leveraging the research fields, support institutional networks and international competitiveness:

• 2015 "ERA Chair of Cognitive Electronics"

• 2016 Twinning "Strengthen Tallinn University of Technology's Research and Innovation Capacity in Nanoelectronics Based Dependable Cyber-Physical Systems"

• 2018 ERC Starting Grant for project "Cosmolocalism"

• 2019 Teaming "Establishment of Smart City Center of Excellence"

• 2020 "ERA Chair in Maritime Cyber Security"

• 2020 "ERA Chair of emerging next-generation photovoltaics"

• 2020 Twinning "Secure and Assured hardware: Facilitating ESTonia's digital society"

• 2020 Twinning "Industrial Strategy and Competitiveness Studies at TalTech"

• 2020 Twinning "Individual Behaviour and Economic Performance: Methodological Challenges and Institutional Context"

3.5.4. PARTNERSHIP WITH SOCIETY

TalTech is strengthening its involvement in shaping international policies through sectoral networks, working groups and national support bodies (Ministry of Education and Research, Estonian Research Council, Education and Youth Board). An important part of the international dialogue has taken place through the Science Business Network, the European University Association (EUA) and CESAER. TalTech has contributed to the development of the European Commission's Framework Programmes (H2020 and HE) as well as other support measures and national development documents have been prepared (e.g. the Aliens Act, the regional strategies of the Ministry of Foreign Affairs).

To improve integration of international students and staff into Estonian society, the university offers Estonian language and culture training to everyone, participates in the organization of international job fairs and has been developing support services for foreigners.

In order to increase international visibility, a new brand and short name TalTech was launched in 2018, the rapid spread of which in the international educational landscape confirms the improved visibility of the university[32] (see also Chapter 3.2.3). Over the past five years, TalTech has hosted nearly 150 foreign delegations, which has helped to establish new sectoral contacts and increased the visibility of both the university and Estonian research and education.

TalTech Innovation and Business Centre Mektory is developing an international conference centre and offers the local start-up community the opportunity to participate in global development programmes and competitions (see also Chapter 3.12). The activities carried out in the Startup Centre are open for international participation and are often initiated in cooperation with external partners.

The university participates actively in international development cooperation projects (Erasmus+ KA2, development aid cooperation organised by the Ministry of Foreign Affairs, etc.), which primarily support education and research in the developing world and so serve society in a global context. Currently, 24 strategic education development projects with the participation of TalTech are underway under the Erasmus+ programme (Table 20).

Table 20. Erasmus+ strategic education development projects

Number of Erasmus+ strategic education development projects launched				
2016	**2017**	**2018**	**2019**	**2020**
6	9	6	11	24

In the previous period TalTech has had mostly a reactive approach to the global university rankings, i.e. the university has not defined a goal regarding positioning in the rankings. The most influential global university rankings are the QS World University Ranking and the Times Higher Education World University Rankings (THE). In recent years, TalTech has fallen in international rankings (see Table 21 and Chapter 3.3). The fall in the rankings can be due to merger with several academically weaker universities and increased competition in general. In order to find the exact reasons that led to the university fall in rankings, a separate thorough analysis will be conducted and a goal is set to improve the position of the university in the rankings (see also Chapter 3.1.3).

[32] Feedback from international partners, guests, networks - growing interest after the launch of a new brand based on visits and cooperation offers.

Table 21. TalTech's position in international rankings. Source: THE, Top Universities

	2013	2014	2015	2016	2017	2018	2019	2020
QS	441	501	601	601	601	601	601	651
THE	N/A	N/A	501	601	601	601	801	801

The university's Strategic Plan 2021–2025 has brought into focus international positioning in both academic rankings (THE, QS) and the UI GreenMetric World University Ranking, which compares efforts for sustainable development. The aim is to find ways to analye and realize the potential of the university and thereby improve its position in the rankings based on the analysis of the methodologies and impact factors and the practices of reference universities (see also Chapters 3.1 and 3.3).

SUMMARY OF STRENGTHS AND AREAS FOR IMPROVEMENT

Strengths

• TalTech's institutional internationalisation is reflected in the increasing share of international academic staff and increasing share of international students.

• Strategic cooperation for the internationalisation in studies takes place in cooperation with the universities of the EuroTech network.

• As a result of active involvement of the university in academic cooperation networks, the share of international co-authored publications is high and the university has been successful in applying for external project funding.

Areas for improvement and planned development activities

• In order to increase students' activeness and interest in international mobility opportunities, new international learning opportunities are under development in the framework of the EuroTeQ Engineering University project, which will provide future-oriented and flexible learning formats in cooperation with Europe's top universities.

• In order to increase the international visibility of the university and improve its position in the rankings, an analysis of the methodologies and impact factors must be carried out.

3.6. TEACHING STAFF

3.6.1. ACADEMIC CAREER MANAGEMENT

The university's Strategic Plan 2020 set a goal to develop the professional potential of its employees, based on employees' motivation, international openness and well-targeted recruitment of staff. Academic staff are expected to have international work experience, regularly engage in self-improvement and actively participate in international research and development and teaching. To this end, an integrated tenure-track academic career model was introduced in 2017. TalTech's academic career management model involves flexibility in combining the roles of lecturers and researchers, sets out the fixed-term and permanent posts, is based on the tenure principle[33] and gradually raises the professional standards of the academic staff. In implementing the model, the university has followed the example of TalTech's reference universities. According to the Regulation on Academic Career Management, all fixed-term, vacant and established posts are filled by way of a public competition or by appointing to a post without announcing a competition. A person can be promoted as a result of attestation for the next rank of a post of Professor or Lecturer. Promotion to the next rank of a post can be applied in case of a person holding a permanent post of Lecturer or Professor, if compliance with the requirements set to the next rank has been verified upon attestation (see the academic evaluation matrix). One of the weaknesses of career management that has been pointed out is that compared to researchers, persons working in a lecturer's career path find it harder to meet the requirements set for a professor's position due to their high workload, which makes it difficult for them to advance in their career. As a solution, the structure of the posts has been complemented in June, 2021. The new structure of the posts has been collated with the 4-stage research profiles descriptors defined by the European Commission. A non-tenured Associate Professor post has been added to the career model, which will focus mainly on high level teaching and educational development activities. The post of Professor of Practice has been added to provide an opportunity to involve practitioners with a PhD in teaching and research.

The structure of academic posts is displayed in Figure 12.

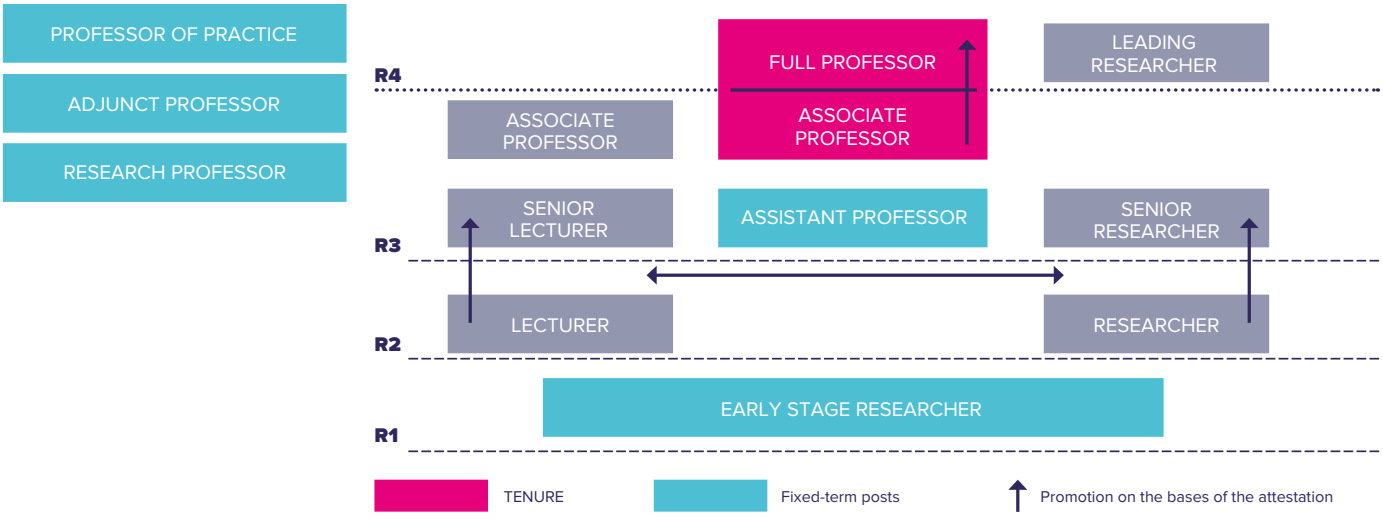


Figure 12. Academic posts at TalTech

Teaching is usually conducted by lecturers and professors, whereas at TalTech researchers are also obliged to conduct teaching. The data presented in the report will henceforth reflect all academic staff as teaching staff.

Figure 13 shows that the number of academic staff decreased after the structural reform in 2017 but a recovery trend can now be seen. The decrease can be attributed to the structural reform in 2017 and the reform of the study programmes carried out from 2016 to 2018 – the smaller number of study programmes and more efficient management have ensured sustainable development of studies with fewer resources. The Work Procedure Rules define the standard workload of face-to-face teaching, and enables monitoring and mapping the need for academic staff.

[33] "tenure" means a permanent academic status of a professor

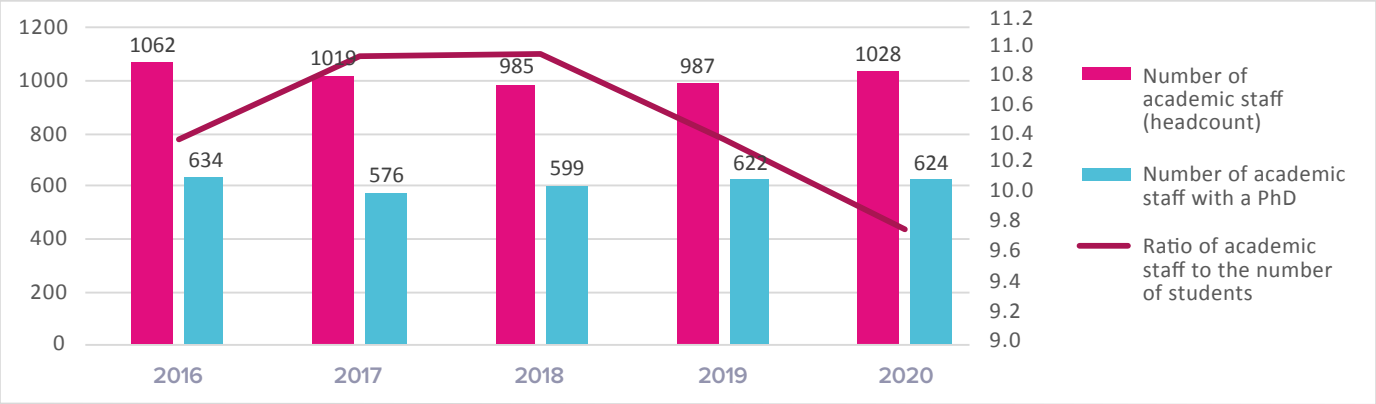


Figure 13. Number of academic staff posts, number of academic staff with a PhD and ratio to the number of students in 2016–2020. Source: NAV

Since 2018, the university has aimed to conclude employment contracts with more successful PhD students in order to integrate them more into the work of the university and guarantee them remuneration at the average Estonian salary level, which is why the percentage of academic staff with a PhD varies. Looking at the percentage of academic staff without including early stage researchers, a significant increase in the number of academic staff holding a PhD can be seen (see Table 22).

Table 22. The share of academic staff with a PhD of the total number of academic staff. Source: NAV

	2016	2017	2018	2019	2020
Share of academic staff with a PhD	60%	57%	61%	63%	61%
Share of academic staff with a PhD, excluding early stage researchers	N/A	N/A	73%	75%	78%

Figure 14 shows that the composition of the academic staff is getting younger. The proportion of younger employees is rising and the percentage of academic staff under 50 years of age is increasing.

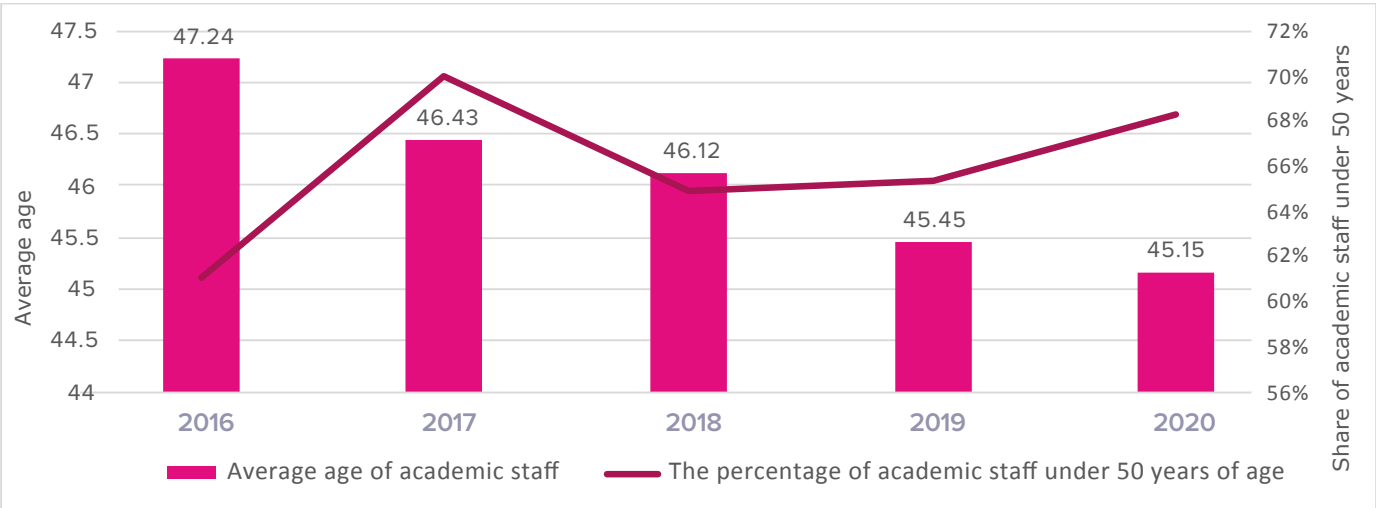


Figure 14. Average age of academic staff in 2015–2020. Source: NAV

The success of academic competitions is assessed mainly on the basis of the number of candidates for the post. The statistics on the competitions for academic posts conducted in 2015–2020 is presented in Table 23. The increasing trend from 2017 indicates that the departments want to find the most competent candidates for teaching positions as well as the fact that the image of the university as an employer has improved. The decrease in the number of competitions is related to the expiry of the fixed-term employment contracts concluded with academic staff members based on the Universities Act until 2015.

Table 23. Competition for elected academic posts in 2015–2020. Source: NAV

	2015	2016	2017	2018	2019	2020
Competitions	356	182	112	116	110	55
incl. competitions for tenured professor posts			31	16	8	8
Number of candidates in competitions	461	244	486	616	414	173
incl. candidates in competitions for a tenured professor post			391	253	96	19
Candidates per competition	1.3	1.3	4.3	5.3	3.8	3.1
Candidates per competition for a tenured professor post			12.6	15.8	12.0	2.4
Candidates per competition, excluding tenured posts	1.3	1.3	1.2	3.6	3.1	3.3

That TalTech has been the top-paying Estonian public university in Estonia (see Figure 15) enhances the attractiveness of the competitions and increases the motivation of existing teaching staff (incl. professors).

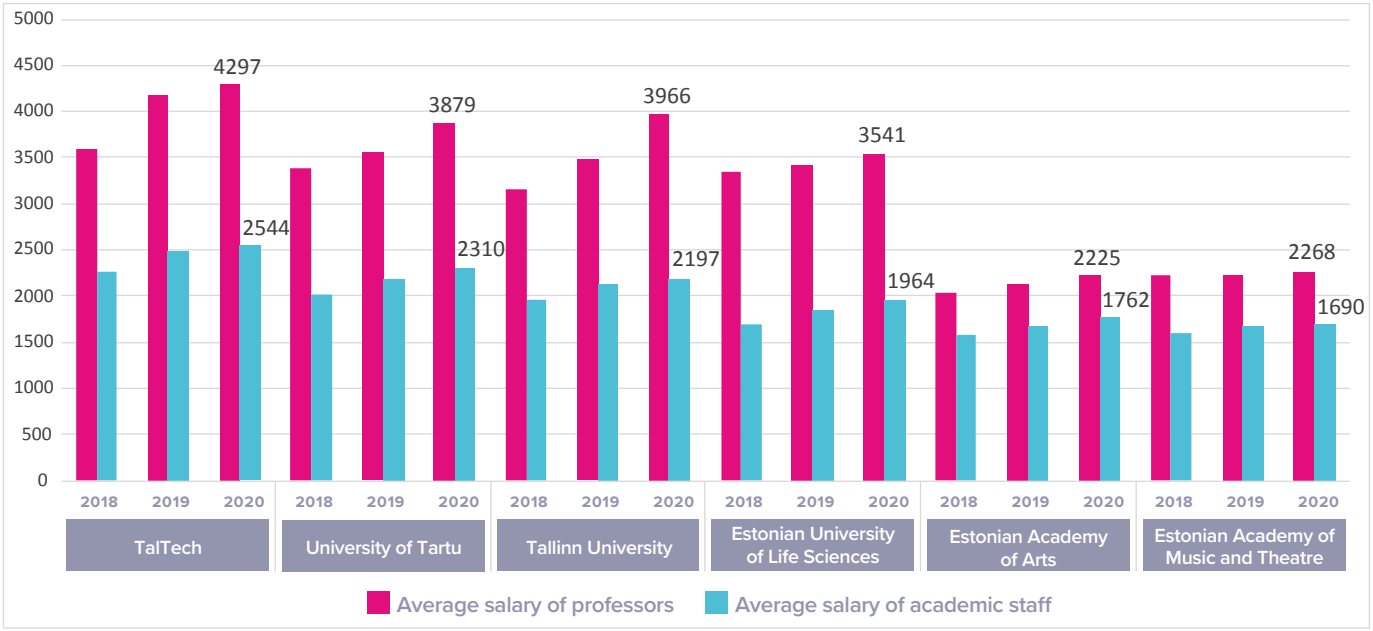


Figure 15. Total salary of academic staff of Estonian public universities in 2018–2020. Source: Universities Estonia

3.6.2. ENSURING EVIDENCE-BASED LEARNING AND PRACTICAL SKILLS

One of the goals set out in the university's Strategic Plan 2021–2025 is to make sure that "our graduates are able to solve real-life problems with their evidence-based mindset, practical engineering skills, good self-management and cooperation skills and entrepreneurial spirit". In order to support teaching by research and development (R&D), the teaching staff are selected based on their R&D competencies. Most teaching staff are involved in the research groups in the respective field of speciality; teaching is closely related to the R&D projects conducted by the teaching staff, in which students are involved. Early stage researchers are also involved in teaching. Cooperation with teaching staff and institutions in and outside the university through joint projects supports attainment of the goal. Cooperation in the university is carried out mainly within the framework of interdisciplinary courses and projects – TalTech's (mainly 1st level) study programmes include courses from different departments and study programmes have been created in cooperation between the Schools (e.g. see Chapter 4.4 and 4.5). In order to enhance cooperation between the members of the teaching staff, regular meetings and experience sharing events are organised (e.g. the Teaching Day at the School of Business and Governance). Cooperation outside the university is reflected in joint study programmes and joint projects carried out with research institutions, state and local government authorities (ministries, regional cooperation projects in Saaremaa and Ida-Viru County) as well as private sector companies (solving real-life problems in industry).

The university involves researchers, creative persons or outstanding practitioners in their field of speciality as visiting lecturers[34] in teaching. While in 2019, the visiting lecturers constituted 26% of the total number of lecturers (see Table 24), they conducted 14% of the volume of scheduled face-to-face teaching[35]. Given that visiting lecturers, participate partially in teaching, usually without being responsible for the course as a whole and contribute to teaching mainly by conducting practical training, the proportion can be considered reasonable.

Table 24. Number of visiting lecturers in 2016–2019. Source: NAV

	2016	2017	2018	2019	2020
Number of lecturers working under an authorisation agreement per year	291	411	431	349	427
incl. recurring agreements with the same person	69	81	87	86	101
Share of visiting lecturers (visiting lecturers/(academic staff+visiting lecturers)	22%	29%	30%	26%	29%

3.6.3. SYSTEMATIC EVALUATION AND DEVELOPMENT OF TEACHING STAFF'S PERFORMANCE

3.6.3.1. EVALUATING TEACHING STAFF'S PERFORMANCE

All academic staff working under an open-ended employment contract are attested at least once every five years, by evaluating the performance of the teaching staff based on the expectations model set out in the academic evaluation matrix[36]. In 2017, the total of 35, in 2018 the total of 25, in 2019 the total of 66 and in 2020 the total of 159 academic staff members were attested. To guarantee objectivity of attestation, the attestation committees must always include persons with qualifications equivalent to the ones of the person filling the post as well as external experts. The work of the committees is organised by the Human Resources Office. Table 25 indicates the level of achievement of performance indicators by the posts approved in the attestations from 2018 to 2020. As regards teaching, the results of attestation are clearly positive, but the links between the results and the level of strictness of the criteria needs further analysis.

Table 25. Level of fulfilment of the expectations set for the post based on the evaluation of the performance of employees that passed attestation 2018–2020. Source: NAV

Title	Publication and number of citations	Activeness and successfulness in applying for competition-based financing	Cooperation with the business and public sector	Inventing and innovation	Supervision	Teaching	Development of studies	Professional activities	Organisation of research and education	Public engagement	Acknowledgements
Senior Researcher	1.72	1.65	0.02	0.41	0.79	1.84		0.88	2.10	0.13	1.92
Senior Lecturer	0.90		0.17		-1.07	-0.20	1.07	1.92	1.27	2.36	1.92
Full Professor	-0.16	0.96	-0.20	-2.70	0.52	0.48	0.08	-2.18	0.68	0.32	-0.60
Researcher	0.70	0.63	0.69	0.22	0.29	2.89		1.53	1.79	2.17	0.64
Junior Lecturer					1.00	0.00	2.00		1.00	1.00	0.00
Lecturer	1.97				1.04	0.17	1.48	1.92	0.56	2.09	-0.07
Associate Professor	-0.25	1.67	1.00	-0.88	-0.44	0.00	0.56	-0.71	1.00	0.78	0.75
Assistant Professor	1.00	3.00	1.00	-2.00	1.00	1.00	0.00	-2.00	1.00	0.00	2.00

Pursuant to the Work Procedure Rules, an annual interview shall be held with each employee in order to analyse the goals, results and development needs in the year, but the annual interviews are not conducted consistently. In order to improve the situation, the summary of the annual interview has formed part of the documentation required for attestation since 2017 and an individual job description shall be signed and reviewed annually with an academic staff member employed under an open-ended employment contract.

In return, every two years, the university asks for employees' feedback on job satisfaction using the TRI*M index[37] developed by the market research and consulting company Kantar Emor, to find out the engagement of those working in teaching-related positions at the university (see Figure 16). The satisfaction of academic staff is characterized by higher engagement among tenured professors, lecturers and early stage researchers (see also Chapter 3.2).

[34] Visiting lecturers do not fill academic positions, an authorisation agreement is concluded with them.

[35] Data from the study information system. SIS data on the spring semester of the academic year 2018/2019 and the autumn semester of the academic year 2019/2020 (Power BI report).

[36] The academic evaluation matrix sets expectations for all academic posts in terms of their competencies and performance in 11 categories of academic activities. In May 2021, the Senate will approve the new version of the matrix, where 11 types of activity have been cut down to 6, which balances expectations for academic staff members regarding research, teaching and service to society and sets concrete expectations for taking up and holding a post. Changes in the matrix will not reduce the requirements. The evaluation matrix is also used to assess candidates at competitions and on the basis of it a ranking is drawn up, which ensures a uniform level of competence and performance of both long-term and new employees.

[37] To characterise employee engagement, the TRI*M index (maximum score120) developed by Kantar Emor is used, which is calculated based on the five questions used in the employee satisfaction survey.

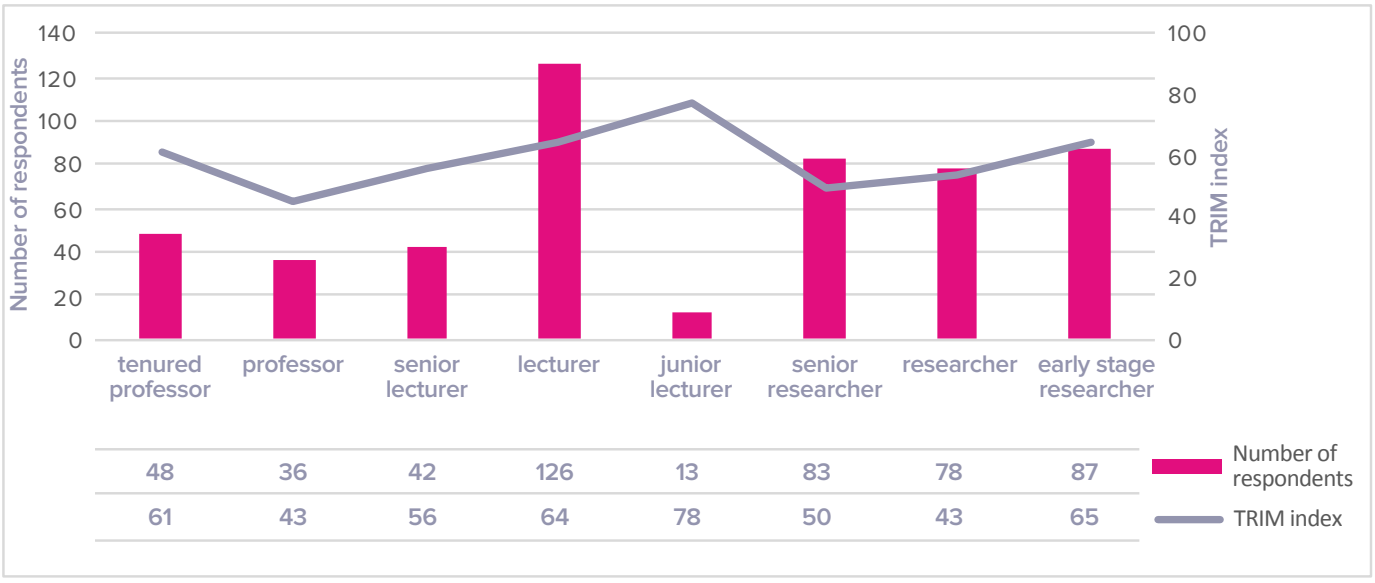


Figure 16. The results of the university's satisfaction survey 2019 by academic staff post. Source: Kantar Emor

3.6.3.2. DEVELOPMENT OF TEACHING COMPETENCE

In order to develop the teaching skills of the academic staff and improve effectiveness of educational development activities, the Good Lecturer Development Programme has been introduced, which provides an opportunity to analyse teaching based on the feedback given to the lecturer. The programme also involves recognition (e.g. awarding the titles Lecturer of the Year, Best Lecturer of the Study Programme, Student's Favourite Lecturer, nomination for the title Estonia's Lecturer of the Year) and offers additional opportunities for educational development activities (activity grant for the development of teaching skills[38], sharing of the best practices with colleagues, etc.).

At the end of each semester, a feedback survey is conducted among students, which allows students to provide input to course development, to draw attention to different aspects in studies and, to be involved in the development of studies. Feedback is collected in accordance with the established rules and is taken into account upon attestation of the teaching staff. Programme directors take students' feedback into account in the development of study programmes and in determining the composition of the teaching staff. The results of student feedback show that there is a small difference between the average ratings given by students over the last six semesters. In most (about 90%) of the courses the ratings are higher than 4 points (average 4.41–4.47) on a 5-point scale, according to which students' satisfaction with teaching can be considered good and there are no significant differences between the Schools.

The direct superior (head of the department) analyses the feedback given to the members of the teaching staff at an annual interview. The members of the teaching staff who receive a lower than average[39] rating can use the measures provided by the Good Lecturer Development Programme: training, mentoring, observing of teaching and other activities supporting development[40]. If the shortcomings persist for a long term, replacing of the member of the teaching staff should be considered (this has occurred on a few occasions). The Human Resources Office organises trainings for the development of teaching and communication skills in compliance with the academic staff development model and the master teacher development[41] model. In addition, the teaching staff have an opportunity to complete various trainings on didactics of higher education or the IGIP Engineering Pedagogy programme (25 ECTS).

Although, the Good Lecturer Development Programme has been concluded as a strategic agreement in the university, its main drawback is that it is focusing on the results of the student feedback survey only. The reasoning behind this is that other forms of feedback (observation of teaching, mentoring, feedback from the programme director) have not yet firmly taken root. In order to further develop the Good Lecturer Development Programme, a network of didactics experts will be established in the Schools. This network will support the development and self-improvement of the teaching staff based on the needs and specifics of the field (incl. the development of training programmes that support digital culture, problem-based learning etc.).

In recent years, more attention has been paid to the training of mentors. As of 2020, there are 56 employees at the university who have completed basic training as a mentor and / or observer of teaching. Systematic mentoring is practised in some structural units, e.g. the mentorship programme in Virumaa College includes mentoring of new employees as well as students and nearly half (46%) of the employees of the College are mentors.

[38] In 2020 in the amount of 2000 euros; 10 grants are awarded each year.

[39] i.e. the 35% lowest rated members of the teaching staff.

[40] Approximately 3% of the trainings cover the didactics of higher education, 40% cover the development of language and communication skills and 20% cover the development of digital skills.

[41] The model displays visually the whole development cycle, which begins with the collection of input information, development and annual interview, review of an individual job description and attestation. It also shows how perceived training needs become specified development and training needs, and provides new guidelines for improvement activities.

Ordinary members of the teaching staff are entitled to take one semester of sabbatical leave with pay every five years in order to pursue professional development at a foreign university for the purposes of research or studies. Table 26 shows that the usage of the semester of sabbatical leave is low and teaching staff prefer to use various mobility programmes and professional conferences for self-development (see also Chapter 3.5). The sabbatical semester is rarely used, because reorganisation of teaching and scheduling involvement of the member of the teaching staff in research in the field of speciality in the same semester causes a lot of practical problems. It must also be pointed out that the members of the teaching staff who have high workload of face-to-face teaching may not have time to be permanently involved in research and it may be inconvenient for them to engage in unaccustomed activity for one semester. In addition to promoting a sabbatical semester, it is necessary to find a balance in teachers' work between research and teaching.

Table 26. Self-development activities of teaching staff in numbers.

Internal trainings for teaching staff of all structural units[42]	2015	2016	2017	2018	2019	2020
Number of courses (source: TÕIS)	34	29	34	35	36	23
Number of participants (source: TÕIS)	483	595	711	459	440	357
Number of teaching staff in mobility for the purposes of self-development (source: secondments register)	74	63	139	179	228	37
incl. national mobility	32	34	52	55	122	0
incl. international mobility	42	29	87	124	106	37
Number of teaching staff in sabbatical semester (source: NAV)	5	12	7	1	7	3

SUMMARY OF STRENGTHS AND AREAS FOR IMPROVEMENT

Strengths

• The career management of the university ensures the sustainability of the academic staff, characterized by:

1) more balanced age structure of the teaching staff;

2) positive trend in the number of candidates for academic posts;

3) an increasing number of members of the teaching staff with a PhD.

• The competencies and performance of academic staff are systematically assessed at attestations and academic posts are filled based on the academic evaluation matrix, which provides assurance of adequate competencies and academic staff development.

• A system has been established for the improvement of teaching effectiveness and the development of studies as well as the improvement of the competencies of the teaching staff - the Good Lecturer Development Programme.

Areas for improvement and planned development activities

• To link job descriptions in the career management more with research and review the standard workloads of teaching in order to create better opportunities for lecturers to apply for professor posts and support science-based learning. With the planned change in career management, the posts of Associate Professor oriented to teaching and Professor of Practice who has practical experience will be created in 2021.

• To support the development of teaching competencies of the teaching staff, it is planned to:

1) create a teacher training programme aimed at providing positive educational support to the teaching staff of the university based on the required skills and competencies;

2) create a network of didactics experts in to bring support for development of teaching competencies closer to the teaching staff;

3) encourage participation in training through diversification and modernisation of training environments and opportunities and active promotion of the sabbatical semester opportunities.

[42] Workload 4 academic hours or more. Does not include training provided by structural units.

3.7. STUDY PROGRAMME

3.7.1. STUDY PROGRAMME MANAGEMENT

The main goal related to study programme development set out in TalTech's Strategic Plan for the last five years was to draw up more broad-based study programmes, improve the competitiveness of graduates and transition to programme-based management and development. The Strategic Plan 2021–2025 places emphasis on academic performance at all levels of higher education and responsiveness to the needs of the economy and society.

Agreements and requirements for the structure of a study programmes and other procedures related to study programmes are laid down in the Curriculum Statute. The requirements of the management and quality assurance of study programmes are set out in the Procedure for Study Programme Management. Study programme management involves consistent development of the study programme in cooperation with the stakeholders, admission and marketing activities, organisation of studies and provision of related support services with the aim of ensuring the quality and effectiveness of the studies and the study programme as well as responding flexibly to the needs of society.

Study programmes reform was carried out at TalTech in 2015–2018 based on the goals set out in the university's Strategic Plan, the recommendations given in external evaluations and as agreed in the administrative contract with the Ministry of Education and Research. Various stakeholders (incl. teaching staff, students, employers) were involved in the planning and implementation of the changes. Also, the best practices of the reference universities were considered. As a result of the reorganisation of the system of study programmes, students' options and the share of independent work increased, coherence between courses and interdisciplinarity improved, more project-based learning was introduced into the study programmes, practical training was incorporated into all study programmes and the volume of courses was harmonised and increased[43]. As a result of the reform, each TalTech study programme has a sufficient number of students[44], the programmes are evidence-based (in particular in master's studies), in line with labour market needs (incl. regionally), broad-based, with a balance between theoretical and practical learning and with adequate options to choose from. The overall number of study programmes has decreased by 18% (from 99 to 81) and by 30% in the first level over five years (Figure 17). Conducting of studies is now concentrated almost entirely on the fields of responsibility which means that the university can contribute to the fields, where it has top-level expertise and for which it bears national responsibility[45].

The effectiveness of the renewed study programmes (incl. with respect to the income of graduates) can begin to be assessed from autumn 2021, when the nominal duration plus one year has passed since first admission. The earned incomes of the alumni are presented in Chapter 3.8. The need to reduce the number of study programmes was triggered also by the general decrease in the number of students – in five years, the number of TalTech students has decreased by about 13% and the number of students admitted by about 19%. This trend has been significantly influenced by the demographic situation (the number of students in Estonia has decreased by about 12% in five years). On average, the number of students per study programme has increased since the reform. The highest number of students is studying in the first level of higher education, the number of students in master's and doctoral studies per study programme has remained in the same range (see Figure 17). The School of Business and Governance and the School of Information Technologies have the highest number of students per study programme and the School of Science has the lowest number of students per study programme.

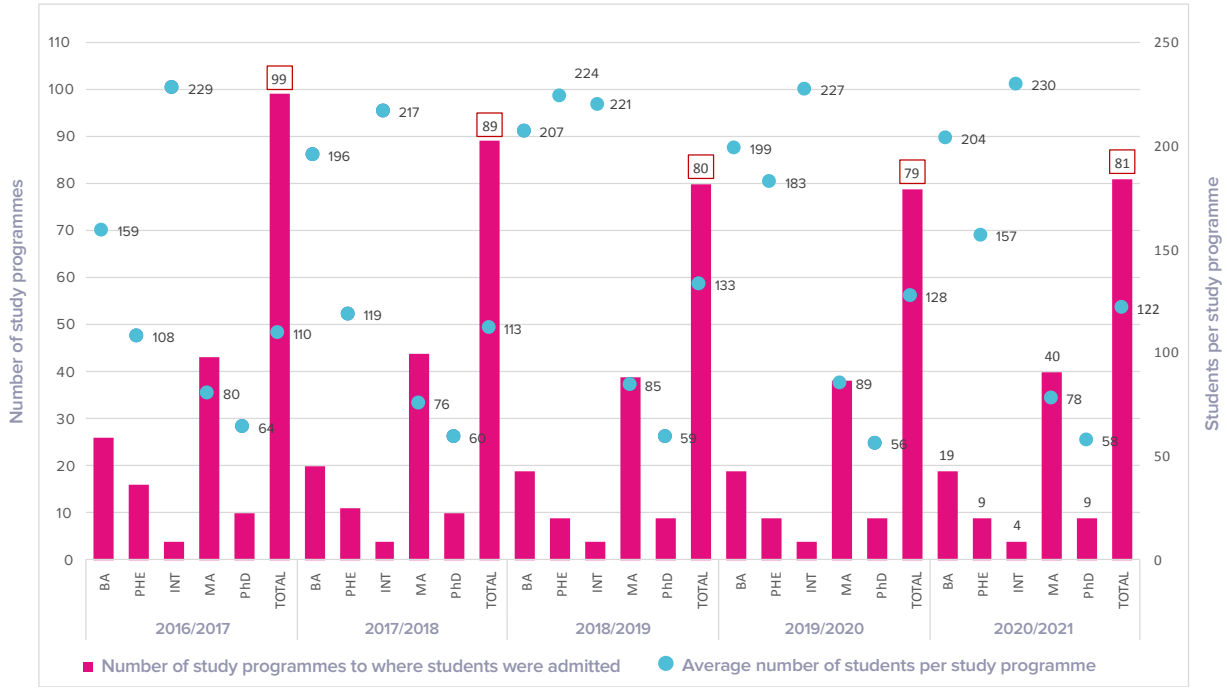


Figure 17. Number of study programmes to where students were admitted and average number of students per study programme. Source: SIS

[43] As a rule, the workload of a course is 6 ECTS (the workload of a course can also be 3, 9 or 12 ECTS).

[44] At least 15 students per main speciality in the first level and at least 10 students per main speciality in the second level (there are also some exceptions).

[45] 95% of the study programmes opened for admission belong to TalTech's fields of responsibility and 96% of the students are studying in the study programmes falling under TalTech's fields of responsibility.

Study programmes are managed by the Schools and courses by the departments. A study programme is managed and its functioning, development, quality and sustainability are the responsibility of the programme director, who reports to the dean. Although the head of department is responsible for the content and teaching of the courses included in the study programme and the quality of the teaching staff, the programme director has the opportunity to have a say in the selection of the teaching staff. However this can be difficult in some cases due to the subordination. Extension of the rights of programme directors in having a greater say in designing the content of the courses taught by the department and in selecting the teaching staff is under discussion.

The involvement of various stakeholders in the design and development of study programmes ensures that programmes are up-to-date and consistent with the expectations and needs of society. This is ensured through the programme advisory board, which includes representatives of the teaching staff, students and stakeholders from outside the university (incl. employers, alumni, experts in the field). A programme advisory board is chaired by a representative of stakeholders from outside the university. Based on the feedback received from programme advisory boards, changes have been made in the study programmes, e.g. in the content and sequence of the courses (see e.g. Chapters 4.6 and 4.7). In addition, when opening new study programmes and planning admissions, it is crucial to consider the current and future needs and trends of the society and labour market, incl. the professional associations'/employers' assessments of the need for specialists and skills in the field. Therefore, programme directors analyse both OSKA reports and the results of feedback provided by various stakeholders – students[46], graduates, alumni.

For effective programme management the resources are allocated to each programme director according to TalTech's Financial Regulation. Funds are allocated based on performance indicators to Schools, who determine their use, incl. the amount to be allocated to programme directors. The programme directors have used these funds, for example to develop the learning environment, purchase study materials, popularise the field (workshops in general education schools, promotional publications and videos, involvement of students) and involve guest lecturers and experts in the field in teaching. For the most part, the programme directors consider the resources allocated for the development of a programme to be sufficient (see e.g. Chapter 4.7).

The Schools recognise their programme directors in different ways. From 2019, the university recognises, besides the best lecturers and other staff, also the best programme directors of the year by granting a monetary award.

A programme directors network has been established to enhance cooperation between the programme directors and study programmes (e.g. in order to reduce duplication of courses, develop interdisciplinary project-based courses), to exchange information and to share experiences. The Development and Quality Division of the Office of Academic Affairs provides support and advice to programme directors in matters regarding development of study programmes and coordinates the network. Networks in the Schools operate effectively involving discussions in the mailing lists of the School of Science, regular meetings in the School of Business and Governance and School of Engineering and informal meetings of the programme directors of the School of Information Technologies. The university-wide network operates through formal thematic info sessions and the sharing of best practices. In 2020, joint development seminars for programme directors and vice-deans were launched in order to share best practices in the form of practical workshops and trainings.

The internal audit of the work organisation of programme directors assessed as effective the operation of the role of programme directors. According to the audit conclusions, the principles of the organisation of the work of programme directors, incl. their workload limits, responsibilities and the role of the Office of Academic Affairs in supporting the activities of the programme directors are well-defined.

For regular internal evaluation of study programmes, the Schools submit an annual feedback report, where the feedback provided by the key stakeholders (students, graduates, employers) is analysed. For this purpose, the online form of self-analysis in the study information system is used, which mainly focuses on: 1) an analysis of the study programme, including assessment of the performance indicators achieved, a description of the activities carried out for the development of the study programme and an assessment of the functioning of the study programme; 2) an action plan indicating the most important objectives for the next year, the persons responsible and the results intended to be achieved by the changes (see also Chapter 3.3. and Annex 3). The feedback reports of previous years mainly pointed out the need to address more intensively the challenge of reducing dropout rates. In response, a Moodle tool was developed, allowing programme directors to track students' mid-term grades in the courses of the study programme. (more details see Chapter 3.10). The use of the tool depends on the structure of the Moodle course and the teaching and assessment methods used (mid-term grades are required). All Schools constantly develop and update their study programmes, cooperation is carried out with employers and students and changes are introduced taking into account the actual issues in society (e.g. cyber security). In order to analyse the functioning of a study programme and the work of the programme director and set further goals in an action plan, the Schools draw up programme management reports, monitor implementation of action plans and conduct annual interviews.

In order to improve the effectiveness of internal evaluation and make decisions, various tools have been developed for programme directors:

1) **the programme director's desktop tool in the SIS** – used as an everyday tool from 2021, enables the programme director to better track and use information on the indicators of the study programme and to make reasoned decisions based on it;

2) **TalTech reporting solution and performance indicators for study programmes** – a comprehensive overview of the performance indicators of study programmes[47] in the Power BI report, which provides information on the admissions of the last years, the number and share of dropouts, the students participating in mobility, the number of international students, students' workload and persons on academic leave. Besides the figures, the report displays also students' progress in completing the courses. A programme director can monitor whether there are any problems with completing a course, e.g. the number of students who have failed to complete a course is too high or something else draws attention that needs further investigation and, if necessary, adjustments in the study pro-

[46] In addition to the regularly conducted feedback surveys in SIS, students also provide feedback through Moodle and the education quality working groups in the TalTech Student Union.

[47] A distinction is made between informative performance indicators supporting the programme director and performance indicators measuring the effectiveness of study programmes

gramme. The reporting solution will be updated and further developed based on feedback from programme directors.

In order to improve the efficiency of the internal evaluation of study programmes, to support the work of programme directors and monitor performance, a more comprehensive and transparent system is planned to be developed in line with the university's quality assessment and monitoring system by agreeing on specific quality requirements and indicators.

3.7.2. FLEXIBLE STUDY PROGRAMMES

The basic principle in designing study programmes is that they must be broad-based and involve a variety of options[48], i.e. the goal is to provide education with opportunities for specialisation in the second half of studies (in first-level study programmes) and integrate speciality specific competencies with general competencies. For example, the bachelor's study programmes of Applied Chemistry and Food and Gene Technology with three, Business with five and International Business Administration with four main specialities enable students to acquire broad-based education and specialise in the second half of the studies and choose between several specialities when continuing studies in master's programmes (see Chapters 4.1 and 4.5).

Common requirements for disciplines providing general competencies, for interdisciplinary courses and internship have been agreed in the Curriculum Statute. According to the concept regarding the learning outcomes in disciplines providing general competencies, each TalTech graduate of first level studies must have acquired the learning outcomes of social sciences and humanities, natural sciences, information and communication technology, mathematics and entrepreneurship at least in the amount of 6 ECTS (except for entrepreneurship, where the minimum amount in the first level of studies is 3 ECTS). A programme director can incorporate the learning outcomes into the general or specialised courses or add a separate course into the study programme. For example, the study programmes of integrated studies include the course Construction Economics and Introduction to Entrepreneurship, which links entrepreneurship education with the field of construction. Moreover, some theoretical courses with low passage rates have been replaced by more speciality-specific courses (e.g. the courses Chemistry and Physics have been replaced by the courses Construction Chemistry and Engineering Physics respectively). Students' feedback has been positive.

Each study programme must contain interdiciplinary studies that integrate of several disciplines or involve students from different disciplines by using active learning methods. Interdisciplinary studies enable students to understand connections between different disciplines, solve interdisciplinary problems in the form of teamwork or a project and develop important transferable skills. For example, in the Robotics and Product Development project courses, interdisciplinary teams of the students of the School of Engineering and the School of Business and Governance are formed, who then solve real-world problems (see e.g. Chapter 4.7).

Students' study load is defined based on the calculation that 1 ECTS corresponds to 26 hours of work. Students also provide regular feedback on the workload of each course. In the last four semesters, the correspondence of course workload to credit points has been assessed rather positively (the average score remains in the range of 4.41–4.45 on a five-point scale), the scorings are uneven across the university. According to the data[49] that students of the School of Business and Governance and the Estonian Maritime Academy are most satisfied with the correspondence of course workload to the credit points granted. Master's and doctoral students[50] have provided more critical feedback. The students who were dissatisfied with the correspondence between the workload and credit points pointed out that workload was higher than prescribed. Where students have indicated that a course's workload is disproportionately high, the workload has been adjusted.

SUMMARY OF STRENGTHS AND AREAS FOR IMPROVEMENT

Strengths

- The university has a well-functioning and effective study programme management system, in which:
  - o each programme director is responsible for the functioning and quality of that study programme and financial resources are appropriately allocated;
  - o the structure of study programmes is flexible and changes are made in cooperation with stakeholders to ensure consistency with the expectations and needs of society.
- Flexible and broad-based study programmes (strong basic education, and later specialisation).

Areas for improvement and planned development activities

- In order to ensure consistency and further improve the quality of study programme management, it is planned to:
  - o extend the rights of programme directors and give them an opportunity to have a greater say over the design and content of the courses taught by the department and the selection of teaching staff;
  - o continue the tradition of development seminars to strengthen the network of programme directors (sharing experiences, boosting informal communication).
- The internal evaluation of study programmes will be further developed, by improving the reporting solution and agreeing on new performance indicators.

[48] In order to provide a sufficient choice of options, 15% of each study programme are elective courses.

[49] i.e. the average score for the statement "The workload of the course corresponded to the credit points (taking into account that 1 ECTS corresponds to 26 hours of lectures and independent work)"

[50] Most of the study programmes that have received less than 4 points for the statement (if at least in one of the last four semesters the score provided to the statement in the feedback was lower than 4 points), are second and third level study programmes.

3.8. LEARNING AND TEACHING

3.8.1. STUDENT ADMISSION

3.8.1.1. ADMISSION TARGETS AND YEAR-ROUND ADMISSION

Admission at TalTech takes place mainly to the study programmes in its fields of responsibility. Specific admission targets are agreed at the university for each academic year, which are analysed and assessed each year. In order to ensure that TalTech has the most academically able students, admission thresholds are reviewed and adjusted regularly. The aim is to maintain or increase the share of entrants whose result of the state examination in broad mathematics is above 90 points, who have won medals at olympiads and who have graduated from an upper secondary school with a medal. In the autumn of 2018, the Olympiads School was established at the university, which brings together talented schoolchildren, provides preparatory courses for schoolchildren for subject proficiency olympiads and motivates them to continue their studies at TalTech (see also Chapter 3.12). From the academic year 2021/2022, the university pays a scholarship to the freshmen who have been successful at olympiads. The targeted admission strategy has reduced the dropout rate (see Chapter 3.10).

Student admissions are governed by the Admission Requirements for students and the admission requirements established separately for each study programme each year. Information on admissions is available to the applicants on the website and in printed materials; those interested are advised by the Admission and Student Counselling Centre.

In order to raise the entrants' awareness of the speciality, to provide assurance to student candidates regarding the receiving of a study place and to establish contacts between the programme director and students, a year-round admission process has been used since 2018 (applications for admission can be submitted from January to July and Estonian citizens and permanent residents of Estonia can take entrance tests in four periods). In total, 49% of the students (i.e. 1322 entrants) who commenced their studies in the academic year 2020/2021, submitted their application before the summer admission period. For citizens of foreign states, the deadlines for submitting documents vary according their home country so that matters related to residence permits and visas can be resolved before the start of the academic year. Entrance tests are organised for citizens of foreign states and study places offered on an ongoing basis.

To apply for the first level of study at TalTech, a person must have upper secondary education or a qualification equal thereto, to apply for the second level of study a person must have higher education and to apply for the third level a person must have a master's degree or an equivalent qualification. Additional admission requirements by study level are presented in Table 27.

Table 27. Admission requirements by study level

Study level	Admission requirements
Bachelor's studies	State examinations in broad mathematics and in the Estonian language (alternatively, you can take the TalTech mathematics or Estonian language test). In some study programmes also an entrance test.
Integrated studies	
Professional higher education studies	Grade point average on the secondary education certificate and an entrance test (e.g. an interview or a test).
Master's studies	Higher education (higher education in a concrete speciality/field may be required) and an entrance test (e.g. a test, interview, essay, master's thesis project or portfolio).
Doctoral studies	A motivation letter corresponding to the topic of the doctoral thesis, a CV and an interview with the supervisor.

Admission of Estonian citizens to the first level takes place mainly based on the state examinations, since the result of the state examination in mathematics generally shows the ability of the applicant to cope in the specialties based on mathematics and logic, and the result of the Estonian language exam shows self-expression skills. In order to provide access to persons from different backgrounds (upper secondary school vs. vocational training), it is possible to apply for some study programmes also on the basis of a professional proficiency test (e.g. in the School of Information Technologies) besides state examinations. The university offers also preparatory courses to upper secondary school students for state examinations and the TalTech mathematics or Estonian language tests. In professional higher education studies, besides the grade point average, a motivation letter and an interview are increasingly used to recruit motivated and knowledgeable students. Thus, the methods for assessing motivation and readiness are increasingly used upon admission.

When applying for the first and second level study programmes taught in English, both the citizens of Estonia and of foreign states must, in addition to the admission requirements listed above, prove their English language skills with at least a B2 level certificate and international students need to pass a general GRE-test.

To ensure transparency and impartiality, the admission requirements, the content of the tests and the assessment criteria are published on the admissions website (separately for Estonians, in Est., and foreigners). The admission process takes place in the admission information systems (SAIS for Estonian citizens, DreamApply for citizens of foreign countries, Glowbase for applicants for doctoral studies). For academic recognition of foreign education qualifications, the university cooperates with the Estonian ENIC/NARIC centre. In the study programmes, to which admission takes place based on tests, the decision on admission shall be made by the admissions sub-committee; appeals and exceptional cases are processed by the admissions committee.

Admission is threshold-based, which means that applicants who pass the threshold and meet the admission requirements will be admitted. As admission thresholds have been raised from year to year, the admission rate has decreased somewhat(see Table 28).

Table 28. Number of enrolled students by study level 2016–2020 (as of 10.11). Source: SIS

	2016	2017	2018	2019	2020
PHE	498	502	421	340	336
BA	1336	1333	1439	1204	1242
INT	182	210	235	200	202
MA[51]	1338	1320	1308	1242	1186
PhD	71	90	99	88	124
TOTAL	**3425**	**3455**	**3502**	**3074**	**3090**

Admission to doctoral studies takes place on the basis of a public competition for predefined doctoral thesis topics or based on the principles of industrial doctorate in three admission periods a year. Since 2015, at the admission to doctoral studies, a higher priority has been given to the scientific excellence of the supervisors. In order to reduce the dropout rate and improve graduation efficiency, a new doctoral study admission system was introduced. Admission to doctoral studies begins with a competition for supervisors, the prerequisite for the participation in which is the availability of additional funding for the supervisor or department and a readiness to create a job for the PhD student in a research group. The scientific excellence of supervisors is assessed by using a threshold that takes into account the number of publications in the last five years, the number of citations and the previous effectiveness of supervision. The supervision workload is also monitored (one supervisor should not have more than five PhD students at a time). From 2019, decisions on the admission of candidates are made by the programme director (previously these decisions were made by the university's admission committee). The main responsibility for selecting candidates rests with the supervisor, who assesses the candidates' suitability for the proposed research topic, conducts interviews, forms a ranking of candidates and submits it to the programme director. Admission targets have been set for each doctoral study programme, from which the programme directors shall proceed when opening new topics. The university has set a goal that industrial doctorates should form 15% of the total number of admitted students. The recommendation given in the quality assessment of doctoral studies – that they should contribute more to the international marketing of doctoral study places by describing the mandatory and recommended criteria of research projects has been fulfilled.

3.8.2. PLANNING AND CONDUCTING OF STUDIES

Planning and organisation of studies at TalTech are governed mainly by Academic Policies and the Curriculum Statute. Studies take place in the form of face-to-face learning[52] (incl. e-learning), practical training and independent work. In 2017, the workload of student's independent work was increased by reducing the workload of face-to-face learning, giving students greater freedom and responsibility for their studies. A standard study plan, i.e. a recommended sequence in which to pass the courses, helps a student to plan his/her studies. Based on the standard study plan, a timetable is prepared for each study programme every semester. This is made available in SIS and in the student portal. A student declares, for each semester, the courses he/she intends to pass in accordance with the standard study plan or his/her individual study path.

3.8.2.1. USING MODERN TEACHING METHODS AND TOOLS

One of the goals set out in the university's previous Strategic Plan was to offer the compulsory courses in the first and second level study programmes with at least basic level e-support[53]. As of the beginning of 2021, approximately 91% of all the e-supports of compulsory courses meet the basic level requirements, 27 courses meet the second level requirements, i.e. the criteria for the national e-course quality label, 11 courses can be fully completed online[54]. The Best Practices of Online Learning have been established. The development of e-support made it possible to introduce a Moodle-based IT solution that monitors student progress and provides an opportunity to prevent discontinuation of studies (see Chapter 3.10). In 2021, 17 TalTech online courses were awarded EKKA online course quality labels and the EKKA Online Course of the Year award went to a water pipeline modelling course created by Prof. Raido Puust at TalTech.

Students' satisfaction with e-learning is reflected in the responses to the SIS feedback questionnaire regarding the statement "E-support to the course (electronic learning environment, digital materials, etc.) helped me acquire the subject". The average satisfaction rates are in the range from 4.25 to 4.5 on a 5-point scale.

According to students, a qualitative leap took place in the use of modern teaching methods and tools in the spring semester of the academic year 2019/2020 (during the first wave of the

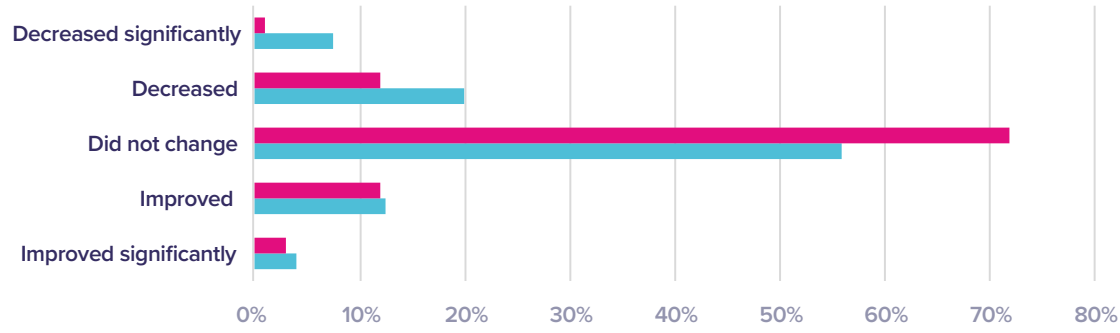
[51] incl. students enrolled to a joint study programme at a partner university

[52] For example, in case the course workload is 6 ECTS, the maximum number of hours of face-to-face learning per semester is 64 (usually 4 hours per week, which is divided between lectures, exercise classes and practical training).

[53] TalTech's e-learning standard divides e-courses into three categories - basic level, advanced level and TalTechDigital e-course.

[54] Example of an e-course: course "Entrepreneurship and Business Planning" 2020 - public (taltech.ee)

SARS-CoV-2 pandemic). Among other things, it was found that the wider use of video lectures, which allow students to replay lectures, makes learning more flexible so that students can learn at their own pace and at the suitable time. Student's satisfaction with e-support increased in the autumn semester of the academic year 2020/2021 in almost all the Schools, which shows that teaching staff adapted to distance and hybrid learning in a way students appreciated. This is also confirmed by a survey in the academic year 2019/2020 among teaching staff on the organisation of distance learning, in the framework of which they were asked to evaluate how distance learning affected students' involvement in studies, participation and the acquisition of learning outcomes. Although teaching staff observed a slight decrease in the participation in studies, it did not have a significant effect on the acquisition of learning outcomes, largely due to flexible learning opportunities (see Figure 18). A 2020 survey conducted by EKKA about distance learning in reached a similar conclusion.



	Improved significantly	Improved	Did not change	Decreased	Decreased significantly
Acquisition of learning outcomes (number of students achieving positive results)	3%	12%	72%	12%	1%
Participation in lectures/studies	4%	13%	56%	20%	8%

Figure 18. Teaching staff's assessments of students' participation in studies during the distance learning period. Source: Teaching staff survey 2020

The teaching staff can apply for additional funding for the development of teaching activities and teaching skills through study programme development grants. In 2020, interest in preparing digital textbooks, digital learning materials and study videos increased four times compared to the previous round of activity grants (in the first round about 12%, in the second round about 50% applications related to e-learning).

One of the goals of the Strategic Plan 2021–2025 is to allocate educational technology resources to help to take e-courses to the second and third levels of e-support. Special attention is paid also on the introduction of problem-based and project-based learning, learner-centred teaching methods and combining practical training with theoretical studies. In 2021, project and problem-based learning is used as a teaching method in 48% of courses; 123 courses are fully based on a project- and problem-based approach. The university considers project- and problem-based learning important and recognises the teaching staff, who apply it and who share best practice, and encourage other teachers to use it. TalTech also organizes professional competitions (e.g. BRICO bridge competition, Robotex in the School of Engineering; IT Innovation Festival in the School of IT; CFA and moot court competitions in the School of Business and Governance) and encourages students and their teams to participate more in competitions with their projects. A working group has been formed at the university to develop the indicators and measures for the wider use of project-based learning in courses.

The modern learning environment is also ensured by the university's high-level laboratories, equipment and learning environments (incl. simulators, auditoriums specially adapted for group work) (see also Chapters 3.11 and 4.6).

3.8.2.2. ORGANISATION OF INTERNSHIP

The organisation of internship is governed by the Academic Policies; the requirements for internship are laid down in the Curriculum Statute and also in the internship guidelines of the Schools. Students can get advice from the student counsellors of the School, an internship coordinator, the Student Counselling Centre and a career advisor. Each internship course has an internship coordinator, who provides advice on completing a concrete internship, helps to find an internship host, organises preparatory briefing and defence of internships. Information on current topics related to internship is shared through a network of internship coordinators. SIS provides the internship coordinator with an overview of students who have completed the respective internship or intend to do so. In order to integrate theoretical and practical learning, all TalTech study programmes include internships

related to the speciality in the amount of at least 6 ECTS. The organisation of internship varies depending on the field: traditional in-company practice (from short-term observation practice to extensive participatory practice) (e.g. in the study programme of IT Systems Administration, see Chapter 4.6), project- and problem-based practice (e.g. in the study programme Business Information Technology, see Chapter 4.2), one-year seagoing practice in certain study programmes of the Estonian Maritime Academy. At the Estonian Maritime Academy and the School of Business and Governance, internship is supported by a special Moodle course.

An overview of internships opportunities and a more convenient opportunity for companies to collaborate is provided by the internship website and the Facebook page of the Student Counselling Office. In addition, some Schools have their own internship portals (see the internship portal of the School of Business and Governance, the internship offers website of the School of Information Technologies). In addition, various career events take place on a regular basis to bring together employers and students interested in internships (e.g. the career fair "Võti Tulevikku" (Key to the Future), the Ida-Virumaa Education Fair "Orientiir", the robotics festival "Robotex", career events conducted by the Schools). Cooperation with large enterprises in Estonia (e.g. Eesti Energia, ABB Eesti AS) plays an important role in the organisation of internship.

The organisation of internship is evaluated and analysed on a School basis. In some Schools, the internship specialists interview the parties involved in internship and monitor data (e.g. the School of Business and Governance by using the Power BI report), which provides input for improving internships. The internal audit of the organisation of internships conducted in 2020 found that organisation of internships at the university was effective. The effectiveness of the internship process has also been recognised at the national level – in 2020, six TalTech study programmes received the quality internship label. In order to develop the internship system and to train internship supervisors, the university also takes part in the project "Supporting the Cooperation between Employers and Educational Institutions in the Development of the Internship System" funded by the European Social Fund, which helps pilot a problem-based form of team internship in cooperation with employers.

3.8.2.3. PLANNING OF DOCTORAL STUDIES

In the semester of admission, a PhD student shall, in cooperation with his/her supervisor, prepare an action plan: the topic of the doctoral thesis, annotation and the activities planned for the first academic year. Before the regular attestation in the first academic year, a PhD student shall submit a report on the implementation of the action plan, which is evaluated by the supervisor on a five-point scale. For attestation in the first academic year, a PhD student shall submit to the attestation committee a schedule and action plan for the whole period of doctoral studies approved by the supervisor. The attestation criteria shall be taken into account upon preparing an annual plan for studies and research. From 2021, a PhD student commencing studies shall submit a research plan and list of the literature approved by the supervisor by the end of the first semester. By the end of the first academic year, a PhD student must have the initial strategy and methodology for his/her research in place.

All admitted PhD students work in a research group or are otherwise involved in a full-time research group whose research is closely related to the topic of the PhD student's doctoral thesis. Teaching and doctoral seminars form a compulsory part of doctoral studies. Doctoral seminars vary across study programmes, but their goal is to learn how best to present research results, to develop argumentation skills, as well as to review the research of fellow PhD students and receive feedback on one's research. For example, in the School of Engineering, doctoral seminars in study programmes are held for 2nd and 3rd year PhD students to review their current progress, action plan and publication plan. Based on the quality agreement for doctoral studies (in Est) concluded in 2020, the requirements for doctoral theses at TalTech were made more flexible without compromising on quality[55].

PhD students provide feedback at annual attestations (see Chapter 3.10), through feedback surveys conducted by the doctoral schools and programme directors. In 2021, it is planned to develop a centrally organised regular feedback system on supervision, organisation of doctoral studies and support services.

3.8.3. STAKEHOLDERS' SATISFACTION AND THE COMPETITIVENESS OF GRADUATES

3.8.3.1. STUDENT SATISFACTION WITH STUDIES

Feedback on the content and organization of studies is collected mainly through the feedback survey conducted in SIS once a semester. An annual graduate satisfaction survey provides a comprehensive overview of the entire study period. Students are obliged to fill in SIS feedback survey, which is why the participation rate is high (approximately 75%). Satisfaction with teaching and organisation of studies is very good, amounting to an average of 4.4 points on a five-point scale in the last five semesters (see Table 29). A positive trend can also be seen in the overall satisfaction of graduates, which is an aggregate assessment of the averages of the responses to individual statements regarding teaching and the study programme (see Table 30). In order to obtain more data for the implementation of changes to programmes, it is necessary to find ways to increase the response rate of graduates (currently about 25%), so that a minimum number of respondents (at least 5) would be ensured in each study programme.

[55] A doctoral thesis prepared based of research papers may be defended on the basis of two research papers; the papers must have been published in Q1 and/or Q2 journals and the PhD student must be the lead author of at least one of the papers.

Table 29. Student feedback on teaching, courses and organisation of studies. Source: SIS

Semester	18/19 autumn	18/19 spring	19/20 autumn	19/20 spring	20/21 autumn
Average at TalTech	4.41	4.40	4.45	4.41	4.47

Table 30. Graduates' satisfaction with their studies (on a five-point scale) Source: Graduate survey 2015–2020

	2015	2016	2017	2018	2019	2020
Graduates' satisfaction with their studies	3.89	3.96	3.96	3.99	4.04	4.02

In addition to quantitative feedback, the university receives a lot of qualitative feedback from the surveys in the form of comments, which are analysed by the teaching staff, programme directors, and heads of departments each semester. In the last five semesters, students have given some 30,000 comments in the feedback survey in SIS, which shows students' interest in giving feedback. The number of respondents and comments in the feedback survey are presented in Table 31.

Table 31. Number of comments and respondents to the SIS feedback survey. Source: SIS

	18/19 autumn	18/19 spring	19/20 autumn	19/20 spring	20/21 autumn
Number of respondents	6833	5140	6204	4873	5702
Number of comments	38753	21342	33239	24226	37307

In addition, the motivation of students to contribute to the improvement of the quality of education is demonstrated by the Education Quality Working Groups, which aim to monitor the quality of education. In recent years, the team of the Education Quality Working Groups, has analysed the results of the open-ended questions and organised information campaigns among students about the importance of feedback. The Student Union has also prepared the good practice for giving feedback and the team of the Education Quality Working Groups developed a plan that encourages the writing of substantive comments through competition between the student bodies of the Schools.

There is an increased need to provide ongoing feedback so that teachers have the opportunity to improve the learning process and better support their current students. This approach is already applied at the level of some courses, study programmes and structural units (e.g. feedback from freshmen, student members of the programme advisory board), but the Office of Academic Affairs is mapping opportunities to contribute centrally by diversifying student feedback options. One of the objectives in developing the feedback system is so that students are able to reflect more on their learning experience, and so contribute to the development of their own learning and self-management skills.

According to the alumni satisfaction survey in 2019[56], TalTech alumni rate their job performance (3.54) the highest and satisfaction with the internship opportunity (2.59) and the level of teachers and teaching (2.84) the lowest[57]. Analysis of the responses to open-ended questions showed that dissatisfaction with the internship opportunities is mainly caused by three factors: 1) a student must find the internship host by himself/herself; 2) internship is unpaid; 3) if a student does not find an internship host, internship is performed in the same enterprise where the student is employed, which does not add any value. The weaknesses pointed out, regarding the level of teaching, included the uneven quality of teaching staff, too theoretical teaching and outdated study materials. Similar comments can also be found in the responses to open-ended questions in the graduate survey. To address these observations, the university has set a goal to increase problem- and project-based learning and provide the support of didactics experts for the development of the teaching skills of the teaching staff.

The competitiveness of the alumni of the university in the labour market is shown by the share of employed persons and their income. In 2020, 98% of TalTech graduates were employed in the labour market, and the average wages of TalTech's alumni has been steadily 20-25% higher compared to the income of graduates of the other major Estonian public universities as well as of higher education graduates in general (see Figure 19). The university's goal is that the income of the graduates of the second level of studies would be at least 1.65 times higher than the average wages in Estonia (see Chapter 3.1).

[56] The survey was conducted by the Ministry of Education and Research among the graduates of 2016–2018 in order to get an overview of the educational background of the alumni, their post-graduation activities, labour market performance and assessments of the quality of higher education and the competencies acquired at the university.

[57] A four-point scale is used in the survey: 1 – totally disagree, 2 – rather disagree, 3 – rather agree and 4 - totally agree.

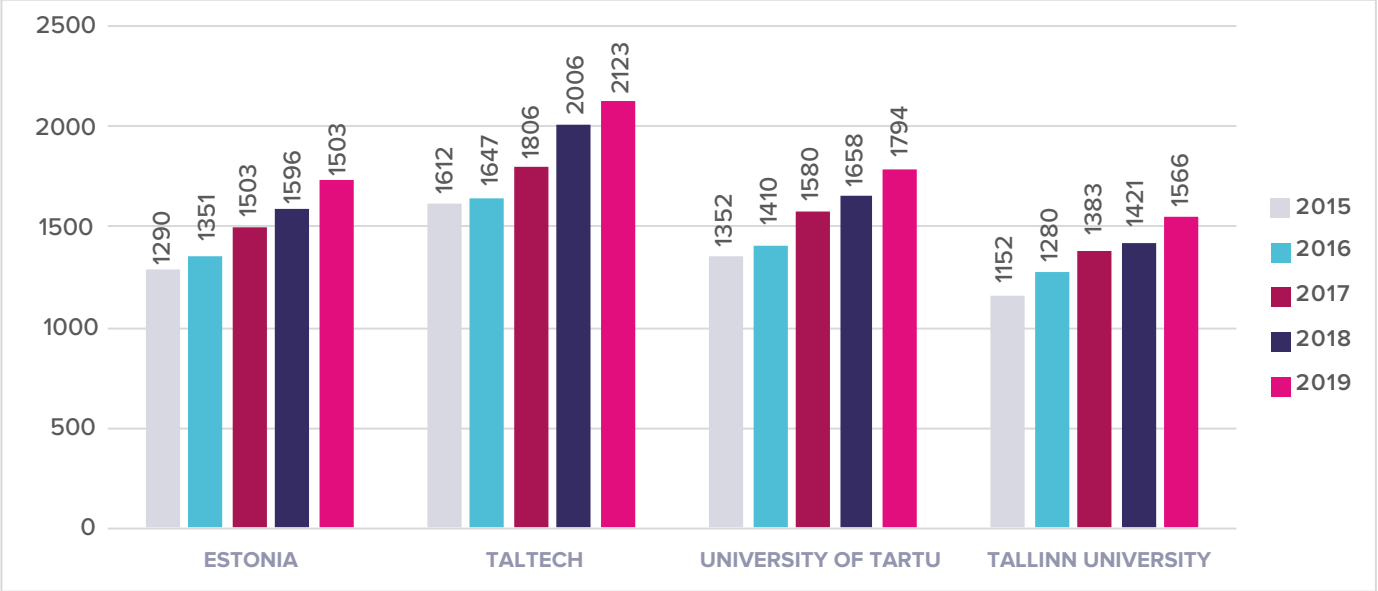


Figure 19. Average income of higher education graduates in 2015–2019 by Estonian public universities. Source: HaridusSilm

No separate employer satisfaction survey is conducted at TalTech; feedback is collected from the programme advisory boards, practitioners involved in teaching and supervisors in the internship host organisations.

SUMMARY OF STRENGTHS AND AREAS FOR IMPROVEMENT

Strengths

• Year-round admissions and the process activities help to develop a motivated student body.

• Compulsory courses are supplied with e-support, which enables flexible learning and teaching.

• Students are involved in the process of improving teaching quality.

Areas for improvement and planned development activities

• In order to improve the quality and flexibility of learning, the number of courses with a higher level of e-support needs to be increased.

• In order to introduce problem-based teaching and learning and to support the development of learning skills, teaching staff must be offered the opportunity to share best practices, to participate in continuing education courses and be provided with support from didactics experts.

• To integrate theoretical and problem-based learning, a working group has been formed to develop indicators and measures for the wider use of project-based learning in courses.

• The feedback system must be developed further, to receive adequate feedback from different stakeholders and encourage the students to self-reflect (development of learning and self-management skills, responsibility for their studies).

3.9. STUDENT ASSESSMENT

3.9.1. ORGANISATION OF STUDENT ASSESSMENT AND METHODS USED

The principles and organisation of assessment of students' academic performance, incl. accreditation of prior and experiential learning (APEL) and attestation of doctoral students have been established by the Senate in the Academic Policies.

The assessment methods to verify the attainment of learning outcomes, the assessment criteria and procedure, incl. the principles for determining the final grade in case a variety of methods are used for the assessment, are specified in the extended syllabus by the lecturer responsible for the course. The lecturer must make sure that students are informed of these before the beginning of the studies and the terms and conditions for passing the course must not be changed[58] during the semester the course is taught.

Assessment may be either graded or non-graded – graded assessment is used in about 75% of the courses. The final grade can be calculated as a total of different components (e.g. homework, test, exam, pass/fail assessment) or based only on an examination or assessment at the end of the study period.

In order to improve the effectiveness of the attainment of learning outcomes and to motivate teaching staff to use continuous assessment of attainment of learning outcomes during the semester, the examination sessions at the end of each semester were terminated in 2019. This allows flexibility in choosing the time for checking students' knowledge and selecting the assessment methods. The experience of distance learning gave a clear message about the need for and possibilities of using interim assessments where it was not applied before (e.g. the Estonian Maritime Academy concluded that the process of teaching and learning was smoother in the courses, where interim assessments were used)[59].

A lecturer has to provide the result of assessment of a written assignment to students within two weeks of the completion of the assignment. However, students have pointed out that the numerical result of assessment of performance without oral/written feedback supporting development is not always sufficient. In order to make personal feedback to students more substantial, teaching staff can provide verbal feedback in the e-learning environment. However, in courses with big classes, this may turn out to be difficult, especially if the automation possibilities are limited.[60] Automated feedback has been used in such cases for example by the School of Information Technologies. It has been found that automatic feedback provides students positive experience in solving tasks.

As more courses have e-support and use the Moodle e-learning environment for assessment, increasingly comprehensive feedback can be provided through Moodle. According to the programme directors, continuous feedback and assessment motivates students. Oral feedback from the teacher also plays an important role. Students have the right to ask a teacher to justify how a grade was calculated or assigned. Disputing study (incl. assessment) related decisions is governed by the Academic Policies.

Assessment of graduation theses and exams in higher education studies at TalTech mostly end with the defence of a graduation thesis. In academic year 2020/2021, a final exam was used in three first level study programmes and in one master's study programme. The preparation of graduation theses is supported by courses in the first level study programmes that foster scientific thinking and the acquisition of good scientific practice and implementation of professional research methodology. The requirements for defences and assessment of graduation theses are laid down in the Academic Policies and the Schools' guidelines for written papers are available to students. A defence committee is responsible for assessing graduation theses, qualifications committees are involved in awarding primary level occupational qualifications. Feedback on aspects related to graduation theses and exams is collected annually in the framework of the graduate survey; the feedback has been mostly positive. Graduates have rated their experience of finding a topic and a supervisor for the graduation thesis the lowest (3.93 points on a five-point scale). This process appears to be most difficult in large Schools with many students and therefore more difficult to find supervisors (the Schools of Information Technologies, Engineering and Business and Governance).

3.9.2. TEACHING STAFF'S ASSESSMENT SKILLS

3.9.2.1. STUDENT FEEDBACK ON ASSESSMENT

Students provide feedback on aspects related to the assessment of courses every semester through the feedback survey in the study information system. The following statements are assessed: "Assessment was carried out in line with the assessment criteria", "The lecturer provided relevant and timely feedback to my studies", "I acquired the knowledge and skills described in the learning outcomes as a result of completion of the course". From among these statements, students have rated the compliance of the assessment with the assessment criteria the highest, the score has remained between 4.52–4.58 points in the last four semesters. Qualitative feedback (comments) has been rather positive, but the difference between the actual assessment criteria and those in SIS, changing of the assessment criteria during the semester and unfair assessment have been pointed out as drawbacks. In the last four semesters students have rated highly also relevant and timely feedback to studies – the average scores remain in the range 4.39–4.44. The statement "I acquired the knowledge and skills described in the learning outcomes as a result of completion of the course" has been given the average score of 4.32–4.38 in the last semesters, but it is associated with different factors. Students understand partially that the acquisition of learning outcomes depends on their own contribution and activities, but shortcomings

[58] Due to SARS-CoV-2 pandemic, an exception to this rule was made in the last two semesters, where it was necessary due reorganisation of studies.

[59] In the School of Business and Government, continuous assessment was actively used already previously. This is shown by the analysis of the assessment in the courses of the TVTB study programme, according to which continuous assessment is used in about 90% of the courses.

[60] Assessment methods that allow faster assessment (e.g. a multiple-choice test) are not suitable in assessing the attainment of all learning outcomes.

in teaching and the course are often pointed out as obstacles hindering acquisition of knowledge and skills, e.g. confusing tasks, workload of the course and level of difficulty, inappropriate pace, too theoretical course, etc. Positive aspects have also been pointed out in comments, e.g. supportive attitude of the lecturer, appropriate teaching methods, practical assignments.

3.9.2.2. DEVELOPMENT OF THE ASSESSMENT SKILLS OF THE TEACHING STAFF

At the university, the teaching staff's assessment skills are developed through in-service training and information activities. In the course of the study programmes reform that took place in 2016–2018, the assessment criteria of all study programmes and their presentation in various information channels (in SIS, Moodle) were reviewed.

The topics of assessment and provision of feedback are addressed also in the didactics trainings provided by the Estonian Centre of Engineering Pedagogy in both Estonian and English[61]. An elective course that develops motivating assessment and feedback skills is included in doctoral study programmes. The topics of assessment are also addressed in the framework of mentoring, individual counselling and lesson observations of the teaching staff. The materials of the in-service study programme "Workshop on Didactics of Higher Education for TalTech teaching staff" and the handbook for engineering pedagogy are available for the teaching staff for independent learning. In the last five years, 178 members of TalTech teaching staff have participated in the courses on assessment at the Estonian Centre of Engineering Pedagogy. The Development and Quality Division of the Office of Academic Affairs also provides advice and support in matters regarding assessment of learning outcomes.

The development of the assessment skills of the teaching staff is a priority set out in the Good Lecturer Development Programme – if a lecturer receives poor feedback from students, the Academic Quality Assurance Coordinator and the HR Training and Development Officer indicate the areas for improvement in the report sent to the Head of the Department. This often includes reference to the feedback and evaluation. The measures provided under the Good Lecturer Development Programme are not yet fully implemented, but the instructions and guidelines have been agreed upon.

Assessment is analysed also in the Schools. For example, the School of Business and Governance is paying greater attention on the distribution of grades in courses and has developed a Power BI report, which allows the programme directors to conveniently track students' grades.

As a result of the study programmes reform, large-scale study programmes were created, which are often taught by several members of the teaching staff and a need has arisen for the teaching staff to cooperate also more closely in assessing students. One possible solution is to appoint the responsible teacher of the course, who is responsible for the quality of teaching and assessment in the course and coordinates the cooperation between other members of the teaching staff. In order to ensure more objective and transparent assessment, the aim is to involve more members of the teaching staff in assessment (incl. at random).

To enhance the assessment skills of teaching staff, the university intends to develop a sector-based support service for the development of the teaching staff within the next five years (primarily through the didactics network).

3.9.3. ACCREDITATION OF PRIOR AND EXPERIENTIAL LEARNING (APEL)

The purpose of APEL is to facilitate a better match between lifelong learning and different study levels as well as studies and the labour market. APEL allows for example recognising prior learning and work experience towards the completion of a study programme. The principles of APEL have been established by the Senate in the Rules for Accreditation of Prior and Experiential Learning. The procedures related to disputing decisions related to assessment are explained in the Academic Policies.

From August 2020, the credit points applied for and granted under the APEL are counted toward completion of the student's workload in the semester, which is why the number of credit points applied under APEL increased. Table 32 shows that, compared to the autumn semester of the academic year 2019/2020, the number of credit points granted under APEL has increased 38% in 2020/2021.

Table 32. Number of credit points applied by and granted under APEL. Source: SIS

	Number of ECTS applied for	Number of ECTS granted
2019/2020 autumn	7,084	7,059
2020/2021 autumn	12,271	11,291

In order to ensure the transparency and uniform quality of APEL, the APEL process is conducted fully online in SIS since 2020. The online APEL process involves preparing an application, adding supporting documents, evaluation, communication between different parties and the storing of applications. User feedback has shown that the useability of the system needs to be improved, which is why it is planned to solve specific problem areas.

In order to ensure regular provision of information, the parties involved in the APEL process (applicants, advisers assessors) are

[61] For example, Curriculum for Continuing Teacher Education - Engineering Pedagogy with the workload of 25 ECTS, Workshop on Didactics of Higher Education for TalTech teaching staff, Practice of Didactics in Higher Education, Teaching and Learning at Tallinn University of Technology, Academic Counselling, Didactics of Higher Education.

trained at least once a semester. The students and the programme directors assessing applications have the opportunity to participate in the APEL seminar organised within the framework of a series of career seminars; matters regarding APEL are regularly addressed at the seminars organised for the university's student counsellors. Up-to-date guidance materials are available to everyone on the university's website.

In order to have a central overview of the APEL process (incl. the applications submitted and their assessment), an APEL adviser is employed in the Office of Academic Affairs, who analyses APEL results regularly and who is a member of the national APEL network.

During the last five academic years, the number of APEL applicants has decreased (see Table 3). One reason is the general decline in the number of students at the university. It has also been caused by a change in the rules related to the workload requirement – a student admitted in the academic year 2017/2018 must complete courses in his/her study programme in the amount of 30 ECTS per each semester. As a result, students passed more courses during their studies and the volume of courses recognised towards the completion of the study programme under APEL decreased. At the same time, the prices for recognising the credit points granted under APEL changed, which harmonized the fees related to APEL.

The number of credit points gained from professional experience, continuing education and based on combined recognition applications also shows a downward trend. Despite of the interim downward trend, recognition of degree level courses of different schools towards completion of studies at TalTech has increased in recent years. One of the main reasons for refusal to satisfy an APEL application is that the learning outcomes of the course applied have not been fully acquired. The difference between the number of credit points applied for and granted under APEL has been steadily low both in the university as a whole and in the Schools (see Table 33). This shows that students get the necessary information on APEL requirements, which provides reasonable grounds to believe that the applications have been prepared knowingly and considerately.

Table 33. Number of ECTS granted under APEL. Source: SIS

	2015/16	2016/17	2017/18	2018/19	2019/20
Number of applicants	1,291	1,119	909	774	832
ECTS applied for (total)	22,513	22,149	16,254	12,766	16,791
ECTS granted (TalTech courses)	11,012	11,287	7,347	4,563	6,116
ECTS granted (other Estonian education institutions)	5,165	5,131	3,776	3,295	4,660
ECTS granted (education institutions abroad)	5,408	4,792	4,541	4,233	5,446
ECTS granted (professional experience, in-service training and combined)	729	721	479	595	509
ECTS granted (total)	22,314	21,931	16,143	12,685	16,731

3.9.4. ATTESTATION OF DOCTORAL STUDENTS

The purpose of attestation of doctoral students is to support the development of doctoral students, to assess the effectiveness of their current work and to evaluate their ability to complete doctoral studies on time and successfully defend their doctoral theses. Based on this, the terms of attestation were fundamentally changed in 2017: the attestation committees based on narrow specialities or Schools were dissolved and a requirement was established to form broad-based attestation committees with at least one member from outside the School where the study programme is taught; the minimum criteria were defined for each academic year, on the basis of which the attestation committee evaluates the doctoral student's progress. Regular attestation of doctoral students takes place once a year at the end of an academic year. The evaluation is based on the doctoral student's study data and report on the implementation of the action plan, to which also the supervisor gives his/her opinion and grade on a five-point scale. The committee shall assess completion of a study programme cumulatively as percentage. In addition to regular attestations, extraordinary attestations may be carried out on the proposal of the programme director or supervisor at a time set by the Dean[62].

In 2019, an IT solution was completed to support more effective organisation of attestation. The evaluation and feedback provided by the attestation committee help the students defend their doctoral theses within the nominal period of studies. The attestation committee sets the expected date of defence to third year and above doctoral students.

In compliance with the requirements for doctoral theses renewed in 2020 based on the quality agreement for doctoral studies of Universities Estonia (in Est) and in line with the need to improve the effectiveness of doctoral studies (see also Chapter 3.10), first-year doctoral students will be attested based on their semester results twice in an academic year starting from the autumn of 2021; the second-year and above doctoral students can also be attested twice an academic year in justified cases by a decision of the supervisor or programme director or on the recommendation of the attestation committee. In addition, the minimum criteria have been laid down for each year depending on the form of the doctoral thesis (a doctoral thesis prepared based on research papers, a monograph or a creative research). The establishment of specific criteria for attestation and the establishment of broad-based evaluation committees have been one step in improving the effectiveness of doctoral studies. The attestation criteria laid down for each academic year provide clear guidance to both doctoral students and supervisors on how to plan their research so that it is possible

[62] For example, if the doctoral student has studied in doctoral studies for a longer period of time or the progress has been assessed as too slow at the previous regular attestation.

to defend a thesis within the nominal period of studies. It is made sure that impartial and substantive feedback is provided to a doctoral student on his / her progress based on the student's results.

As a result of these changes, the number of doctoral students exceeding the nominal period of studies has decreased.

SUMMARY OF STRENGTHS AND AREAS FOR IMPROVEMENT

Strengths

• In order to make the organisation of studies and the assessment process more flexible, the examination sessions were terminated and instead a deadline is set for taking exams.

• The APEL process has been transferred online, which increases transparency and harmonises quality.

• The attestation of doctoral students is transparent and substantive feedback is provided to each doctoral student.

Areas for improvement and planned development activities

• To improve the provision of feedback to students by using technical solutions (e.g. Moodle) and motivating teaching staff to help and support students' progress. In 2021, the teaching staff's workload principles in the Financial Regulations will be reviewed.

• To enhance cooperation of the responsible teacher and the other member(s) of the teaching staff in the development of assessment tasks and in the assessment of assignments and to promote various teaching and assessment methods through the didactics experts network which is under development.

• To prepare instructional materials and e-learning courses for the development of the assessment skills of teaching staff; to create a self-study online environment for the development of the pedagogical skills of teaching staff.

3.10. LEARNING SUPPORT SYSTEMS

One of the goals of the implementation plan of the university's Strategic Plan 2021–2025 is to provide seamless and cost-effective support services with an aim to support and better combine high-quality studies, research and innovation.

3.10.1. INFORMING AND COUNSELLING OF STUDENTS

3.10.1.1. COUNSELLING SERVICES

The bases for informing and counselling of students are provided in the Academic Policies. The study information system is the official information channel for students. Students are also entitled to receive additional information from the School, the Student Union, the Office of Academic Affairs and other structural units of the university.

The university's central counselling services have been brought together under the Student Counselling Office, to make it convenient for students to find solutions to their questions and problems.[63] The Office provides general academic counselling, career counselling, psychological counselling, counselling of students with special needs and admissions counselling services. It also mediates internship and job offers. In matters regarding general organisation of studies and everyday issues, advice is provided by students, who can be contacted through various channels (incl. live chat). Student counsellors provide separately consultations for students in need of support in sciences (the project "ReaalAbi"[64]). A career advisor helps students make informed career decisions and career choices and a qualified advisor provides counselling to students with special needs. Counselling services are free and available in both Estonian and English[65]. Approximately 1/3 of queries of the total number of queries made to the Student Counselling Office are in foreign languages.

Advice on matters of academic progress is provided also by the student counsellors of the dean's offices of the Schools. In substantial matters regarding the study programme and studies, students can turn to the programme director, in doctoral studies to the supervisor of the PhD student. In order to ensure the uniform quality of counselling, seminars and briefings are organized regularly for study counsellors and programme directors.

At the beginning of an academic year, a pre-week is organised for students, where university life and support services are introduced. In addition, freshmen are supported by fellow students (buddies). In order to prevent discontinuation of studies and ensure the effectiveness of learning, students are offered the courses Laboratory of Learning Skills and Self-management, which help to analyse one's own learning style, find appropriate learning strategies and apply the psychological knowledge and skills to cope better at the university.

In the pre-week for international students, besides information regarding organisation of studies, information about local living conditions, habits and everyday issues is provided. In order to better support international students, specialists providing advice on residence permits and other regulations are working in the Admission and Student Counselling Centre. The course Estonian Language and Culture also supports adaptation.

3.10.1.2. STUDENTS' SATISFACTION WITH THE COUNSELLING SERVICES

Feedback on counselling and support services is collected using the feedback survey in the SIS, where students assess the counselling service provided by the dean's office (in the last semesters satisfaction has been high, at least 4.5 points on a five-point scale). The comments added to the ratings are rather positive: staff had good attitude, they were friendly, in general responded quickly and competently, the issues were resolved, etc. Both oral and written feedback to the "ReaalAbi" service is provided immediately after counselling. Students are satisfied with the service (4.88-5.0 points on a five-point scale). In the future, it is planned to offer the "ReaalAbi" service in English as well.

The results of the 2019 university alumni survey show that more than 50% of alumni did not need the support of counsellors during their studies. However, 7% of respondents said they did not receive the support they needed, 22% said support was available and adequate, and 16% were unaware of the support services. The aim of the university is to reduce the number of students who do not know how to ask for help due to lack of awareness. Establishing the Student Counselling Office was a major step forward in this direction.

3.10.2. MONITORING STUDENTS' PROGRESS AND SUPPORTING THEIR DEVELOPMENT

3.10.2.1. STUDENTS' PROGRESS AND DISCONTINUATION OF STUDIES

The most important indicator in assessing graduation efficiency is the ratio of enrolled students to graduates[66]. Graduation efficiency has increased by 10 percent points. While in 2016 the efficiency was 40%, in the last three academic years it has gradually improved amounting to 50% in 2020. The efficiency is the highest in master's studies and the lowest in professional higher

[63] The Student Counselling Office was established based also on the experience of other foreign universities (e.g. University College Dublin in Ireland).

[64] ReaalAbi – student-to-student counselling in mathematics and physics launched as a pilot project in the autumn of 2020. Four students offer those interested 45-minute counselling sessions in mathematics and physics. All service users fill in a feedback form after the counselling.

[65] Excluding ReaalAbi, which is currently in Estonian only. Counselling services are also available in study units outside the campus (e.g. in the Estonian Maritime Academy, the Colleges).

[66] In the study programmes with a nominal duration of 4 years or more, the number of graduates is fixed after the nominal duration of studies plus 2 years have elapsed from the admission; in the study programmes with the nominal duration of less than 4 years, the number of graduates is fixed after the nominal duration of studies plus 1 year have elapsed from the admission. The number is confirmed at the end of the academic year when the nominal duration of studies plus 1 year of 2 years have elapsed from the admission.

education studies (see Figure 20). One of the goals of the university's Strategic Plan is to increase graduation efficiency at the first and second study levels to at least 60% over the next five years. The target set for graduation efficiency in doctoral studies (76 graduates in the performance agreement and a 10% annual increase in the number of graduates in the Management's Action Plan) has not been achieved. In 2019, 66 doctoral students and in 2020, 55 doctoral students defended their doctoral thesis. In 2020, the number of students, who defended their thesis within the nominal period of studies, increased slightly and the average length of doctoral studies decreased to less than six years. The number of defences in recent years has been affected by several factors. In the years 2010–2015, an average of 130 new PhD students were admitted per year, whereas in 2016, the university moved to to a new PhD students admission system and the number of enrolled students dropped to 71. The new attestation requirements and criteria established in 2017 led to exmatriculation of many PhD students who had exceeded the nominal duration of studies. The number of defences in 2020 may have been affected also by the SARS-CoV-2 pandemic situation in the world. The impact of the changes made in doctoral studies on graduation efficiency can be expected to be seen in the next few years.

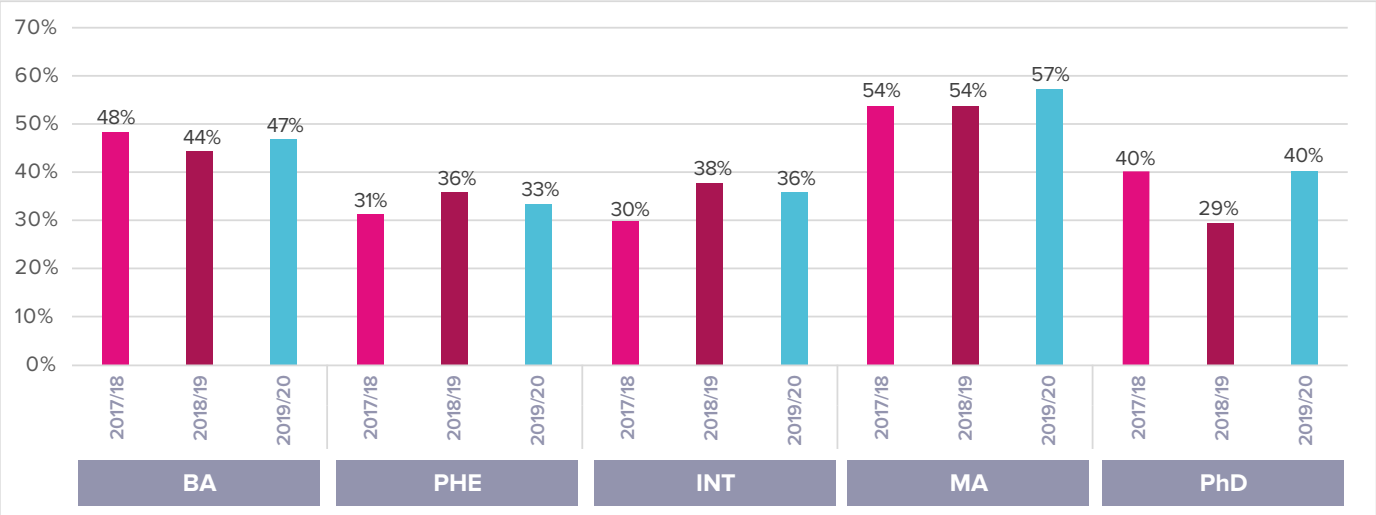


Figure 20. Graduation efficiency by study level 2017/18–2019/20. Source: SIS

The students' average period of studies by study level is presented in Table 34. At the individual level, most students complete their studies within the nominal duration of studies (i.e. the nominal duration of studies plus 1 year or 2 years). It should be noted mind that the time spent on academic leave is also taken into account when assessing graduation efficiency, but this is not included in the student's individual study time and all students who have graduated are included.

Table 34. Students' average period of studies by study level. Source: SIS

Study level	2017/18	2018/19	2019/20
Bachelor's studies (3 yr.)	3.6	3.5	3.6
Professional higher education studies (3 yr.)	3.9	4.0	4.4
Professional higher education studies (3.5 yr.)	3.8	3.6	4.0
Professional higher education studies (4 yr.)	4.6	4.4	4.4
Integrated studies (5 yr.)	6.1	6.3	6.0
Master's studies (1 yr.)	N/A	1.0	1.0
Master's studies (2 yr.)	2.4	2.5	2.4
Doctoral studies (4 yr.)	5.9	5.9	6.2

Figure 21 indicates that the drop-out rate has decreased slightly in the last three academic years[67]. In the academic year 2019/2020, about 12% (16% in the previous year) of students discontinued their studies. The university's aim is to further decrease the percentage, as well as to reduce the dropout rate in the first academic year – in the academic year 2019/2020, 710 first-year students, i.e. about 23% of the enrolled students, were exmatriculated. The dropout rate, especially in the first year of study, is higher at the first level of higher education. The dropout rate in doctoral studies has decreased, which is a direct result of the fundamental changes made in the admission to and organisation of doctoral studies five years ago.

[67] The number of enrolled students reflects all the students matriculated in the period between 01.01-31.12. A student who discontinued studies in the period between 01.08 of the year of admission to 31.07 of the following year is considered to have dropped out in the first year. As an exception, in 2019/2020, due to the extension of the academic year, the period observed is from 01.08 of the year of admission to 27.08 of the following year. Share of dropouts = number of dropouts between 1.10-30.09/number of students as of 10.11

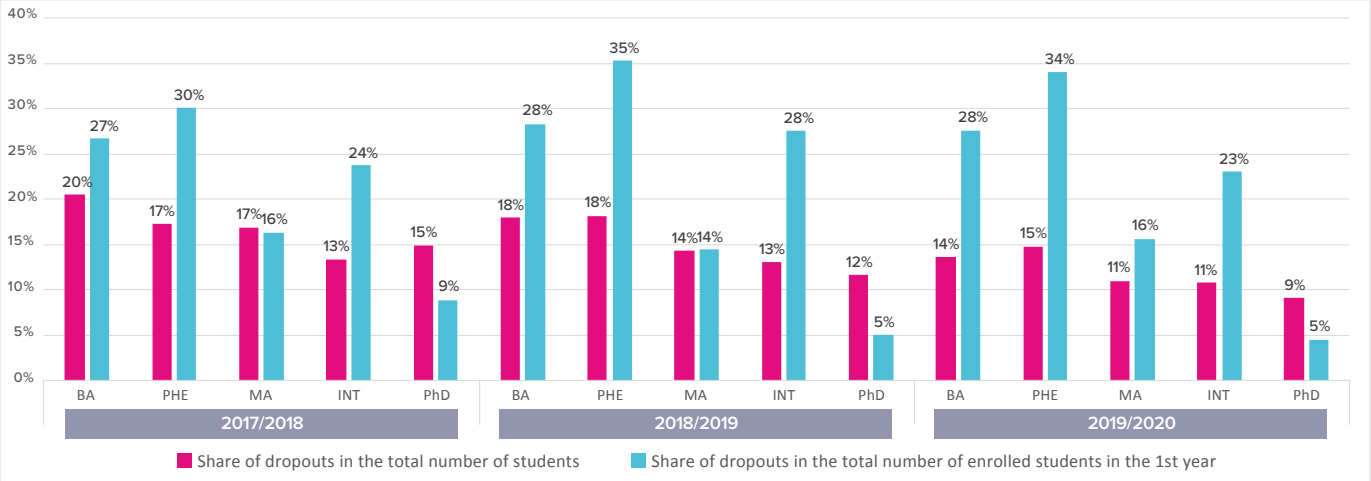


Figure 21. Share of dropouts in the total number of students and share of dropouts in the number of enrolled students in the 1st academic year by study level in the academic years 2017/2018–2019/2020. Source: SIS

The main reasons for discontinuing studies are lagging behind in studies and the resulting financial obligations, wrong choice of specialization, economic reasons, in master's and integrated studies also working while studying. A feedback survey conducted among PhD students showed that slightly more than one third of the PhD students discontinued studies due to delays in accepting articles for publication; nearly fifty per cent mentioned working outside the university which does not allow them to contribute sufficiently to studies, as the main reason.

3.10.2.2. MONITORING STUDENTS' PROGRESS

Various measures are taken to reduce dropout rates and to support students' progress. In order to ensure a motivated and high-level student body, the admission requirements are changed from year to year, the admission thresholds are raised, mentoring and pre-sessional courses (incl. language studies and mathematics) are offered (see also Chapter 3.8). In order to facilitate the timely completion of doctoral studies and increase efficiency, the attestation requirements for doctoral students will be updated from the autumn of 2021 (see Chapter 3.9.4 for more details). A comprehensive feedback system and mentoring programme for PhD students who have exceeded the nominal duration of studies, is under development, regular trainings for supervisors will be conducted in the Schools. Regular doctoral seminars are held as a compulsory part of doctoral studies, within the framework of which PhD students receive feedback on their research and gain experience in presenting their research, which supports the effectiveness of doctoral studies. In addition to attestation, interim assessments are carried out in some Schools (e.g. the School of Engineering), during which the PhD student, in cooperation with his/her supervisor, reviews his/her research plans and introduces them to a large audience. The "Career Planning for Doctoral Students" course supports the development of PhD students and provides knowledge of the career development process and skills for personal career development.

The university has developed and continues to develop a Moodle-based system for monitoring students' progress, where the programme director can get an operational overview of interim results in the compulsory courses of the students in his/her study programme using the Power BI solution[68]. In order to increase the efficiency of the tool, the aim is for the teaching staff to use more interim assessments (especially in the study programmes with a high drop-out rate), which allows spreading the workload, monitor students' progress on an ongoing basis and intervening in time, if necessary (see also Chapter 3.9).

3.10.3. STUDENTS' EXTRACURRICULAR ACTIVITIES

To support students' extracurricular activities, funds are allocated to student organisations and bodies from the university budget. Student organisations include the Student Union, cultural clubs (choirs, the photo club), sports and dance clubs, the debate club, the robotics club, the motorsport club, the software development club, the student formula FS Team Tallinn.

In 2020, there were 28 registered student organisations at the university and each School has its own Student Assembly. In the academic year 2020/2021, there were 2073 (about 20% of the total number of students) students at the university who are active in student organisations. In addition, the Schools support their Student Assemblies, students' professional competitions (e.g. the international competitions BuildIT, BRICO, Formula Student). Student Assemblies and organisations organise events (e.g. the career events bringing together study programmes and employers "Võti Tulevikku" (Key to the Future) and the internship café organised by the School of IT), company visits, practice days and field trips.

Students are involved in the work of the university's decision-making and advisory bodies (the Senate, the Senate's committees, School councils, the Library Council, programme advisory boards, general meeting of the Student Campus), and they also participate in the work of the Federation of Estonian Student Unions. The representatives of the Schools elected by the students form the Student Union, which is the highest decision-making body of TalTech's students organisations.

The Student Union awards several scholarships at the Development Fund competition in spring. TalTech's Student Union also

[68] In Moodle, the programme directors can assess students' performance in the courses based on the interim results and offer additional support, if necessary.

awards the titles Student of the Year, Student Organisation of the Year and Student Deed of the Year at the anniversary ceremony of the Republic of Estonia.

The individual development and motivation of students is also supported by their involvement in research projects (see Chapter 3.11).

3.10.4. RESOURCES SUPPORTING LEARNING

3.10.4.1. ICT SOLUTIONS SUPPORTING LEARNING

The university's Strategic Plan 2020 aimed to develop the education infrastructure by focusing on the first level of higher education and e-learning assets. The implementation plan of the Strategic Plan for the new period sets a goal to ensure convenient and sustainable environments (both physical and virtual) at the university.

In 2017, a more user-friendly study information system with a more modern design was completed. The developments of the SIS and the document management systems have helped to reduce the amount of paper documents. Part of the study documentation has been digitized (e.g. orders, the APEL process, digital signing of assessment sheets).

The university uses TalTech Moodle's e-learning platform, which can be interfaced with other information systems of the university and which is being developed by the Educational Technology Centre[69]. In 2021, integrating of TalTech Moodle with SIS and the digital collection of the library is under development. The organisation of distance learning is supported by MS Teams and Moodle BigBlueButton, hybrid learning is supported by 44 auditoriums supplied with Echo360 video recording systems. In addition, portable cameras, tablets, 360-degree cameras and microphones are used in teaching. The teaching staff can test and apply innovative teaching and learning scenarios in the Teaching and Learning Lab, in the Mektory XR Center and independently record videos in the newly equipped.

Since the autumn of 2020, personal information related to studies is available to students on the TalTech student portal unique in Estonia, where the timetable, exam times, news, incoming mail, etc. are displayed. The student portal is integrated with the university's main information systems (e.g. SIS, Moodle, the library borrowing system) and can also be used within TalTech's mobile app.

3.10.4.2. AVAILABILITY OF STUDY MATERIALS AND THE LIBRARY

TalTech's library provides access to high-level scientific information. There are about 70,000 paper objects in the library; there is a 4,700-square metre reading space at the disposal of the visitors and the library is supplied with modern computer workstations and rooms for individual and group work. Databases are acquired and collections are supplemented based on the university's study programmes and research directions, textbooks are ordered on the basis that there should be at least one textbook per 5-7 students. The members of the university have access to more than a hundred databases, including 85 licensed databases. All persons interested can use full texts from the databases in the TalTech computer network, uni-ID owners can use the full texts via the VPN connection without any time and space restrictions. The e-resources portal PRIMO enables search from multiple research literature databases and the digital collection of TalTech's library. The digital collection provides access to graduation theses, e-textbooks and e-learning materials and other digitized materials.

As a result of the library's user survey, opening hours have been extended (a study room is open 24 hours a day), the number of e-textbooks has been increased, instructional videos introducing the use of databases have been created, computers have been updated and registration upon entering the library has been terminated. In coming years, it is planned to connect the e-catalogue ESTER with the e-resources portal PRIMO to make it easier to find scientific information, and a repository of the university's scientific data is being created. Study materials for teaching and research are available, the service is user-friendly and survey results of have been taken into account in the development of the library.

3.10.5. SCHOLARSHIPS AND STUDY ALLOWANCES

To support participation in the research and learning process and development of personal skills, students have the opportunity to apply for scholarships. In addition to state funded study allowances and scholarships (speciality, performance or doctoral scholarship), there are also company funded speciality scholarships mediated by TalTech's Development Fund. In the last three years, an average of 99 scholarships per year have been offered to students through the Development Fund in the total amount of 189,000 euros. In addition, from 2021/2022, the university pays scholarships to students who have successfully competed at international subject proficiency olympiads during their upper secondary school studies.

SUMMARY OF STRENGTHS AND AREAS FOR IMPROVEMENT

Strengths

• Versatile counselling services are provided to students both at Schools and centrally in the Student Counselling Office.

• Students can obtain the necessary information quickly and conveniently from the student portal.

• A system for monitoring students' progress has been developed to reduce the drop-out rate and identify students at the risk of dropping out.

Areas for improvement and planned development activities

• Further steps need to be taken to increase graduation efficiency and reduce dropout rates (to make the existing systems more efficient; a comprehensive feedback and mentoring system is under development in doctoral studies).

[69] Before 2019, HITSA Moodle was used, which did not meet all the needs of the university.

3.11. RESEARCH AND DEVELOPMENT ACTIVITIES

3.11.1. ORGANISING AND MANAGING R&D

According to the Strategic Plan 2021–2025, the mission of TalTech is to be a leading provider of engineering and economics education, a leader in the engineering sciences and in smart technologies. At the strategic level, research and development activities are organized and managed by the Vice-Rector for Research and the Vice-Rector for Entrepreneurship according to their areas of responsibility.

At the school and department level, the activities in the field of R&D are organised by the Dean (Vice-Dean for Research) and the Head of the Department, respectively. The central academic structural unit at the university is the department, which joins research groups engaged in R&D with a similar profile. University-wide issues related to the management of R&D are processed and decisions are prepared by a permanent 14-member Committee for Research belonging to the university's Senate and serviced by the Research Administration Office.

3.11.1.1. TALTECH AS THE FLAGSHIP OF ESTONIAN ENGINEERING AND IT EDUCATION AND RESEARCH

TalTech, being the only Estonian university, where higher education can be acquired at all levels in the fields of engineering and technology, information technology, economics, natural sciences and maritime affairs, has knowingly chosen its strategic direction and is moving in the direction. The self-positioning of the university's 124 research groups (as at the end 2020) shows that their main areas of activity according to the Frascati Manual are: 1) electrical engineering, electronic engineering, information engineering 2) biological sciences 3) computer and information sciences 4) materials engineering 5) chemical sciences and economics and business (equal number of research groups).

In order to better define the university's profile, the Academic Strategic Plan was adopted in 2019, which sets out the university's strategic R&D areas: 1) smart and energy efficient environments 2) dependable IT solutions 3) valorisation of natural resources 4) future governance 5) innovative SME s and digital economy. The positioning of the research groups by self-analysis shows that their fields of activity coincide with the university's strategic R&D areas and the university's profile at large. TalTech's strengths in basic and applied research are reflected in the R&D directions in a balanced way and the focus of the university's academic strengths is based on the external expectations (valorisation of resources, smart IT solutions, green transition, cyber security, robotisation/automation). In order to promote and substantiate these R&D areas, a coordination committee has been established for each strategic R&D area, the aim of which is to initiate (interdisciplinary) projects, act as an active spokesperson of the university and communicate with internal and external cooperation partners. As the working format of the coordination committees is new, their substantive launch, operating practices and mechanisms of action are still under development.

The sectoral specificity of university's R&D activities is also reflected in the organisation and management: a greater need for investment in equipment and research infrastructure, more active cooperation with entrepreneurs, dialogue with employers and professional associations to prepare required specialists, leading public debate in defining important development needs and R&D choices for Estonia, more active implementation of the principles of an entrepreneurial university (development of spin-off and start-up companies). In 2017, a structural reform was undertaken to make management more flexible and dynamic and better meet the needs of society. Eight faculties were merged into four schools and the Estonian Maritime Academy and more than 60 departments were merged into 20 departments.

Due to its profile and position, the university senses a clear responsibility for the challenge of the twin transitions (to a green and digital economy) which society faces and will pursue these goals both in the narrower sense (e.g. the university's goal to become a climate-neutral university) and the broader sense (conducting the necessary R&D and preparing specialists according to employer´s needs). TalTech is committed to ensuring that the chain, which begins with research, continues with transfer of research results to education and ends with the specialists required for employers, works as efficiently as possible, and so helps to address society's challenges.

3.11.2. HIGH-LEVEL R&D BASED ON THE NEEDS OF SOCIETY

TalTech's Strategic Plan 2021–2025 and its Academic Strategic Plan 2020–2030 both point out that, as a research university, TalTech works towards strengthening its international position, systematically generating new knowledge and contributing to selected focus areas of cutting-edge science and technology. The university considers it important to foster highly international collaboration and publish its research results in internationally recognized, high-impact, scientific journals.

Based on its responsibilities as a research university and in accordance with its strategies, TalTech organises its R&D activities with an aim to meet socio-economic needs and societal challenges. The university considers effective communication of research findings to the general public important in order to make the university's activities better understood by society and increase interest in engineering.

In the regular R&D evaluation carried out in 2017, TalTech was one of the two universities in Estonia (the other was University of Tartu) positively evaluated in all the research areas (natural sciences, engineering and technology, medical and health sciences, agricultural and veterinary sciences, social sciences, humanities and the arts). In the scientific impact category the ratings were either good or very good, in the societal impact of research category however, one field was rated as satisfactory, the others as good or very good (the humanities and arts were rated only as satisfactory but these are not within TalTech's strategic research priorities).

Table 35 shows a selection of indicators used for monitoring the effectiveness of R&D.

Table 35. Selected indicators measuring R&D performance

Indicator	2015	2016	2017	2018	2019	2020	Target 2020
1. Number of research articles[70] per academic staff member with a doctoral degree*. Source: Scopus	0.67	0.67	0.73	0.80	0.87	0.94	1
2. Citations of research articles per academic staff member with a doctoral degree[71]*. Source: Scopus	**20.8**	**25.8**	**28.6**	**30.5**	**33.4**	**35.2**	**23**
3. Number of scientific publications per academic position. Source: ETIS	1.35	1.28	1.20	1.23	1.31	1.65	N/A
4. Share of international co-authored research publications (%) (TalTech). Source: Scopus	46.5	50.3	52.2	59.2	62.5	65.7	N/A
DTU**	56.5	60.7	60.3	63.6	64.1	68.8	N/A
Aalto**	55.3	59.6	59.9	61.8	64	67.3	N/A
Chalmers**	54.2	55.6	58.3	59.2	62.3	62.1	N/A
5. Average number of citations received per a journal article (TalTech)[72]	6.1	6.3	7.4	5.7	5.8	6.3	N/A
DTU**	10.3	10.6	11.0	12.0	12.1	12.2	N/A
Aalto**	8.0	8.4	9.4	10.5	10.8	12.2	N/A
Chalmers**	9.0	9.5	10.3	10.8	11.3	11.8	N/A
6. Share of articles published in Q1 journals out of the total number of articles published in the respective year (%) (TalTech)[73]	46.9	46.4	53.2	49	53.7	55.3	N/A
DTU**	82.8	84.5	81.1	81.3	83.3	83	N/A
Aalto**	76	80.6	74.9	77.9	77.9	78.9	N/A
Chalmers**	76.6	81.8	78.8	78.9	78.5	80.7	N/A
7. Revenue from R&D business agreements (million euros)*	**5.6**	**5.1**	**5.4**	**7.1**	**10.6**	**11.0**	**7.5**
8. Revenue from R&D project agreements (million euros)*	**6.8**	**15.3**	**16.7**	**16.8**	**17.4**	**18.4**	**17.4**
9. Number of patents granted (owned or co-owned by TalTech)	3	9	9	10	3	10	N/A
10. Number of spin-off companies	13	13	13	14	16	14	N/A
11. Success rate in H2020 proposals (%)	5.0	17.3	5.8	17.1	16.1	9.5	N/A

* A selection of RD indicators set out in the Management's Action Plan until 2020.

** TalTech's reference universities

TalTech's total revenue from research and development, amounting to 47.3 million euros in 2020, has increased by 28.5% compared to 2015 (36.8 million euros). This shows research groups improving success with applications for research funding from national and international support measures and in carrying out R&D and innovation-intensive cooperation with companies and the public sector in Estonia and abroad. The success rate in EU Horizon 2020 proposals in 2020 has decreased but one reason for this decline could be the end of the framework programme with an overall increase in the total number of proposals submitted Europe wide and the specificity of many of the later calls.

The increase in research funding is due to active participation in various funding programmes, including EU structural funds, research grants financed from the Estonian state budget, the EU Horizon 2020 programme, various Interreg cross-border cooperation programs (Estonia-Russia, Central Baltic, Estonia-Latvia and the Baltic Sea Region Programme), and regional support schemes (NordForsk, Baltic Research Cooperation Programme). TalTech participates in all pillars of the Horizon 2020 programme and in many of its partnerships. The Estonian Research Council is responsible for managing the Estonian Research Infrastructures Roadmap which is a list containing nationally important research infrastructure units. At the moment the list includes 17 research infrastructures and TalTech is involved in 11 units including the two infrastructures (Naval Architecture and Hydrodynamics Infrastructure and Smart Industry Centre) where TalTech is the leading partner. In

[70] Articles in scientific journals in respective year

[71] Total number of citations of articles in scientific journals in the last five years per academic staff with doctoral degrees in respective year

[72] The total number of citations received by the articles published in the reporting year and four previous years is considered relative to the total number of articles published in the same period. Source: Scopus

[73] The share of articles published in Q1 journals out of the total number of articles published in the respective year. The SJR (SCImago Journal Rank) indicator, normalized by the subject field, has been used to ensure comparability of the university data. Source: Scopus's SciVal Benchmarking module.

addition, the university participates in international research infrastructures like Nordic e-Infrastructure Collaboration, European Molecular Biology Laboratory, European Organization for Nuclear Research and others. The university is a coordinator of 23% of the Horizon 2020 projects it participates in. During the period 2014–2020, TalTech participated in 74 projects with a total grant financing of 35.89 million euros to TalTech[74]. This constitutes an increase of more than 200% compared to the FP7 programme for which the total amount of Taltech's grants was 11.73 million euros.[75]

In Horizon 2020, the university has received one ERC grant, one Teaming project (the FinEst Twins Smart City Center of Excellence), three ERA Chair projects and four Twinning projects. A further objective is to be more successful in applying grants that support research excellence (e.g. ERC) and to coordinate more consortia in order to build R&D capabilities and gain management/leadership experience in international R&D.

In addition to the main funding programmes mentioned already, the university's research groups seek other international funding opportunites and collaborations to diversify their financial sources and mitigate risks. Some examples of the latter include the NATO SPS Programme, the European Space Agency, Pitt Hopkins Research Foundation, Folke Bernadotte Academy and others not so commonly or widely used instruments.

On the other hand, a significant share of competitive R&D funding poses a certain risk to the stability and sustainability of research groups, e.g. a decrease in the European Union's structural funding may also cause a decrease in R&D revenue.

In order to support the strategic R&D areas and other projects, discussions have started at the Rectorate level about developing a grant fund to bring more stability to the highly competitive R&D projects landscape (e.g. to provide some additional funding to researchers whose project proposals have received high scores but were not funded by national or international programs).

3.11.2.1. R&D SUPPORT SYSTEMS

In order for R&D results to be better and more visible and so that researchers can focus on their main tasks, TalTech has been developing its system of support services. In the middle of 2016, a new Project Accounting and Reporting Division was established under the Finance Office, the aim of which is to improve the quality of financial reports of projects and provide various types of financial assistance to project staff.

In 2018, the new Rules for Project Administration and accompanying guidelines were adopted, which clarify the stages of applying for, initiating, implementing and auditing R&D projects, the accompanying responsibilities (e.g. procurement, filling in time sheets) and division of roles (the project manager, the project coordinator and the person responsible for preparing financial statements).

From the beginning of 2020, a team of project proposal writers has been working in the Research Administration Office to improve application success rates and thereby increase the budget revenue from competitive project grants. It is planned to establish a grant accelerator, the aim of which is to support junior researchers in preparing grant applications by mentoring, providing them with training and personal support services.

In 2020, TalTech launched a major project for administration of R&D projects, the aim of which is to make the initiation and implementation of R&D projects more systematic, ensure compliance with internal and external regulations and introduce software to support the whole process. An important part of this reorganisation is to separate the roles of principal investigator and project manager/administrator.

The supply of funding opportunities for researchers is constantly being improved; the funding opportunities database Research Professional has been available to all since the beginning of 2021.

In 2021, the capacity of the project proposals writing team has been expanded by hiring new people, a new project management software will be tested and introduced, data management guidelines and a tool for creating data management plans was developed. The data management guidelines and the tool will provide a clearer framework for the FAIR principles (in particular, in terms of the conditions of project funding) and helps the university implement central support processes that allow researchers to better collect, store and provide ongoing access to scientific data.

3.11.3. RESPONDING TO THE NEEDS OF SOCIETY AND COOPERATION WITH PARTNERS

National and international partnerships and cooperation with the public, private and third sectors is a strategic priority of the university. TalTech has institutional cooperation agreements with 17 institutions, such as ABB AS, Utilitas AS, Eesti Pank, Starship Technologies OÜ, the North Estonia Medical Centre and the city of Tallinn. A framework agreement with SKELETON Technologies OÜ and FLIR Systems Estonia OÜ is under preparation.

In the period 2016–2020, the university has had 216 different local business partners (agreements concluded with companies). Looking at the profile of these companies, the university has been most engaged with construction and building materials companies (30), followed by information and communication companies (16), consulting companies (14) and companies in the education and research sector (14). The university has also worked with 32 international business partners in the same period.

Since the start of the SARS-CoV-2 pandemic, the university has been able to respond quickly to the new needs of society. TalTech's projects received 38% of the target grants from the Estonian Research Council aimed at solving problems caused by the SARS-CoV-2. TalTech submitted 31 proposals for the Horizon 2020-funded European Green Deal Call that ended in January 2021, which forms 31.2% of the total average number of proposals submitted under Horizon 2020 in the last three years (2018–2020)[76]. This also shows that the university responds flexibly to opportunities that open up and is seeking to contribute to the goals of the green transition.

[74] See Horizion 2020 Dashboard (as of 20 May 2021)

[75] See FP7 Projects

[76] In 2018, the total of 82, in 2019 the total of 88, in 2020 the total of 128 proposals were submitted by the university under Horizon 2020. The three-year total average number of proposals was 99.3 (82 + 88 + 128/3). In January 2021, 31 proposals were submitted, i.e. 31.2% of the total average number of proposals submitted under Horizon 2020 during the last three years (2018–2020). (31/99,3*100).

Entrepreneurial partnerships and the necessary support services are developed and provided by the newly created Technology Transfer Office and the Innovation and Business Centre Mektory (see also Chapter 3.12).

In general, cooperation with stakeholders can be divided into four areas:

a) **promotion activities and development of a general RDI framework** that includes TalTech's promotional events, collaboration and providing input to help private and public sector partners to find better outcomes for R&D solutions and plans, improve relevant ecosystems, disseminate good practices, present success stories and develop and popularise an RDI-oriented mindset. For example, TalTech participated in the preparation of the Estonian Research, Development, Innovation and Entrepreneurship Strategy for 2021-2035, plans and implements joint activities with Tehnopol, Startup Estonia and Enterprise Estonia (EAS), introduces university competencies/laboratories to entrepreneurs, organises lecture series for entrepreneurs; TalTech researchers are members of national (e.g. the national Innovation Policy Committee[77], Praxis Centre for Policy Studies[78]) and international representative/advisory bodies (the Group of Chief Scientific Advisors of the European Commission[79], the partnership EIT RawMaterials[80]).

b) **business cooperation**
Table 35 shows that the volume of business contracts has increased significantly (96.4%) since 2015, reaching 11 million euros in 2020. The average value of business contracts in 2020 was 72,674 euros, while the average duration of contracts concluded in the same year was about four months. A challenge facing the university is to seek to conclude high-value R&D framework agreements in order to secure more strategic co-operation relations with business partners. The share of contracts financed by foreign partners is about 6%, and in future more attention will be paid to cooperation with international companies. This will create better opportunities for integration into international value chains, through which the university can contribute to the export of services and products with higher added value. At the same time, the university shall continue to strengthen its relationships with key local partners, as our ten largest business partners currently provide some 27% of total business revenue.

TalTech has actively participated in measures that support the research and development needed for business and therefore also benefit the economy. For example, the smart specialization support measure, under which entrepreneurs can request the necessary applied research and product development from R&D institutions in defined smart specialisation growth areas. Under this support measure, TalTech has concluded cooperation agreements with entrepreneurs to the amount of 12.91 million euros (see Figure 22).

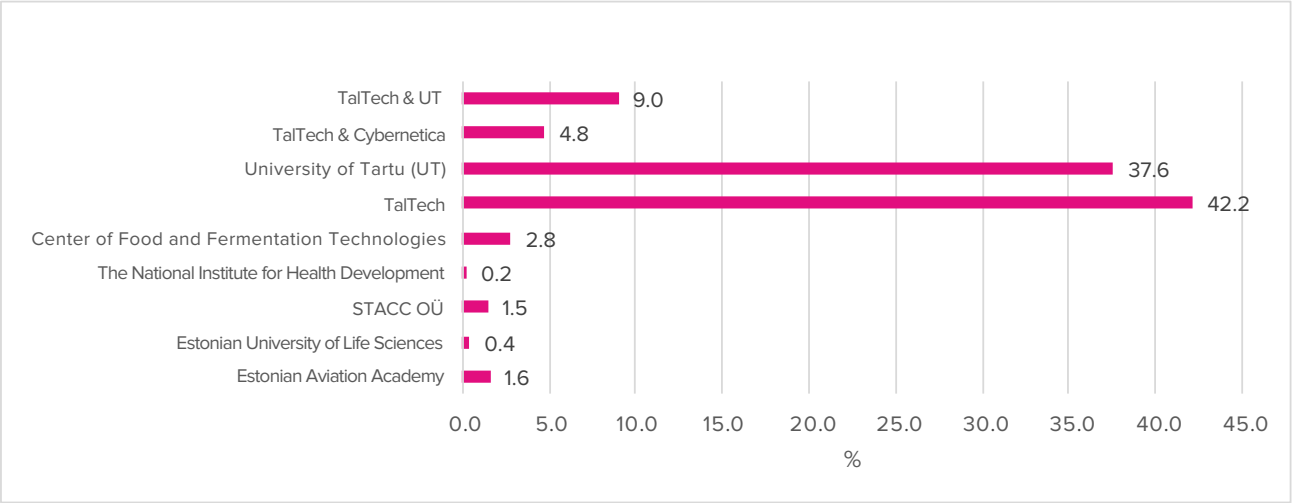


Figure 22. Share (%) of the value of business contracts concluded under the applied research support measure "Nutikas" out of all the contracts concluded with R&D institutions (as of 01.02.2021)

In addition to the smart specialization support measure, the university is actively contributing to the first round of a programme which aims at creating higher added value for the Estonian wood, food and mineral resources industries (ResTA). The funding for this programme was about 10 million euros and TalTech's share of this was 36.6%.

There are four business cooperation coordinators working in the Technology Transfer Office and nine business development specialists (eight in departments and one in the Estonian Maritime Academy), who help companies to find cooperation opportunities with the research groups and contribute to promoting business cooperation more generally.

In order to improve cooperation in future, it should be considered how to better communicate the university's value proposition and meet the specific needs of entrepreneurs, for example in conducting applied research.

c) **knowledge and technology transfer**
As the absorptive capacity of R&D of local companies is low, the development of knowledge and technology transfer capabilities must be addressed more actively. The further development and improvement of the respective service or competence was also in focus in 2019, when cooperation between the employees of the Mektory Technology Transfer Office and the university's business development specialists intensified significantly and plans were made to strengthen and expand the customer portfolio.

[77] Erkki Karo, Head of the Ragnar Nurkse Department of Innovation and Governance, Innovation Committee, member

[78] Tiina Randma-Liiv, Vice-Dean for Research of the School of Business and Governance, Praxis Centre for Policy Studies, Supervisory Board Member

[79] Maarja Kruusmaa, the Group of Chief Scientific Advisors of the European Commission, member

[80] Michael William Hitch, partnership EIT RawMaterials, Executive Board Member

In parallel to this, discussions have taken place about TalTech's IP commercialization policy and about possible models for the creation and financing of university's spin-offs. In the context of the Strategic Plan 2021–2025, the university's support to spin-offs will become increasingly important in order to contribute more to the commercialization of research results. Knowledge and technology transfer are also supported by an industrial doctorate offer, the focal point of which is to create a place for doctoral studies at the university for a researcher or engineer employed by a company (and whose work includes significant research and development work). TalTech was the first Estonian university to launch an industrial doctorate in 2016/2017. Between then and 2020, a total of 54 industrial doctoral students have been admitted.

d) **promoting TalTech's focus areas**
At the end of 2019, the Smart City Center of Excellence (the first Teaming project that Estonia is involved in) started its activity under the leadership of TalTech with a 32 million euro launch budget, focussing on smart and sustainable interaction of five domains (data, governance, transportation, energy and built environment/architecture).

TalTech is the leading partner in establishing the European Digital Innovation Hub in Estonia, EDIH[81]. The aim of the hub is to increase the competitiveness of the Estonian economy and industry in companies and the public sector by supporting the development/implementation/ introduction of artificial intelligence and robotics technologies. The focus is on industry and the circular economy. It is planned to establish at least one EDIH in each country, and in Estonia it will be coordinated by TalTech.

Under TalTech leadership, the idea of establishing an Academy of Engineering has been proposed, and consultations are currently underway. This academy would promote the engineering industry and engineering education, contribute to the green and digital transition and promote long-term economic growth.

TalTech plans to contribute to measures under the Just Transition Fund (JTF) (which will launch soon) as the transition mainly affects Ida-Virumaa, where TalTech Virumaa College is located and where there are companies, whose fields of current or potential future activities are closely related to the research interests of the university (e.g. CO_2 capture, (renewable) energy production, circular economy, chemistry, cyber security, big data, robotisation, hydrogen production). The university has already set up a steering committee for the JTF measures and activities and prepared a vision document describing TalTech's contribution and actions in Ida-Virumaa.

3.11.4. INTRODUCING RESEARCH RESULTS TO STUDENTS

One of the goals of the university's Strategic Plan is to improve the incorporation of an evidence-based mindset into teaching practices. One indicator of evidence-based teaching is the participation of research group members in teaching activities: in the academic year 2019/2020, 58% of the of research group members (excluding doctoral studies) participated in teaching, showing that links between research and teaching can and should be enhanced.

Although there are differences between fields and programmes, top researchers and academic staff with doctoral degrees do need to be more involved in teaching. A definitive target will be set for each study level specifying the compulsory contribution of teaching staff with a doctoral degree to teaching. In this way, scientific achievements can be better introduced to students and students can become more involved in ongoing R&D projects.

RD activities are becoming increasingly mission-based (e.g. the five mission areas of the Horizon Europe programme) and interdisciplinary, as a result of which various problem-based projects have been launched at TalTech, where ambitious societal challenges are addressed in collaboration between researchers and students. Some noteworthy examples include the self-driving car Iseauto, Student Satellites and Formula Student. This contributes to making the whole learning process more interactive, engineering-oriented and fosters an entrepreneurial spirit that ultimately popularises a research career. Promoting problem-based and project-based learning is one of the university's major goals for the next five years. Our new membership of the EuroTeQ network, through which we can develop international joint projects (see also Chapter 3.5) also contributes to this.

Mektory with its labs and meeting rooms and opportunities for (international) interdisciplinary cooperation (see also Chapter 3.12) also contributes to joint activities between the teaching staff and students. TalTech also has a modern research infrastructure that supports R&D: as of 2019, the university had 74 laboratories, of which 11 are accredited, three laboratories plan to expand their scope of accreditation and two new laboratories are planned to be accredited. Discussions are being held on how to ensure the optimal use of laboratories for both research and teaching, and how to organize their use in collaboration with stakeholders outside the university in order to gain maximum benefits from research infrastructure use. These problems are addressed in the TalTech Development Programme 2016–2022 launched under the ASTRA programme.

As several types of grants (e.g. research funding through the Estonian Research Council) allow scholarships to be paid for students' work on a project, students are also involved in the implementation of various grants as research staff. The involvement of a student can be organized in different ways, e.g whether the supervisor/ researcher talks directly to his/her student(s) or introduces possibilities of participation in project activities during his/her courses.

Students can also get information about research projects carried out at the university from the information channels of the university and schools (websites, social media) and the Estonian Research Information System, ETIS. In addition students can contact an employee of a structural unit, a teacher or supervisor. In 2019, TalTech had 9 ongoing team grant projects funded by the Estonian Research Council, in which a total of 33 students from bachelor's, master's and integrated studies participated. The involvement of doctoral students in research is governed by TalTech´s Good Practice of Doctoral Study. Most PhD students are involved as research staff in various university projects or conduct research at their employer in a field directly related to their doctoral thesis.

[81] funded from the Digital Europe Programme and the Structural Funds

SUMMARY OF STRENGTHS AND AREAS FOR IMPROVEMENT

Strengths

• The clearly defined R&D priorities (focus areas) and areas of intervention, as described in the university's Strategic Plan, are designed to meet the societal challenges of the years ahead.

• A functioning partnership and cooperation network involving entrepreneurs (which is reflected in the number and value of business agreements, cooperation agreements) and other partners, supported by, inter alia, the activities of the Technology Transfer Office and the Innovation and Business Centre Mektory.

• Revenue from national and international R&D project agreements forms a significant part of total R&D revenue and demonstrates the success of our research groups in applying for competitive grants.

• The university's modern R&D infrastructure (laboratories, equipment) makes it possible to offer it as an active service to internal and external customers and to promote problem-based and project-based learning.

Areas for improvement and planned development activities

• To better organise the project management process and improve support services to provide support throughout the process from developing the proposals to preparing the final project reports, thereby strengthening the capacity to apply for and implement R&D projects and diversify the portfolio of financing sources.

• To be more active in transferring research knowledge to the business sector, develop more strategic partnerships with enterprises (framework agreements, organisation of applied research) and better integrate into international value chains.

• To launch substantive action by the coordination committees which will promote defined R&D directions (management models, goal setting, initiation of joint projects, financing).

• To define more clearly the expectations of, and goals for the management (e.g. tenured professors) and the research group activities, so as to increase the number of publications, in particular in high-level (Q1) scientific journals, and to ensure the competitiveness and sustainability of the research groups.

3.12. SERVICE TO SOCIETY

The overall goal of the TalTech's Strategic Plan 2021–2025 is to contribute to society through research, education and innovation. Therefore, the university initiates development activities, which enhance prosperity in the community, and disseminates recent know-how in the field of engineering and economics through degree studies, continuing education, research and advisory services, and in cooperation with all the university's stakeholders.

3.12.1. PUBLIC ENGAGEMENT

TalTech provides opportunities to enhance awareness, prosperity and solidarity by carrying out activities and by sharing its knowledge and infrastructure – TalTech is open to society. The university provides more than 20 services (incl. trainings and technology camps) for various target groups (from schoolchildren to elderly people): the library, the museum, the bookbindery, sporting facilities, concerts, exhibitions, alumni events (see Sub-chapter 3.12.2), Mektory, the Smart City Center of Excellence (see Chapter 3.11), events and courses organised for schoolchildren and young technology enthusiasts (see Sub-chapter 3.12.3), accommodation services, rental of rooms for conferences and seminars, etc. Partners from outside the university (e.g. schools and companies) often use the assembly hall of the university to celebrate their events. The impact of research and development on society is analysed in Chapter 3.11.

TalTech researchers contribute to the national policy-making process with applied research (e.g. evaluation of the smart specialisation strategy for the Ministry of Economic Affairs and Communications in 2019). The university's involvement in the media in its focus areas helps to make TalTech's contribution visible to society and provides an opportunity to find new possibilities for and innovative forms of cooperation. In comparison with the largest universities in Estonia, TalTech is the spokesperson in the fields of technology, engineering, space, IT and research development with enterprises in Estonian media. The university's objective is to maintain and increase the role of a spokesperson in these fields, as well as to have a greater say in the field of medicine, health and natural and formal sciences, where rapid technological developments are taking place. The ambition of TalTech is to introduce important focus topics in international media, primarily through international cooperation projects (e.g. EuroTeQ).

The TalTech Library, the only public central library of technology in Estonia, provides its services to members of the university as well as to the public, and makes an essential contribution to the development of the community. In 2021, the library had 33,000 registered readers, from whom 58% were from outside the university. Educational exhibitions are regularly organized in TalTech's open areas[82]. The library has more than 160,000 visitors a year (see Chapter 3.10).

In addition, the university contributes to charity initiatives. Voluntary activities and knowledge sharing on important topics are encouraged. For example, TalTech has participated in projects increasing awareness on anti-corruption, has cooperated with the Estonian Food Bank and has brought science teachers together to help schoolchildren to catch up in distance learning (the Reaalabi initiative), etc.

In order to develop cooperation between the university and companies, the Innovation and Business Centre MEKTORY[83] was established in 2013, the activities of which help to develop business-oriented partnerships and provide the necessary support for that (see also Chapter 3.11). In order to fulfil Mektory's goals, in cooperation with companies and embassies, 25 seminar and meeting rooms, prototyping laboratories and cooperation areas, workspaces for start-ups and innovative projects, and a conference hall have been built totaling 4,300 m^2. In 2018, the TalTech simulation-demo centre was built to present TalTech's competencies and prototypes. In normal times, more than 50,000 people visit Mektory each year. More than a hundred companies, organisations and embassies have participated in the development of Mektory. Also, Mektory has a role as the TalTech Conference Centre, providing full science and business conference service. TalTech Conference Centre is a member of the Estonian Convention Bureau and received the Most Innovative Conference award in 2019. Every year, Mektory organises up to 1,000 trainings, seminars and conferences for companies and more than 1,000 events for students[84]. Public events bring the university closer to society – at conferences and seminars, TalTech researchers introduce their latest scientific achievements, thereby involving both entrepreneurs and citizens. For example, Robotex, the biggest robotics festival in the Nordic countries and Estonia was initiated by TalTech. The university also actively participates in the annual Researchers' Night Festival, which aims to popularise science among children and adults. Within the framework of the festival, workshops and seminars are organised both in general education schools and in TalTech. In cooperation with the Tallinn City Enterprise Department free lecture series are organised for emerging entrepreneurs.

Since 2015, Tallinn University of Technology has also been actively participating in the ADAPTER network, which brings together researchers and companies. Every year, the ADAPTER network organises a cooperation festival for companies, where research activities and achievements of universities are introduced. In 2015 and 2017, TalTech was the main organiser of the festival.

In 2020, in the framework of the TalTechDigital initiative the XR Centre specialised in the technologies of virtual and augmented reality was established, which provides services for schoolchildren, students, teaching staff, researchers, units of the university and companies[85]. In the Researchers' Night Festival various free workshops were provided for those interested in the field of extended reality.

[82] For example, in the building of the School of Business and Governance, in the library gallery, in the museum of the university.

[83] "Modern Estonian Knowledge Transfer Organisation for You".

[84] To date, more than 20 conferences have been organised, including 9 international scientific conferences. For example, the international conference Manufuture with more than 600 participants took place in 2017 and the university's Vision Conference was held in 2018 in the framework of TalTech's 100th anniversary. In 2021, it is planned to organise 5 virtual scientific conferences, e.g. Cold Climate HVAC & Energy 2021, Modern Materials and Manufacturing 2021, Baltic Polymer Symposium 2021, the main organiser of which is TalTech.

[85] Courses, workshops, advisory services and solutions for enterprises in the field of XR. For example, under the leadership of the XR Center, an augmented reality application for Swedbank was developed in 2020 as a student project.

TalTech actively contributes to high-level cultural and sports activities. The activities of organized cultural and sports groups are managed by the Cultural Centre of Tallinn University of Technology and the Sports Club of Tallinn University of Technology. The cultural activity follows the strategy approved in 2020. The university has six high-level cultural groups[86] that take actively part in dance and song festivals and have received national and international awards (e.g. Ullo Toom Folk Dance Scholarship 2020 – the highest award in Estonian folk dance, a gold diploma in the Kaunas Lituania Cantat Festival and 3rd place in Grand Prix). Major creative projects have been implemented, such as the rock opera "Four Drops of Digital" (2018), "Inventors' Song Festival" (2019).

TalTech Sports Club offers sporting opportunities for students, employees and alumni on favourable terms. Students can attend the optional course Basics of Physical Movement. The number of members of the Sports Club increased by approximately 68% in the years 2016–2020. The representative teams of TalTech ball games (both men's basketball and women's and men's volleyball) play at the highest level of the Estonian Championship and in the Baltic League. The representative table tennis team plays in the strongest league of the Estonian Championship. The university contributes to society by offering flexible opportunities to combine a sports career and studies[87] and by organizing public sports events (e.g. TalTech Training Day, TalTech relay race).

3.12.2. STAKEHOLDER ENGAGEMENT

3.12.2.1. ALUMNI ARE TALTECH'S QUALITY LABEL

One indicator of the university's success is its alumni. The university's alumni related objectives are set out in the university's Strategic Plan 2021–2025, according to which alumni are important partners of the university, whom the university should involve more in its activities. As of 2020, TalTech had a total of 74,709 alumni (of whom 2,489 were international alumni). In recent years, the average salary of TalTech graduates has been 20–23% higher than the average salary of graduates from the other Estonian higher education institutions (see Figure 19).

In order to better organise the cooperation between the university and the alumni, the Alumni Association of Tallinn University of Technology and the foundation Development Fund of Tallinn University of Technology have been established. Cooperation with alumni is coordinated by Mektory. Usually, 6–7 annual major events are organised for alumni (see Annex 4). The number of active alumni has grown steadily. Alumni are actively involved in the development of study programmes through programme advisory boards to ensure that studies are in line with the needs of the labour market (see also Chapter 3.7). Alumni also make a significant contribution to the scholarship fund of the Development Fund[88] (see also Chapter 3.10). In the coming years, it is planned to further increase the involvement of alumni through their participation in various university bodies and working groups (as members of the programme advisory boards, guest lecturers, sponsors, internship supervisors, members of theses defence committees, organising study visits in their companies, as spokespersons, etc.). The possibilities of the alumni network will be continuously expanded, so that alumni can communicate more in their field of specialization on social media channels, find former fellow students establish connections for research and carry out business cooperation.

3.12.2.2. EMPLOYEE PARTICIPATION

The Strategic Plan of TalTech 2020 set a goal to enhance cooperation with companies and the public sector, which has been brought even more into focus in the new Strategic Plan 2021–2025: TalTech's goal is to be the engine of economic development in Estonia and increase the university's influence in society both in Estonia and internationally. TalTech's researchers participate actively in shaping various development policies and are involved in the preparation of several sectoral strategies, policies and legislation. For example, TalTech's professor Tarmo Soomere is President of the Estonian Academy of Sciences and advises the Government of the Republic and helps to shape the state's research and development actions, business, innovation and education policy. Professor Maarja Grossberg is the President of the Estonian Young Academy of Sciences. The Rector Tiit Land is a member of the University Board of Stockholm University. The Vice-Rector for Research Maarja Kruusmaa is the first Estonian to be elected as one of seven members of the Group of Chief Scientific Advisors of the European Commission to advise the top leaders of the European Union. In addition, TalTech representatives participate in the following national decision-making and advisory bodies of research and education: the Government's Expert Panel of Economic Recovery; the National Research and Development Council; the Research Policy Committee; the Innovation Policy Committee; the Expert Council of Scientific Collections; the National Research Awards Committee; the assessment councils of the Estonian Research Council (ETAG) and the EKKA; the expert panels of evaluation of applications for development and target grants and support for research infrastructures of national importance in the field of natural sciences, engineering and technology, medical and health sciences, agricultural and veterinary sciences, social sciences.

TalTech researchers are actively involved in the management of various state-owned companies, NGOs and foundations as members of the supervisory board (e.g. central bank Eesti Pank, Eesti Post AS, Eesti Energia AS, Foundation Tallinn Science Park Tehnopol, STACC OÜ, ELIKO OÜ). The researchers of Tallinn University of Technology participate basically in all professional associations and unions in the fields of activity of the university, contributing to the preparation of requirements for professional qualifications, defining of sectoral competencies as well as the assessment of professional skills of applicants for professional qualification certification (see Table 36).

[86] The Academic Male Choir of Tallinn University of Technology, the Academic Female Choir of Tallinn University of Technology, the Engineers' Male Choir, the folk-dance group Kuljus, the Chamber Choir of Tallinn University of Technology, the Brass Band of Tallinn University of Technology.

[87] Every academic year, TalTech admits 10 persons who have achieved outstanding results in sports and who meet the general admission requirements, offering them an opportunity to participate in studies on a part-time basis free of charge.

[88] The purpose of the Development Fund is to collect and mediate grants to Tallinn University of Technology and to involve Estonian entrepreneurs in cooperation with the University of Technology.

Table 36. A selection of professional and trade unions and associations where TalTech employees are involved as members

Type of the association	Professional and trade unions and associations
Professional associations	The Federation of Estonian Engineering Industry, Estonian Association of Information Technology and Telecommunications, Estonian Taxpayers Association, Estonian Association of Engineers, Saaremaa Entrepreneurs Association, the Estonian Association of Electrical Enterprises, the Estonian Clothing and Textile Association, the Estonian Chemical Industry Association, the Estonian Asphalt Pavement Association, the Estonian Shipowners Association, the Association of Estonian Adult Educators Andras, the Estonian Lawyers Union, the Estonian Furniture Industry Association, the Estonian Association of Real Estate Maintenance, the Association of Estonian Tourism Education, Estonian Association of Mining Enterprises, etc.
Unions, associations, societies	FinanceEstonia, Robotex, Estonian Information Security Association, Estonian Union of History and Philosophy of Science, Estonian Association for Quality, Tallinn House of Scientists, Estonian Society of Moritz Hermann Jacobi, Estonian Human Resource Management Association PARE, PROLOG – Estonian Supply Chain Association, Estonian Librarians Association, the Concrete Association of Estonia, the Estonian Convention Bureau, Estonian Design Centre, Association of Mechatronics, Estonian Aviaton Cluster, etc.
Chambers of Commerce	The Estonian Chamber of Commerce and Industry, the British-Estonian Chamber of Commerce, the American Chamber of Commerce Estonia
Representative organisations	The Estonian Employers' Confederation, World Energy Council Estonia

TalTech values the contribution of academic staff to society through professional, research and educational activities, as well as activities and recognitions addressed to the public. Public engagement is assessed based on the Academic Evaluation Matrix annexed to the Regulation on Academic Career Management, which sets out expectations for the performance of academic staff depending on their position and which is used as a basis for both the attestation and recruitment of academic staff. Upon evaluating the public engagement of academic staff members, their successful experience in their field of specialisation in an enterprise or in the public sector, participation in the work of professional and trade associations, participation in the development of national research and education policies, participation in expert panels and assessment councils and management of international conferences, research organisations or editing of scientific journals is taken into account. In addition, employees who guide the development processes of society as opinion leaders, being influential spokespersons in both national and international media and at the events of research or business organisations, are highly valued.[89]

3.12.3. CONTINUING EDUCATION AND OTHER LIFELONG LEARNING ACTIVITIES

TalTech organises continuing education and educational activities for school students in compliance with the university's Strategic Plan 2021–2025, Estonian Lifelong Learning Strategy 2020, the Adult Education Act and the Continuing Education Standard. Continuing education and educational activities for school students are coordinated by the TalTech's Open University. The Schools also offer continuing education based on their area of specialisation. The goal is to bring, by 2023, all lifelong education activities in line with the common quality standard under preparation; the process is supported by the developments of the continuing education information system TÕIS. Discussions held with EKKA regarding evaluation of the quality of continuing education at the national level continue.

The principles of continuing education at the university are set out in the Continuing Education Regulations. TalTech conducts continuing education in almost all fields of education set out in the International Standard Classification of Education (ISCED). The effectiveness of lifelong education is monitored by the Rectorate and the Vice-Rector for Academic Affairs. Continuing education indicators are presented in Table 37.

Table 37. Participation in lifelong learning offered by TalTech 2016-2020. Source: TalTech Open University

Key indicators	2016	2017	2018	2019	2020
Participants in continuing education, total	14,066	13,767	14,262	16,357	15,628
Incl. open study students*	3,749	3,584	2,710	2,209	1,749
Incl. school students**	2,058	2,126	2,525	2,659	2,397
Number of study programmes	407	378	432	439	385
Number of courses	759	841	832	801	714
Participants in school students workshops	3,731	3,057	3,096	3,767	703
Continuing education academic hours, total	35,510	32,613	33,916	31,806	29,448
Open study ECTS, total***	39,965	35,908	28,096	24,311	20,609

Notes: * - incl. degree level students in open study; ** - preparatory school center and technology school students; workshops for school students; *** - number of ECTS decreased after the study programmes reform in 2017

[89] For example, Head of the Estonian Centre of Engineering Pedagogy Tiia Rüütmann received the Adolf Melezinek Meritorious Service Award. TalTech's Professor of Energy Technology Alar Konist received the President's Young Scientist Award 2020.

The number of participants in continuing education courses has increased in recent years (except for the decrease due to SARS-CoV-2 pandemic in 2020). The goal is to reach 18,000 continuing education participants, incl. 3,000 open study students, per year in 2025. The number of open study students decreased after the study programmes reform in 2017 and changes made to organisation of studies; the aim is to increase the number of open study students.

The number of study programmes and courses has remained stable, there are no plans to increase the number significantly. In 2020, the biggest number of adult learners participated in the courses in the fields of information and communication technology (44%), engineering (19%) and economics (10%) (see Figure 23). In the coming years, more attention will be paid to the satisfaction of adult learners with the courses completed.

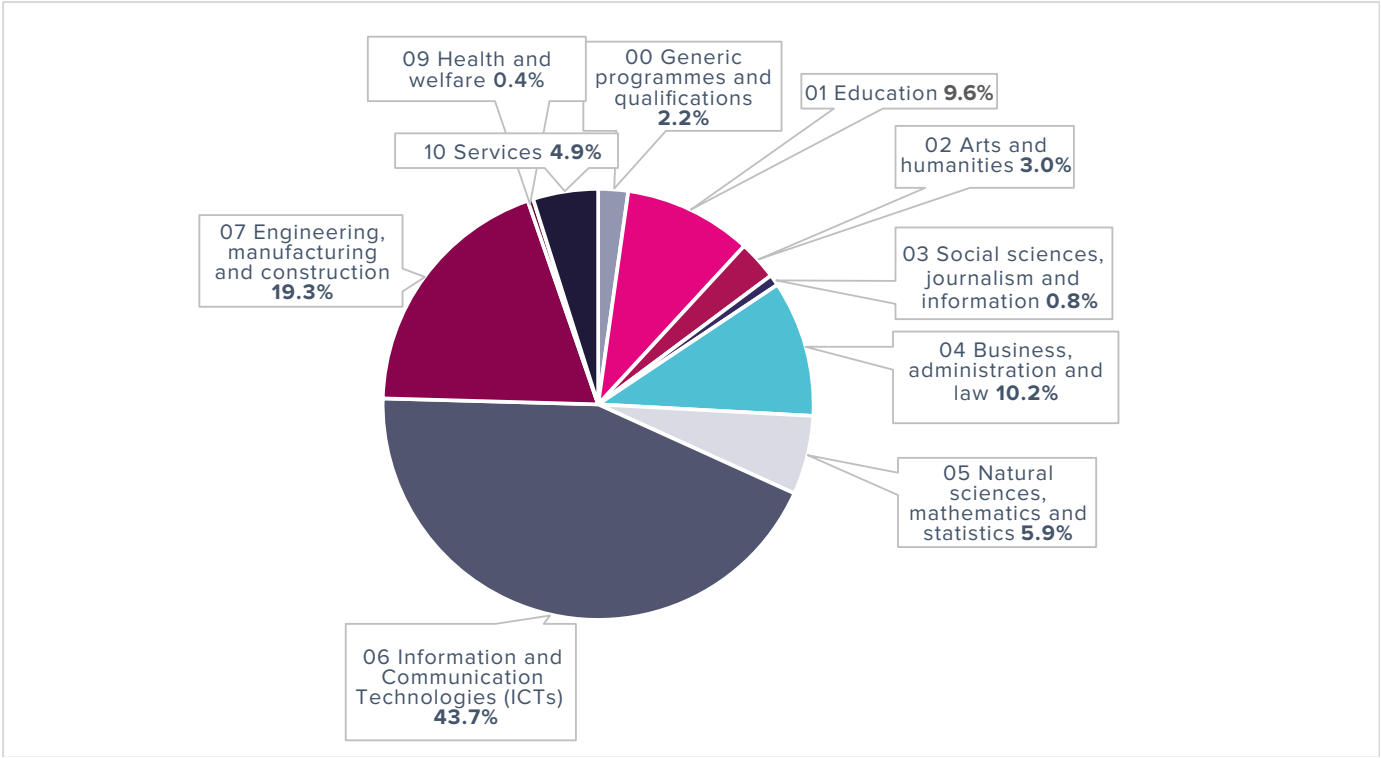


Figure 23. Adult learners participation in continuing education by fields of education (ISCED 2013), 2020. Source: TalTech Open University

3.12.3.1. NEW FORMS OF CONTINUING EDUCATION

One of the goals of the university's Strategic Plan 2021–2025 is to introduce new forms of continuing education and lifelong learning based on the learners' and labour market needs. The implementation plan of the Strategic Plan has laid down the indicators stemming from the objectives of the Strategic Plan. At the beginning of 2021, most continuing education courses were transferred online and new e-learning opportunities were created, including for school students.

Interest in the courses for development of digital skills, cyber security, intellectual property and other similar courses has increased. The Open University has developed a comprehensive online course "Digital Wisdom", which has been attended by both people from outside the university and TalTech employees. Under other major training agreements, continuing education is organised for managers and employees of the North Estonia Medical Centre (PERH) and information security training is provided under an order of the Information System Authority to the key personnel of the state agencies. However, only a small portion of TalTech teaching staff is participating as Open University lecturers. The number of teaching staff is planned to be increased by recognising their participation in continuing education in the academic career model. Courses in the field of civil engineering comply with the 7th-8th level occupational qualification standard according to the European Qualifications Framework (EQF). The Tartu and Virumaa Colleges of TalTech and the Centre for Blue Economy of the Estonian Maritime Academy in Kuressaare also offer opportunities for renewing one's qualifications.

The Open University has increased the volume of international projects carried out through EIT Digital summer schools, mainly for students from Spain, Italy, France, Belgium, Sweden and Finland. In addition, courses have been provided to students from the USA, China, Japan in the field of e-government, cyber security, robotics and 3D printing. In 2020, two EIT Digital summer schools took place in the form of e-learning for the total of 71 participants.

Courses for school students enhance knowledge in formal sciences and natural sciences and raise interest in degree studies at Tallinn University of Technology. TalTech's School of Technology involves also primary school children in technology cir-

cles and courses. The total of 22% of the students who have attended courses for schoolchildren have later come to study at TalTech. New technology courses, such as the Young Engineer Programme, aim to increase the share of entrants to 40%. In 2021 and 2022, TalTech will start cooperation with state gymnasiums by offering them elective courses in the formal school programme. The School of Exams and Olympiads prepares students for subject proficiency olympiads and organises the Earth Science and School Mathematics Olympiads. In 2021, more than 4,000 Estonian school students were able to participate in preparatory e-courses for final examinations in mathematics free of charge. The Estonian Centre of Engineering Pedagogy provides in-service training for teachers of technology subjects in general education and vocational schools.

The continuing education information system TÕIS developed in 2015 is the university's register of study programmes, courses and learners, which allows displaying of continuous education courses in the courses calendar and through which you can register for a study course. In 2021, a solution will be developed for issuing digital certificates with the university's digital stamp.

SUMMARY OF STRENGTHS AND AREAS FOR IMPROVEMENT

Strengths

• TalTech members contribute actively to policy-making and the work of various professional associations.

• TalTech alumni contribute to the process of improving the quality of university education and the skills and employability of graduates. The graduates are highly valued and well recognised in their fields of specialisation and are at the top of the salary scale in Estonia.

• The number of participants in TalTech's continuous education courses is stable, most of the trainings have been quickly transferred online.

• TalTech's continuing education programmes are primarily aimed at providing education related to the universities fields of responsibility.

• TalTech is able to meet the demand for training related to IT and digital skills.

• TalTech involves school students in technology education starting from primary school, the volume of programmes has increased.

• TalTech provides broad access to high-quality and high-level scientific information.

• TalTech's cultural groups and sports club contribute to high-level cultural and sports activities.

Areas for improvement and planned development activities

• More effective involvement of alumni in university life and development of activities (as members of the programme advisory boards) and increasing the various opportunities of the alumni network (incl. international alumni).

• Better coordination of continuing education using customer relationship management software CRM and key quality standards; development of the capabilities for issuing digital certificates.

• Enhancing involvement of the university's teaching staff in conducting continuing education courses by valuing it in the academic career model.

• Popularising TalTech's degree studies among school students and guiding them through specialised technology and science courses to apply more actively for student places.

• Popularising engineering and technology education in society by introducing the views of the university and popularising science.

4.

SELF-EVALUATIONS OF CHOSEN STUDY PROGRAMMES

4.1. APPLIED CHEMISTRY, FOOD AND GENE TECHNOLOGY

Name of the study programme	Applied Chemistry, Food and Gene Technology (LAAB)
Study	Bachelor's study
School	School of Science
Programme director	Vello Tõugu
Principal compiler of the self-evaluation of the study programme	Vello Tõugu, Programme Director, Associate Professor, Department of Chemistry and Biotechnology
A brief description of the process of self-evaluation of the study programme	The programme director Prof. Vello Tõugu carried out self-evaluation of the study programme from 2019 to 2020. Lecturers of the speciality courses, students and alumni participated in the evaluation process. Feedback provided in SIS and in the report prepared by the Education Quality Working Group was used for the evaluation. Based on the conclusions, a new version of the study programme was created, which was widely discussed at the department, in the programme advisory board by involving employers and in the school council. The report has been written by the programme director based on the evaluation and it was discussed in the department council in August 2020. In November 2020 self-evaluation report was reviwed by internal experts (Tiia Plamus, programme director of Materials Technology and Katre Koit, Study Director of EMERA).

AGGREGATED DATA ABOUT THE STUDENTS OF THE STUDY PROGRAMME

	2017/18	2018/19	2019/20	2020/21
Number of students	57	79	119	155
Number of students enrolled	57	38	57	72
Number of graduates	0	0	22	N/A
Number of dropouts	27	17	15	N/A

The first admission to the study programme took place in the academic year of 2017/18. The number of enrolled students increased distinctly in the academic year of 2020/21 (the number of students admitted was 72). This may be due to more intensive marketing on social media as well as the fact that due to the SARS-CoV-2 pandemic, fewer people went to study abroad). There is readiness in the department to teach 80 students, so the target can be considered to be achieved. The reason for the low number of students admitted in the academic year of 2018/19 is unknown – the number of applications was as usual, but the information published in the same year about the underfunding of science in Estonia may be one of the reasons. The goal is to maintain the admission rate of 2020/2021.

4.1.1. PLANNING AND MANAGEMENT OF STUDIES

The bachelor's study programme Applied Chemistry, Food and Gene Technology with three main specialities was created as a result of the reform of the first level study programmes, when the study programmes of Applied Chemistry, Biotechnology, Gene Technology and Food Technology were merged. The proposal for merger of the study programmes was prepared by the committee of the reform of study programmes[90], in order to adapt to the declining number of students and make sure that graduates meet better the needs of the dynamic labour market. The draft study programme was prepared by the leading lecturers, after which employers, alumni, students were involved in the development within and outside the framework of the programme advisory board[91]. Upon development of the study programme, it was considered important to start speciality courses earlier with an aim of reducing the dropout rate. Upon development, the study programme was compared with Nordic technical universities specialising in the same field. These universities do not have a single study programme with such different main specialities and learning outcomes, because in bigger countries/universities separate study programmes are, as a rule, sufficiently economical due to a greater number of students. The workloads in Science, Mathematics, Chemistry and speciality courses taught in the main specialities are similar to the workloads of the corresponding study programmes in the reference universities, which allows students to continue their studies in master's degree programmes at universities abroad. In terms of the wide range of main specialities, the study programme is similar to the study programme Science and Technology taught in English at the University of Tartu.

The specialization is based on the demand of the labour market and previous experience. Each main speciality has a large elective courses module. In justified cases, students can also choose a course from outside their main speciality to the elective module. Such a solution is the most rational in the case of a study programme, which covers a very wide field and the graduates of which do not have a dominant employer, as it allows flexible choice of courses.

Freedom of choice puts a great responsibility on the student in designing his or her studies, but at the same time, it also gives him or her the opportunity to shape his or her own educational path. The study programme is dynamic and open to change and facilitates mobility due to its relatively substantial modules.

The university has set a quality goal to reduce the dropout rate to less than 40% and the established minimum number of students per main speciality is 15. The School has considered the shortage of students to be a significant problem and has wanted to increase the number of students enrolled in order to ensure a sufficient number of graduates in all the main specialities. To that end, marketing, in particular the visibility of the department and the study programme on social media, has been enhanced and efforts are made to improve cooperation with schools.

In order to develop the study programme, feedback from students and lecturers provided in SIS, the report prepared by the Education Quality Working Group and information obtained from interviews with students are used. All problems that evoke response of a larger audience are addressed by involving the stakeholders. As a result of self-evaluation carried out in 2019-2020, changes were introduced, which took effect from the admission of the academic year of 2020/21. The studies of Organic Chemistry were reorganised, its compulsory workload was increased in the main specialities of Food and Gene Technology, the number of extensive courses with the workload of 9 ECTS credit points was reduced in the main speciality of Gene Technology, Physics course was brought to the 1 semester, accumulation of critical courses in the 3rd semester was reduced, the course Biotechnology was added for genetic engineers as an alternative to the course Fundamentals of Chemical Technology. In addition, the students have to choose the main speciality in the 3rd semester now instead of the 4th semester.

To support the study programme by research and development, the lecturers are selected as much as possible based on their research competencies: almost all lecturers participate in research projects as principal investigators or leaders, early stage researchers are involved in teaching. The research competence of the teaching staff is based mainly on the research carried out at TalTech Department of Chemistry and Biotechnology. The high level of research is evidenced by several national and university awards received by lecturers conducting teaching (e.g. in recent years national research awards have been awarded to Prof. Tõnis Timmusk (2019), Prof. Tõnis Kanger (2016), in earlier years to Prof. Peep Palumaa (2011), Prof. Nigulas Samel (2002), Prof. Margus Lopp (2004), Prof. Toomas Paalme (2015). The university's Best Junior Researcher award has been awarded to Dr Kaarel Adamberg (2012) and Dr. Pirjo Spuul (2017). External partners are selected based on the partner's willingness to contribute to teaching. The major partners in preparing graduation theses are the Center of Food and Fermentation Technologies (CFFT), the National Institute of Chemical Physics and Biophysics (NICPB), the National Institute for Health Development and Protobios. Many specialists working in the institutions listed above are involved in teaching speciality courses. Many food companies, some medical laboratories and companies are involved as internship hosts. Some students have prepared their graduation theses in other departments of the university (Department of Cybernetics, Department of Marine Systems and Department of Materials Science). Students prepare their bachelor's theses mainly in research groups and the topics of their theses are closely related to the research of the research group, in the case of food technology also to contract development work. The good level of graduation theses is evidenced by the fact that several theses have been awarded prizes at the Estonian National Contest for University Students (in 2020 Jana Sarnavskaja 1st prize, in 2019 Helena Palu 2nd prize., in 2018 Susan Kõomägi 2nd prize).

[90] The committee consisted of representatives of lecturers, students, employers and alumni of three study programmes.

[91] The programme advisory board is a body that provides advice to the programme director and consists of four representatives of employers, three lecturers and four students. The head of the advisory board of the study programme Applied Chemistry, Food and Gene Technology is Dr Ave Lellep from the North Estonia Medical Centre.

The need for the graduates in the labour market proves high relevance of the study programme. In the field of food technology the demand for graduates exceeds the number of graduates. In some application areas the problem is the salary level that does not meet the expectations of the graduates[92]. Graduates can continue their studies in more than ten master's degree programmes in Estonia[93] and most of the employers are also interested in hiring specialists with a master's degree, whose knowledge and skills would exceed that of specialists with professional higher education. The majority of students want to pursue a master's degree. Therefore, the study programme is primarily aimed at continuing studies for a master's degree. Based on the graduation rate in first year, the number of students enrolled to the main speciality of Applied Chemistry must be increased in order to achieve the goals set by the university. To this end, marketing efforts are expanded both on social media and in general education schools and seminars will be held for chemistry and biology teachers.

Coherence of the study programme is ensured mainly by taking into account the feedback received from students and lecturers and by holding discussions in various working groups, which replace the previous organisation of studies coordinated by the chair. A chart illustrating the interconnections between courses is attached in Annex 7. In the first two semesters the core courses are taught, but there are also parts of courses in the first semester, where the current state and developments of the speciality are introduced. The students select their main speciality in the third semester. In the draft programme, a range of possibilities was suggested to ensure smooth process of studies and improve coherence of the courses. The major changes include better synchronisation of the courses of Biochemistry and Organic Chemistry, bringing the course Physics, which is integral to the study of other courses, to the first semester, changes in the distribution of the topics of Molecular Biology and Cell Biology between semesters and coordinating the content of similar courses. As the first students of the study programme graduated from the university in the academic year 2020/21, it is not yet possible to analyse the opinions of the alumni and employers. Feedback from students and lecturers provided in SIS and the report prepared by the Education Quality Working Group play an important role in managing the study programme. In the course of this process, it has become evident that informing students about the conclusions drawn based on feedback and the implemented improvement actions constitute a bottleneck and a suitable form is sought for that. A solution could be closer cooperation with the students' Education Quality Working Group and involvement of the student representatives in the advisory board and tutors in the feedback discussions. The Head of the Department of Chemistry and Biotechnology participated in the last meeting with the rapporteur of the Education Quality Working Group (in November 2020) and the meeting took place in a very good atmosphere of mutual understanding. Improvement of substantial involvement of employers in the discussions in the advisory board poses a challenge. Since the employers of the graduates of the main specialities of Chemistry and Gene Technology are primarily interested in specialists with a master's degree and there are no large dominant employers who would employ a significant number of graduates, the involvement of specialists from outside the university in the development of the bachelor's programme has turned out to be a challenge.[94] It is planned to involve more alumni of the study programme in the future. In order to improve coherence of the courses and coordinate the activities, the lecturers of the Department of Chemistry and Biotechnology have allowed their colleagues access to their study materials in Moodle.

Specialised studies take place mainly in the TalTech Building of Natural Sciences renovated in 2005, where also the chemistry, biotechnology and food technology laboratories are located. The study laboratories have adequate supplies of equipment required for practical training in core courses at bachelor's level. In 2017, the study laboratory, where practical training in Molecular Biology, Cell Biology and Microbiology takes place, was renovated and students moved to better conditions. Purchase of supplementary equipment of the study laboratories was financed from the (EU funded) program ASTRA. Graduation theses are prepared in research laboratories, where also some specialised practical courses take place.

The resources allocated to the programme director for the development and marketing of the study programme are adequate. These funds are also used to purchase laboratory consumables and to develop new courses. The costs of teaching courses (incl. lecturers' salaries) are financed from the departments' funds. The departments receive funding for all their activities (both teaching and research) as a single appropriation from the common fund in compliance with the university's Financial Regulations, one of the criteria of which is the number of students. It is not possible to indicate separately the amount of funds allocated for the study programme in the appropriation to the department from the common fund.

All compulsory courses and several elective courses are supplied with e-support in the Moodle environment, which meets at least the minimum requirements established by the university. Improving the quality of e-support and adding materials is an ongoing process, which was significantly accelerated by distance learning in the spring of 2020. Several courses have received the e-course quality label. In recent years two compulsory core courses have received the e-course quality label: Fundamentals of Chemistry and Biochemistry. The elective course Virtual Practical Lab Course is taught fully online (on the Labster platform). Besides courses with e-support, it is important to have textbooks of the core subjects in Estonian. With the support of the Ministry of Education and Research, textbooks in Estonian in biochemistry and organic chemistry have been published. For example, Tymoczko, Berg, Styder "Biokeemia lühikursus" (2016), Press House of Tallinn University of Technology (translated by Prof. Palumaa); Francis A. Carey, Robert M. Giuliano, "Orgaaniline Keemia" (2015), Press House of Tallinn University of Technology (translated by T. Kanger); (Chemometrics). The textbook of molecular and cell biology in Estonian, published by the University of Tartu, is also freely available to students on the Internet. Through the university's network, students can access the most important research databases (Web of Science, Scopus and Chemial Abstract) and important research articles, which are especially useful in preparing graduation theses. Most of the students use Mendeley or Zotero citation tools upon writing their graduation theses.

An obstacle for participation of international students in the studies is the language of instruction, although the number of visiting students in the (master's) courses taught previously in English was also small. Visiting students from other Estonian universities are welcome, but national mobility rates are low, since there are no funds to support it and and it is difficult to match the timetables of

[92] The average salary of the graduates of the preceding study programmes in the years 2016-2018 has been at the same level with the average salary in Estonia (i.e. it has remained in the range between 1147 – 1297.41 euros a month)

[93] For example, the master's courses Chemistry, Biomedicine, Biotechnology at the University of Tartu, Food Technology at the Estonian University of Life Sciences, Biology at Tallinn University and Health Technologies and Medical Physics at TalTech, as well as the Science Teacher specialities at the University of Tartu and Tallinn University.

[94] As of 2016, graduates of all levels of Applied Chemistry and Gene Technology worked for 151 employers in Estonia. Many graduates also worked abroad. Besides the university (doctoral studies were also considered as working at the university), the major employers were the Center of Food and Fermentation Technologies (CFFT), the laboratories of Central Hospitals, AS Cambrex, national laboratories, AS Kevalt and AS Protobios.

different universities. Study mobility has taken place in the form of changing a study programme, which has been mainly due to the student's willingness to change his or her place of residence and thus also the university. In such cases, APEL has been successfully applied.

General competencies are developed on speciality courses and the study programme includes also an optional module with the workload of 6 ECTS credit points and a personal development module with the workload of 9 ECTS credit points, within the framework of which various general competencies can be developed. With the consent of the programme director, students can also choose suitable courses for personal development from outside the selection provided in the module. On speciality courses, value-based competencies are developed in discussing topics (environmental sustainability, bioethics). In the teaching process it is considered important to develop learning competencies required for lifelong education – group work is carried out, oral and written self-expression skills and mathematical competencies are developed. Students' theoretical knowledge is solidified by practice, where they acquire manual dexterity skills required for experimental work. The workload of studies (1 ECTS credit point corresponds to 26 hours of work) is reviewed based on student feedback, considering it optimal if a few students consider the workload to be slightly high. In order to harmonise the workload of independent work, large-scale practice classes have been incorporated into the corresponding theoretical courses. Among other things, changes in teaching Molecular Biology and Cell Biology were made based on the feedback provided by students, who pointed out the differences in the workload of independent work in the subsequent semesters.

SUMMARY OF STRENGTHS AND AREAS FOR IMPROVEMENT

Strengths

• Teaching is closely connected with the research and development carried out by the lecturers and the research group related to the study programme.

• The study programme offers students a great freedom of choice in selecting the content of their studies, which provides an opportunity to continue their studies in more than ten master's degree study programmes in Estonia and ensures their competitiveness abroad.

• The study programme is dynamic and open to change, which is also supported by the structure of the study programme and its relatively large modules.

• The main courses are supplied with high-quality textbooks and study materials in Estonian and adequately equipped study laboratories.

Areas for improvement and planned development activities

• Greater involvement of the alumni in the work of the programme advisory board, because they are the ones who can best assess the usefulness of acquired knowledge and skills in the labour market.

• Efforts must be made to better explain how student feedback is implemented, so that they would really feel the benefits of feedback. To this end, joint discussions are held with students belonging to Education Quality Working Group and advisory boards.

• To enhance cohesion between courses, all the lecturers teaching in the study programme shall provide access to their digital course materials for colleagues in Moodle.

4.1.2. LEARNING, TEACHING AND ASSESSMENT

Admission to the study programme is threshold-based; students are admitted based on the results of the state examinations in broad mathematics and in the Estonian language. Threshold-based admission ensures enrolment of a student regardless of competition. Application of the results in mathematics and the Estonian language allows secondary school graduates commence studies, even if the level of teaching in key subjects (chemistry, physics, biology) has not been very high at their school. Pre-sessional courses in mathematics and physics are offered to students and differences in basic knowledge in biology are taken into account in setting the pace of study in the 1st semester and additional counselling is offered. Currently, the threshold is adequate for the selection of students with the required potential: in 2018, the threshold was raised by 10 points; in 2019 the threshold of the exam Estonian as a Foreign Language was raised, because the language skills of some entrants were not sufficient for studying speciality subjects. The plan is to raise the threshold by another 10 points in the near future to ensure a more even level of the entrants and lower dropout rate. A motivated student body will develop during the first academic year, because in the case of threshold-based admission based on the state examinations, some students commencing studies are not sure about the selection of a speciality.

Potential students are informed about study opportunities on the university's website, at study fairs, on the university's and department's social media and by organising laboratory visits and workshops for pupils, giving lectures on topical issues in the field and by providing student shadowing opportunities. The biggest event, where the study programme is introduced, is the Open Doors Day held at the university during the spring holidays, in the course of which 90-100 students visit the events introducing the study programme. The Open Doors Day in 2021 will take place online, which is why videos introducing the learning opportunities are under preparation. Students and doctoral students are involved in the popularization of the study program. The department also prepares pupils for the practical part of subject olympiads and supervises research papers of some pupils. It was planned to start continuing education courses for upper secondary school teachers in spring 2021 fostering their closer interaction with the university. This is postponed due to the anti-epidemic measures and the trainings will be conducted in the form of video lectures in December 2021. General education schools are interested in extensive Chemistry and Biotechnology elective courses, in the framework of which the lecturers of the study programme have conducted practical workshops. After enrolment, courses related to the main speciality will begin in the first semester, where the perspectives of the speciality and the main research and development directions of the department are introduced in order to facilitate selection of the main speciality.

Students have ample opportunities to plan their studies: there are three main specialities as well as a number of elective courses to choose from. Upon a reasoned request, students can include speciality courses not included in the study programme in the electives module if this is necessary due to the student's choice of specialization (e.g, special courses in programming, disciplines of applied physics, data processing, etc.). A student can choose

his or her internship host as well as the supervisor of his or her graduation thesis. Almost all students are involved in the research, development or creative (RDC) activities, since the practical theses are mostly related to the RDC projects of the supervisors. The big number of graduation theses (40 master's theses) prepared in Prof. Tõnis Timmusk's neurobiology lab is worth pointing out. Many students prepare their theses in other research and development institutions or companies. For example, the graduates of 2020 prepared their graduation theses in the Center of Food and Fermentation Technologies (CFFT), OÜ Krimelte, in the Department of Cybernetics in cooperation with the Department of Materials Science, and in OÜ Must Küüslauk. In most cases, a co-supervisor is appointed from the department and the defence can be closed upon the company's reasoned request. From the admission of the academic year of 2020/21, a student must choose his or her main speciality in the 3rd semester instead of the previous 4th semester so that the student could be engaged in a particular field earlier.

The objectivity and reliability of assessment of students is ensured by its compliance with the previously published assessment criteria. A lecturer is obliged to provide explanation of the grading rationale. On most courses, a grade consists of several components. An important part of the grade is the examination (final test), but midterm test and process grades (for presentations, reports) also affect the final grade. The weight of process grades in determining the final grade is different on different courses. Based on the feedback, students are mostly satisfied with the assessment. Dissatisfaction with the assessment on some courses (one course in the autumn semester of 2019/20) has been caused by communication problems and the fact that information was not updated in different environments. The changes in assessment made in the spring semester due to transfer to distance learning did not cause dissatisfaction among students. However, the application of digital solutions for testing knowledge requires the development and implementation of new and modern solutions, in particular in the case of distance learning.

Accreditation of Prior and Experiential Learning (APEL) supports learning and takes full account of the interests of the student. Several students have come to the study programme from other study programmes and are satisfied with the number of credit points granted under the accreditation of prior and experiential learning (APEL). In the academic year 2019/20, 160 ECTS credit points wre granted under APEL, from among which 112 ECTS credit points for courses passed before matriculation and 33 ECTS credit points for courses passed at TalTech, the amount of ECTS credit points for studies abroad (9 ECTS credit points) was small due to travel restrictions, some students managed to be quarantined only.

Special attention is paid to the assessment of bachelor's theses, the results of which are considered very important by students. All graduation theses are reviewed by a reviewer approved by the programme director and a graduation thesis is thoroughly reviewed also by an appointed member of the defence committee. Defence committees are formed by main specialities. As a rule, the defence committee gives grades by consensus, voting is carried out on very few occasions. A graduation thesis is assessed by a committee consisting of 5-6 members, from among whom one is usually from a partner institution.

Lecturers use a variety of teaching methods from the classical lecture-exercise-practical training-exam system (e.g. on the course Organic Chemistry) to the flipped classroom method (e.g. on the course Fundamentals of Chemistry) and courses almost fully studied online. E-support is provided to all compulsory courses and many elective courses in Moodle. The use of digital means varies in the courses – there are courses that are 90% based on digital processes (e.g. Bioinformatics, Virtual Practical Lab Course, Philosophy), but there are also courses where digital solutions have a support function (primarily courses requiring practical laboratory work). For example, in the practical training on the courses of Molecular Biology and Cell Biology, digital support is only available in the form of e-mail exchange with the PhD students supervising the practical training, but the students have been very satisfied with the procedures and the distributed printed materials. The implementation of digital solutions has been successful, but there are still areas and methods that need to be improved, especially in checking knowledge and competencies, as well as in activating the audience in lectures and practice classes.

If a lecturer receives negative feedback from several students, the programme director talks to the lecturer and they shall together find out the reasons for dissatisfaction and the ways to eliminate the problems, e.g. the lecturer can be referred to a training or asked to make changes in the organisation of studies. The teaching staff have the opportunity to attend various trainings for professional development also without any referral or recommendation. Many lecturers use this opportunity. Moodle training, digital tools training and presentation skills training have had the highest attendance. The availability of digital tools trainings for the teaching staff and support in using educational technology tools has improved. The unsuitability of a course (Chemical Engineering) in one speciality, too tight time frame for practical classes, too big workload of some courses, classes starting at 8.a.m. in the morning and small amount of face-to-face teaching in some courses are identified as bottlenecks in the last report of the the Education Quality Working Group. These bottlenecks are being analysed.

During internship, students get acquainted with a significant range of techniques required in working life. An internship can be completed in companies, incl. in private-sector research and development centres (the Center of Food and Fermentation Technologies), laboratories and academic research groups (the National Institute of Chemical Physics and Biophysics, the National Institute for Health Development) in Estonia and abroad. There are good opportunities for international mobility thanks to the Erasmus programme; however it is mainly the master's students who make use of that possibility. Mobility within Estonia, especially cooperation with the research laboratories of the University of Tartu, is possible, but is minimal due to the lack of financial resources supporting that. The students of Applied Chemistry and Gene Technology often do their internsip in a research group, where they later write their graduation thesis. Based on the graduate survey, feedback on supervision has been mainly positive. Since students' work is funded from the supervisor's RDC funds and the supervisor at the laboratory is usually a PhD student, the students have to work within restricted framework, which reduces independence, but provides an opportunity to work in a laboratory supplied with modern equipment. Employers expect graduates to be familiar with modern experimental methods and to have experience in handling expensive laboratory equipment, which can only be acquired in research laboratories.

A relatively high dropout rate is a problem. The most common stated reason for discontinuing studies is that the study programme failed to meet the student's expectations, but, as a rule, the dropouts have had difficulties in completing their courses and they have not been interested in additional counselling. This may be due to financial reasons and the need to earn a living besides studies. Sudden decrease in face-to-face teaching certainly plays a role in the dropout rate compared to upper secondary schools and, in some cases, also in the lack of independent learning skills that develop in the first semesters. Students' progress is monitored based on key courses, i.e. in the 1st semester on the course of Fundamentals of Chemistry and in the 2nd semester on the course Biochemistry, and Power Bi and Moodle interim reports can also be used. Students lagging behind are contacted by the student counsellor of the dean's office, who will direct the students to further counselling if necessary.

SUMMARY OF STRENGTHS AND AREAS FOR IMPROVEMENT

Strengths

• Several main specialities and a large number of elective courses, as well as writing a thesis on an experimental research project provide students with great opportunities to shape their learning path, thus making teaching more student-centred and personal.

• Evidence-based learning – the majority of courses are taught by top specialists in the field and learning is supported by experimental research carried out in a research laboratory based on which graduation theses can be written.

• The constructive feedback of students on individual courses is constantly taken into account. Most lecturers request feedback themselves and take it into account.

Areas for improvement and planned development activities

• It is planned to raise the admission threshold further in order to reduce the dropout rate and ensure a more even level of entrants.

• In order to meet the needs of the labour market, efforts will be made to maintain the admission rate achieved in 2020, despite raising the threshold. To this end, marketing efforts are expanded on social media and cooperation with schools is reinforced.

• The use of digital tools and the implementation of e-learning have not always been sufficiently efficient. In order to introduce digital solutions, it is necessary to continue educational technology training and individual counselling of teachers.

4.1.3. DEVELOPMENT, COOPERATION AND INTERNATIONALISATION OF TEACHING STAFF

All courses are taught by professionally competent members of teaching staff, the vast majority of whom are also involved in RDC activities. The teaching staff includes several specialists from other institutions (e.g. Tagli Pitsi from the National Institute for Health Development, Kaia Palm from Protobios, Ildar Nissamedtinov from the Center of Food and Fermentation Technologies). No formal study programme specific goals have been set in terms of quality, as the feedback from students is good. As a result of the student feedback provided in the previous three years, one lecturer has been replaced, one lecturer has been referred to a presentation skills training and the workload of one lecturer has been reduced. In addition, conversations have been held with several lecturers and various aspects of their teaching methodology and organisation of studies have been discussed, which has resulted in improved student progress or feedback. The aim is to pay attention to substantive bottlenecks and to avoid classifying teachers based on average score given in feedback, so that achieving a higher score would not become an end in itself. Many of the lecturers teaching in the study programme have been recognised as the best lecturer of the school in different years (e.g. Prof. Tõnis Timmusk, Prof. Margus Lopp, Dr Ly Villo, Prof. Toomas Tamm and Marju Laasik).

The qualification and number of teaching staff is adequate. The workload of lecturers of speciality courses is optimal, since lecturers involved in R&D activities teach on a part-time basis. Generational renewal is going well, many honourable lecturers have been conferred the Professor Emeritus/Emerita status in recent years and newcomers have settled in, and in some fields this process will take place in the near future. The average age of lecturers is 53 years. The sustainability of such organisation of studies depends on the success of the teaching staff in applying for and implementing grants and project contracts. The feedback provided by students shows that they are satisfied that the courses are taught by specialists in the field and that lecturers from outside the university are involved in teaching various specific topics.

The participation of lecturers of speciality courses in international study-related mobility is low. Most lecturers are committed to ongoing research in order to be successful in extremely tough competition for research funding, as this is crucial to their careers. The internationalization of lecturers takes place mainly through their continuous participation in international research networks and mobility as researchers; many research articles are completed as a result of international cooperation and in international teams (the department has several international doctoral students).

All significant criteria regarding teaching and research laid down in the “Academic Evaluation Matrix” are taken into account in the selection and attestation of employees, but in practice, in senior-level positions the emphasis is on research and development and success in applying for grants and contracts.

SUMMARY OF STRENGTHS AND AREAS FOR IMPROVEMENT

Strengths

• The majority of lecturers participate in or lead research projects.

• Both PhD students and specialists from outside the university are involved in teaching.

• Due to lecturers’ different educational paths and the experience gained in other universities, the courses and teaching methods are diverse and students can get acquainted with different perspectives.

Areas for improvement and planned development activities

• The international mobility of the teaching staff as lecturers is a matter of concern, which is partly compensated by their regular participation in international research cooperation and networks.

Annexes:

Annex 5. Study programme form of Applied Chemistry, Food and Gene Technology

Annex 6. Descriptions of the key courses of the Applied Chemistry, Food and Gene Technology

Annex 7. A chart illustrating the interconnections between modules/courses of the Applied Chemistry, Food and Gene Technology

Annex 8. Teaching staff of the Applied Chemistry, Food and Gene Technology

4.2. BUSINESS INFORMATION TECHNOLOGY

Title of the study programme	Business Information Technology
Study	Master's study
School	School of Information Technologies
Programme director	Gunnar Piho
Principal compliers of the self-evaluation of the study programme	Gunnar Piho, Programme Director, Associate Professor, Head of the Department of Software Science Riina Soovik (assistant to study programme) Kristina Murtazin (assistant to a project- and work-based learning) A group of bachelor's students (Hanna-Liisa Vilbiks, Annela Pindis, Martin Joonas Pariis)
A brief description of the process of self-assessment of the study programme	In June 2020, a group bachelor's students of Business Information Technology (H.-L. Vilbiks, A. Pindis and M. J. Pariis) defended a bachelor's thesis "Self-Assessment of the IABM Curriculum of Tallinn University of Technology and the Reference Architecture of its Supporting Information System"[95]. During the 2019/2020 academic year, they conducted interviews with different stakeholders (students, faculty, alumni, industry), collected data, and analysed interviews. The development of the study programme Business Information Technology and its development principles have been described by K. Murtazin, O. Shvets, and G.Piho in the conference proceedings of EDUCON-2020[96]. The study programme advisory board, teaching staff and students of the study programme and the teaching council of the School of Information Technologies have been informed of the self-evaluation and the future development plans. The self-evaluation report was reviewed by the internal experts of the field (Prof. Emer. Jaan Penjam and Prof. Peeter Ellervee).

AGGREGATED DATA ABOUT THE STUDENTS OF THE STUDY PROGRAMME

	2017/18	2018/19	2019/20	2020/21
Number of students	171	160	152	172
Number of students enrolled	54	51	30	74
Number of graduates	33	18	22	N/A
Number of dropouts	49	24	16	N/A

About 60 students are admitted to the Business Information Technology Master's programme (hereinafter also IABM) each year. Unfortunately, only about half of them graduate. There seems to be a pattern that the students have no time for university when the economy is doing well. When the economy is facing challenges, the students are back at the university again.

A high dropout rate is the biggest challenge and a development engine. As most IABM students are already working professionals, the main development focus of the study programme is integrating work-based and project-based educational methods into the study programme.

4.2.1. STUDY PROGRAMME DEVELOPMENT AND MANAGEMENT

DEVELOPMENT

The School of Information Technologies at TalTech aims to educate high-qualified IT professionals for the Estonian economy in all computing sub-disciplines defined by ACM/IEEE-CS[97]. With its three specialisations[98], the master's programme Business Information Technology contributes to the sub-disciplines of Information Technology, Information Systems and Data Science.

Like all the study programmes in TalTech, the IABM programme has a programme advisory board, where students, alumni, faculty and industry meet. The official meetings of the IABM programme advisory board take place at least once a semester. Representatives from significant Estonian companies like the largest operating banks in Estonia (SEB, Swedbank), telecom service providers

[95] M. J. Pariis, A. Vilbiks and H.-L. Pindis, „Self-Assessment of the IABM Curriculum of Tallinn University of Technology and the Reference Architecture of its Supporting Information System" TalTech, Tallinn, 2020.

[96] K. Murtazin, O. Shvets and G. Piho, "Curriculum for Business Information Technology Studies at BSc and MSc Levels – Observations from a Long-term Educational Endeavour," in IEEE Global Engineering Education Conference (EDUCON2020), Porto, 2020.

[97] Association for Computing Machinery (ACM), Association for Information Systems (AIS), "ACM: Content: Education: Curricula recommendations: IS 2010 Curriculum Guidelines for Undergraduate Degree Programs in Information Systems," 2010.

[98] Business analysis and enterprise architecture; information systems analysis and architecture; data analysis and intelligent systems.

(Telia), and top software companies (Helmes, Nortal, CGI) are or have been active members in the advisory board. In 2010, the IABM advisory board initiated the process of redesigning and modernising the study programme. This process has been documented and published[99].

During the development process of the IABM study programme, different qualification and competency frameworks[100] and study programmes[101] were analysed. Based on the analysis and after five step by step changes[102], the following study programme model was proposed.

Study module	ECTS per semester	Total classroom hours	Total learning hours
Information Technology	6	64	156
Business/Entrepreneurship	6	64	156
Mathematics	6	64	156
Specialisation	12	128	312

In this model, every student, in every semester, starting from the first semester in the Business Information Technology bachelors' programme (hereinafter IABB) up to the final semester in the IABM, must take courses from four different study modules: information technology, business and entrepreneurship, mathematics, and specialisation.

STUDY PROGRAMME

The general idea of the IABM study programme is that the master's thesis topic defines a student's specialisation and, as a result, students can design their study programme freely and flexibly based on their interests and development needs, and needs of the master's thesis topic. However, in choosing the courses, the students still have to follow the logic and requirements of study courses and modules, especially if they require a pre-course or pre-knowledge.

The IABM study programme[103] consists mostly of elective courses, except the courses Thesis Seminar I, Thesis Seminar II, and the Thesis. All the electives are 6 ECTS courses. From every module, except specialisation, the students must take at least two courses. From the specialisation module, every student must take at least four electives in addition to two compulsory Thesis Seminar I and Thesis Seminar II courses (see Table 38).

Table 38. Structure of the IABM study programme.

Semester	IT Management	Entrepreneurship	Math.	Specialisation	Specialisation
1	Elective	Elective	Elective	Elective	Thesis Seminar I
2	Elective	Elective	Elective	Elective	Thesis Seminar II
3	Elective	Elective	Elective	Elective	Elective
4	Elective	Elective	Thesis		

Thesis Seminar I, Thesis Seminar II, and the Thesis are 30 ECTS in total. During the Thesis Seminar I, students conduct a systematic literature review to shape the thesis topic to receive 6 ECTS. At the end of the Thesis Seminar II, students must develop the preliminary results of the thesis to receive another 6 ECTS. Usually, the second Thesis Seminar is followed by a semester or two to improve and finalise their thesis. After the thesis defence, the student receives the remaining 18 ECTS.

To give students flexibility and to motivate students to take responsibility for their education, students can choose courses in the amount of 30 ECTS (free-choice electives) from any other study programme from TalTech or any other university. For instance, students can take 30 ECTS from Civil Engineering or Science and, as a result, prepare for a multidisciplinary career path. This mechanism also supports students' Erasmus mobility as students can study abroad for one semester and choose any courses they would like to take there.

Another educational innovation in the IABM is engaging students in supervising the capstone projects of IABB students. The system is illustrated in Figure 24 below. After completing the Thesis Seminar I, and the IT Project Management courses, a master's student may supervise bachelor's students' capstone projects. The idea is that a master's student plans something innovative and research-based to implement in industry or as part of some project or research, and IABB students implement it. Such a project can lead to a group defence where IABM students get their master's degree, and IABB students get their bachelor's degree. Currently, one such mixed group of students has already defended their thesis[104].

[99] K. Murtazin, O. Shvets and G. Piho, "Curriculum for Business Information Technology Studies at BSc and MSc Levels – Observations from a Long-term Educational Endeavour," in IEEE Global Engineering Education Conference (EDUCON2020), Porto, 2020.

[100] The European Qualification Framework, CEPIS frameworks including the European e-Competence Framework, the Estonian Qualification Framework, also the ACM reference curricula

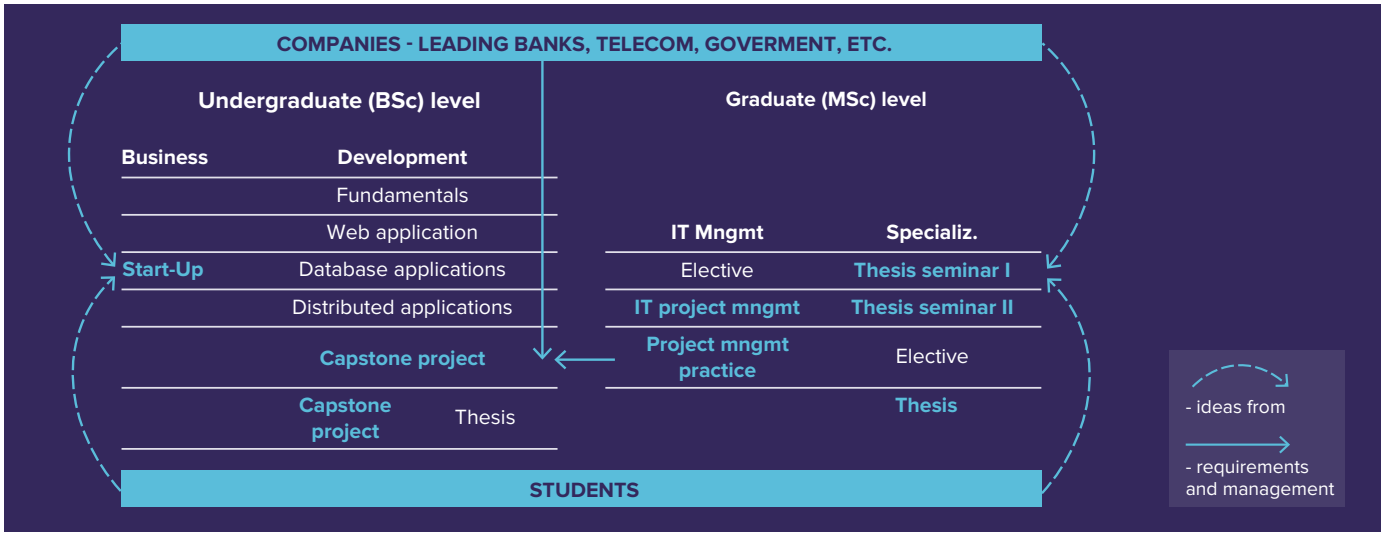
[101] From several reference universities in the USA (MIT, Carnegie Mellon), UK (Leeds, Durham, York, Edinburgh, Warwick), Norway (Western Norway University), Denmark (Aalborg), Sweden (KTH, Chalmers), and Finland (Aalto, Tampere)

[102] 2012, 2013, 2014, 2016, 2017/2018; in both (bachelor's and master's) study programmes

[103] In master's level (IABM programme) the information technology module is called IT Management and the business module is called Entrepreneurship, to stress the general focus of these modules.

[104] They developed a bank customers app specifically aimed at young people that helps to plan and control their personal budget.

Figure 24. System of the study programmes of Business Information Technology.



The IABM programme has study groups both in Tallinn and at Virumaa College (in Kohtla-Järve, the industrial part of East Estonia). In Kohtla-Järve, 8 students started as a pilot in the academic year 2019/2020. In the academic year 2020/2021, 14 new additional students commenced studies in Kohtla-Järve. The study group and the study model in Kohtla-Järve have been designed based on the needs of the electrical power and oil industry.

In addition to the students' freedom and responsibility in designing their learning path, the IABM also includes work-based learning opportunities. For this, there are four 6 ECTS courses called Work-Based Project (WBP) I – IV. WBP courses are like a thesis. To take these courses, a student must first write a small (one A4) proposal, where a problem, an objective(s), methodology, expected results, and learning outcomes are identified. Based on this one A4 proposal, the programme director, after consulting with related faculty members, either accepts or helps students improve the proposal. Typically, the problems to solve in the WBP course are related to the industry's real problems or a project of a university's research group[105]. The committee of three members (both from faculty and industry) assesses the WBP based on the written report and oral project defence. This change was introduced in the IABM programme during the two-year (from 2018 to 2020) work-based learning pilot programme. Twelve students participated in this pilot.

Since most of IABM students are already working as IT specialists, there is no professional practice in the programme. Removing the professional practice from the study programme is an example, where students' feedback was considered. Workplace-based learning and flexibility in drawing up one's study programme, have also been introduced into the study programme based on student feedback. As students are represented in the study programme advisory board, student feedback is always heard and considered in the programme development.

RESOURCES

Apart from funds for salaries and notwithstanding the shortage of learning space for students and groups for out-of-classroom studies , the IABM programme has enough resources for high-quality teaching.

The average of 160 active students (9600 ECTS) are taught every year. In Estonia, the full-time workload is 1700 hours. In the IABM study programme, the lecturer's workhour has taken equal to the student's credit point for general planning. The full-time teaching loadincludes 1400 ECTS (hours) for teaching, 200 ECTS (hours) for thesis supervision[106], and 100 hours for meetings and other organisational activities. As the master thesis is only 30 ECTS and not 50, a full-time lecturer must teach students for 1520 ECTS (hours) a year, and therefore, for all our students, we need only (9600/1520 ≒) 6.32 full-time lecturers. Therefore, every full-time lecturer must teach (1520/60 ≒) 25.3 students a year, which is acceptable and comparable with other universities[107].

However, the overall situation is good. TalTech library provides adequate modern electronic learning materials. The ACM Digital Library, the IEEE Explore Digital Library and O'Reilly for Higher Education (Safary) are some examples. These resources are available for students via a Virtual Private Network from every possible physical location where the Internet connection is available. The situation with the licensed software is also good. For the IABM students, the following licensed software packages are currently available: Windows 10, Office 365, Azure Dev Tools for teaching, LabView, MathWorks, Enterprise Architect, Rational Rose, Parallels Desktop for Mac, SPSS, and others. Moreover, if any other licensed software is needed for a lecturer to conduct a course, sufficient financial resources are usually available for the study programme to acquire the required academic licenses.

In addition to the salaries and operational costs, every study programme at the School of Information Technologies has its

[105] E.g. the project of the e-Med lab of open secondary use of health data.

[106] For successful supervision of four master theses a year

[107] A full-time lecturer has two courses a semester with 60 students in a class (twelve lectures a week).

additional yearly budget for the extraordinary costs and development. The additional budget allocated to IABM for development is 40,000–60,000 euros a year, depending on the number of admitted students. This budget gives the study programmes the freedom and the flexibility to act according to the needs. For instance, the teachers can provide students with additional software (e.g. ReSharper[108]), licensed courses (e.g. PluralSight[109]), accessories, and other tools needed for the teaching, individual projects, or work-based learning.

TalTech is using Moodle as an e-learning platform. There are three defined quality levels for the online courses at TalTech (see also Chapter 3.8.2). The first level is the basic level, which means that electronic study materials for students are available online. Although not all study courses of IABM have reached the first level[110], the IABM study programme aims to reach the second level with all courses in the next 3-5 years. Higher quality standards have been set for the second level, the . The most important features included at the second level are self-assessment and automated feedback for students. In addition, the teachers, who are fluent in English, are encouraged to prepare high-quality learning materials in English to allow Erasmus mobility online and offline. As TalTech is a partner of the EuroTech Universities alliance in the EuroTeQ (European Universities Initiative) project, the Erasmus mobility is a topical issue. One target of the EuroTeQ project is that in 2025, 25% of EuroTech/EuroTeQ students participate in the consortium-wide (online and offline) Erasmus. Since most classes in the IABM study programme are in Estonian, there are no international students at present.

Although the IABM study programme encourages international mobility (30 ECTS are free choice elective courses), students' international mobility is low. Every semester one to two students are studying at a foreign university. In the autumn semester of 2020/2021, one student was studying at Czech Technical University in Prague. One student is going to Bergen (Western Norway University of Applied Sciences, HVL) to write his master's work in the spring semester.

SUMMARY OF STRENGTHS AND AREAS FOR IMPROVEMENT

Strengths

- The IABM study programme:
  - o is methodologically designed and implemented;
  - o supports students' flexibility in designing their learning path;
  - o supports students' work-based learning;
  - o contributes to regional development;
  - o has adequate resources;
  - o supports students' mobility.

Areas for improvement and planned development activities

- In the next 3-5 years the focus will be on the development of online learning materials that support more student's self-assessment, work-based learning and both virtual and real Erasmus mobility, including mobility of English-speaking students.

4.2.2. LEARNING, TEACHING AND ASSESSMENT

ADMISSION CRITERIA

The admission target of the IABM study programme is to accept 50-70 students a year in Tallinn and 20-30 students in Kohtla-Järve[111]. It is also planned to open a study group in Tartu for 20-30 IABM students. This year, 14 new students started in Kohtla-Järve and 60 in Tallinn. Unfortunately, eight students from the Tallinn study group already dropped out during the first two months.

All the admission information is publicly available on the university webpage. As the IABM programme is one of the most popular and well-known study programmes, there are usually no difficulties in recruiting new students. Also, the salary of graduates plays a crucial role here. While in 2018, the average gorss salary of all TalTech graduates of 2005-2017 was 1,987 euros a month, the average salary of Business Information Technology graduates was 2,614 euros a month, ranking fourth after Informatics (2,737 euros), Cyber Security (2,647 euros) and Information Systems Analysis and Planning[112] (2,667 euros) programmes. However, without publicity campaign, only 30 new students started their studies in 2019/2020. In 2020/2021, the professional publicity campaign in online media (the total cost was 1,500 euros) helped achieve the targets.

The IABM has no entrance examination. A candidate must have a bachelor's degree in ICT or a comparable field. The number of admitted students depends on how many candidates pass the threshold. To pass the minimum threshold (6.0 points), a candidate must have a weighted average grade of at least 3.0 in the bachelors' level and the candidate's bachelor's thesis grade must not be lower than 3 (good). If an applicant fails to meet these requirements, he or she can be accepted based on a motivation letter and professional resume if the applicant's working experience in the required field (software development, IT operation or data analytics) is at least three years. In conclusion, the IABM programme has flexible admission requirements for both academically successful candidates and experienced practitioners. This year we also started with a minor module (48 ECTS) in the IABB, which provides "an entry permit" to the IABM for non-IT graduates. The IABB minor is also available in TalTech Open University.

[108] some years ago, when the university had no centralized licenses for ReSharper

[109] https://www.pluralsight.com/, 100 licences for students in 2018 and 2019

[110] Currently, approximately 50% of study courses have reached the basic level.

[111] A thumb formula for calculating the optimum of students is that 24 students in a study group are mostly zero-sum game: 8 students are paying the fixed costs; 8 students are paying the salaries and 8 students are paying the study programme development costs.

[112] Similar study programme to the IABM, but dedicated to the working professionals with a non-IT background

LEARNING CENTRED APPROACH

The new IABM study programme is student- and learning-centred, and is based on the modern inductive learning[113], collaborative learning, and action learning principles, and supports both project-based and work-based learning opportunities. These general ideas and aims are supported in IABM by the flexibility in designing students' study path, work-based learning possibilities, and building a culture and system supporting learning. How IABM students can design their learning path, use the Work-Based Project I-IV courses and take responsibility for their education, is described in paragraph 4.2.1.

In The IABM, the focus is on the building of a supportive learning culture. The main questions are: 1) what is learning (evidence-based) and how can teachers support students in learning; 2) how to support teaching staff (evidence-based) so that the teaching staff can support students. The idea is to inform teachers, but not to force them. The teaching staff have the right to teach according to their own beliefs. However, the students have also the right to choose both the courses and the teachers. The main goals are: 1) to prepare two online courses about learning and supporting it (one for students and one for teachers); 2) to identify students shortcomings in learning and how to better support them in learning; and 3) to understand personalised feedback (e.g. in work-based learning) and its automation possibilities. As regards the first two points, the educational researchers from Tallinn University are involved in the studies. As regards the third point, two of our teachers are carrying out their doctoral research in the field (co-supervised by Prof. Martin Meeter from the Vrije Universiteit in Amsterdam).

ASSESSMENT CRITERIA

There are two main challenges related to the assessment criteria: 1) how to make sure that students are learning 26 hours per 1 ECTS as stated in the regulations; 2) how to differentiate the grades students get. The question is – how to move towards a more learning supporting and motivating grading model. One of the IABM goals for the next 3-5 years is to search for a fair and flexible assessment criterion both for the work-based learning students and for ordinary learners. Therefore, every teacher has been asked to experiment with different assessment criteria as well as methods. There is only one rule – the assessment criteria must be discussed and explained to students and agreed, when possible, at the beginning of the study semester but not later than before the exams.

The assessment model of the master's thesis has already been changed. In the last three years (six defence sessions), IABM has had a permanent thesis defence committee with members only from the industry and other universities (chairman, Professor Jüri Kiho, the University of Tartu; member, Professor Peeter Normak, Tallinn University). First, this committee will assess whether the work is worthy of a master's degree. After that, all the master's theses will be ranked, and the committee sets the grade boundaries. As the committee has previous years' experience, the theses' quality is maintained evenly over the years, however with a moderate upward trend. Such a system also helps set similar requirements for theses and grades in similar university programs. As many members of the committee are top specialists from the industry, the system also helps make sure that the theses topics are relevant to the industry.

SUPPORT SERVICES

The university provides different support services (career, psychological, study counselling, tutoring) for students. In IABM, the aim is to build a supportive learning culture where students are learning hard, are happy, and willing to ask help from fellow students, from teachers, from IABM teaching assistants, and the IABM programme director. IABM has three teaching assistants: Riina Soovik –study programme assistant; Kristina Murtazin – assistant of work-based learning and master theses; Olga Jurkevitš – assistant of Kohtla-Järve study group.

The biggest issue in the IABM programme is a high dropout rate. The measures applied in the study programme to help students graduate are: 1) flexibility in designing one's own study path; 2) work-based learning opportunities; 3) thesis seminars; and 4) a supportive atmosphere. The examples of measures of trying to cultivate a unique "my study programme" culture, both in students and in faculty, are the following traditional annual events: 1) the festive ceremony for the first-year students[114]; and 2) the summer-seminar for the teaching staff. The general topic for discussion was how to improve the quality of teaching materials to better support the students in learning. Last year's seminar was about the professional development and self-determination of the teaching staff. Not all members of the teaching staff participate, but as the goal is not to force, but to motivate and support, the participation of 10-15 lecturers annually is rather good for the first steps towards success.

Other projects and ideas in developing "my study programme" include 1) websites for students and teaching staff; 2) academic-year-end festive event (the business information technology day) to bring together the students, teaching staff, alumni of the study programme and industry; 3) a business information technology yearbook where it is planned to publish the best papers written by students together with teaching staff. The first activity has been described above. The second activity involves restarting the old and forgotten tradition. The third activity is related to integrating learning and research in IABM and making teaching and learning more attractive for students and teaching staff.

[113] M. Prince and R. Felder, "Inductive Teaching and Learning Methods: Definitions, Comparisons, and Research Bases," Journal of Engineering Education, vol. 95, pp. 123-137, 2006.

[114] The 2020 event for first year bachelor's and master's students in the study programme Business Information Technology.

SUMMARY OF STRENGTHS AND AREAS FOR IMPROVEMENT

Strengths

- The IABM study programme:
  - o supports personalised learning paths;
  - o includes work-based learning;
  - o graduates are well-paid professionals;
  - o is popular and well-known among industry and prospective students;
  - o is developing a culture of "my study programme";
  - o has started activities to improve learning and teaching.

Areas for improvement and planned development activities

- In the next 3-5 years:
  - o in order to boost the learning and teaching quality, the goal is to improve the assessment methodology and the know-how of teaching and learning both among students and lecturers;
  - o in order to reduce the dropout rate of students, a supportive atmosphere will be created through several get-together events (e.g. the Business Information Technology day);
  - o in order to motivate students to graduate and write an outstanding Master's thesis and publish thesis results, publishing of the business information technology yearbook is planned.

4.2.3. DEVELOPMENT, COOPERATION AND INTERNATIONALISATION OF TEACHING STAFF

Table 39. Teaching staff of IABM study programme in numbers.

No of courses in IABM	76
No of lecturers in IABM	48
No of female lecturers in IABM	17
No of PhD level lecturers in IABM	28
No of professor level lecturers in IABM	10
No of not Estonian speaking lecturers in IABM	5
No of unique courses in IABM	40
No of lecturers teaching these unique IABM courses	28
No of female lecturers teaching these unique IABM courses	5
No of full-time university academicians teaching these unique IABM courses	19
No of full-time researchers teaching these unique IABM courses	5
No of industry professional teaching these unique IABM courses	4
No of PhD level lecturers teaching these unique IABM courses	16
No of prof. level lecturers teaching these unique IABM courses	5
No of assoc.-prof. (senior lecturers) level lecturers teaching these unique IABM courses	6
No of lecturers, who do not speak Estonian, teaching these unique IABM courses	2

In IABM, the teaching staff are highly qualified and motivated. All the teachers have either a PhD degree, are PhD students or have a strong industrial background. Usually the teaching staff get together once a month for informal discussions. There is a tradition to organise days out of Tallinn for relaxing, professional discussions, and self-development.

All courses are taught by professionally qualified teaching staff who are associated with a scientific research group or have excellent industrial experience (see Annex 11). All research groups from the Department of Software Science are involved in teaching in the IABM study programme or at least in supervising a thesis.

ETHICS

IABM was among the first study programmes in TalTech, who started rooting out plagiarism. The first years were quite hard for students and teachers when the master's thesis defence committee refused to accept theses, where the PlugScan identified incorrect referencing or plagiarism. It was hard, it was painful, but it worked. Currently, all the procedures related to the academic ethics in TalTech have been formalised. All the students' theses and home assignments, including the source codes of software programmes, are checked for plagiarism. All students and academic staff are informed that there is zero tolerance for academic fraud. Every year there are increasingly less cases to solve. Typically, only one or two cases related with first-year bachelor's students a year. In IABM, referencing rules are the topic of the Thesis Seminar I.

MOBILITY

The IABM study programme supports (30 ECTS of free-choice elective courses) students' and teachers' mobility. The employment contract of TalTech academic employees guarantees a free semester once in five years. The Lecturers Grant of the School of Information Technologies provides financial resources for mobility. The total amount of the Lecturers Grant of the School of IT can be up to 10,000 euros. Two years ago, two grants were provided, 10,000 euros each, and a year ago we provided eight grants in the total amount of 60,000 euros. The requirements for awarding the grants are the following: 1) at least 1/3 of the money shall be used to develop a course (e.g., for preparing learning materials); 2) up to 1/3 is intended for international mobility (visiting colleagues at the universities abroad); and 3) up to 1/3 is allocated for the improvement of the working environment (e.g. buying a coffee machine, microwave, fridge). Unfortunately, the SARS-CoV-2 has made some corrections in plans, and all the lecturers had to postpone their mobility plans.

However, the current situation with mobility is unsatisfactory, and a breakthrough is expected to be achieved in 3-5 years. The goal of cooperation with EuroTech Universities alliance in the EuroTeQ Engineering University project (funded by the European Universities Initiative) is to advance virtual Erasmus mobility and a virtual EuroTeQ Campus. The School of Information Technologies already started educational activities towards EuroTech/EuroTeQ by organising visits to EuroTech universities. Such visits have already been made to TU/e (Eindhoven University of Technology) and DTU (Technical University of Denmark). Both visits focused on teaching quality and students' real-life projects in the study programme. Both visits have been influential also in the development of the IABM programme. As a result of the visit to TU/e, cooperation with education researchers from Tallinn University to develop a learning website was started. As a result of the visit to DTU, the publication-based graduation opportunity was launched in IABM and other master's programmes of the School of Information Technologies.

EVALUATION

TalTech has formalised all the evaluation procedures, and it also works well in practice for most cases. In IABM, the programme director conducts evaluation meetings with every lecturer every year. In these evaluation meetings, the topics discussed include students' feedback, successes and challenges in the previous year, plans and expectations of the programme director for the next year. In the IABM programme, it is already a tradition, that (besides the feedback obtained at university level) the study programme director also meets with students of every course at least every semester.

SUMMARY OF STRENGTHS AND AREAS FOR IMPROVEMENT

Strengths

- The IABM study programme:
  - o has a right balance of industry professionals and scholars teaching in the study programme;
  - o most of the lecturers are related to a research group and are active researchers;
  - o during the last five years, there has been a positive cultural change related to the improvement of academic ethics.

Areas for improvement and planned development activities

- In the next 3-5 years, the focus will be on
  - o redesigning and boosting mobility among students and lecturers, especially to EuroTech universities;
  - o academic evaluation and promotion procedures of the academicians, whose main task is teaching must be reviewed and improved (the university's current career policy is not motivating teaching enough);
  - o increasing the number of both PhD level and female lecturers.

Annexes:

Annex 9. Study programme form of Business Information Technology
Annex 10. Descriptions of the key courses of Business Information Technology
Annex 11. Teaching staff of Business Information Technology

4.3. INDUSTRIAL ECOLOGY

Name of the study programme	Industrial Ecology (NAEM)
Study	Master's study
School	School of Engineering (Tartu College)
Programme director	Annely Kuu
Principal complier of the self-evaluation of the study programme	Annely Kuu, Programme Director, Associate Professor
A brief description of the process of self-evaluation of the study programme	The preparation for institutional accreditation was coordinated by the programme director, whose actions were supported by the steering group consisting of Lembit Nei Professor, Director of Tartu College), Katrin Kangur (Coordinator) and Tiit Lepasaar (Councellor). Input for the self-evaluation report was received from both the teaching staff and students through an anonymous survey. Together with the steering group, a schedule was set out; sectoral working groups were formed for preparing the self-evaluation report: • Teaching and learning: K. Lehtme (Director of Studies), Dr A. Kuu (Programme Director/Associate Professor) • Continuing education: Dr A. Kuu, K. Kalda (Public Relations Manager) • Research: A. Kuu, Dr K. Kangur (Coordinator), L. Nei (Professor), Dr Egge Haiba (Senior Lecturer) • Internship: Dr J. Raamets (Lecturer), K. Lehtme • Development: Prof L. Nei, Dr K. Kangur • Financial resources: T. Lepasaar (Counsellor), Prof L. Nei • Mobility: K. Kalda, Prof L. Nei, Dr K. Kangur • Marketing and communication, services to the public: K. Kalda, Dr A. Kuu In November 2020 the self-evaluation report was reviewed by the internal experts of TalTech (Leno Saarniit, School of Business and Governance and Prof Tauno Otto, School of Engineering).

AGGREGATED DATA ABOUT THE STUDENTS OF THE STUDY PROGRAMME

	2017/18	2018/19	2019/20	2020/21
Number of students	44	51	54	42
Number of students enrolled	14	19	23	32
Number of graduates	7	15	9	N/A
Number of dropouts	8	5	3	N/A

Both the number of students and the admission rate have increased since the 2017/18 academic year. The number of graduates in 2019/20 was lower than the number of graduates in the previous academic year, because several master's students were on parental leave in the last academic year. The main reasons of dropouts are family obligations and high professional workload (as most of our MA students work part- or full-time).

4.3.1. PLANNING AND MANAGEMENT OF STUDIES

The goal of Industrial Ecology MSc programme (hereinafter referred as NAEM) is to educate specialists in industrial ecology with a master's degree, who have extensive knowledge and practical skills with regard to understanding the basic principles and implementing various methods of industrial ecology, incl. the principles of circular economy, in enterprises. To this end:

1. the study programme covers the main subjects related to industrial ecology;

2. the study programme covers modern approaches to industrial ecology;

3. the study programme is promoted (e.g. at events aimed at popularising science such as Researchers' Night Festival, and popular science journals such as Jälg ("Track"), various fairs and conferences).

The study programme is topical and essential for Estonia. In 2012, Estonia adopted a Regulation [in Estonian], based on Direc-

tive 2009/125/EC of the European Parliament and of the Council, which requires the implementation of industrial ecology principles in the development of new products. In 2015, the European Commission adopted the Circular Economy Action Plan, which was followed by the European Green Deal in 2019 and the European Commission adopted a new Circular Economy Action Plan on March 11, 2020. Estonia has committed to developing a circular economy strategic document and action plan under the leadership of the Ministry of the Environment by the end of 2021. This means that it is important for the Estonian state and economy to train qualified circular economy specialists who can apply the principles and methods of industrial ecology and circular economy aimed at redesigning products and production processes in enterprises. The specialists are in increasing demand, as evidenced also by the OSKA study (in Est), according to which, as a result of the introduction of the principles of the circular economy, the number of jobs in the waste sector related to waste processing and recycling is increasing. The most important directions in development are resource efficiency, eco-innovation, eco-design and creating industrial ecosystems. The NAEM study programme provides the necessary training for these concepts.

According to the Procedure for Degree Level Programme Management, the appointed programme director is responsible for the development, management and functioning of the study programme. Annely Kuu has been the programme director of the NAEM study programme since September 1, 2018. Previously, the courses were organized into two separate (bachelor's and master's) levels of studies. The specialty courses in Industrial Ecology were brought together under master's studies in 2015. The study programmes with similar structures of reference universities served as an example. The change made to the study programme in 2018 was due to the amendment of the Curriculum Statute, according to which the workload of a course is, as a rule, 6, 9 or 12 ECTS credit points. The members of the programme advisory board, teaching staff, and students are involved in the development of the NAEM study programme. The members of the programme advisory board have recommended the involvement of more professionals from other universities, specialists from outside the College, as well as from other specialities at TalTech. The recommendation has been taken into account (e.g., guest lecturers and professors from TalTech and Estonian University of Life Sciences are involved in teaching the course NTK1600 Material recycling technologies; NTK1560 Environmental Technology Practices in Industrial Ecology).

Estonian and European enterprises and consumers must make greater efforts to move towards circular economy where resources are used more sustainably. Closer cooperation with enterprises is needed to develop a comprehensive study programme, thereby increasing its relevance and necessity. Cooperation is carried out between the Industrial Ecology study programme and the study programmes titled Telematics and Smart Systems and Structural Engineering and Construction Management, but in order to develop the Industrial Ecology study programme, it is necessary to strengthen the cooperation and enhance efforts to involve various ICT solutions and enterprises interested in industrial ecology approach. Student feedback is also considered an important component in the development of the study programme. For example, overlapping topics (microplastics) in two courses (NTK1560 Environmental Technology Practices in Industrial Ecology and NTK1580 Water Pollution and Protection) was pointed out, the topic is now discussed in the NTK1580 Water Pollution and Protection. The graduates of the Industrial Ecology study programme are both prepared and motivated to pursue a doctoral degree at TalTech (Egge Haiba, 2017; Jane Raamets, 2020) or other universities in Estonia, or abroad. The programme director organises meetings with the teaching staff of the Industrial Ecology working group once a month or more frequently, if necessary; current problems in the Industrial Ecology working group are solved in MS Teams. The research and development activities of the teaching staff are reflected in their teaching assignments (Aija Kosk who teaches the course titled NTK1470 Practical Environmental Economics is a specialist in ecosystem services, environmental management; Egge Haiba - NTK1580 Water Pollution and Protection - pharmaceutical residues; Annely Kuu- NTK1560 Environmental Technology Practices in Industrial Ecology - recultivation of quarries). This gives students the opportunity to participate in the research and development activities carried out by the teaching staff to write a graduation thesis, and it improves the teaching staff's competence in the field.

The objectives, learning outcomes, content of studies, teaching methods, and assessment criteria and methods of the NAEM study programme comply with the Academic Policies of TalTech. The logical sequence and coherence of the courses is in accordance with the Curriculum Statute, the topics covered in the courses are reviewed annually, the sequence of the lectures and homework are agreed upon and if a course is taught by several members of the teaching staff, the order of presentations and topics are agreed upon. The aim of the general studies module is to provide general knowledge (NTK1550 Entrepreneurship; NTK1610 Introduction to Scientific Research and Academic Self-Expression); the core studies module provides additional in-depth knowledge in the fields necessary for the acquisition of the speciality of industrial ecology as well as for industrial ecologists working in enterprises; the aim of the speciality module on technology is to provide knowledge in technology-related fields necessary for the successful acquisition of the industrial ecology speciality. The aim of the module on industrial ecology is to create conditions and opportunities for acquiring the basic principles of industrial ecology and a methodological framework for the tools used in industrial ecology. The abovementioned modules are complemented by elective course modules, the aim of which is to provide an opportunity to acquire in-depth knowledge and skills in the field of industrial ecology. To enhance knowledge and skills in the areas related to the Industrial Ecology MSc programme and to broaden the general worldview of students, an optional studies module is provided, which enables a student to select courses not included in the study programme. The study programme supports students' creativity and entrepreneurship skills by teaching the courses titled NTK1550 Entrepreneurship, NTK1470 Practical Environmental Economics and NTK1440 Design for Environment. The knowledge acquired based on all these modules is applied towards a graduation thesis, which consists of an analysis of and solution to a specific problem in the field (see Annex 14). The common goal of the study programme modules is to train industrial ecologists with a master's degree who have acquired the knowledge and practical skills required for the implementation of various methods of industrial ecology in enterprises with the aim of increasing resource efficiency of the production process, reducing the environmental impacts of production, and minimising the flow of materials and energy, and who are able to conduct cooperation and manage in the field of sustainable development at the level of an individual company in Estonia and internationally. In order to achieve these goals, the teaching staff collaborate closely by discussing the topics covered in the courses, avoiding overlapping topics and taking new trends in industrial ecology into account.

Many Estonian higher education institutions teach various specialities related to environmental protection, but the speciality of industrial ecology is not taught at either the master's nor at bachelor's level. However, the transition of enterprises to a new circular economy business model requires the training of versatile specialists who have, in addition to professional knowledge

in industrial ecology, the ability to commercialise their ideas in line with the company's strategic goals and responsibilities. In order to ensure the flexibility and competitiveness of the study programme, in Estonia and internationally, the NAEM study programme is regularly (2017, 2020) reviewed and compared with similar study programmes in Europe, and continuous cooperation is carried out with universities abroad (e.g., Lappeenranta-Lahti University of Technology (LUT University, Finland), ITMO University (St. Petersburg, Russia); the University of South Florida (USA); Sumy State University (Ukraine), the University of Oxford (UK), Michigan State University (USA).

The most similar study programme is the Industrial Ecology master's programme taught at the Chalmers University of Technology (Sweden), which is characterized as an engineering approach to environmental and resource efficiency issues. Both the NAEM and Chalmers's study programmes are based on product life cycle assessment and material flow analysis, but the NAEM study programme includes more technical courses (e.g., NTK1600 Material Recycling Technologies; NTK1560 Environmental Technology Practices in Industrial Ecology). The master's study programme of the Norwegian University of Science and Technology contains a package of industrial ecology methods (e.g., life cycle assessment, material flow analysis, resource efficiency analysis, etc.) and its goals and learning outcomes are similar to the ones of the NAEM master's programme. The Environmental Engineering (specialisation in Environmental Management) study programme taught at the Technical University of Denmark focuses on sustainable development. The share of technical courses of the study programme taught at the Technical University of Denmark is smaller compared to the NAEM study programme. The Nordic Master in Environmental Engineering programme taught at Aalto University is more focused on the environment and environmental technology; it partially coincides with the technology module of our study programme. The Delft University of Technology is another university in Europe which teaches Industrial Ecology; a comparable study programme is Renewable Energy Systems. Compared to other European universities, direct parallels can be drawn between the NAEM study programme and the study programmes taught in Chalmers, Norway and Denmark, in particular in terms of the content, structure and learning outcomes. The analysis of other study programmes used in the comparison showed a difference in the learning outcomes: the TalTech's NAEM study programme is also based on the life cycle, material flows and ecodesign, and a graduate of the Industrial Ecology master's programme has acquired more engineering-oriented knowledge required for qualifying as an industrial ecology specialist.

The adjustment of physical and financial resources to the changing needs (e.g., the number of students) is ensured by regular funding allocated to the department and at the disposal of the College and the programme director to finance the development of the study programme. The purpose of the funding is to support the involvement of lecturers from outside the institution, e.g., NTK1600 Material Recycling Technologies- Tiia Plamus (TalTech), Kaarel Soots (Estonian University of Life Sciences), Margit Olle (Estonian Crop Research Institute); NTK1560 Environmental Technology Practices in Industrial Ecology - Siim Küünal (DioTech); NTK1510 Production Processes and Logistics – Toomas Tiirik (AS A. Le Coq); Rain Piirsalu (OÜ Thermoarena), Hannes Luts (OÜ Locosmart); purchasing of teaching materials and equipment and services and organising study tours e.g., to AS Estonian Cell, Kunda Nordic Tsement AS, AS Eesti Energia, AS O-I Production Estonia (former Järvakandi Klaas), AS A. Le Coq, AS Vireen, Tallinna Jäätmete Taaskasutuskeskus AS etc.). Internal project-based funding has been used for development projects carried out in cooperation with the Telematics and Smart Systems study programme (The Development and Testing of Drone-based Technologies for Remote Sensing of the Environment and Buildings in the Industrial Areas of North-Eastern Estonia; Eco-friendly and Smart Solutions for Using Recycled Materials in Construction), and for the development of the study materials and creating the material and technical base of the Industrial Ecology (NAEM) study programme. Generous funding (more than 150 thousand euros) from our university has been allocated in recent two years with the aim of updating the infrastructure of the Industrial Ecology MSc programme, including establishing a dedicated Industrial Ecology lab at Tartu College, updating teaching infrastructure and workspaces for students. The Industrial Ecology Laboratory was established to ensure cooperation and development opportunities for students, companies, and other stakeholders. To ensure further integration of technical fields, it is necessary to further enhance cooperation with the Telematics and Smart Systems and Structural Engineering and Construction Management study programmes.

The NAEM study programme and Tartu College follow the principles of environmental protection and sustainable development, which is also reflected in the courses of the Industrial Ecology study programme (e.g., NTK1540 Sustainable Development and Global Problems, NTK1490 Energy Consumption and Resources, NTK1440 Design for Environment, NTK1630 Sustainable Living, NTK1600 Material Recycling Technologies). Paper handouts are used to a minimum extent and study materials are available electronically in the e-environment (Moodle). Within the premises of Tartu College, at Puiestee 80A, a utility system that allows the improvement of the indoor climate and energy saving is present. In the computer classroom (A202) and lecture room (A104), the room thermostats are used for room heating control. In the corridor of the II floor and in the classrooms A104 and A105 in the building at Puiestee 80 A, the Osram fluorescent tubes were replaced with modern LED tubes, resulting in about 50% of energy savings. The lighting control systems of both the classrooms and the corridor have sensors to detect the movement of people and adjust the intensity of light in accordance with the available natural light. Tartu College sorts the waste generated in the course of work as required.

Tartu College has actively created opportunities for students to study independently (room C101, the college library, rooms for independent work and group work). The facilities have relevant needed equipment (computers and a printer with a scanner). Due to increase in the number of students and based on student feedback (feedback surveys are conducted twice a year) more opportunities have been created for independent work. A dedicated seminar room (A103, capacity of 12-15 people) is available for students and teaching staff, in addition to the multimedia classroom (A204, capacity of up to 30 people), with most up-to-date technical solutions for interactive remote and distance learning. The library collections have been updated with the lending collection of professional literature. Materials can be borrowed from the library and TalTech master's theses are publicly available in the digital collection of the TalTech library. To make sure that the material is up-to-date, the library can map the needs of the teaching staff and inform of the latest professional literature and, if necessary, order the corresponding literature.

SUMMARY OF STRENGTHS AND AREAS FOR IMPROVEMENT

Strengths

• The Industrial Ecology study programme taught at TalTech's Tartu College follows the example of the study programmes with similar structure taught at leading European universities. It is an extremely important field in the Estonian and European context lacking competent circular economy experts. The Industrial Ecology study programme is competitive as it trains the required experts.

• The courses correspond to the needs of society and the study programme is interdisciplinary, involving conceptual methods and requiring knowledge and skills in economics, management, engineering and environmental sciences.

• The research and development activities of the teaching staff are reflected in their teaching. The teaching staff make sure that the topics covered in the study programme are up-to-date, and they introduce the latest scientific developments in their courses.

• The students are involved in research and development, incl. research conducted in the Industrial Ecology as well as in the Drones Lab.

Areas for improvement and planned development activities

• Cooperation with the private sector companies shall be further enhanced; their representatives should be more involved in teaching (they should be encouraged to introduce their companies and company-specific technologies) as well as in development (using their feedback provided in the internship course).

• To ensure further integration of technical fields, cooperation with the Telematics and Smart Systems and Structural Engineering and Construction Management study programmes should be enhanced.

4.3.2. LEARNING, TEACHING AND ASSESSMENT

The admission requirements and procedure ensure equal access to education and enrolment of motivated students. Students' prior knowledge and motivation is assessed with a professional proficiency test. The test is compiled by an ad hoc admissions sub-committee consisting of 3 members. The deadlines for the test are in May and July, and the answers of the tests are assessed by at least two people. Information days are organized for potential students; the representatives of the College have actively participated in several regularly held professional conferences (e.g., Circular Economy Conference, Everything Food Conference, Oil Shale Conference); the programme director answers all questions raised by incoming students. The College awards a one-time scholarship to the top five students with the highest admission test scores to support the commencement of their studies.

Student-centred approach is applied in studies, considering the student's individual abilities and needs (e.g., most lectures are recorded and can be viewed later). An individual action plan is prepared for students doing their internship abroad. In order to compensate for the different level of prior knowledge of the entrants, the teaching staff provides additional materials and helps if needed. Most of the courses of the study programme have e-support (i.e., all compulsory courses and three out of the four elective courses are supported with Moodle), allowing the availability of both compulsory and recommended study material at any time. The online environment allows students to take part in studies even in situations when they cannot attend the classes (due to SARS-CoV-2 or any other reason). A student can select optional courses from other universities or within the university (the minimum of 6 ECTS credit points) and, in cooperation with the programme director and the study manager, a student can also choose elective courses from other universities, making sure that the learning outcomes and goals of the course meet the requirements of the NAEM study programme. If students have any problems related to their studies, they can turn to the lecturer, the study manager, the programme director, or the director of the College. Recently (in the academic year 2019/20) TalTech opened the peer tutoring programme, which Tartu College will join after it has completed the required training.

The teaching staff regularly provide students written or oral feedback on their homework assignments. Since 2018, students can evaluate the effectiveness of feedback in the feedback survey. The feedback survey includes a statement "The lecturer provided relevant and timely feedback to my studies" and the average rating provided in the survey was 4.81 in the academic year 2018/19 and 4.71 in the academic year 2019/20. However, this is an area that can be improved by cooperating with the students and agreeing on reasonable deadlines and the form of providing feedback.

As regards the supervision of graduation theses, the teaching staff and the students agree on the best solution for them (online and/or regular meetings). Many of the students' graduation theses are related to the research and development or creative activity of the teaching staff. For example, Aija Kosk (environmental management) - Kaisa Aadna; Annely Kuu (soil fauna, recultivated quarries) - Inga Maršalok; Egge Haiba (composting sewage sludge) - Päivi Ojala; Mari Ivask and Lembit Nei (studies on the environmental status and environmental protection) - Jüri Järvis, Egge Haiba, Jane Raamets. In order to enhance the research activities of the teaching staff, there is a coordinator Katrin Kangur at the College, who informs about possible funding opportunities and provides assistance in the application process (SEA2LAND - Annely Kuu (mesofauna), Jane Raamets, Laura Lokko (microbial activity and biomass); KIK16009 - Lembit Nei, Egge Haiba (the degradation efficiency of pharmaceuticals and personal care products in sewage sludge composts); KIK20033 – Lembit Nei, Egge Haiba, Annely Kuu, Laura Lokko (Optimisation of sewage sludge composting technology with aim of more efficient degradation of pharmaceutical residues); H2020 project 945307 eMOTIONAL Cities - Lembit Nei; pending PRG1543 and KIK20114 - Annely Kuu, Lembit Nei and Egge Haiba (pharmaceutical residues in sewage sludge). For the purposes of research transparency and in order to attract interest for possible cooperation, the research projects and the areas of specialisation of the teaching staff are introduced on the College website. Teaching staff from other study programmes at Tartu College are involved in the NAEM study programme: Dr Aime Ruus, Kristo Kalbe, and Rinaldo Rüütli (NTK1560 Environmental Technology Practices in Industrial Ecology); Dr Ernst Tungel (NTK1640 Analysis of Mathematical Data in Industrial Ecology); Dr Nele Nutt (NTK1600 Material Recycling Technologies). Tartu College has an environmental technology lab, a chemistry lab, and an industrial ecology lab. Academic staff involves students in fieldwork within the framework of research and development projects.

The teaching methods used include lectures, seminars independent homework (essays, reports, problem analysis and solutions), tests, group work, watching video materials, tours, etc. The assessment methods used in the NAEM study programme are an oral or written examination, credit test, an essay, a report, teamwork, a questionnaire, and others. The final grade can be calculated as a total of different components (e.g., homework, test, exam, credit test) or based only on an examination or credit test at the end of the study period. As a rule, the final grade is

formed of different components (homework + exam/credit test). For example, in the NTK1600 Material Recycling Technologies course, the prerequisite for taking an exam is the completion of a practical home assignment on a given topic, which constitutes an elaboration of the home assignment completed in the course titled NTK1570 Industrial Ecosystems taught in the 2nd semester. In the NTK1560 Environmental Technology Practices in Industrial Ecology course, the prerequisite for taking a credit test is the completion of a home assignment, which constitutes a problem solution; students get input for the home assignment from the course titled NTK1490 Energy Consumption and Resources. The assessment methods to verify the achievement of the learning outcomes, the assessment criteria and procedure, incl. the principles of determining the final grade if several methods are used for the assessment, are specified in the course descriptions, and are introduced by the teaching staff in the first lecture. In certain cases (e.g., if the student is on an internship / sick leave), students can agree with the teaching staff and complete a course by doing additional homework assignments.

A student's prior learning and work experiences can be counted towards the completion of the programme (APEL). The Manager of Studies, Kaie Lehtme, provides students with advice on APEL and in the NAEM study programme APEL has been applied to complete the courses titled NTK1550 Entrepreneurship and NTK1470 Practical Environmental Economics.

In the NAEM study programme, internship plays an important role in acquiring the speciality as well as in writing a master's thesis - several masters' theses have been written based on the experience gained during internships. Between 2015 and 2020, a total of 65 students completed master's internship. Students find internship hosts themselves. The university's internship supervisor (Jane Raamets) as well as the manager of studies and programme director provide advice and, if necessary, assistance to students in finding an internship host. The workload of internship is 6 ECTS credit points, i.e., 156 hours or at least four weeks of internship. The average length of internship is 9 weeks. A total of 31% of the students have done their internship in the same company where they work, but in the course of internship they should get acquainted with the entire company. One student has completed his internship abroad (Romania). In the last five years, several public sector institutions like the Estonian Environmental Inspectorate, Estonian Environmental Board and Agricultural Registers and Information board have hosted our students' internship. The Estonian Environmental Inspectorate has hosted the biggest number of interns (11 students), followed by the second most popular Estonian Environmental Board (4 students). Three students have completed their internship in the Agricultural Registers and Information Board. AS Click and Grow, Hendrikson & KO, AS Ragn Sells, Viru Keemia Grupp are important internship hosts from the private sector. Student feedback on the organisation of internships has been positive; students have the opportunity to do their internship for a longer period of time, or to do their internship in several different institutions or companies. Feedback from entrepreneurs provides the College guidance on better organisation of internship and information on the compliance of the study programme with the labour market needs. The strengths pointed out include students' ability to adapt quickly, their broad-mindedness and in-depth knowledge as well as good organisation of internship by the university. The entrepreneurs have pointed out the lack of the knowledge of legislation as a weakness and have recommended providing more information on legislation and the teaching staff have taken this seriously by adding discussion materials in the courses titled NTK1510 Production Processes and Logistics; NTK1580 Water Pollution and Protection; NTK1490 Energy Consumption and Resources; NTK1470 Practical Environmental Economics.

Students have opportunities for mobility within Estonia (the studies take place every other week, optional study module) and for international mobility (ERASMUS). TalTech's Mobility Centre regularly organises events on studies abroad. Tartu College supports its students in finding and making use of various mobility opportunities. An Erasmus student exchange coordinator (Kai Kalda) is employed at the College, with whom students can make an appointment and discuss the opportunities offered; the College regularly provides information on specialised events and opportunities for international mobility. The students of the NAEM study programme can choose from among a number of different programmes to go study abroad as an exchange student. All information about the possibilities and requirements is published on the TalTech website. Students have the opportunity to choose the courses with the approval of the programme director. In order to ensure that students and teaching staff gain international experience, cooperation has been launched with universities abroad: Lappeenranta-Lahti University of Technology LUT, ITMO University (St. Petersburg) and Sumy State University (Ukraine). The College has signed cooperation agreements to exchange students and the teaching staff under ERASMUS+ programme also with Michigan State University and the Seinäjoki University of Applied Sciences (Finland). In 2017/18, our students studied under international mobility programmes in the Czech Republic (Czech University of Life Sciences), Germany (Georg-August-Universitat Gottingen), the USA (University of New Mexico) and Spain (Polytechnic University of Catalonia). One student spent six months in Bulgaria within the framework of the ERASMUS+ funded project CLEAN UP! As regards the mobility of master's students, it must be noted that they are adults with work and family obligations, which is why Tartu College has set a goal to explore and provide shorter-term mobility opportunities, primarily with our cooperation partners in Finland and St. Petersburg.

In order to reduce/prevent academic fraud, TalTech has established the Principles of Academic Ethics, with which both the teaching staff and the students are familiar. As a rule, the teaching staff inform students on the grading criteria and the perils and consequences of academic fraud at the beginning of the first lecture. As of 01.01.2020, no academic fraud has been detected in the NAEM study programme. Every year the teaching staff of the NAEM study programme inform students that their (home) assignments are randomly scanned using the Ouriginal plagiarism checker with an aim to examine the independent assignments. The test and examination questions are designed to minimise the potential for academic fraud.

There have been no bullying or harassment cases at the College. A student can always turn to the programme director, manager of studies, or the College director with such a problem and TalTech also created opportunities for notifying of problems by establishing the Procedure for Whistleblowing and Verification of Whistleblowers' Complaints in 2019.

The main reason for discontinuing studies in the NAEM study programme has been the inability to balance work, family life and studies, which is why students have been unable to commit adequate time to studies. In admission counselling and admission interviews attention is drawn to these issues, so that incoming students can better assess their possibilities and workload.

Public Relations Manager (Kai Kalda) has created a Facebook alumni group. Communication with and between the alumni is also important for creating new opportunities for collaboration and internships. Two of our alumni - Merilin Keerme (currently working at Viru Keemia Grupp, Head of the Environmental Department) and Dagny Kungus (currently working at Ministry of the Environment, Environmental Management Department) are the members of the Industrial Ecology programme advisory board.

SUMMARY OF STRENGTHS AND AREAS FOR IMPROVEMENT

Strengths

• To make sure that the students are adequately qualified and motivated, a professional proficiency test is conducted upon admission.

• The flexible form of study makes it possible for working students to study and allows applying for the accreditation of prior and experiential learning (APEL) towards the completion of the study programme.

• Students are involved in the research and development activities carried out by the teaching staff.

• An internship in enterprises helps to acquire the speciality and gives students an opportunity to write a master's thesis.

Areas for improvement and planned development activities

• More involvement from students in order to improve the provision of timely and efficient feedback.

• To encourage alumni to give feedback, annual surveys should be conducted and alumni should be encouraged to stay involved in teaching by inviting them to talk about their experiences and work in the field.

• To reduce the dropout rate, students' support systems (counselling, regular meetings with the programme director) should be developed further.

4.3.3. DEVELOPMENT, COOPERATION AND INTERNATIONALISATION OF TEACHING STAFF

The qualifications of the teaching staff in the NAEM study programme comply with the Standard of Higher Education, Academic Career Management and are evidenced also by their publication indicators. For example, Annely Kuu (h-index 9, sum of timed cited 782); Lembit Nei (h-index 12, sum of timed cited 426); Mari Ivask (h-index 11, sum of timed cited 427). The programme director is responsible for the annual analysis of the performance and feedback indicators of the study programme in the SIS. The analysis of annual student feedback on the lowest and highest rated courses and student feedback on the teaching staff forms a part of the self-evaluation of the study programme. For example, in the academic year 2018/19, the following courses received the highest average score: NTK1570 Industrial Ecosystems (4.83) and NTK1560 Environmental Technology Practices in Industrial Ecology (4.97). The following courses received the lowest average score: NTK1470 Practical Environmental Economic (4.78) and NTK1580 Water Pollution and Protection (4.67), but these are still very high scores. In the academic year 2019/20 the course NTK Water Pollution and Protection received the average score of 4.81. Students give feedback on the teaching staff twice a year, whereas the most important information is reflected in the comments. Based on students' comments, e.g., Jane Raamets has added homework in the courses NTK1490 Energy Consumption and Resources, NTK1510 Production Processes and Logistics to support coherence between the courses. The assessment system has also been made more flexible (there is not only an exam anymore; homework, class assignments must be completed before taking an exam). She has also changed the topics covered at the lectures based on the feedback to prevent overlapping topics and to meet students' interests. To improve the transparency of assessment, Jane Raamets has introduced clear assessment criteria and provides verbal feedback on the work. The results of the feedback are analysed at an annual appraisal interview. The average score given to the teaching staff in feedback is very good - 4.71 on average. Many members of the teaching staff the NAEM study programme have received the Best Faculty Member Award (Jane Raamets, Egge Haiba). In 2020, Jane Raamets received the best lecturer activity grant. In order to improve themselves, the teaching staff have the opportunity to attend online didactics lectures in the Estonian Centre for Engineering Pedagogy at TalTech and choose from among internal trainings or trainings provided in other universities. For example, Egge Haiba has obtained the International Engineering Educator "ING.PAED. IGIP" Certification; Annely Kuu has completed the continuing education course Fundamentals of Psychology at the Institute of Psychology SVPH.TK.067 (2020) and Basic Training for Mentoring (2018) at the University of Tartu.

In the last three years, visiting lecturers from other Estonian higher education institutions have participated in conducting the studies, e.g., Aivar Pere (NTK1550 Entrepreneurship - 6 ECTS credit points) from the University of Tartu and Pille Mötsmees (NTK1390 Management Psychology - 6 ECTS credit points). Pursuant to §23 of the Academic Policies, the supervisor of a master's thesis can be from outside the university, provided that the supervisor has at least a master's degree. In this case the university appoints a co-supervisor from the university who is a member of TalTech staff. One of the responsibilities of the co-supervisor is to monitor the effectiveness and quality of external supervision, agree with the external supervisor on the tasks that need to be supervised. If the external supervisor should discontinue supervision for any reason, the co-supervisor shall complete the supervision. Such co-supervision ensures a more uniform level of supervision. In the NAEM study programme, there have been supervisors from outside Tartu College, e.g., from ABB and co-supervisors from TalTech the Department of Civil Engineering and Architecture ("Environmental Performance Evaluation in ABB AS Compact Secondary Substation"), the Institute of Social Studies of the University of Tartu ("Adaptation to climate-induced health risks in Estonia: challenges for health care and rescue systems") and the Institute of Chemistry of the University of Tartu ("Free water content measurement in sewage sludge by thermogravimetric methodology"). In the NAEM study programme, often the members of the teaching staff from other Estonian higher education institutions or the representatives of employers are involved as opponents of the graduation theses (e.g. "The impact of psychosocial risk factors on the employees of Tartu College of Tallinn University of Technology", reviewer environmental specialist from Hendrikson & KO; "European Union waste legislation and its influence in Rapla County", reviewer from the Estonian Environmental Inspectorate; "State supervision of enterprises with major hazard and dangerous enterprises and cooperation between authorities", reviewer from Estonian the Academy of Security Sciences, etc.).

Making new contacts and effectively building a network of contacts both in teaching and research is a priority for Tartu College. The members of the teaching staff regularly participate in specialised conferences; Professor Lembit Nei has worked as a visiting Professor at Oxford University and Michigan State University, he is National Coordinator of the European Biotechnology Thematic Network Association. Cooperation has been carried out with the composting technologies expert S. L. Maksimova (National Academy of Sciences of Belarus, Department of Biological Sciences), Professor Mari Ivask is a member of a working group of the COST Action. External reviewers, who also provide advice on

the development of studies, have been involved as opponents of the PhD theses. We have an effective cooperation with Professor Henry Alegria from the University of South Florida: he has hold a Fulbright Scholarship at Tartu College for 3 months. Another good long-term collaboration partner is Prof. Richard Compton (Oxford), together with whom we have planned to study the phytoplankton community structure. Our adjunct professor Zenia Kotval is holding professor's position at Michigan State University, but regular advice and support from her side is permanently secured. Recently we have established collaborative links with Sumy State University via ERASMUS+ Programme (professor Nadiia Demikhova), but due to the current travel restrictions the relevant exchange visits have been postponed).

Every year, an appraisal interview is held with the members of the teaching staff, where their expectations and needs regarding their self-development are considered and mutual feedback is given on performance. The students' feedback on the teaching staff is analysed, the areas of improvement and students' comments on the teacher are discussed. At appraisal interviews, the expectations and needs of the members of the teaching staff are mapped (the appraisal interview includes a point - training needs). The interviews have shown that the teaching staff need complementary knowledge in didactics. It would be rational to identify the training and development needs of all the members of the teaching staff of the College in the teaching staff development plan and, with the consent of the programme directors (Annely Kuu, Helle Hallik, Aime Ruus) make available additional development trainings for the College's teaching staff. For example, one of the opportunities for the development of the teaching staff is the TalTech's Open Lectures Week, which enables the teaching staff to receive feedback from colleagues. Tartu College supports versatile self-improvement of the teaching staff (e.g., TalTech internal trainings). Use of digital technologies is encouraged and the university has made a significant contribution to this; the teaching staff of the NAEM study programme have actively used educational technology services and participated in continuing education courses (Digital Wisdom course - Jane Raamets (2019), Annely Kuu (2019), Kai Kalda (2020); Conducting Webinars - Egge Haiba (2020); Use of Smart Devices in Teaching - Jane Raamets (2018) etc.). The New Teaching Staff Information Days are held regularly for novice teaching staff; the coordinator of Tartu College informs new employees of work arrangements (intranet, working and rest time, health promotion services, etc.) at TalTech; the manager of studies and the programme director inform the new employees of the organisation of studies. Kai Kalda helps novice teaching staff in creating a course in Moodle; in matters regarding the assessment methods and structure of a course, a novice teaching staff can turn to the programme director and other members of the teaching staff.

In order to motivate and encourage the teaching staff, the Procedure for Recognizing Tartu College Employees (in Est) and the TalTech Acknowledgement Procedure have been established. In addition, Tartu College regularly organises seminars/tours to cooperation partners (e.g., Räpina School of Horticulture in 2019), which fosters communication between the members of the teaching staff of different working groups, development of ideas and problem solving. The working groups of the College collaborate closely, e.g., Annely Kuu teaches the course RAH1340 Basics of Research to the students of the main speciality of Cyber-Physical Systems in the study programme Telematics and Smart Systems, Kai Kalda and Jane Raamets teach the Digital Literacy course to the first-year students of the main speciality of Cyber-Physical Systems in the study programme Telematics and Smart Systems.

The teaching staff of the NAEM study programme participate in professional networks, cooperate with partners (Jane Raamets is a member of the International Society of Indoor Air Quality and Climate, International Society for Industrial Ecology; Estonian Educational Personnel Union; Egge Haiba - Estonian Water Works Association; Annely Kuu is a member of Estonian Academic Agricultural Society; Lembit Nei –is the coordinator of the European Biotechnology Association EBTNA for Estonia, etc.). Several faculty members (e.g., Egge Haiba; Annely Kuu) supervise students within the framework of their research activities (pharmaceutical residues, soil fauna, etc.). Since 2018, Katrin Kangur has been working at the College as a coordinator, with whose assistance the teaching staff have contributed more to writing research and development projects. Research and development can be enhanced, and more visibility could be achieved by providing more information on the activities of the research group of Environmental Technologies on the College's webpage and by strengthening cooperation between the college's study programmes and between enterprises and the college/university. The teaching staff of the NAEM study programme are also involved in popularizing the speciality (e.g., publishing in the popular science journal Jälg, TalTech's journals Mente et Manu, Studioosus, participating in Researchers' Night Festival, and offering various workshops for upper secondary school students).

SUMMARY OF STRENGTHS AND AREAS FOR IMPROVEMENT

Strengths

• The teaching staff are highly valued by the students.

• Possibilities and skills to use digital technology.

• The teaching staff are actively engaged in professional development.

Areas for improvement and planned development activities

• A training plan shall be drawn up in collaboration with other programme directors of the college and mutual training needs of the teaching staff shall be mapped.

• The share of teaching staff with a doctoral degree needs to be increased.

• Cooperation and the communication network with Estonian and other international universities should be strengthened (visiting lectures and lecturers, public presentations).

• Connections with professional associations directly involved in circular economy should be strengthened.

Annexes:

Annex 12. Study programme form of Industrial Ecology

Annex 13. Descriptions of the key courses of Industrial Ecology

Annex 14. A chart illustrating the interconnections between modules/courses of the Industrial Ecology

Annex 15. Teaching staff of Industrial Ecology

4.4. INDUSTRIAL ENGINEERING AND MANAGEMENT

Name of the study programme	Industrial Engineering and Management (MARM), ENG
Study	Master's study
School	School of Engineering
Programme director	Prof. Kristo Karjust
Principal complier of the self-evaluation of the study programme	Prof. Kristo Karjust (Programme Director, Professor, Director of the Department of Mechanical and Industrial Engineering)
A brief description of the process of self-evaluation of the study programme	The self-evaluation report was compiled mainly by the programme director during the period from August to October of 2020. The self-evaluation report was discussed at the meeting of the programme advisory board on 22.05.2020 and the strengths and areas for improvement of the study programme and courses were discussed separately with the students in May-June 2020. Mihkel Mägi and Kerd Kaarus formulated students' views. Feedback and development ideas were also asked from visiting lecturers from the companies. In November 2020 the self-evaluation report was reviewed by the internal experts of TalTech (Prof Jakob Kübarsepp, School of Engineering and Katre Koit, Estonian Maritime Academy).

AGGREGATED DATA ABOUT THE STUDENTS OF THE STUDY PROGRAMME

	2017/18	2018/19	2019/20	2020/21
Number of students	44	54	50	57
Number of students enrolled	22	15	23	27
Number of graduates	17	20	19	N/A
Number of dropouts	8	10	6	N/A
Number of international students	24	23	22	11

The number of students in the study programme has remained more or less the same, in the range from 54 to 64. The number of students enrolled has also remained the same (15-28) in order to ensure the quality of teaching and access to well-equipped and modern study laboratories.

4.4.1. PLANNING AND MANAGEMENT OF STUDIES

PROGRAMME DEVELOPMENT AND MANAGEMENT

The master's programme Industrial Engineering and Management has been developed in cooperation with University-Consortium for Science and Technology BALTECH, initiated in 1997 by the Rectors of seven universities of the Baltic States and Sweden. Currently, the study programme is running simultaneously in 4 universities in Sweden, Latvia, Lithuania and Estonia, which means that it is easy for students to move between partner universities. At TalTech, the study programme is run in cooperation between the School of Engineering and the School of Business and Governance.

As the study programme contains technical and economic specializations, all technical courses are combined with economic and social courses to prepare internationally competitive managers for industry (head of factory, production manager, production engineer, quality manager, development manager, etc.). The study programme focuses on the following topics: Digital Manufacturing, Production Engineering - Planning and Control, Strategic and Financial Management, Supply Chain Management, Quality Management, Rapid Product Development, Production Planning and Management, Internet of Things for Industry and Innovation. The key words for the present situation worldwide are production globalisation, international and local cooperation, and a dynamic market. The study programme aims to prepare engineers who will be experts not only in a particular field of engineering but who also have the skills required for company management. The concepts of design, development and management of integrated systems of people, information, equipment and materials are included in the study programme. Graduates of the programme can work in any field, starting with manufacturing and ending with retail.

The development of the study programme Industrial Engineering and Management is coordinated by the programme director in cooperation with the programme advisory board, the School of Engineering and the School of Business and Governance. The programme advisory board includes representatives of potential employers, professors/lecturers and student representatives. Employers, e.g. Baltic States Festo Oy and Harju Elekter Elektrotehnika AS, are involved as external experts. In addition, there is close cooperation with various professional associations (e.g. the Federation of Estonian Engineering Industry), together with

whom joint seminars and workshops are conducted. The programme advisory board carries out regular internal evaluation (one or two times a year) of the study programme. Based on the evaluation results, various changes have been made to the modules of the study programme, such as changes to the structure of the modules and courses.

The content of the courses is constantly evolving along with the emergence of new and useful technologies and needs of manufacturing companies (close annual communication with the Federation of Estonian Engineering Industry). As regards the field of manufacturing, top-level specialists from several enterprises (e.g. specialists from Ericsson Eesti AS, ABB, IMECC, etc.) are regularly involved in delivering lectures and conducting practice classes/training sessions of a course. The feedback provided by visiting lecturers on the content of the courses and organization of studies has been taken into account in the development of the study programme (for instance, changes have been made to the time and place of the courses, changes to learning outcomes, etc.). Besides manufacturing companies, there is close cooperation with MEKTORY. For example, cooperation is carried out in various course projects using MEKTORY's infrastructure and equipment (the mechanical engineering lab).

The courses (e.g. IoT, Production Digitalization and Production Process Optimization) in the study programme are very closely linked to the research and development carried out by the teaching staff. See Annex 19, e.g. Prof. Kristo Karjust (Interreg project INforM, automation projects of the Technology Competence Center), Prof. Martin Eerme (business agreements in the field of product development), Prof. Tauno Otto (Eramsus + projects related to the developments of virtual smart factory and Industry 4.0), Senior Researcher Raivo Sell (the self-driving car Iseauto).

STUDY PROGRAMME

The study programme has been built on new technologies (IoT, Industry 4.0, Production Digitalization, etc.). A wide range of elective courses helps students design their own study path in accordance with their interests and needs (see Annex 18 and Table 40). The modules of Business Management and Operations Management are based primarily on economics and management courses and the modules of Technology-based Enterprise and Industrial Engineering are based on engineering and technology courses.

Table 40. General structure of the study programme Industrial Engineering and Management (source: SIS)

Main speciality	Module	ECTS	
General studies	Business management	18.0	Management related
Core studies	Technology-based enterprise	18.0	Engineering related
Special studies	Operations management	24.0	Management related
Special studies	Industrial Engineering	24.0	Engineering related
Free choice courses		6.0	
Graduation thesis		30.0	Engineering and Management related
Total		**120.0**	

If a student wants to study abroad for a semester or a year, he/she must agree his/her options with the APEL adviser. This guarantees that the credit points received abroad are eligible for the student's study programme. Since the study programme Industrial Engineering and Management is developed in cooperation with the universities mentioned above, it is easier to go on student exchange to the partner universities, as then the students can take exactly the same courses as in TalTech.

In the last 4 academic years, the number of students participating in student mobility has been 1-3 students a semester, i.e. 5-15% of the students. The study programme is international (the language of instruction is English) and aimed primarily at recruiting international students in Estonia.

In May 2019, an international double master's degree agreement between Vilnius Gediminas Technical University and Tallinn University of Technology was signed. The first students from VGTU came to study to TalTech in 2019/2020. As the language of instruction of the study programme Industrial Engineering and Management is English, a large number of international students is participating in different courses of the programme. In order to expand student mobility opportunities and further career opportunities, there is a plan to create more possibilities for pursuing a double master's degree and enhance cooperation with international universities.

The workload corresponding to the credit points is estimated in the course of development of the study programme upon designing and developing the courses. The analysis is based on the students' feedback on the course. Our experience has shown that students will react quickly if the allocated credit points do not correspond to the actual workload.

Most courses have been developed for several years. During this period the right balance has been found between the actual student workload and the workload expressed by credit points. The order of the courses is determined in the standard study plan, which is the basis for the development of the timetable. For some courses, you need to successfully complete a prerequisite course (see Annex 18).

In the period 2014 -2018, several changes were introduced to the study programme based on students' needs and feedback, which was collected at various round table meetings and from regular student feedback surveys. The new modified study programme started in 2015/16 and the updated version in 2018/19. In addition, technological and industrial advances have been taken into account in making changes to the courses and modules. In industry, the demand for manufacturing engineering and operations management competencies is increasing and use of ICT in engineering education should be fostered through various optional courses. The needs of industrial partners are discussed

mainly with the Federation of Estonian Engineering Industry, which joins various manufacturing and service companies.

Student feedback on the study programme and courses has been positive with an average score above 4.0. Besides obtaining feedback from students, there is also close communication with the teaching staff. Each semester, their feedback is taken into account in preparing the timetable and also transferring a course from one semester to another, e.g. due to lecturer mobility, etc. Nevertheless, communication and coordination between the teachings staff, in particular between the staff of different schools, should be enhanced. There is a plan to start regular meetings and workshops for all the teaching staff responsible for the courses in the study programme. Currently the communication between schools takes place mainly through the meetings of the programme advisory board, where very few persons from each school are involved.

Since the study programme was developed in cooperation with University-Consortium in Science and Technology BALTECH, it has close cooperation with KTH, VGTU, Lund and Riga Technical University. Many students from the study programme have studied in those universities one or two semesters. Besides student exchange, there is close cooperation with different universities and manufacturing companies also in supervision of master's theses. The total of 90% of master's theses are based on the topics proposed by a manufacturing company.

RESOURCES

The physical and financial resources for the development and implementation of the study programme are allocated from the budgets of the dean's office and the department. The funds have been used, among other things, for carrying out various social media campaigns to increase the number of students, creating videos introducing the study programme and purchasing various consumables for practice classes and laboratory work (e.g. for courses EMT0140 Internet of Things for Industry, EMT0160 Production Digitalization and EMT0040 Computer Aided Manufacturing).

In the TalTech library there are very good conditions for individual work and little seminar rooms for working in teams of 4-12 people. There are numerous study places for students in the halls of every building. The department's computer class, open from 8.00 a.m to 8.00 p.m. and equipped with different novel ERP, PDM, CAD, CAE and Factory Floor Planning software, is used for studies. Students can use a variety of equipment for their assignments in Protolab (3D scanners, 3D printers and laser sintering units), Flexible Manufacturing systems and Robotics Demo Centre (Virtual and Augmented Reality technologies, robot on- and offline programming with Yaskawa, ABB, Omron and Festo robots and AGV units), etc. (see Figure 25).

Figure 25. Overview of the FMS, AR/VR and robotics lab

SUMMARY OF STRENGTHS AND AREAS FOR IMPROVEMENT

Strengths

• Strong cooperation between the School of Engineering and the School of Business and Governance. The programme covers the main engineering and business management areas; technical courses are combined with economics and social courses;

• The structure and learning outcomes of the study programme are focused on innovative technologies (IoTProduction Digitalization), which allow for a swift response to changes in society.

• The courses (e.g. IoT, Production Digitalization) in the study programme are very closely linked to the research and development carried out by the teaching staff.

• A wide range of elective courses in the study programme helps students design their studies according to their interests and background;

• High level and very well-equipped laboratories (students can use different equipment in Protolab (3D scanners, 3D printers and laser sintering units) and Flexible Manufacturing systems and the Robotics Demo Centre (Virtual and Augmented Reality technologies).

Areas for improvement and planned development activities

• To enhance cooperation with international universities, there is a plan to increase the number of agreements for awarding double degrees.

• To help through counselling students with different levels and interests select their personal learning path based on their prior learning and experience.

• To improve the efficiency of the study process, briefings introducing the goals of the study programme and interconnections between the courses shall be conducted at the beginning and end of a semester.

4.4.2. LEARNING, TEACHING AND ASSESSMENT

STUDENT ADMISSION

Admission to the study programme takes place all the year round and students can choose whether to apply for admission in a classroom at the university or online. Students who take the online admission test in the Moodle environment, will have an interview in Skype or Zoom after receiving a positive test result.

The number of international students applying for admission to the study programme has increased year by year. The study programme Industrial Engineering and Management is one of the most competitive programmes at the university among international students, which shows the importance and relevance of the study programme compared to other foreign universities. The number of applicants in the last four academic years has been in the range of 150-180 students, while the number of eligible applications has been 48-74, i.e. about a third of the submitted applications have been eligible (see Table 41). Thus, the admission requirements allow selecting the best student candidates to the study programme.

Table 41. Number of applications of international students in the study programme.

	2017	2018	2019	2020
Number of eligible applications	48	61	74	73
Number applications	150	181	165	165

The applicants to the study programme come from Estonia as well as other European Union countries. In addition, there are many applicants from India, Pakistan, Iran, various African countries, as well as China, Georgia, Russia and Ukraine. Every year, there are also students interested from Mexico, the USA and Brazil, which shows that the study programme is attractive to and very popular among international students.

STUDENT-CENTRED TEACHING AND LEARNING

Students' individual capabilities are considered and their development is supported through providing an option of flexible study path, which is introduced by the programme director in the first lecturers or upon admission. A course coherence tool (see Annex 18) has been developed, which allows students to get an overview of the interconnections between and overlapping of courses and to prevent a situation where a course is declared for which a prerequisite course has not yet been passed, in which case it would be more difficult to achieve the learning outcomes.

In addition, various projects are carried out on various courses and for master's theses to provide solutions to the real-world challenges of industry. A short list of master's theses related with company's use cases: "Relocation and layout optimisation of Windak OÜ factory"; "Analysis of Customer Specific Signal Cable Assembly Development for an International ICT Company Providing Hardware Solutions for Cellular Networks"; "Optimisation Of Sub-Assembly Process in Radio Manufacturing"; "Optimization of Supply Chain Using Metamodel-Based Simulation In Parmida Company"; "Erp and Advanced Planning and Scheduling System Integration in Standard AS; "Sustainable and Eco-Friendly Sailing Yacht Production"; "Improvement of Manufacturing Operations Tracking Process in Kitman Thulema AS".

All compulsory courses and most of the elective courses are supplied with e-support in Moodle. In teaching the courses, modern digital solutions and software, such as ERP (MS Dynamics NAV), CAD (Solidworks, SoldiEdge, Autodesk Inventor), CAM (Siemens NX), CAE (Ansys, LS-Dyna), simulation software (Aris, Visual Components, RobotStudio, Arena, Motosim, etc.) and different scientific software (Matlab, Design Expert) are used.

Supervision of students' research papers is organised in compliance with the Requirements for Student Works at the School of Engineering. Students can choose their supervisors from the School of Engineering or the School of Economics. There is close cooperation between the supervisor, the department and the student. The topics of master's theses are agreed with the programme director and presented on the course EMT0120 Industrial Robotics and Advanced Manufacturing (a project course in the spring semester, before the defences). The last part of the course is intended for thesis presentations. Student feedback on the supervisors and the supervision process has been good and very good.

The independent work of students is specified in the course description. Lecturers' consultation hours and e-mail addresses can be found and lecture materials are available in Moodle.

Since most of the master's theses are based on topics proposed by or research related to companies, students are involved in research and development via participation in R&D projects and supervision of graduation theses in the department. The teaching staff contributes to research financed by the state and to international development projects. Students can be and have been involved in many development projects carried out in cooperation with companies and many master's theses are related to topics proposed by companies. Also, many opponents of graduation theses come from companies. Close cooperation is also carried out with MEKTORY and IMECC in order to involve more students in research and development.

For recognition of prior work experiences, a student shall fill in an application in SIS, describe his/her work experience and submit the application to the APEL advisor, who forms an academic committee for evaluating eligibility to apply for credit transfer. An interview can be conducted with a student to determine whether the student's knowledge and skills correspond to the learning outcomes. In this process, experts can give additional material to students for learning or practical exercises, homework and set a new date for an interview. If after the second interview the student's knowledge and skills are still not adequate, he/she must declare the course and pass an exam. Every year 5-10 students pass through that procedure.

In the years 2015-2017, the average salary of the graduates of the study programme has been in the range from 1,905 to 2,187 euros, i.e. it has been on average 1.68 times higher than the average salary in Estonia. This exceeds the university's goal, according to which the salary of the graduates of master's studies must be 1.65 times higher than the average salary in Estonia.

SUMMARY OF STRENGTHS AND AREAS FOR IMPROVEMENT

Strengths

• The admission process is well-considered and well-organised (a speciality test and an interview) and supports admission of talented student candidates with different backgrounds.

• Students have plenty of opportunities to use the topics and projects related to their work in their studies and master's thesis and to apply the gained knowledge in solving problems in a real work environment.

• Opportunities are provided to join various (incl. international) research and development projects during studies.

• Modern software (various novel ERP, PLM, CAD, CAE and Factory Floor Planning software) is used in the study process.

• A large share of group work fosters communication between students.

• Good online courses and highly qualified teaching staff.

Areas for improvement and planned development activities

• In order to develop student grading practices and provide them more substantive feedback, lecturers' knowledge and skills required in assessment should be improved through in-service training and sharing of the best practices.

• Lectures should be recorded and "watch later" options should be provided in order to improve the conditions for carrying out independent work and making progress in studies.

4.4.3. DEVELOPMENT, COOPERATION AND INTERNATIONALISATION OF TEACHING STAFF

The teaching staff includes lecturers from the industry and internationally renowned professors. Top- or middle-level managers of successful companies are engaged in the courses as guest lecturers, who introduce the technologies used in their enterprises, supporting theoretical knowledge with practical examples and use cases. The teaching staff is diverse (lecturers from different nationalities and cultural backgrounds) (see Annex 19).

Many courses are taught by more than one lecturer, each focused on a certain topic related to his/her research (e.g. on the courses Internet of Things for Industry, Production Digitalization, etc.).

As the language of instruction of the programme is English, the first criterion is high proficiency in English. The present language proficiency level is close to high or excellent.

To harmonise the English language proficiency level of the teaching staff, in-service training is provided to them and the lecturers engaged in the study programme are encouraged to participate in the continuing education courses for lecturers conducted by the Estonian Centre of Engineering Pedagogy to help them improve and update their pedagogical skills

The lecturers follow the principles of academic ethics and guidelines established by the university. In problematic cases, the programme director and the vice-dean for academic affairs provide assistance in following the guidelines.

Lecturers have the opportunity to participate in international staff mobility and international cooperation programmes. Various modern study materials have been jointly developed and new courses have been created, such as the Internet of Things and Industry 4.0 solutions. International cooperation and mobility are funded mainly from Erasmus+ programmes.

The university provides continuous education courses with the aim of introducing new teaching/training methods and upgrading and improving the know-how of academic staff in the field.

The academic staff develop their knowledge and skills through research and development projects as well as through contacts with employers.

Every lecturer can see his/her students' feedback via SIS. Feedback varies, including both positive feedback as well as some critical feedback regarding updating of materials and the timetable. Students have pointed out that lectures should start no earlier than 16.00, or even 17.00, since 90% of the students are working in various manufacturing companies. The results of feedback have been analysed and taken into account in planning the teaching staff's in-service trainings and in making changes to the study programme.

As a rule, at technical universities the lecturers are engineers without pedagogical education. Pedagogical skills are gained through one's own experience. From time to time, pedagogical courses are organised for lecturers at TalTech. This is particularly crucial in today's fast-paced world. The teaching skills of new members of the teaching staff are developed through trainings and collaboration with senior lecturers and professors. The teaching staff apply their new skills in continuous improvement of the courses and scientific work and publishing their research results. Many courses are related with scientific projects and work, which allows new members get immediate feedback from the group/project leader. The lecturers' teaching skills are taken into account in their re-election; it is one of the performance indicators considered in expert evaluation. In the re-election process, the students' representative is always entitled to communicate the Student Board's opinion about the lecturer. However, the main problem with re-election is that there is often no real competition. Every lecturer can see his/her students' feedback in SIS at the end of a semester. A lecturer can see students' assessment of his/her work and of the course.

Lecturers are constantly developing themselves through in-service training and seminars, both professionally and in the field of engineering pedagogy. The Estonian Centre of Engineering Pedagogy operating at the Department of Mechanical and Industrial Engineering of the School of Engineering conducts corresponding trainings for the teaching staff.

As a rule, the academic teaching staff have to conduct research and report the results. As a rule, the departments select their main research topics that are related to their field of activity. However, those fields are not always related to a particular course delivered. Research still provides good support for course preparation. Usually, there is a direct link with research and development. Most of the teaching staff is engaged in several projects involving cooperation with different universities and companies. The topics proposed for student projects and graduation theses are usually inspired by research and development projects. Teaching staff use the same methods, technologies and tools for teaching practical skills to students as in their own projects. Teaching staff use their research results in improving their course(s) or in creating new ones.

SUMMARY OF STRENGTHS AND AREAS FOR IMPROVEMENT

Strengths

• Teaching staff includes lecturers from industry as well as internationally renowned professors; managers of successful companies are engaged in the courses as guest lecturers, who introduce the technologies used and the developments in their enterprises; diverse teaching staff (lecturers from different nationalities and cultural backgrounds);

• Many courses are taught by more than one lecturer, each providing his/her perspective, depending on their research field;

• Lecturers offer alternatives for passing a course through projects (incl. international projects).

Areas for improvement and planned development activities

• To harmonise the English proficiency level of the teaching staff, members of the teaching staff shall be encouraged to complete in-service training.

• Regular in-service trainings for improvement of pedagogical skills and for updating teaching methods.

• To strengthen cooperation between the teaching staff at the level of different disciplines (economics+engineering) and at the level of courses.

Annexes:

Annex 16. Study programme form of Industrial Engineering and Management

Annex 17. Descriptions of the key courses of Industrial Engineering and Management

Annex 18. A chart illustrating the interconnections between modules/courses of the Industrial Engineering and Management

Annex 19. Teaching staff of Industrial Engineering and Management

4.5. INTERNATIONAL BUSINESS ADMINISTRATION

Name of the study programme	International Business Administration (IBA), ENG
Study	Bachelor's study
School	School of Business and Governance
Programme director	Merle Küttim
Principal complier of the self-evaluation of the study programme	Merle Küttim (Programme Director, Researcher Department of Business Administration)
A brief description of the process of self-evaluation of the study programme	The period of preparation of the institutional accreditation report coincided with the period of application for EFMD accreditation for the IBA study programme. Therefore the input collected in the years 2019-2020 for EFMD programme accreditation (interviews with the teaching staff, the questionnaire for the teaching staff, mapping of the resources, analysis of the learning outcomes and assessment methods, grade distribution analysis, analysis of external partners and external relations, 15-page EFMD datasheet, 100-page EFMD report, 10-page student report, SWOT analysis) was used for the institutional accreditation report. The self-evaluation of the study programme was mainly carried out by the programme director Merle Küttim. Following collegues were also involved: Katrin Arvola (Lecturer, Department of Business Administration), Natalie Gurvits-Suits (Associate Professor, Department of Business Administration), Laivi Laidroo (Vice-Dean for Academic Affairs, Associate Professor, Department of Economics and Finance), Enn Listra (Professor, Dean of the School of Business and Governance), Tarvo Niine (Associate Professor, Department of Business Administration) Helena Rozeik (Entrepreneurship Cooperation Coordinator), Kristin Semm (Quality Officer, School of Business and Governance). In November 2020 self-analysis was reviewed by the experts in the field (Leno Saarniit, Merli Reidolf and Kirsti Rumma, School of Business and Governance).

AGGREGATED DATA ABOUT THE STUDENTS OF THE STUDY PROGRAMME

The study programme International Business Administration (hereinafter also IBA) is a self-paid study programme taught in English. Therefore, international students make up almost 90% of the total number of students studying in the study programme. Stricter admission requirements have improved student performance, but reduced the number of students enrolled, which is why the total number of students studying in the study programme has decreased. The graduation rate (graduation within the nominal duration of studies + 1 year) has increased year by year in the period between 2017 and 2020 (amounting to 52% in 2017/18, 56% in 2018/19 and 60% in 2019/20). The dropout rate has been about 10% of the total number of students. The main reason for discontinuing studies is failure to pass the courses and non-participation in studies, followed by financial reasons.

	2017/18	2018/19	2019/20	2020/21
Number of students	379	378	356	283
Number of students enrolled	127	104	92	41
Number of graduates	68	72	79	N/A
Number of dropouts	41	48	34	N/A
Number of international students	328	332	319	253

4.5.1. PLANNING AND MANAGEMENT OF STUDIES

DESIGNING AND DEVELOPMENT OF THE STUDY PROGRAMME

The IBA study programme takes into account the goals set for the study programmes in the university's Strategic Plan. The programme is broad-based, while also promoting a more specific range of specializations besides the acquisition of general and fundamental knowledge through four specialities (Marketing, Entrepreneurship and Management, Accounting and Business Intelligence, Finance).

The continuous monitoring and improvement of the IBA programme consists of several activities on annual basis: analysing

Power-BI reports, analysing the input from internship reports and supervisors, regular meetings with the programme advisory board, meetings with lecturers at the beginning of the semester organised by the programme director, drawing up the self-evaluation report of the programme, analysing the KPIs and areas for improvement during individual appraisal with the programme director (the Dean and the Vice-Dean of Academic Affairs), meetings with all programme directors to monitor general results and discuss common problems.

The IBA programme has undergone an international EFMD programme accreditation process (EFMD accredited in 2021), which is a thorough programme accreditation system for business and/or management programmes offered by the global management development organisation EFMD[115]. This accreditation covered all facets of programme provision: from its institutional, national and international environment, through its design, delivery, outcomes and impacts, to its quality assurance processes.

In order for the programme design to be up-to-date and innovative, the IBA programme has undergone several changes that came into effect in 2017, 2019 and 2021. This has been undertaken for several reasons: to meet better with the needs of the labour market, offer more flexibility for the students and follow university-wide initiatives. The improvements carried out include: i) reviewing the internal consistency of the learning outcomes at programme, module and course level as well as the sequence of courses, ii) updating the number of specialisations and courses, iii) standardising course formats (e.g. introducing 6 ECTS courses). As regards the main changes, instead of two specialisations, four special studies modules have been created since 2019: Marketing, Entrepreneurship and Management, Accounting and Business Intelligence, and Finance. Additionally, the volume of special studies was increased from 36 ECTS to 63 ECTS. The main change for the 2021 admission has been introducing the BA Thesis Seminar to support the planning phase of the thesis.

In the course of the above-mentioned development activities, the IBA study programme has been compared with other study programmes, incl. internationally and the best practices have been taken into account in the development of the study programme. In overall terms, the programmes compared with the applicant programme (IBA) are similar English language business programmes in Estonia and in other Nordic-Baltic countries. The total of 153 first level (business) programmes taught in English admitted students in the region in 2020. These comparisons have helped to design specialisations and course listings.

The research and development activities of the teaching staff support the study programme — according to the Estonian Research Information System, 50% of the lecturers teaching in the IBA study programme have participated in research and development projects in the period from 2017 to 2020. Many lecturers have entrepreneurial and business consultancy experience. An example of how research is incorporated into teaching is the project “Edu ja Tegu” (Deed of Success) led by the Ministry of Education and Research and involving lecturers of the Department of Business Administration. The aim of the project is to promote entrepreneurship education at all study levels and as an output a model of entrepreneurial competencies has been developed, on the basis of which lecturers have been trained and students have been able to evaluate their strengths and areas for improvement on various courses.

However, involvement of students in research and development could be greater. It is hindered by the study level and the language of instruction in the study programme. First and foremost, master’s students and PhD students are involved in projects and in case of Estonian public procurements there is also the language barrier. At the same time, students of the IBA study programme participate in the marketing team of the TalTech Satellite Programme under the supervision of lecturer René Arvola. In addition, the lecturers have introduced their research to students in order to raise interest in the subjects (e.g. in Microeconomics, Economic Sociology, Bachelor Seminar).

TalTech School of Business and Governance has worked on internationalisation and comprehensive selection of international partners in recent years and these efforts are continuing through the process of implementing the strategic plan for further internationalisation. The previous list of 200 partners has been reduced to ca 100. The aim is to move up in rankings, to widen strategically the School’s impact zone from Estonia to SELL[116] countries, and correspondingly to work more closely with the universities and companies in the region. The main forms of cooperation with international academic partners on the IBA programme include student and staff exchange, participation in courses, internship, R&D projects and supervision. For example, OTH Regensburg offers the students in the IBA study programme an opportunity to attend seven free online courses in the spring semester of 2021.

THE OBJECTIVES, LEARNING OUTCOMES AND STRUCTURE OF THE STUDY PROGRAMME

The objectives of the courses in the IBA study programmes and their intended learning outcomes are linked to those of the programme and its modules (see Annex 20). The specialist courses build on the competencies acquired in general and core studies modules. The three academic years/six semesters of the IBA programme consist of three main modules: 1) the general studies module, 2) the core studies module divided into Methods, Markets, and Economy, and Core Business Competences and 3) the special studies module, divided into Marketing, Entrepreneurship and Management, Accounting and Business Intelligence, and Finance specialisations. The fourth module consists of free choice studies.

To enhance general competencies, the IBA study programme contains courses covering the learning outcomes in the field of the humanities, natural sciences, information and communication technologies, mathematics and entrepreneurship in compliance with the Curriculum Statute. The IBA study programme supports the development of creativity and entrepreneurship through the relevant courses, e.g. Introduction to Entrepreneurship (compulsory course), Start-up Entrepreneurship (compulsory course in the main speciality of Entrepreneurship and Management, elective course in other main specialities), Creativity and Innovation (compulsory course in the main speciality of Entrepreneurship and Management, elective course in other main specialities), Venture Creation (elective course), Internship (elective course).

In order for the study programme to provide sufficient challenges for students with different levels of knowledge and skills, pre-sessional courses in mathematics are offered, foreign language courses are provided, flexibility is provided in selecting the main speciality, elective and optional courses and in compiling an indi-

[115] EFMD is a global, non-profit, membership-driven organisation dedicated to management development. It is an accreditation body for business schools, business school programmes, and corporate universities.

[116] Suomi (Finland), Eesti (Estonia), Latvija (Latvia), Lietuva (Lithuania)

vidual study plan. Students can also participate in study abroad. In 2016/2017, 10 students in the IBA study programme participated in the Erasmus student exchange programme, in 2017/2018 the number increased to 21 and in 2018/2019 the number dropped to 12. In order to increase the number of students participating in student exchange, the study programme has been made more flexible (elective courses have been added) and comparison of the IBA study programme with the courses offered at the universities abroad has been carried out. In addition, the incoming Erasmus students enrich the local learning environment. The highest numbers of incoming students come from Germany, France, Austria, Italy and the Czech Republic.

Feedback on the content of the study programme is requested from various stakeholders. Students, employers and lecturers are involved in the work of the IBA programme advisory board. The programme advisory board includes representatives of employers from the Finnish-Estonian Chamber of Commerce, newspaper Äripäev, PwC Estonia and Estonian Travel and Tourism Association. Based on the recommendations of the programme advisory board, more attention has been paid to the English language proficiency of the lecturers (level C1 English language proficiency requirement has been set), internship in the speciality has been added, the main specialities have been developed. Students provide feedback through a regular university-wide survey and lecturers can request feedback separately on the courses taught by them. As a result of the feedback, the number of specialised elective courses has been increased, the composition of persons conducting studies has been changed, and coherence with the study programme Business taught in Estonian has been improved. The university also conducts graduate surveys. The International Student barometer[117] also provides an overview of the the situation and opinions of international students. If necessary, feedback is requested on a specific topic, e.g. in spring 2020, a survey on distance learning was conducted among the students and lecturers of the School of Business and Governance.

PHYSICAL AND FINANCIAL RESOURCES

The study programme International Business Administration (IBA) is a self-paid study programme. Tuition fees are covered in accordance with the rules set by the university. The sustainability of the study programme in the long term is determined by a sufficient number of strong student candidates. In order to mitigate risks (e.g. declining interest of the Finns) marketing efforts are expanded in other target markets, especially in Europe, including in the Baltics.

As regards the databases required for studies, students can access online research databases as well as specific financial information databases (Eikon, Orbis Europe, etc.) via the library. Since 2018, the School of Business and Governance has been mapping the needs for textbooks and other resources used on the courses, in order to get an overview of the study and research literature related to the study program. In the course of the process, new textbooks, in particular online textbooks have been ordered to the library to improve students' access to study materials. At the same time, international students need support and more information for using the library's online services. This is one of the topics covered in the briefing for incoming students and the library's resources are introduced at the Bachelor's seminar.

As regards environmental protection and sustainable development, the School of Business and Governance joined the PRME initiative in 2019 and has developed its ethics, research and sustainability (ERS) strategy. The broader trends in society and ERS are addressed in the IBA programme aims, which is to support analytical thinking with a long-term perspective that allows students to take business decisions while adhering to the principles of ERS. The programme contains several courses directly related to ERS, including Working Environment and Ergonomics (compulsory), Fundamentals of Life (elective), Environmental and Sustainable Development Economics (compulsory), International Business and Ethics (compulsory). However, attention should be paid to comprehensive treatment of ERS topics in the study programme and to promoting sharing of best practices among lecturers.

The classrooms are supplied with presentation equipment, in some classrooms there are also video recording possibilities. Those lecturers, who have needed, have received touch-sensitive tablets for conducting studies. There is a lack of special rooms for group work and language learning, where the furniture can be easily rearranged depending on the number of participants and activities. There are computer workplaces and spaces in the library. There are places for students for team and individual work on open premises. Students can use facilities in the Student Union building and they have also a room for their activities in the SBG building (first floor).

SUMMARY OF STRENGTHS AND AREAS FOR IMPROVEMENT

Strengths

• Collecting and using extensive input for the development of the study programme (e.g. meetings of the programme directors, appraisal interviews, self-evaluation of the study programme in SIS, study analysis on the intranet, a data analyst employed at the School).

• Study literature is available, because the use of textbooks has been mapped and missing study materials (primarily online textbooks) have been ordered.

• To foster student mobility and make it easier to find courses at a partner higher education institution corresponding to one's study programme, an analysis of Erasmus partnership agreements (the level of higher education institutions, accreditations, proportion of similar courses) has been conducted.

Areas for improvement and planned development activities

• To increase students' involvement in research and development by sharing the best practices of foreign countries and the teaching staff of the study programme (introducing research to students, involving them in projects, encouraging students to visit conferences and seminars, carrying out analysis of research articles).

• To integrate the topics of environmental protection and sustainable development into studies at the study programme level by sharing the best practices of foreign countries and teaching staff of the study programme.

• To introduce more than hitherto the services of the online library (by regularly ordering from the library briefings in English on the use of data sources and information search).

[117] https://www.i-graduate.org/international-student-barometer

4.5.2. LEARNING, TEACHING AND ASSESSMENT

ADMISSION REQUIREMENTS AND PROCEDURES

The student target market for the IBA programme consists of high-potential domestic and international high-school graduates with focus on the Baltic countries, Finland and South-West Russia. In addition to marketing activities in Estonia, the university partakes in the international promotion activities organised together with other public universities in the target markets designated in the Estonian strategy for introducing higher education internationally 2015-2020 (i.e. Finland, Russia, Turkey, Georgia, Ukraine, India and China). The School of Business and Governance also undertakes marketing activities based on the target markets of the IBA programme (Finland, Latvia and Lithuania).

In terms of admission requirements, the recruitment of students for the IBA programme follows two complementary paths: 1) Estonian secondary school graduates are admitted on the bases of a threshold achieved at national state exams (or equivalent). The result obtained in mathematics (broad) has to be at least 60 points and in the Estonian language at least 55 points. English skills at the level of B2 are required. 2) International applicants are admitted based on the admission exams. The grade point average of secondary education of applicants has to be at least 60% of the maximum possible. English proficiency has to correspond to the level of B2. In order to admit stronger candidates, the admission interview was added to the motivation letter in 2018 and the test in mathematics in 2019 (the SAT test has been used since 2021). The applicants have to obtain at least 5 points out of 10 for all the parts.

In addition to the general consulting by the Office of Academic Affairs and study programme representatives, there are student ambassadors (five from the IBA programme in 2021) who advise the candidates, provide information about the university and life in Estonia and offer an insight into the daily life. The ambassadors are all studying at TalTech and have had the experience of applying for a visa and the residence permit, choosing their lectures and getting adapted to life in Estonia.

STUDENT-CENTRED APPROACH IN THE STUDIES

Students' individual abilities and needs are supported through frexibility, provision of a range of options to choose from, continuing education (in mathematics), foreign language studies (English, Estonian and optional other foreign language courses), student exchange, joint briefings (for first-year students, selecting the main speciality, on internship), individual counselling (by the student counsellor and programme director) and career seminars.

Students can influence the content and organization of their studies starting with the preparation of an individual study plan. In the IBA programme, students can choose between four main specialities (Marketing, Entrepreneurship and Management, Finance, Accounting and Business Intelligence). In addition, the study programme contains elective courses in the amount of 6 ECTS credit points (from among 33 ECTS credit points) in the general study module, elective courses in the amount of 24 ECTS credit points (from among 96 ECTS) in the speciality module and optional courses in the amount of 6 ECTS credit points all across the programmes at the university. This means that the combinations of courses taken by the students of the IBA study programme vary to a great extent.

In addition, the representatives of students participate in the work of the IBA programme advisory board, which discusses, among other things, the planning of the teaching and learning process. Students influence the development of the study programme also through feedback on the completed courses provided in SIS and the feedback on the studies as a whole provided after graduation. Students also provide feedback on the learning process to the lecturers (if the lecturer requests feedback on his/her course), the student counsellor and the programme director. On an ongoing recommendations are made to lecturers for making changes in the studies and lecturers have been replaced in the long term. As a result of graduate feedback , starting from the spring semester of 2019/20 bachelor's seminars have been conducted, where the requirements and deadlines related to writing of a graduation thesis are explained and advice is provided on preparation of a thesis outline.

The lecturers employ a variety of teaching methods depending on the aim and learning outcomes of the course. These pedagogic methods entail written as well as oral components, and also face-to-face and technology enhanced learning. In overall terms there are pedagogic methods: 1) designed for familiarising the students with the topic (lectures, visiting lecturers, panels, reading materials, lecture slides and notes); 2) based on discussing the topic (questions-answers, group discussions, seminars, debates); 3) for implementing what is learned into practice (exercises, role-plays, tests, case studies, internship).

Lecturers acknowledge the critical role of student motivation. According to student feedback, students are more motivated to learn on courses where the link to practical applications is more apparent. Therefore, the lecturers' task is also to "advertise the course" in the beginning, to explain the challenges that can be faced faced better by becoming proficient in the topic area. Another popular way of boosting student motivation is to develop grading schemes, which give small but more easily obtainable rewards in the beginning and keep students continuously engaged.

The lecturers supervise and give feedback to the students' independent work based on the content and goals of the course. For example, on the course Management and Leadership, group work is supervised in several stages: preparing homework instructions and discussion with the students, registration of the homework topic, submission of the interim report, submission of the written final report, oral presentation, provision of feedback by the lecturer and fellow students. At the same time, the study programme is important in making Estonian-language study programmes more international through joint teaching of students from different study programmes. For example, on this course, homework is done together with the students of the study programme Business taught in Estonian.

Information on the actual workload of students and the correspondence of credit points is obtained primarily from the student feedback survey. In addition, in the autumn semester of the academic year 2020/21, the School of Business and Governance started analysis of teaching and assessment, where the workload of the courses, the proportion of independent work and consideration of students' individual differences is assessed with a survey for lecturers. Previously, the number of hours allocated to face-to-face learning and the workload of students have been adjusted from 4 ECTS credit points to 6 ECTS credit points in case of some courses, e.g. E-marketing, Market Research and Market Planning.

ASSESSMENT OF STUDENTS AND APEL

To ensure the relevance of assessment methods, the assessment methods and criteria are related to the learning outcomes they measure. The programme director monitors, based on student feedback and the description/extended syllabus of the course, that the teaching and assessment methods applied are consistent with the goals and requirements of the study programme and the course.

The methods used in the assessment consist of both formative and summative elements. There is a combination of tasks not evaluated or with low point value and tasks with high point value. These depend on the intended learning outcomes that students are expected to obtain, and include: drawing a concept map, short feedback, lecture summary, self-assessment tests, written mid-term and final exams (with some courses also containing an oral part), written assignments (essays, tests, lab work, article analysis, learning diary, self-reflection, multiple-choice), oral assignments (individual and group presentations; pitching business ideas, role-playing, discussion), other forms of assessment (active participation in discussions and assigned tasks, bonus tests).

Students are informed about the assessment criteria at the beginning of the study in the first lectures, the criteria are listed in the course description in SIS and in the extended syllabus in Moodle. One way in which students can influence the choice of teaching and assessment methods is through feedback, especially if the lecturer gathers feedback on the course as a whole or on a certain element (e.g. self-evaluation on the courses Management and Leadership, Introduction to Entrepreneurship). Students' grades indicate aslo to the lecturer how different assessment methods work.

Transparent and objective assessment is ensured by informing students about the assessment criteria, compiling guidelines, practice tests, and formative feedback. In case of courses taught by several lecturers (e.g. where different persons conduct lectures and practice classes) several members of the staff can be involved in assessing. Persons from outside the university are also involved in assessment. For example, on the course Introduction to Entrepreneurship, practitioners are involved as mentors helping to develop business ideas and as members of the jury evaluating the business ideas. In 2019, Heikki Sal-Saller (In Nomine), Jana Pavlenkova (Prototron) and Saurabh Satia (CureAssist) were involved as members of the jury at the entrepreneurship education final event "Äriideed ellu!" ("Ideas for Business!"). People from outside the university are also involved as supervisors of graduation theses and members of thesis defence committees.

The student counsellor is the APEL adviser and the programme director is the APEL assessor, who can involve the lecturers of the corresponding course in making a decision. In the years between 2018 and 2020, 126 APEL applications (including applications for transfer the credits obtained as an Erasmus student) were registered in the IBA study programme. A total of 1563 ECTS credit points have been transferred, of which 222 ECTS credit points are for learning gained from continuing education courses and 1341 ECTS credit points for learning gained from non-TalTech courses. Ineligible applications have been returned to be supplemented or it has been recommended in the course of counselling not to apply for APEL. The reasons have been missing documents (e.g. description of the duties performed, employer's assessment), non-compliance of the learning outcomes, non-compliance of the educational institution of a foreign country.

STUDENT SUPPORT SERVICES

The organisation of studies helps students to achieve the learning outcomes, by providing flexibility, pre-sessional courses and individual counselling. The university offers a 4-week Refresher Course in Mathematics for Business Students (3 ECTS) as an elective course, followed by the compulsory Fundamentals of Business Mathematics course. However, it is necessary to improve support for students' individual development through student tutors in science, who can be motivated by paying scholarships to them. The briefings regarding selection of the main speciality, internship and graduation theses help students to make their choices. Students who have exceeded the nominal duration of studies are informed of the deadlines of and requirements for graduation theses and the programme director helps to find a thesis supervisor and topic, if necessary.

The dean's office is the main place where students can turn to in matters related to organisation of studies. Each study programme has its own student counsellor, who provides advice to students regarding matters related to compiling an individual study plan, study allowances, accreditation of prior and experiential learning and studies abroad. The programme director provides advice in substantial matters related to the study programme, e.g. the structure of the study programme, further study opportunities in the chosen speciality, assessment of the eligibility of the courses for studies abroad. In the case of concerns, students can first turn to the student counsellor, but also to the lecturer or programme director. If necessary, a student counsellor or programme director can refer a student to career counselling or psychological counselling (1-2 cases per semester).

Early leavers/dropouts form approximately 10% of the total number of students (in 2017/18 the dropout rate was 11%, in 2018/19 13% and in 2019/20 10%). The main reason for dropping out is failure to complete the courses. This is followed by economic reasons, which hinder payment of tuition fees. The reasons for voluntary withdrawal include changing the university, family-related reasons and taking up employment. To reduce the share of early leavers and dropouts, the university has developed study analytics that show a student's progress based on the interim results in Moodle using the traffic light system (green, yellow, red). This allows the programme director to monitor students' progress on a course basis. In addition to study analytics, from the academic year 2020/2021, a survey of IBA students has been conducted in the middle of a semester to get an overview of the courses being taught.

Internship has been included in the IBA study programme since 2019 and it allows to apply the knowledge acquired in the course of studies in performing specific work tasks. Until 2019, the internship completed by students was accounted for as an optional course, which is why no feedback has been collected on internship. To mediate internships, an internship portal of the School of Business and Governance was created in 2020, where companies and institutions can advertise their internship and job opportunities and conduct competitions. In addition, an internship fair is held at the School, where companies can introduce their offers, expectations and work environment directly to students. However, only about 10% of the advertisements and internship offers are for English-speakers, which is why it is necessary to increase the availability of internships for international students.

It has been difficult to monitor the success of the alumni in the labour market, because a vast majority of the graduates go abroad (which is why, e.g. Statistics Estonia's salary data cover only 10% of the graduates of the IBA study programme). However, the statistics show that the salary level is higher that the average in Estonia, e.g. it was 1.23 times higher in 2018. According to the IBA programme graduate survey, the majority of graduates either work and/or continue their studies at master's level (a handful have entered into TalTech master's programmes). The Estonian companies hiring TVTB students are Live Nation Estonia, TransferWise, Nordea Bank, SEB, Danske Bank, TV Play Baltics AS. In order to deal with the topic of graduates, the School's alumni portal was created in 2020, which strengthens the network of graduates and helps to involve them in activities related to the School and study programme (e.g. mentoring, supervision, giving lectures).

SUMMARY OF STRENGTHS AND AREAS FOR IMPROVEMENT

Strengths

• To make it easier to find an internship host, the School has created an internship portal to mediate internships and jobs for students. In addition, an internship fair is held at the School.

• To strengthen the ties between the alumni and the university and to get a better overview of their progress, the School has created an alumni portal.

• Cooperation with the study programmes taught in Estonian (incl. joint courses) contributes to internationalization of Estonian-language study programmes.

Areas for improvement and planned development activities

• An academic tutor system must be created, where students who have passed a course help others (in particular on the courses of Economics, Statistics and Finance). Scholarship should be paid to tutors.

• The share of advertisements for English-speakers on the School's internship portal and the share of internship offers for English-speakers at the internship fair shall be increased.

• To strengthen the ties between the graduates and the university, events shall be organised for the alumni, cooperation shall be developed through the alumni portal (in accordance with the interests of the alumni), including in the form of online events.

4.5.3. DEVELOPMENT, COOPERATION AND INTERNATIONALISATION OF TEACHING STAFF

TEACHING STAFF

The courses in the IBA study programme are taught by a required number of professionally competent lecturers. The goal for the English language proficiency level of the teaching staff is at least C1. It is also important that the full-time lecturers have at least a master's degree and R&D and/or business experience in the field. From among 60 lecturers teaching in the IBA study programme 35 have a doctoral degree and 25 have a master's degree. The average age of lecturers is 45 years. As regards research performance, the teaching staff of the IBA study programme published 29 research articles in ETIS category 1.1 (journals indexed in the Web of Science and Scopus databases) in 2019.

To reinforce cooperation between the lecturers in the IBA study programme, briefings are held at the beginning of the semester, one of the aims of which is to provide an overview of the logic of the study programme as a whole and the interconnections between courses. For example, on the professional English language course, materials from other courses of the study programme are used for teaching. In order to plan studies and exchange experiences, meetings in research groups and between lecturers teaching the same course take place, especially if practice classes are conducted by hourly paid teaching staff (e.g. on courses of Entrepreneurship, Marketing).

At the School of Business and Governance, the biggest training and team-building events are Teaching Days held twice a year before each semester. The topics that have been covered at these events include working with a multicultural class, teaching methods, helping students with special needs, group work, digital teaching, etc. The School of Business and Governance has a mobility fund to support the participation of its staff in international conferences and trainings (e.g. Tarvo Niine, Paavo Siimann, Susanne Durst have participated in ITP[118] trainings). To make sure that international experience reaches the School of Business and Governance, the School has run special trainings for the management and staff on different topics and held conferences.

In the year 2019/20, the average student rating of the IBA study programme was 4.14[119] and it has increased slightly. However, the rating is below average of the bachelor's studies at the School (4.36). From among the components evaluated, the courses received the highest rating (average 4.16), followed by the rating given to the teaching process and oneself as a learner (average 4.14) and the rating given to the teaching staff (average 4.14). Based on the feedback from students, the share of specialised elective courses has been increased, lecturers have been referred to a continuing education course on didactics, lecturers teaching the course have been replaced (e.g. in Project Management, IT Foundations, Marketing Communication, Organizational Behaviour, International Business).

ACADEMIC ETHICS

In order to prevent academic fraud, the principles of academic ethics are introduced in a briefing for first-year students. Each lecturer introduces the good academic practice in more detail at the beginning of studies and the corresponding topic is included also in the extended syllabus of a course. To make sure that the teaching staff applies the same intervention methods in

[118] The ITP programme is dedicated to helping business/management school faculty members enhance their skills, capabilities and mind-set.

[119] Ratings of the courses are given on a 5-point scale

the case of similar cases of academic fraud, the Procedure for Processing Violation of Good Academic Practice and Contemptible Behaviour has been established at the School of Business and Governance (10.06.2019). The corresponding procedure has been introduced to lecturers also at the Teaching Day.

Intolerance towards fraud is also evidenced by the fact that in the years 2018-2020, 18 cases related to students of the IBA study programme were registered in the School's register of academic misconduct. Plagiarism has been detected in research and graduation theses, homework performed as group work and cheating and other violations of the examination or test procedures have been detected. On six occasions, the violation has been serious and the proceeding has concluded with the issuing of a written reprimand by the dean. In the cases where extensive plagiarism has been detected in the middle of a course, e.g. in homework, the lecturer has gone over the principles of academic ethics once again. In one case, an already defended thesis was plagiarised, which was then followed by annulment of the result of the defence. Informing wider public about academic fraud helps to prevent it from recurring on different courses. In penalising the student, it is taken into account whether it was the student's first or repeated violation.

INTERNATIONAL MOBILITY AND INVOLVEMENT OF PRACTITIONERS IN TEACHING

One of the indicators of international mobility is the growing share of research articles completed in international cooperation. According to SciVal, the School has had publication cooperation with 122 institutions in different countries in Business, Management and Accounting and with 77 in Economics, Econometrics and Finance in the period from 2016 to 2020.

Besides cooperation in research, international cooperation is also important in teaching. Between 2017 and 2020, 13 lecturers from the IBA study programme participated in staff mobility under the Erasmus+ programme in Europe. Seven of them have participated in the Erasmus+ programme more than once. The most visited countries are the following: Spain, the UK, Finland, the Czech Republic, Poland and the Netherlands. The most visited of the partner universities are the following: University of Jyväskylä, NHTV Breda University of Applied Sciences, Czech Technical University in Prague and Birmingham City University. For example, in the course Marketing Management, the management training programme Emerald Forest Hotel is conducted in cooperation with the lecturers from universities abroad.

Practitioners have contributed as guest lecturers in 14 courses. There have been 18 guest lecturers during the years 2019–2020. Guest lecturers participate in both lectures and practice classes on average once a semester per course. Guest lecturers are carefully selected, before the lecture they meet the lecturer and the topic of the lecture is discussed so that it fits with the topics covered on the whole course. Guest lecturers are predominantly representatives of large or medium-sized companies operating in the international market (e.g. Swedbank, Telia, KPMG, L'Oréal, DHL, Defendec, Tallink), which give students valuable practical knowledge and a high level of international business experience.

EVALUATION OF A LECTURERS' WORK

A lecturer receives feedback from different parties. At the end of each semester, students provide feedback on the completed courses in SIS. A lecturer can request feedback from students, e.g. through Moodle. Colleagues provide feedback through lesson observations, e.g. in 2020 in the Open Lectures Week, lecturers of the IBA programme invited other lecturers (Kirsti Rumma, Raili Lahi) to participate in their lectures and visited various lectures (Marina Järvis, Maris Zernand-Vilson) themselves.

The immediate superior provides feedback on the lecturer's work and performance at an annual appraisal interview. In the course of an appraisal interview, the feedback given by students after each semester in SIS, as well as participation in research and development projects, is analysed. Lecturers, who belong to highly or the highest rated lecturers based on the results of feedback provided in SIS, can apply for activity support (participation in trainings, preparation of study materials) and the School has established a statute for recognizing the best lecturers. If a lecturer is one of the lowest rated lecturers at the university, solutions are sought to support the development needs, e.g. in the form of in-service training.

Academic staff members employed under an open-ended employment contract are attested at least once in every 5 years of employment in order to evaluate regularly achievement of the expected work performance indicators. In order to ensure uniform principles, the director at the Department of Business Administration participates in the work of all the committees and an attestation committee shall include at least one tenured professor. At the attestation, the performance of the persons subject to attestation is evaluated based on the indicators set out in the academic evaluation matrix and applicable to the given position by focusing on the key elements (e.g. in the case of lecturers: teaching, development of studies and supervision).

The Department of Business Administration holds sectoral meetings at least once a quarter, where, among other things, the development, methodology and organization of studies are discussed. In addition, here are peer-to-peer workshops across study programmes, where experiences are exchanged and best practices are discussed. The topics discussed so far include, for example, intercultural communication, application of the flipped classroom method in business studies. In June 2020, the Department of Business Administration established the Acknowledgement Procedure, in the framework of which the best lecturers, supervisors and promoters of innovation in studies are acknowledged.

The teaching staff of the IBA programme are involved in activities linking the programme to the society at large as during the last five years one-third of them have worked in the private sector and one-tenth have been entrepreneurs. Some participate in different research projects with companies/the public sector and have business consultancy experience. Collaboration with companies is active also through guest lecturing, company visits, graduation theses supervision, mentoring and solving of company problems. For example, on the Project Management, Operations Management, and Introduction to Entrepreneurship courses students participated in the international competition "L'Oréal Brandstorm 2020", in which teams of three had to come up with

ideas on how to build a plastic-free future. However, cooperation with companies and universities from Finland, Latvia and Lithuania needs to be improved. This is the geographical area that the IBA programme admissions marketing focuses on and it should be also more represented in the classroom.

SUMMARY OF STRENGTHS AND AREAS FOR IMPROVEMENT

Strengths

• Common understanding between the lecturers teaching in the study programme and improvement of cooperation in ensuring coherence of courses (teaching days, regular meetings at different levels, training).

• Greater awareness of the importance of good academic practice, as the School applies a procedure for notifying of and processing violation of good academic practice and the topic is also discussed on the courses.

• Linking teaching with practice through the lecturers' experience in the private sector, involvement of practitioners, case analysis.

Areas for improvement and planned development activities

• To improve internationalisation, to move from exchanging students and lecturers to (joint) courses, e.g. online courses, with partner universities from Finland, Latvia and Lithuania.

• To improve cooperation with Finnish, Latvian and Lithuanian companies (solving the companies' problems, involving practitioners in studies, case studies, internship hosts).

Annexes:

Annex 20. Study programme form of International Business Adminstration

Annex 21. Descriptions of the key courses of International Business Adminstration

Annex 22. A chart illustrating the interconnections between modules/courses of International Business Adminstration

Annex 23. Teaching staff of International Business Adminstration

4.6. IT SYSTEMS ADMINISTRATION

Name of the study programme	IT Systems Administration (IAAB)
Study	Bachelor's study
School	School of Information Technologies (IT College)
Programme director	Siim Vene
Principal complier of the self-evaluation of the study programme	Siim Vene
A brief description of the process of self-evaluation of the study programme	The self-evaluation of the study programme was mainly carreid out by the programme director Siim Vene from April to November 2020. Assistance also provided Nele Teearu (assistant to programme director) and Kristel Marmor (study manager of IT College). Self-Evaluation report was discussed and agreed with the teaching staff. In November 2020 self-analysis was reviewed by the experts in the field (Prof. Emer. Toomas Rang and Prof. Eduard Petlenkov).

AGGREGATED DATA ABOUT THE STUDENTS OF THE STUDY PROGRAMME

	2017/18	2018/19	2019/20	2020/21
Number of students	21	27	59	136
Number of students enrolled	21	15	44	107
Number of graduates	0	0	2	N/A
Number of dropouts	11	12	17	N/A

4.6.1. PLANNING AND MANAGEMENT OF STUDIES

DESIGNING OF THE STUDY PROGRAMME

The goal of the study programme IT Systems Administration (hereinafter also IAAB) is to train IT systems administrators and architects. Unlike other study programmes taught at the School of Information Technologies that focus on software development or specialise in IT hardware, the main emphasis of this study programme is on learning about systems that enable cloud-based solutions, such as servers, data storage, computer networks, administrative processes, etc.

The Strategic Plan of the School of Information Technologies for 2020+ sets out the main goal of studies, which is to train ICT promoters who are able to ensure Estonia's internationally competitive position and development in the field of ICT. The Strategic Plan also lays down that study programmes shall be developed in compliance with the ACM and IEEE curricula recommendations, international and national professional standards and development trends in science and technology. In order to support the sustainable development and innovation goals and the entrepreneurial spirit of students, they are involved in industrial and academic projects where the theoretical knowledge learned can be applied to tackle real-life problems. Academic staff is trained to understand and apply modern evidence-based teaching methods and tools that support learning.

The action plan of the IT College of Tallinn University of Technology for the academic year 2020/2021 sets out the following main study objectives: increase in the number of students graduating within the nominal duration of study, purposefully designed coherent study programmes across the School and continuing education, high-quality teaching, up-to-date methods. All the objectives have been taken into account in designing and developing the study programme and the objectives set have been realised.

The study programme is constantly updated and developed in line with changes in technologies and society each year. The programme advisory board (consisting of students, representatives of large enterprises who are members of the Estonian Association of Information Technology and Telecommunications, such as Telia, Swedbank, Microsoft, Bolt, EENet) convened at least once a year is involved in planning of the changes. The current status of the study programme, enrolment data, plans for updating or replacing courses are introduced to the programme advisory board. Recommendations for designing new courses as well as assessment of the relevance of the existing courses are taken into account. After merger of the IT College and Tallinn University of Technology, the study programme was in a very poor state, where the number of students enrolled decreased every year. To remedy the situation, an extensive study programme reform was carried out and the study programme has been substantially modified. Seven courses have been removed from the study programme and eleven new courses have been added. The priorities have be re-focused so that system administrators can also become familiar with the principles of software development (version control), since application of infrastructure as code principles is required in the labour market. A course, where cloud computing applications are taught, has been added to the study programme to improve cloud computing competencies.

The study programme can be considered important for a number of reasons. There is high demand for system administrators in both the public and the private sector. According to the OSKA reports on ICT 2016, 37,000 ICT professionals will be required by 2020, which is 1.5 times more than in 2013. The report also points out that higher education institutions and vocational schools must provide ICT professionals with better practical skills.

The main indicator of the success of the introduced changes is drastic increase (ca 7 times) in the number of students enrolled in the study programme in the last three years (2018 – 15, 2019 – 44, 2020 – 107).

Before updating the study programme, in 2018 similar study programmes were examined and compared with an aim of finding a combination of courses of IT systems development and administration that would meet contemporary expectations in corporate IT systems management organisations. The comparison of the study programmes showed that the study programmes of Informatics at Tallinn University of Technology and Computer Science at the University of Tartu are somewhat similar to this study programme, but in these study programmes stronger emphasis is placed on software development and in-depth theoretical knowledge. A similar study programme is taught at Tallinn University under the name of Computer Science, but this specialises in software development and digital media.

The primary criterion in selecting external partners is interconnections between their field of activity and the goals and learning outcomes of the study programmes. Cooperation with external partners is focused mainly on supervision of graduation theses by experts working in the public and private sectors. The aim is to support and reinforce the knowledge acquired by students in real-world projects. In the course of preparation of graduation theses, automation, integration, development and implementation of IT infrastructure services (monitoring, backup, virtualization, data storage systems, etc.) of many large and small Estonian companies have been analyzed and carried out. In addition, there is a high percentage (50%) of visiting academic staff in the study programme, who are involved based on their professional competence. Involving practicing experts in teaching helps students to better understand what they are learning through real-life examples. Experts have been involved from Fitek AS, Pipdrive, Tieto Estonia AS, Telia Eesti AS, Bonamore OÜ.

DESCRIPTION OF THE STUDY PROGRAMME

The assessment criteria and methods stem from the learning outcomes of the courses and are used to measure acquisition of the learning outcomes. The assessment methods used include written and oral examinations and tests, individual and group work, presentations of group work, etc. Due to the applied nature of the speciality, in many courses an independent project must be completed as part of an exam/assessment, through which the student can demonstrate his/her specific knowledge and skills.

Upon the development of the study programme, an additional objective besides developing professional knowledge and skills is to enhance general competencies across multiple courses as well as in individual courses. The course Basics of Enterprenuership and Business Communication ICY0031 supports entrepreneurship and provides advice for starting a business, the course IT Systems Support and Arrangement in Enterprises ICA0004 gives an idea of important ICT processes in enterprises, the course Social, Professional and Ethical Aspects of IT ICY0004 points out the ethical and social dimensions in usage of technologies. A project-based approach is often applied in teaching the courses, where students must solve real-world problems in groups, for example in the course Information Storage Technologies the students must design and implement a horizontally scalable data storage service. Such an approach enhances teamwork, project reporting, presentation and time management skills. Internship in an enterprise/work environment develops communication skills and social competencies.

Since the study programme is practice-oriented, internship plays an important role in the study programme (workload 24 ECTS credits) (see Annex 24). Prerequisite courses must be completed before doing an internship, which ensures that the students going on internship have completed most of the study programme and have gained sufficient knowledge and skills to perform tasks at the level of a junior specialist under the supervision of a supervisor. Internship coordinators provide assistance (individual counselling, training/seminars) in finding an internship host; in addition, internship offers are mediated to students (internship offers are collected and displayed on the corresponding subpage of the website and are forwarded via a mailing list). The students can also turn to the university's career advisor, attend seminars/trainings organised by the Student Counselling Office.

The students' feedback on internship has been positive over the years; they can see interconnections between what they have learned in the study programme and what they have experienced on internship. Feedback on the process is requested in the internship blog (a confidential self-analysis tool between the internship coordinator and the student), in the internship reports (an academic paper submitted to the internship defence committee) and at the oral defence. Supervisors at the host organisation are not trained separately, but students' feedback on supervision is monitored and so far the quality of supervision has been very high. In order to improve the quality of supervision of workplace internship, the goal is to prepare guidelines for employers and supervisors at the host organisations and publish them on the School's website along with the recommendations of current internship supervisors for future internship supervisors.

The internship hosts in the study programme (incl. its predecessor at the IT College) include several public and private sector institutions (e.g. Telegrupp AS, Telia Eesti AS, Swedbank AS, Ellore OÜ, Saue Rural Municipality Government, IT and Development Centre at the Estonian Ministry of the Interior (SMIT), CITIC Telecom CPC Estonia OÜ, Playtech Estonia OÜ, the Information System Authority (RIA), ABB AS, Eesti Energia AS). Before a student goes on internship, it is checked whether the host organization is suitable, taking into account the nature of the study programme.

Various tasks are performed during internship. Here are some examples:

- Administration and development of business applications, administration of application databases and preparation of statistical reports
- Designing, installation, documentation and management of IT systems
- Configuration and management of network connections
- Administration of IT infrastructure services, configuration of office software and other software used in the enterprise, operating system administration
- Management of workplace-related hardware and software, preparation of guidelines, keeping records of hardware assets.

Students working as IT specialists can do their internship based on work experience by way of a simplified procedure. During the last three academic years, 43% of internships have been completed by way of a simplified procedure.

The study programme has been structured so that students can choose a narrower specialisation from among the suitable elec-

tive courses and select between different levels of complexity (see Annex 26). Students can change the content of their studies by selecting between the elective courses offered. Almost 50% of the speciality courses are elective courses, which provides flexibility in selecting a suitable schedule and planning one's individual study plan. The optional study module provides students an opportunity to study courses not included in the study programme. It is also possible to attend more optional courses than required in the study programme. The study programme has been developed with an aim of making it as easy as possible for students to change the study programme at the School of Information Technologies should they want to change their speciality in the first academic year.

International mobility of students takes place mainly within the framework of the ERASMUS program. Until now, students have showed little interest in international mobility; an average of 1-2 students in an academic year have wanted to gain knowledge at a university abroad. All the applications have been satisfied and assistance has been provided to students in compiling a suitable syllabus at a university abroad. Opportunities for international mobility are introduced at a briefing at the beginning of each academic year.

It is difficult for international students to participate in the study programme, since the majority of the courses are taught in Estonian. Courses related to networking are taught in English (Fundamentals of Networking ICA0013, Fundamentals of Wireless LANs ICA0008, Advanced Routing and Switching ICA0010, Advanced Networking ICA0014, Computer Network Security ICA0015). At the same time, these courses help students to acquire better professional English proficiency through instruction in a foreign language.

Feedback on the content of the study programme (modules, courses) is requested from the programme advisory board at least at the end of each semester and at least once a year. As a result of the feedback, new courses have been added to the study programme (Basics of Cloud Computing ICA0017, Foundations of Software Testing ICD0012, Automated Testing ICD0004, Foundations of IT Management and Operation ITB1708, MicroServices and Container Architecture ICM0014, Physics for Poets NSO0160, Environmental Protection and Sustainable Development YTG0060). The existing subjects that are no longer so relevant have been updated or removed (Fundamentals of Natural Sciences and Sustainable Development YFX0060, Information Systems Projects and Project Management ICY0009, Intellectual Capital Theory ICY0023). The semesters when the courses are taught have been changed in order to improve cohesion between the courses and their logical sequence. Some academic staff members have been replaced based on the feedback, when students have submitted justified complaints regarding the quality of teaching.

RESOURCES

There are sufficient financial resources for the implementation and development of the study programme, on average about 40,000 euros are allocated annually; the amount varies over time, depending on the total number of students studying in the study programme. The programme director is responsible for the use of the budget allocated for the development of the study programme. The development budget has been used to finance, for example, the purchase of equipment, training of academic staff, and payment of salaries or additional remuneration for (visiting) academic staff. The availability of resources ensures that the study programme is sustainable in the long run - teaching is carried out by competent academic staff and modern technologies are used. A laboratory base has been created, which can also be used by students of other study programmes for specialised studies (virtual servers for students, remote access to practicums and laboratories).

There is technological and methodological readiness to conduct distance learning and /or increase the share of e-learning or hybride learning, if necessary.

Teaching is mostly paperless, using study information systems, recording and "watch later" options, virtual labs and communication with the lecturer and other students via digital channels.

Students have access to various research databases. The frequency of use of the databases among students has not been measured.

Suitable conditions have been created for students to perform both independent and group work. There are modern computer classes and laboratories, several seating areas in the public space of the study building, where one can work both individually and with a group.

SUMMARY OF STRENGTHS AND AREAS FOR IMPROVEMENT

Strengths

• The study programme is practice-oriented – teaching focuses to a significant extent on solving real-world problems encountered in the working environment.

• The study programme is flexibly structured allowing the students to design their own study path within the study programme.

• Opportunities have been created for changing the study programme within the School of Information Technologies in the first academic year.

Areas for improvement and planned development activities

• To increase laboratory capacity by involving private companies and cloud service providers.

• To prepare interactive guides for improving the quality of supervision of graduation theses and internship (the main points to pay attention to in supervision, self-assessment questionnaires, etc.).

• To involve, besides students and employers, also alumni in the work of the programme advisory board.

4.6.2. LEARNING, TEACHING AND ASSESSMENT

The goals related to teaching are to maintain and improve the quality of teaching, to admit students with good academic abilities and to stabilize their number, to increase the number of students graduating within the nominal duration of study and to reduce the number of students dropping out at the beginning of studies. Feedback from target groups (alumni, employers, students, programme advisory board) is used to assess the quality of teaching.

Several different channels are used to inform potential students about learning opportunities in the study programme. There is a page describing the study programme on the university's website, information leaflets have been prepared for sharing at fairs and school visits, social media campaigns are organized several times a year, articles have been written, visits to secondary schools and participation in information days have been planned.

ADMISSION PROCEDURES

Year-round admission of students is used to ensure flexibility of admission procedures. There are to different admission options addressed to different target groups.

First, there is an admission system based on state examinations, which allows upper secondary school graduates to commence studies. State examinations include examinations in broad mathematics and in the Estonian language and, to meet the threshold, the result of the examinations shall be 55 and 45 points respectively. In order to reduce the number of early leavers/dropouts, the admission thresholds will be changed so that from 2021 the result of the state examination in broad mathematics must be at least 65 points and the result of the state examination in the Estonian language must be 55 points.

Another option for admission is the professional proficiency test, the level of complexity of which is similar to the COMPTIA or EU-CIP certification exams for system administrators. Persons, who have not passed state examinations (e.g. graduates of vocational schools or specialists already working on the labour market), but have passed the test (and attained at least 60 points) can commence studies in the study programme. In recent academic years, about one third of the students (35-39%) have been admitted through passing state examinations and the rest (61-65%) through passing the professional proficiency test, which shows that the majority of the students admitted are specialists who have previously gained IT knowledge or who are already working in the field. The admission procedures are transparent and objective, all student candidates have equal opportunities in the form of thresholds, and all results are auditable. The success of the admission is demonstrated by the fact that the number of students enrolled has increased 2.5 times in the last academic year. At the same time, such volatility in the number of enrolled students has also made it more difficult to plan studies and ensure their quality. The optimal would be somewhere between 60-70 students.

TEACHING

In order to take into account students' individual abilities, opportunities are provided for in-depth acquisition of subjects (additional materials, individual tasks). Advice is provided in choosing the elective and optional courses, the internship host or the topic of a graduation thesis based on the student's interests and needs. Students can take a bridge course in mathematics to support smooth continuation of studies.

Students are offered the opportunity of individual consultations conducted by the assistants assigned to the course. Additional materials for independent learning are available online, all the lectures and practicums are recorded and students can watch them later. The needs of students with special physical needs are taken into account in cooperation with the Office of Academic Affairs, if necessary.

Digital means that support planning and conducting of studies have been integrated into the study process; study information systems (SIS, Moodle) are used and Microsoft Teams is used for team collaboration. Trainings are regularly organised for the teaching staff to improve digitalization of the courses or to improve their skills to use digital tools. E-support is provided for compulsory courses in Moodle and the goal is to provide all the courses with e-support. Extensive use of digital tools (including recording of lectures and enabling to watch the lectures later) has created conditions for conducting studies partially of fully in the form of distance learning, if necessary. Based on the transition to distance learning due to the SARS-CoV-2 pandemic, the teaching staff can be considered to have good general digital skills.

ASSESSMENT OF STUDENTS

An academic staff member shall prepare a course description for the course (see Annex 25), which shall include the workload of face-to-face learning (or also e-learning), the list of independent assignments, description and workload of independent learning and the assessment methods and criteria. Both teacher-centered methods such as lectures, guided discussions, seminars and practicums (ICA0004 IT Systems Support and Arrangement in Enterprises) and student-centered methods such as individual and group work projects, blogging (ICY0004 Social, Professional and Ethical Aspects of IT) are applied in teaching. As a rule, the overall grade of a course is a combination of the grades for solving practical tasks, knowledge checks, group work and the final exam.

There are two types of independent work: independent written assignments (pojects, essays, reports) and graduation theses. Most courses have forums in Moodle, where students can ask for advice and lecturers can guide them. A lecturer gives thorough feedback on the independent work either upon completion of the intermediate stages of the work or upon final completion of the work.

Supervision of graduation theses is coordinated by a separate lecturer, the College has developed a well-functioning procedure for the students for writing graduation theses. The stages of the procedure of writing a graduation thesis are the following: a graduation thesis seminar (an overview regarding the content and form of a graduation thesis is provided, ideas are given for finding a topic and information is provided on the activities/schedule related to defence), submission of the thesis outline, defence of the thesis outline, pre-defence of the graduation thesis, defence of the graduation thesis. The process of compiling

a graduation thesis takes place in the Moodle e-learning environment, where information is provided and students can ask questions, documents are submitted, information materials are kept, etc. A graduation thesis is defended at a public meeting and those interested can follow the defence online. Besides the supervisor from the university, representatives of companies can be involved as supervisors of a thesis. Representatives of companies are also involved in reviewing graduation theses and in the work of the defence committee.

At the end of each semester, students provide feedback on the courses of the ending semester in the study information system. Ratings are given on a 5-point scale and students can add their comments. The positive aspects pointed out by students include constructive feedback received from lecturers, clear assessment criteria, good organisation of studies, clear instructions provided by the lecturer, practical examples and tasks illustrating the theory. The volume of work performed by students for 1 ECTS needs to be analysed, because according to students, it differs across courses, and the arrangement of the courses (setting clear tasks, deadlines for completing independent work) should be reviewed. Analysis of the feedback is carried out by the programme director and the study manager. If necessary, the problem areas pointed out in the feedback are analysed also together with the lecturer. As a result of feedback received, for example, lecturers have supplemented study materials, explained in more detail the assessment criteria of independent work. Each lecturer shall also analyse the feedback given on the course taught by him/her and it is recommended that the lecturer give his/her opinion on the feedback received.

SUPPORT SERVICES AND SUMMARY

Upon planning the timetable of the IAAB study programme it has been taken into account that there may be persons among students who are already working, which is why the studies take place in the afternoon. Payment of specialty and performance scholarships motivate students to graduate within the nominal duration of study.

Students can use TalTech's counselling services and turn to the student counsellors of the dean's office of the School of Information Technologies with issues concerning the organisation of studies. The first contact in the IAAB study programme is assistant to the programme director, who provides advice to students in matters regarding the organisation of studies and who has access to students' data and their previous performance. The programme director provides assistance to students of the study programme in substantive matters: accreditation of prior and experiential learning (APEL), choosing a thesis topic, assessing suitability of the courses for studies abroad, solving problems with lecturers, etc.

A dropout survey has been conducted at the university every year since 2015. The reasons for discontinuing studies can be divided into two: reasons concerning the university and reasons concerning factors not related to the university. The IAAB bachelor's study programme was opened in 2017/2018 and during this period most of the dropouts discontinued their studies at the beginning of the studies, either in the first days of the academic year or in the first semester. The main reasons for discontinuing studies were wrong choice of the study programme, failure to complete the required number of courses in the first semester, due to which the student was either exmatriculated (the student failed to complete at least 15 ECTS in the first semester) or was required to pay tuition fee for each ECTS for the volume of study by which the student fell short of the nominal load. In addition to the reasons for discontinuing studies mentioned above (unsuitable study programme and requirements regarding the organisation of studies), it is difficult for working students to continue their studies due to extensive workload – persons working in the field are also welcome to study in the IAAB study programme besides upper secondary and vocational school graduates.

In order to reduce drop-out rates, information is provided and the study programme is introduced at several university-wide and study programme related events organised before the commencement of studies (in the admission period) and shortly before the commencement of studies (in the pre-week) – open doors days take place, the specialities are introduced in social media, briefings are held to introduce the organisation of studies, meetings are held with the programme director, etc. All students are informed of the contact persons who offer advice regarding the organisation of studies and other matters. The university has a functioning website and a system of tutors and students have the opportunity to participate in psychological and career counselling. There are a number of leisure activities for students that help them make friends/find like-minded people and strengthen their desire to study and integrate into the membership of the university.

SUMMARY OF STRENGTHS AND AREAS FOR IMPROVEMENT

Strengths

• Flexible admission procedure that takes into account different target groups (admission is possible on the basis of both state examinations and the professional proficiency test).

• Use of different teaching methods depending on the learning outcomes of the course.

• A multi-stage procedure for writing a graduation thesis that supports the students.

• Extensive use of digital tools in the studies.

Areas for improvement and planned development activities

• Enhancing cohesion between courses.

• A more substantial analysis of student feedback together with academic staff in order to improve the quality of teaching (teaching methods, digital competence, flexibility in conducting studies).

• To improve the opportunities of digital learning, e-support must be provided to all the courses in the study programme .

• The drop-out rates at the beginning of the studies (in the 1st and 2nd semester) must be reduced through various counselling activities.

• The number of enrolled students must be stabilised and the number of enrolled students with good academic abilities must be increased by optimising the thresholds.

• Greater involvement of students in introducing the study programme and promoting opportunities to study in the field.

4.6.3. DEVELOPMENT, COOPERATION AND INTERNATIONALISATION OF TEACHING STAFF

The main objective related to the teaching staff in the context of this study programme is the use of evidence-based and up-to-date teaching methods and tools that support learning. Practical experience should be shared by involving practitioners in teaching.

One of the strengths of the IAAB study programme is involvement of a significant number of visiting academic staff who share their industrial experience and best practices. In the study programme, courses are taught mainly by lecturers and senior lecturers, whose main responsibility is to teach and develop studies (conduct teaching, supervise, constantly update the courses taught). Great importance is attached to professional work experience outside the university, participation in innovation activities, contribution to preparation of funding applications, participation in projects.

Since it is an applied study programme and practical skills and adaptation to changing needs is considered important, instead of research and development, lecturers are mainly engaged in the development of studies, which constitute primarily projects that help modernize teaching methods either in the course or across the College, e.g. a College lecturer developed a proctoring solution and a process to facilitate distance learning. The College's action plan sets the following goals: the teaching methods must be professional, updated and continuously improved and multimedia support must be provided for e-learning.

Many lecturers teaching in the study programme have an international background and have obtained either a bachelor's or master's degree abroad prior to teaching in the study programme. The academic staff of the study programme do not teach in higher education institutions abroad, but they participate in practical projects carried out in enterprises in collaboration with colleagues from abroad. Lecturers of foreign higher education institutions are not involved in teaching, but full-time international members of teaching staff are involved in conducting studies in the study programme.

The College's development days organised once a semester and didactics seminars support the exchange of experiences between academic staff (both full-time and visiting). One of the aims of the seminars is to create a common information space for full-time and visiting lecturers in order to enhance cooperation in teaching and improve the quality of the supervision of graduation theses.

The requirements for the qualification of the teaching staff, based on which the academic staff is selected, are laid down in the Regulation on Academic Career Management. One of the bottlenecks is the high workload of the top specialists teaching in the study programme as visiting lecturers, which means that they can usually teach only one course. They are involved as supervisors, reviewers of graduation theses and members of thesis defence committees. Extensive involvement of visiting lecturers is a strength in terms of teaching practical skills to students, but also a weakness, as there is no corresponding competence within the university, which puts sustainability of the courses at risk, should an external visiting lecturer decide that he/she no longer wants to continue collaboration with the university. One solution would be rotating of the university's lecturers who can teach the courses of visiting lecturers.

A procedure for processing violation of good academic practice and contemptible behaviour has been established at the School, which the teaching staff must follow. On the positive side, it can be pointed out that the procedure has been applied only in a few cases during an academic year. The procedure for processing violation of good academic practice is introduced to students at briefings. The procedure is introduced to enrolled students together with other information on the organisation of studies at the briefings in the pre-week. The teaching staff have been informed of the applicable regulations. At the beginning of an academic year, the good academic practice is introduced to students and, among other things, an explanation is provided on what is considered plagiarism at the university.

Academic staff, including visiting academic staff, have the opportunity to attend internal trainings organised by the university. When a lecturer starts working as an assistant, he/she will be mentored by a full-time lecturer. The college sees the involvement of assistants in teaching also as an opportunity to ensure training of a new generation of teaching staff. An assistant starts by supervising practical assignments, individual consultations and then conducts seminars independently.

The cooperation with practitioners in the field, including alumni, is very good. The majority of them teach courses with narrow specialization (server management, monitoring, cloud technologies, data storage, etc.). Many members of the teaching staff are former alumni of the study programme. Every year the alumni are also involved as members of defence committees, supervisors and opponents of graduation theses. Many of the students studying in the study programme are working in the same field already during their studies and are therefore aware of the expectations of the labour market, what competencies employers expect graduates to have and what professional and general competencies are required.

SUMMARY OF STRENGTHS AND AREAS FOR IMPROVEMENT

Strengths

• Involvement of practitioners of the field in teaching, supervision of graduation theses and work of the defence committees helps to ensure that the studies are consistent with the labour market needs and that students acquire competencies that meet the requirements.

Areas for improvement and planned development activities

• Developing cooperation between the academic staff and supervisors of graduation theses with an aim to improve and harmonise the quality of graduation theses.

• Creating more opportunities for in-service training of the teaching staff.

Annexes:

Annex 24. Study programme form of IT Systems Administration

Annex 25. Descriptions of the key courses of IT Systems Administration

Annex 26. A chart illustrating the interconnections between modules/courses of IT Systems Administration

Annex 27. Teaching staff of IT Systems Administration

4.7. PRODUCT DEVELOPMENT AND ROBOTICS

Name of the study programme	Product Development and Robotics (EARB)
Study	Bachelor's study
School	School of Engineering
Programme director	Prof. Raivo Sell
Principal complier of the self-evaluation of the study programme	Prof. Raivo Sell (Programme Director, Professor of the Department of Mechanical and Industrial Engineering)
A brief description of the process of self-evaluation of the study programme	The preparation of the self-evaluation report started under the leadership of the programme director in the spring of 2020. Karl Läll, Jaan Kirsch, Eliise Toom were involved in the process as student representatives; ABB Eesti and the Federation of Estonian Engineering Industry were involved as employers' representatives. The starting points of the self-evaluation of the study programme were discussed and agreed with the programme advisory board. In November 2020 self-analysis was reviewed by the experts in the field (Prof Jakob Kübarsepp and Prof Tauno Otto, School of Engineering).

AGGREGATED DATA ABOUT THE STUDENTS OF THE STUDY PROGRAMME

	2017/18	2018/19	2019/20	2020/21
Number of students	60	97	152	175
Number of students enrolled	49	56	73	73
Number of graduates	N/A	N/A	23	N/A
Number of dropouts	24	24	28	N/A

4.7.1. PLANNING AND MANAGEMENT OF STUDIES

DESIGNING AND MANAGEMENT OF THE STUDY PROGRAMME

The needs and expectations of various stakeholders have been analysed and the recommendations of the employers and requirements stemming from the development trends of technology have been taken into account in designing the study programme. In the design phase, several meetings were held with the employers and the process has continued through the programme advisory board, which includes representatives of employers, students, as well as the professional association – the Federation of Estonian Engineering Industry. Estonia's top companies in the engineering sector, e.g. ABB Eesti, Ericsson Eesti, Stoneridge Estonia, Cleveron, Starship Technologies have been involved and contributed most actively in the development process at various levels. The study programme complies with the occupational qualification standard for Mechanical Engineer, level 6, in terms of the main mandatory competencies and learning outcomes of the study programme. With the corresponding specialisation in master's studies, the study programme complies with the occupational qualification standard for Diploma Mechanical Engineer, level 7.

The proposals and recommendations made in the OSKA study in the sector of manufacturing of metal products, machinery and equipment for modernisation of technical higher education have been taken into account in the development of the study programme. The study programme has been constantly updated based on student feedback, the recommendations of the programme advisory board and the needs of employers. The main changes made in the last three years are the following:

• The course Physics I was reorganised and made more speciality-specific (the studies are more interconnected with the speciality courses and are conducted by mechanical engineers in cooperation with the lecturers of the School of Science in the framework of the Classical Mechanics course. The course focuses on four main areas: statics, kinematics, dynamics and thermodynamics).

• The courses Descriptive Geometry, Technical Drawing and Computer Aided Engineering were merged into one integrated course Engineering Graphics.

• The elective courses were updated (Personal Finance, Data Communication and Management, Smart Houses).

• The share of project-based learning has been increased (a new elective course Electrical Vehicle - project) and the assignments in project-based courses were linked with the challenges of the enterprises.

• The course Introduction to Speciality, in the course of which the speciality is introduced, guest lectures are delivered and companies (future employers) are visited, has been added to the study programme.

The study programme is constantly evolving and, after the first students graduate from the programme, alongside the abovementioned stakeholders the opinions and feedback of the alumni will be taken into account when making changes to the study programme.

During the development of the study programme, a comparison with similar study programs in mechanical engineering, mechatronics and robotics at neighboring technical universities (KTH, Chalmers, Aalto, Tampere TU, DTU, RTU and KTU) was conducted. The comparison showed that very different study programmes are used to teach the fundamentals of mechanics and robotics, but the fundamentals courses and core studies are similar in the study programmes. The directions and focuses of specialization are different. As regards the study programme Product Development and Robotics, it was important that the name of the study programme would express clearly and comprehensibly the content of the study and at the same time be attractive to the entrants. By now, in Estonian secondary schools elective courses in robotics and, in some schools also in product development, have been launched. The use of the same terms in the name of the study programme provides entrants with clear and comprehensible information about what they are going to study.

The study programme is developed and studies are planned in compliance with the global development trends undergoing fast and great changes in the field of product development and especially robotics. In order to keep up with the development trends, the leading research group of the study programme has joined various international organizations engaged in the field of development of practical robotics and self-driving vehicles. In 2019, TalTech joined the Autoware Foundation, which is software consortium supporting open-source projects enabling self-driving mobility, and in 2020 the International Alliance for Mobility Testing and Standardization (IAMTS).

The research groups of the Department of Mechanical and Industrial Engineering support directly the launch and implementation of the study programme through their research topics. The Autonomous Vehicles Research Group, Smart Industry Research Group and Automated Production Systems and Real-Time Monitoring and AI Models Research Group are directly connected with the study programme Product Development and Robotics. Their research topics and findings are applied in teaching and practical training. For example, the first self-driving car in Estonia developed by the Autonomous Vehicles Research Group (Iseauto) is used on the compulsory course Autonomous Vehicles of the main speciality of Robotics and the smart production monitoring system developed as a result of research of the Automated Production Systems and Real-Time Monitoring and AI Models Research Group is used on the elective course Internet of Things (IoT). Students can participate in research projects and contribute to research results within their area of specialisation. The PhD students, researchers and professors involved in a research group offer students an opportunity to join a specific topic or project of the research group within the framework of various projects. For example, students are involved in the development of a self-driving vehicle related to Horizon 2020 projects. The students are also involved in FinEst Twins Smart City Center research on V2X technologies, incl. adaptive traffic control systems, communication between different types of vehicles and infrastructures. Students are first engaged in simpler assignments and as experience grows, they can contribute to producing of research results. Participation in the work of research groups is arranged as an extracurricular activity or related to speciality courses, depending on the specific topic and student. The programme director of the study programme Product Development and Robotics received the Estonian Science Communication Award in 2020 for the promotion and popularization of robotics (incl. Iseauto, Robotex).

STRUCTURE OF THE STUDY PROGRAMME

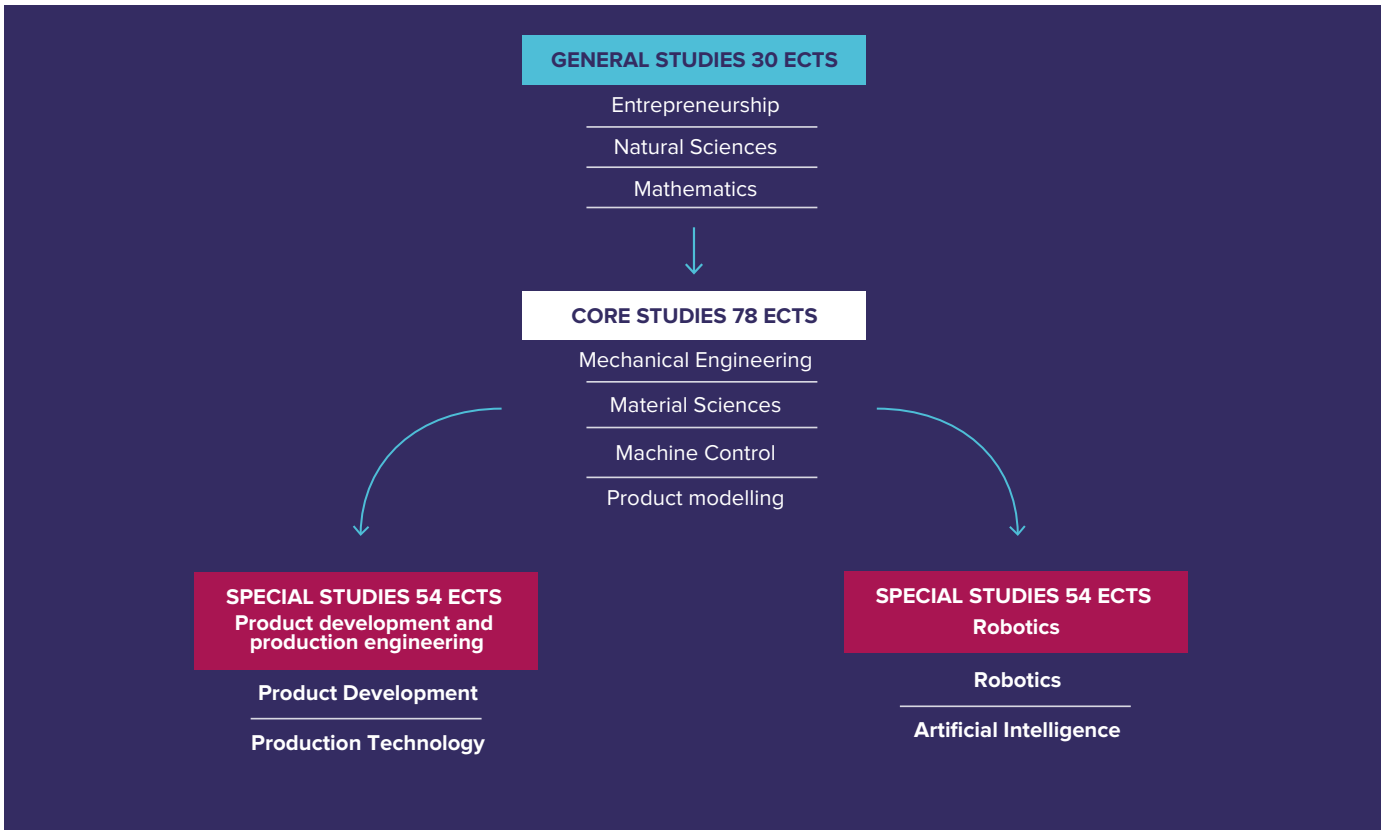


Figure 26. Structure of the study programme of Product Development and Robotics.

The modules of the study programme and the courses in the modules form a coherent whole of the main speciality and provide students with key competences required in the field (see Figure 26). The key competencies are listed in Annex 30, which indicates in detail in which modules and on which courses the competencies are acquired. Assessment on the courses, in particular speciality courses, and acquisition of learning outcomes is as practical as possible and is based on continuous assessment. For example, on the basic courses (Classical Mechanics, Engineering Graphics, etc.) the final grade can be obtained based on the tests conducted during the semester and on speciality courses based on practical assignments and team projects (Microcontrollers and Practical Robotics, Internet of Things (IoT), etc.). A student's workload is calculated taking into account the indicative ratio, where 1 ECTS credit point corresponds to 26 hours of work used by a student for study. This is not an exact ratio, as students' progress and abilities are different, as is the share of face-to-face learning and independent work on different courses. Student feedback has also varied. Nevertheless, the workload of independent work has been adjusted based on the student feedback and the programme director has given recommendations to lecturers to adjust the workload. Problems have occurred on courses taught by several lecturers, who have different requirements and different approaches to assessment of their students' knowledge. Most of these cases have been resolved and the lecturers have been replaced if the requirements have not complied with the course description and workload in ECTS credit points.

Creativity and entrepreneurship are supported mainly through speciality courses and teamwork projects. On the courses Product Development Project and Robotics Project, interdisciplinary teams are created, where in addition to students of this study programme, students of economics can also participate. Entrepreneurship practice is related to the course Speciality Project, where it is assumed that some students choose entrepreneurship practice and support the product development team in product commercialization and marketing.

Students are encouraged to spend one semester of their studies abroad at TalTech partner universities, which is supported, for example, by the Erasmus + student mobility programme. The respective opportunities and programmes are introduced in the first semester on the course Introduction to Speciality.

RESOURCES

For the development of the study programme, a separate accounting object has been created in the department, which is managed by the programme director. Baseline funding is provided from the budget of the dean's office and funding for the study environment, purchasing and creating of materials and tools has been obtained from the respective projects and financial support measures.

For example, creating of the material and technical base and development of study materials was financed from the HITSA (Information Technology Foundation for Education) project "Self-driving vehicles and autonomous systems lab-competence center" and EU-funded Erasmus+ projects: "Innovative Open Education on IoT: improving higher education for European digital global competitiveness" and "Educate and Train emerging Challenges: Internet of Things". The development of the learning environment, incl. the study programme, has been supported by several other EU and business projects. For example, a modern Robotics Demo Centre was built at the department, where studies are conducted and student projects are carried out. In the Demo Centre, there are separate labs of virtual reality and flexible manufacturing systems.

The funds allocated for the study programme have been used for the development of the learning environment, purchasing study materials, advertising, cooperation with general education schools and prevention of interruption of studies. For example, workshops have been conducted in upper secondary schools, promotional publications and videos have been produced to support the marketing and recruitment activities related to the study programme, and remuneration has been paid to students who have been involved in these activities.

Students are provided with all the necessary study materials, including study literature. Teaching materials in Estonian have been compiled for some courses and have been published as books. For example, the textbook "AVR mikrokontrollerid ja praktiline robootika" was compiled for the course Microcontrollers and Practical Robotics. All compulsory courses are supplied with e-support in Moodle.

SUMMARY OF STRENGTHS AND AREAS FOR IMPROVEMENT

Strengths

• The quality of teaching has been steadily improving; several practical projects have been integrated into the study programme.

• The strong base of research projects and practical development projects supports the development and conducting of studies.

• Innovative practical laboratory equipment and teaching aids (home-study laboratory kits, the self-driving vehicle Iseauto, autonomous robot) and modern software are used.

Areas for improvement and planned development activities

• To update the courses in the core module, the content of the courses in the core module should be analysed and updated, if necessary.

4.7.2. LEARNING, TEACHING AND ASSESSMENT

ADMISSION REQUIREMENTS

Admission to the study programme Product Development and Robotics is threshold-based. The threshold is a minimum of 45 points in the state examination in the Estonian language and 50 points in the state examination in broad mathematics, and the total amount of points shall be at least 100. The number of students admitted has increased every year, despite the general decrease in the admission rate in higher education. In advertising and introducing the speciality, great emphasis is placed on explaining the specifics of the speciality and introducing the career opportunities, as well as on the organization of studies in order to ensure that the students admitted are motivated. It is more important that students make an informed choice rather than admit as many students as possible. To achieve this goal, speciality-related workshops are organised in upper secondary schools, active contribution is made to the Young Engineer Programme and other practical activities aimed at school students. Mass advertising as well as production and distribution of printed materials has been reduced.

STUDENT-CENTRED TEACHING

Students' individual abilities and needs are taken into account in the teaching process and their development is supported throughout the whole study period. On more complicated core courses, such as Classical Mechanics and Higher Mathematics, additional consultations are provided to help students better understand the topics and pass the midterm tests. Other lecturers have been selected to provide additional consultations in order to offer a different perspective on the respective topic. Additional consultations are financed separately from the programme's development funds.

In order to better understand the chosen speciality and plan a career, there is a compulsory course Introduction to Speciality in the first semester, in the course of which practical assignments are completed on the topics of both main specialities to help new students understand what their speciality studies in their third year involve. The same course also includes company visits with an aim to introduce opportunities in the labour market (including future potential jobs) and internship opportunities. The practical assignments in both main specialities comprise a lecture-workshop set conducted in the first half of the semester. The practical assignment in the main speciality of Product Development and Production Engineering is an innovative product created using simple means, where students get an overview of the practical meaning of product development. To better understand the main speciality of Robotics, a small mobile robot is built, programmed and put into operation. The practical work takes place in cooperation with TalTech Robotics Club.

ASSESSMENT OF STUDENTS

The assessment criteria are defined in the extended syllabus of each course. The assessment criteria must be indicated for each course in the online environment and each lecturer must introduce the assessment criteria to students in the first face-to-face lectures. Assessment is carried out continuously or in the form of an exam or pass/fail assessment at the end of the semester depending on the specifics of the course. The programme director encourages and supports implementation of continuous assessment, which allows knowledge to be checked on an ongoing basis, with emphasis on practical skills and knowledge rather than factual knowledge. For example, the final grade of the course Physics I /Classical Mechanics is formed based on the mid-term assessments in four modules (Statics, Kinematics, Dynamics and Thermodynamics) instead of the previous final examination. Similar continuous and hybrid assessments are applied on most of the speciality courses.

APEL can be used to complete the study programme. Assessment is based on learning outcomes and the programme director decides on the substantial compatibility of learning. The student counsellor and the APEL adviser provide help with the formalities. So far, all submitted APEL applications have been approved.

The study programme includes an internship in the amount of 6 ECTS, which is carried out usually in summer in a company, which is engaged in product development or robotics. The main goal of an internship is to gain experience in a manufacturing company, which consolidates the acquired knowledge. An internship is organized as follows: the student shall find an internship host on the Facebook page of TalTech internship offers, online job portals or through the professional association. The suitability of the internship assignments shall then be approved by the internship coordinator. An internship is carried out (the minimum of 5 weeks), during which it is recommended to keep an internship log, which will later be attached to the internship report. After completing an internship, the student makes a short presentation, describing how he or she found the internship host, what the assignments were and what knowledge and skills he or she acquired. The presentation takes place at an internship seminar, which is attended also by students of first courses in order to show them how they can make sure that their internship goes smoothly and what jobs await them. In addition to the presentation, an internship report must be submitted, which describes the company and the student's activities carried out during the internship. Finally, an application has to be submitted in SIS, accompanied by a report and the opinion of the supervisor of the internship at the host organisation (incl. feedback on the student's performance). On the feedback form, companies can also indicate whether they are looking for interns also in the following years and give recommendations for improving the organisation of internship.

No training is organised for supervisors at host organisations, as every year internships are done in approximately 50 different institutions. There is a constant exchange of information with long-term partners and larger companies (such as ABB and Stoneridge) regarding the organisation of internships and the expectations of both parties.

The speciality courses are mostly of a practical nature – a product, solution or concept is created on the courses either individually or in a team. Both main specialities have a Speciality Project course, which is intended for applying the knowledge and skills acquired during the studies in tackling an interdisciplinary teamwork challenge. A project involves companies that set a task and participate in the assessment process. The first speciality projects with companies that took place in 2020 were very

successful and received very good feedback from both students and companies.

In the spring semester of 2020, students successfully completed projects proposed by three companies. For example,

1. HOOB in cooperation with Stoneridge Electronics gave the task to automate the tending process of an assembly machine for soot particulate sensors (see the solution).

2. The Digital Construction Cluster gave the task develop a bricklaying program for an industrial robot based on a brick wall drawing created in SketchUp (see the solution)

3. Hammarprodukter OÜ gave the task to design a machine for installing reflective stickers on a plastic plate. Plastic plates with reflectors are used to mark power lines to warn birds of hazard (see the solution).

Various innovative digital distance learning methods and tools have been applied in teaching. For example, special home-study labs for robotics and the Internet of Things have been developed, which allow the practical work of these courses to be carried out outside the schedule or at home. Home-study labs were fully in use in the spring of 2020, when the university was closed due to the coronavirus outbreak and speciality courses had to be conducted remotely. Thanks to the home-study labs, the practical work was not left undone, but was performed at home. In addition, simulation tools were used and students had remote access to the university's software.

STUDENT SUPPORT SERVICES

For example, in 2017, 22 students out of 49 students admitted to the Product Development and Robotics study programme interrupted studies and 13 completed the study programme. The dropout rate is 44.9 and the percentage of students who have graduated within the nominal period of study is 26.53.

There are various solutions and services to support students and reduce the dropout rate. A support group of senior students in the same field has been set up to help freshmen settle in at the university and provide support both individually and in smaller groups. For example, joint physics studies took place in small groups at Mektory under the supervision of senior students. Also integration parties are organised for first-year students to create a team spirit and encourage mutual support.

A separate system has been established to monitor students' academic performance and their current progress, which is used in the first two years. The monitoring system is designed to identify students who have learning difficulties in the middle of a semester and as a result are likely to drop out. The programme director contacts everyone individually in cooperation with the student counsellor to identify the cause of the problem and find solutions to overcome the difficulties. The system also has a student view that shows each student his or her general progress on a 100-point scale. The monitoring data is based on ongoing mid-term assessments in the Moodle e-learning system. The user interface and statistics module as well as the student view have been specially developed for the study programme Product Development and Robotics. This system serves as a model for TalTech's university-wide student monitoring system.

The graduates of the study programme Product Development and Robotics are competitive and highly regarded in the labour market and successful in their further studies. The salary level of graduates compared to the average salary in Estonia has been approximately 1.3 times higher in recent years and shows an upward trend, which was also a goal set for the study programme. Students have participated in internationally renowned projects such as Iseauto, Formula Student, Student Satellite, which has given them invaluable experience and has significantly raised the value of the students who participated in these projects in the eyes of employers.

In addition to regular feedback provided in SIS, each semester the programme director conducts a survey among students, where students evaluate the entire set of courses in the semester and each course separately (incl. its merits and drawbacks). The ratings given by students to the set of courses on a 5-point scale have usually remained between 4 and 5. The feedback survey conducted allows the programme director obtain information directly from students before an exam session and provides valuable information on how to improve the organisation, content studies and teaching. The feedback survey provides the programme director the latest firsthand information, as a result of which conversations have been held with the lecturers, with regard to whom students have pointed out problems, and lecturers, who have received relevant and positive feedback, have been recognised. As a result of feedback, conclusions have been made for making changes to the study programme or courses and feedback provides regular input for the development of the study programme.

SUMMARY OF STRENGTHS AND AREAS FOR IMPROVEMENT

Strengths

• Teaching and assessment is carried out by taking into account practical skills, which are often acquired through teamwork.

• Various measures are implemented to support students' progress, such as additional consultations on certain courses, a support group consisting of senior students.

• A monitoring system has been established to help identify students with learning difficulties before the examination session, which serves as a model in the development of a university-wide monitoring system.

• Various innovative digital distance learning methods and tools are applied in teaching.

Areas for improvement and planned development activities

• Activities for reducing the dropout rate with the help of the established monitoring system shall be continued and lecturers should be encouraged to use interim results (if they have not yet done so).

• The share of project-based learning and cooperation with companies shall be increased.

• To update engineering studies, it is necessary to join the CDIO network and implement the CDIO approach in the study programme of Product Development and Robotics.

4.7.3. DEVELOPMENT, COOPERATION AND INTERNATIONALISATION OF TEACHING STAFF

TEACHING STAFF

Teaching is carried out by experts in their field and experienced lecturers. There are a total of 20 full-time lecturers in the study programme, including lecturers of speciality courses, from among whom 13 are experts in the field holding a PhD. The rest of the lecturers have a master's degree, from among whom many are pursuing a PhD. Practice classes are conducted mainly by PhD students, including international PhD students, of the Autonomous Vehicles Research Group. The list of lecturers and their qualifications are presented in Annex 31.

The teaching staff of the study programme of Product Development and Robotics are encouraged to apply a student-centred approach and develop the course accordingly. To this end, various meetings have been held between the members of teaching staff and the programme director to discuss and share experiences in the application of student-centred methods in teaching. Lecturers' attention is drawn to motivating the students who are lagging behind as well as offering challenges to active and talented students.

The teaching staff of the study programme of Product Development and Robotics are encouraged to participate in the continuing education courses for lecturers conducted by the Estonian Centre of Engineering Pedagogy. The Estonian Centre of Engineering Pedagogy operates in the same department and collaborates closely with the programme director. The programme director (Raivo Sell) has completed the international IGIP engineering pedagogy programme and has been awarded the title International Engineering Educator ING.PAED.IGIP. The aim is for all lecturers to have completed in-service training in engineering pedagogy in the field of new teaching methodologies, academic ethics and a student-centred approach and for key lecturers to have been awarded the title International Engineering Educator ING.PAED.

TEACHING STAFF MOBILITY

Lecturers have the opportunity to participate in international staff mobility and international cooperation programmes. Various modern study materials have been jointly developed and new courses have been created, such as Internet of Things. International cooperation and mobility are funded mainly from Erasmus+ programmes. For example, in 2019, the programme director spent half a year in the United States under a BAFF programme, which has resulted in continuous successful cooperation with the research group for autonomous intelligent systems from Florida Polytechnic University and cooperation is carried out on research and development projects as well as in matters regarding studies and study programme development.

EVALUATION OF A LECTURERS' PERFORMANCE

The teaching staff of the speciality courses are encouraged to participate in the research projects and business ventures of a research group. Most of the members of the teaching staff are involved in the development of study materials as well as in the development of practical business related solutions. Participation in projects and the results of research and development are taken into account when evaluating a lecturer's performance. Lecturers' performance is evaluated mainly on the basis of student feedback. Besides the feedback system created by the university, the programme director has prepared a separate feedback survey on the courses and lecturers, which is conducted each semester immediately after the end of studies. The feedback of different years is compared to make conclusions on the areas of improvement and the planned improvement activities are discussed with the main lecturers of the course. The feedback given is introduced to the lecturer and, if necessary, the areas for improvement are discussed individually with the lecturers.

On speciality courses, PhD students, incl. international PhD students, have been involved in conducting practice classes, which enables the students to be better and more directly involved in the research topics and encourages them to join practical projects of the research group. For example, the practice classes on the course Autonomous Vehicles are conducted by an international PhD student, whose research topic is related to the same field. International PhD students participate also in teaching single modules of a course, which opens up new horizons for the students. For example, the computer vision module on the course Digital Manufacturing.

SUMMARY OF STRENGTHS AND AREAS FOR IMPROVEMENT

Strengths

• Some speciality courses are conducted by international PhD students, which fosters internationalisation.

• Speciality-related Erasmus+ projects support the development of the teaching staff, internationalisation and creation of innovative teaching materials.

• Teaching in the speciality is conducted by PhD students, which allows bachelor's students to get more involved with practical research.

Areas for improvement and planned development activities

• To increase the number of lecturers who have completed in-service training in engineering pedagogy, which is a goal intended to be achieved in cooperation with the Centre of Engineering Pedagogy through the in-service training programme.

• To encourage the teaching staff to implement project-based teaching methodologies and principles.

Annexes:

Annex 28. Study programme form of Product Development and Robotics

Annex 29. Descriptions of the key courses of Product Development and Robotics

Annex 30. A chart illustrating the interconnections between modules/courses of Product Development and Robotics

Annex 31. Teaching staff of Product Development and Robotics

4.8. TELEMATICS AND SMART SYSTEMS

Name of the study programme	Telematics and Smart Systems (EDTR)
Study	Professional higher education studies
School	School of Engineering (Virumaa College, Tartu College)
Programme directors	Žanna Gratšjova (Virumaa), Helle Hallik (Tartu)
Principal compliers of the self-evaluation of the study programme	Žanna Gratšjova, Helle Hallik
A brief description of the process of self-evaluation of the study programme	The self-evaluation report was prepared in the period from April to August 2020. All academic staff, management of the colleges and also support staff, alumni and employers were involved in the process. Approval was granted and counselling was provided by the the TalTech Office of Academic Affairs. In November 2020 self-analysis was reviewed by the experts in the field (Prof Kalle Tammemäe and Prof Peeter Ellervee, School of Information Technologies).

AGGREGATED DATA ABOUT THE STUDENTS OF THE STUDY PROGRAMME

	2017/18	2018/19	2019/20	2020/21
Number of students	100	193	230	264
Number of students enrolled	97	110	78	87
Number of graduates	No graduates yet			
Number of dropouts	30	57	26	N/A

The Telematics and Smart Systems study programme at Virumaa College and Tartu College consists of two specializations. These are Telematics Software and Cyber-Physical Systems. The programme is healthy with the admission rate remaining at the desired level. The drop-out rate is a bit high as students discontinue their studies, mainly in the first academic year, due to reasons discussed later in this report. In order to address this issue, ensure suitability of the speciality, and avoid interruption of studies, interviews are conducted during the admission process to find out the students' motivation and commitment to studies. Since the study programme was opened in the academic year 2017/18 and the nominal duration of studies is 3.5 years, the first graduates defend their graduation theses in January 2021.

The admission rate increased in the academic year 2018/19 due to the addition of the Processes Automation as a specialization to the study programme. In the academic year 2019/20, there were no longer enough applicants for three specializations, and besides taking the average grade into account, interviews were held to help select the most motivated students. In the academic year 2020/21, no admission was opened to the specialization of Processes Automation. Admission to this specialization was terminated due to overlapping topics in Automation and IT, and the fact that it was not practical to teach two very similar specializations. It was decided to include the special courses in Automation in the study programme as elective courses.

4.8.1. PLANNING AND MANAGEMENT OF STUDIES

BACKGROUND AND THE NEED TO OPEN THE STUDY PROGRAMME

The interdisciplinary sector of telematics and smart systems applications has developed rapidly in recent years. New concepts in networked systems – digital manufacturing, the Industrial Internet, the Internet of Things and Cyber-Physical Systems – together with innovative cloud and software technologies have greatly affected the development of smart technologies. As a result, there has been a significant increase in the demand for competent telematics and smart systems specialists, both in the field of development of specific telematics software and in smart systems engineering as a whole. Companies and institutions that develop and/or implement telematics software and cyber-physical systems have difficulty finding suitable workforce. The key message of the comprehensive OSKA report on ICT prepared by the Estonian Qualifications Authority points out the same need – all the sectors of the Estonian economy need professionals who can commission and implement new ICT solutions. Tallinn University of Technology is the most suitable university for implementing such a study programme. At TalTech there are both engineering and IT competences including in the areas of research and practical cooperation with companies. It is important to conduct studies in this sphere, in any region, where industrial enterprises are located.

As a result of the structural reform that took place in 2016, two specialities taught at colleges were merged: Applied Information Technology at Virumaa College and Cyber-Physical Systems at Tartu College. Later, the main speciality Processes Automation was added. From the former separate study programmes, the main specialities were formed in the new study programme Telematics and Smart Systems. The goals and learning outcomes of the study programme are the same in both main specialities. However, as the studies take place in different (in social, economic, cultural terms) counties of Estonia, the learning outcomes and organisation of studies may differ and cater for specific student needs at the two colleges despite the merger.

The study programme was developed early 2017 in adherence to the OSKA reports, the surveys conducted by the Estonian Unemployment Insurance Fund, Estonian Lifelong Learning Strategy 2020, Estonian Education Strategy 2021–2035 and the "Estonia 2035" Strategy, and other fundamental documents were studied during the development process. The study programme was developed by taking the mission, goals and action plan of the colleges into account. The professional higher education study programme Telematics and Smart Systems (EDTR) combines the fields of Telematics, Software Programming, Processes Automation and Cyber-Physical Systems. Teaching in the main speciality of Cyber-Physical Systems takes place at the Tartu College of TalTech School of Engineering and the main speciality of Telematics Software and Processes Automation at Virumaa College.

The acquired education provides sufficient practical and theoretical basis for continuing studies for a master's degree in the fields of ICT or engineering. From autumn 2019, the master's studies in Business Information Technology taught by the TalTech School of Information Technologies also takes place in Virumaa College, providing people in the region a good opportunity to obtain a master's degree in the county. It is also foreseen that a novel MSc programme will be developed at Tartu College in a few years.

MANAGEMENT OF THE STUDY PROGRAMME

Both main specialities have a programme advisory board, which include the representatives of both main specialities. The programme advisory board meets at least twice an academic year to discuss the bottlenecks, areas that need improvement, and changes related to sectoral development trends. As a rule, the programme advisory board meets in an extended composition, involving also the representatives of the professional association (Estonian Association of Information Technology and Telecommunications), enterprises, and alumni.

The Virumaa and Tartu Colleges also have a joint working group in the field of smart systems, the aim of which is to launch the development of digital infrastructure and digital learning in a joint study programme. As part of a joint development project, the members of the working group have developed the necessary cloud lab platform, thus providing students with opportunities for carrying out practical work in telematics and smart systems. Based on the needs of the main specialities, various modern cloud technologies have been used in the development of the cloud lab platform. The vision is to develop gradually the learning environment of telematics alongside with the full implementation of the study programme. There is a problem with a small number of working group meetings who could contribute to development of the speciality due to the high workload of employees. The plan is to prepare an annual action plan to ensure a more systematic operation of the working groups.

Since the study programme is new and has had no graduates yet, its development is particularly relevant; the meetings of the programme advisory board are held at least once a semester, in addition, the working groups (which include all the teaching staff of the specialities) at Tartu and Virumaa analyse the courses of the same field to ensure better coherence, e.g., by avoiding unnecessary repetition of teaching the same technical topics if this does not help consolidate the knowledge gained. The members of the working group also monitor the lists of elective courses, by considering the feedback from students, the programme advisory board and internship hosts.

Figure 27 below provides an overview of the system of college advisory boards, working groups, and development teams.

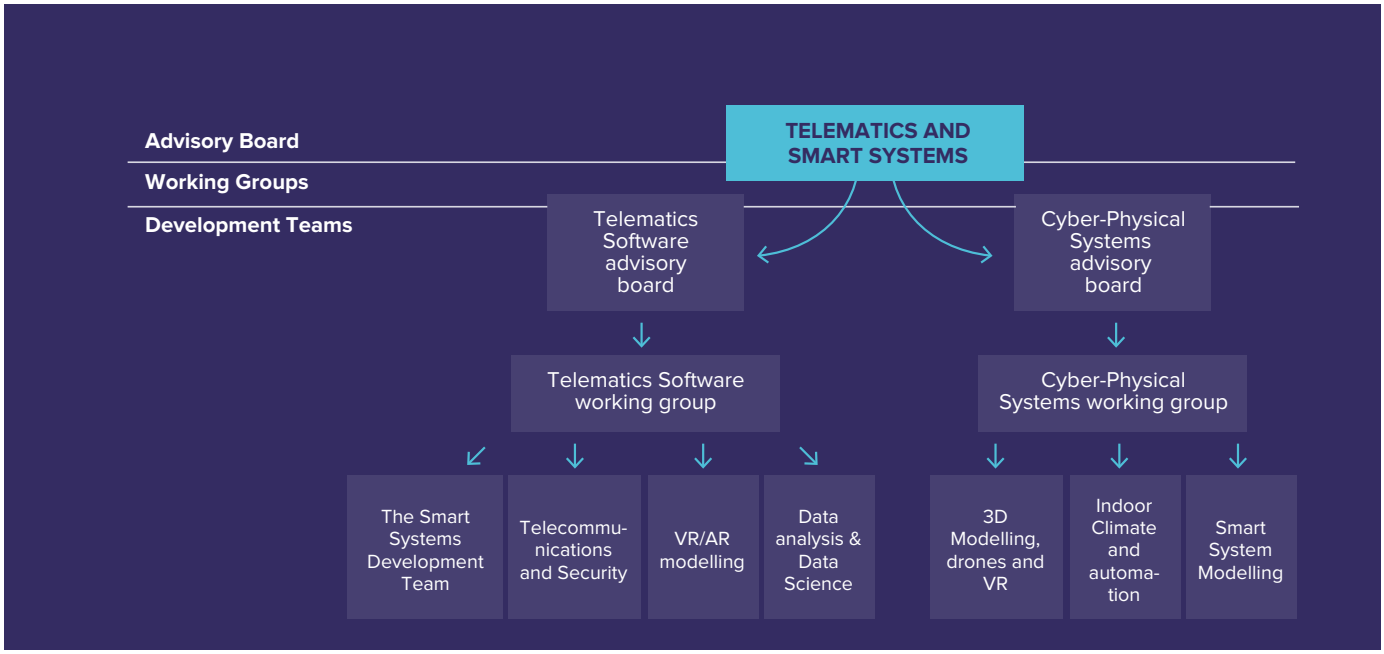


Figure 27. The system of advisory boards, working groups and development teams.

According to the Procedure for Study Programme Management, the appointed programme director is responsible for the development, management and functioning of the study programme. Each main speciality of the EDTR17 study programme has its own programme director: Helle Hallik (PhD) at Tartu College and Žanna Gratšjova (MSc) at Virumaa College. In order to better monitor and analyse performance indicators, the university started developing an IT solution in 2018, which allows programme directors to comprehensively monitor all information concerning their study programme. Twice a year the university allocates financial resources to programme directors for study programme development, including for expanding the material base, promoting the study programme, improving employee motivation, etc. depending on the number of students. The colleges have used these funds, for example, for the activities of the technology club, hiring guest professors and lecturers, training teachers, payment of additional student scholarships, study tours, and other activities that support learning.

FEEDBACK

At Virumaa College, the studies take place in the form of both regular study and block mode studies, in Tartu in the form of regular studies. The logical sequence and coherence of the courses (see Annex 34) is discussed in the colleges' joint Telematics and Smart Systems working groups and with the programme advisory boards.

1. Based on the recommendations of the programme advisory board and in cooperation with the representatives of companies and members of the advisory board (e.g national energy company Eesti Energia), new courses (e.g., RAM0790 ICS Visualisation and Control Principles (based on SCADA systems) have been developed and added to the study programme. In addition, the study programme has been supplemented with project courses (e.g., EVR0080 IoT Project, NTR0640 Living Lab Project, NTR0610 Prototyping Electronic Devices).

2. Feedback from the students, employers, and alumni of the study programme, NDFR14 Cyber-Physical Systems Engineering and RDIR02 Applied Information Technology, is considered. All inputs have been considered in the current study programme updated in the spring of 2020 and in the new version of the study programme under development. The new version was created since Virumaa College decided to close the main speciality of Processes Automation (due to the lack of students). As there is still demand for processes automation specialists, which may increase in future, it was decided to expand the main speciality of Telematics Software by adding the courses of the main speciality of Processes Automation. Due to this, the NTR0390 Algorithms and Data Structures course was replaced with the course RAA0580 Control Instrumentation in the Telematics Software core study module. Courses RAA0950 Electrical Engineering, EVR0040 Communication Systems for Industrial Automation, RAA0540 Automatic Systems Design were added as elective courses to the Telematics Software speciality module.

3. Gathering student feedback and the development of the study programme and main speciality accordingly is a continuous process. For example, after the completion of the course NTR0560 Introduction to Telematics and Smart Systems Studies, the areas for improvement of the studies are discussed with the first-year students who have not yet developed a so-called study routine and are therefore capable of taking a fresh look at the teaching and learning process. Based on student feedback, significant changes have been introduced in the main speciality of Telematics Software: for example, the elective course EVK0020 Data Science and Machine Learning and the EVR0080 IoT project have been added; in the course Training Practice I the Data Science direction is developed and several graduation theses have been written in the field, e.g., "Creating an interactive IoT data visualization and analysis application with Python and Dash", "Instructional materials development, Creating an interactive IoT data visualization and analysis application with R and R Shiny". Development projects have been launched and graduation theses are written also in the field of Computer Vision, e.g., "Creating an Android training application with object recognition using TensorFlow", "Stream of people automatic counting using OpenCV computer vision library", and others. In the main speciality of Cyber-Physical Systems, the following elective courses have been added: NTR0580 Mechatronics, NTR0620 Introduction to Programming in Python.

4. Besides the feedback provided in SIS, each member of the teaching staff asks students for their opinion on the course and takes it into account in teaching and creating study materials. The replies given in the survey conducted among the teaching staff (in spring 2020) show that lecturers value students' feedback highly and, if possible, take it into account when making changes in a course. For example, lecturers O. Dunajeva (RAM0580, Data Analysis), Ž. Gratšjova (RAM0730, Database Systems), J. Kuzmina (RAM0620 Programming) have started to record their lectures, e.g., the solutions of sample assignments, have changed the order of the course modules (e.g., in the course Digital Literacy, MS Excel is now taught at the very beginning of the course). Lecturer A. Rootsi (NTR0049 Sensors and Actuators Systems Engineering) has added additional film footages at the request of students. M. Meriste (NTR0560 Introduction to Telematics and Smart Systems Studies) takes student feedback into account by including topics of interest in the introductory course of the main speciality.

5. Feedback on the content and goals of the study programme has been requested from both students and alumni of the predecessors of the study programme at both colleges (see Alumni Survey, in Est) the last survey was carried out in the spring-autumn of 2020. The alumni have expressed their willingness to participate in continuing education courses in order to keep up with the latest trends and technologies. Lack of elective courses in the study programme has been pointed out as a shortcoming. In order to provide a wider choice for students, several elective courses have been created, such as EVR0080 IoT Project, EVR0040 Communication Systems for Industrial Automation, EVK0020 Data Science and Machine Learning, NTR0610 Prototyping Electronic Devices, NTR0640 Living Lab Project. Students can also choose courses from all study programmes of Tallinn University of Technology. The plan is to develop a virtual labs and online lectures capacity in cooperation with the School of Information Technologies.

The social learning environment is very highly regarded at both Virumaa and Tartu Colleges, as shown by regular student feedback surveys as well as employee satisfaction surveys. According to the 2019 employee survey, employee satisfaction at Tartu and Virumaa Colleges is the highest at TalTech.

DEVELOPMENT OF THE STUDY PROGRAMME

Virumaa College has four development teams consisting of lecturers in the following areas: 1) Smart systems development, 2) Telecommunications and security, 3) VR / AR and modelling, 4) Data analysis, data science. All the teams include students, who are paid a small remuneration for that. The aim of the development teams is to improve the research and development capacity in the respective field, including the ability to write articles and apply for research funding. Funding for the development activities has been received primarily from HITSA project grants. One constraint is the lack of staff with a research degree, which means that there is not enough competence to obtain research funding. The people and enterprises in the county of Ida-Virumaa expect that, in connection with the fair transition process, a regional IoT, Virumaa innovation centre of digitalisation and green technologies (ViruTech) could be established at Virumaa College.

Tartu College has established a development team consisting of the representatives of both colleges and private sector. A development plan for Tartu College has been conducted by private IT technology company Thinnect headed by Dr Jürgo-Sören Preden (this company has developed a huge sensor network in Tallinn consisting of 800 units, and the students are encouraged to be involved in their research and development activities).

The development areas of Tartu College are 3D modelling, remote sensing with drones and VR; indoor climate and control engineering; Smart Systems Modelling, where teaching staff and engineers work together with students.

Tartu College was established only 14 years ago, and the infrastructute and equipment needs to be improved. During past three years TalTech has allocated sufficient financial resources (ca 250,000 euros) for the development of the laboratories at Tartu College. The well-equipped small laboratories provide an excellent modern study environment for the students. Drones, different cameras for remote sensing and other equipment for laboratory experiments have been obtained during the recent 2 years. A powerful 3D printer (Modix BIG-60 V3), 3D scanner (Einscan-SE) and Sony a7R III camera were obtained recently. Excellent presentation equipment, including a modern multimedia classroom (A204) and a dedicated room for interactive seminars (A103) is available. Coincidentally, Tartu College exploits a whole study building as a real-life Living Lab, equipped with different sensors, actuators and automatized computer-based devices, conrollers, etc.

Great attention is paid to the development of students' creativity, entrepreneurship, and teamwork skills. The study programme includes NTU0050 Basics of Entrepreneurship, RAH1230 Teamwork and Management, RAE0570 Prototyping courses. The students can take the following elective courses: MMJ5250 Venture Creation, TMJ3300 Entrepreneurship and Business Planning, EVM0060 Project Management. For example, on the RAA0520 Robot Systems course, students whose main speciality is Telematics and Smart Systems and Mechanical Engineering and Energy Technology Processes Control study together and work on a joint project. In addition, in many speciality subjects, a course project completed in a team or individually forms part of the course grade. Furthermore, in Tartu, students have the opportunity to take the courses of the main speciality Building Design and Architecture in the study programme Structural Engineering and Construction Management as optional courses, e.g., NTS1920 Drawing, Composition, Colour and Shape, NTS1860 Introduction to Studio.

In all speciality courses, laboratory work and practical training are carried out in order to consolidate the acquired theoretical knowledge. Practical training and team project activities related to development projects are carried out in laboratories. Participation in applied research helps both teaching staffs and students, involved in projects, to create new knowledge in the field and provides opportunities for cooperation with companies. Students involved in applied research can also do their internship in the speciality in this way. For example, three students and two engineers from Tartu College participated in the applied research ordered by AS Milrem ("Applied research project on system of sensors and software algorithms for safety and driver assistance on remotely operated ground vehicles for off-road applications"), where fieldwork was performed with drones and methodologies for 3D modelling of landscapes and buildings by using photogrammetry were developed. One student did his internship in the speciality in the framework of the research. The activities in the applied research are related to the NTR0480 3D Modelling of the Environment course, where students have acquired basic knowledge and skills in the field. Such research is a good opportunity for the staff to improve their knowledge and skills in a specific field and to use these skills in the supervision of students in practical training or in other teaching activities at the college (e.g., NTR0560 Introduction to Telematics and Smart Systems Studies). They also provide input for further work in other applied research (e.g., the applied research project for creating a cost-effective interchangeable 3D spatial data infrastructure with survey-grade accuracy - AS Reach-U) and develop skills in the processing and 3D modelling of point clouds created using lidar and photogrammetry.

In the years 2018-2020, supplementary funding was applied from the Information Technology Foundation for Education HITSA programme in the total amount of 169,643 euros (3 applications received funding). Within the framework of these projects, study laboratories for industrial robots and automatic systems, digital manufacturing, multimedia and telematics were furnished, a training cell with an industrial robot was purchased, and practical guides and study materials were developed. A 3D and drone lab, a telecommunication lab, and an electronics lab have been built at Tartu College. In addition, funding is provided at School level through financing specific development projects that take the number and performance of students into account. The above-mentioned funding has helped to create a very good lab capacity for teaching and research.

COOPERATION WITH COMPANIES AND UNIVERSITIES ABROAD

The largest business partners are Eesti Energia AS and Viru Keemia Grupp AS, as well as several IT companies, (educational) institutions in the region. Cooperation takes place mainly in the form of internships, from where the student usually also gets the topic for their graduation thesis and a supervisor from the company. The representatives of companies are also involved in the study programme development as the supervisors of internship and members of the defence committees of graduation theses, lecturers, etc. Eesti Energia AS and Viru Keemia Grupp AS also offer scholarships to college students through the TalTech Development Fund.

As regards foreign partners, Virumaa College has built close cooperation with Polotsk State University in Belarus. The partner has been selected based on similar specialities and regional opportunities and challenges. The cooperation has been financed

from the project budget of the Ministry of Finance as well as ERASMUS+ grants. The study materials in the field of IoT are developed jointly, and research and development activities in the field are also planned for the future.

Tartu College has fruitful cooperation and exchange of experience with Seinäjoki University of Applied Sciences in Finland (under the ERASMUS agreement between the college and the University of Applied Sciences). The development activities and exchange of teaching staff which took place within the framework of the Nordplus programme helped to launch the study programme. Cooperation has been launched with the companies Thinnect, TRIT Services OÜ and Evikontroll Systems OÜ and a cooperation agreement has been signed with the non-profit association Mensshed Estonia in Tartu, who are the host organisations which provide a working environment for interns. Students prefer companies in Tartu and regional companies (Enics, Elektrilevi, the Simulation Centre of Estonian Military Academy, Rand and Tuulberg) as internship hosts, but it is also possible to successfully carry out internships outside Tartu (e.g., in Hades Geodeesia OÜ). The students who graduated from the preceding study programme NDFR14 established the company Smartvent OÜ (now named Calidity) during their studies. The programme director has close contacts with them, and they have offered themselves as an internship host for the students of the speciality of Cyber-Physical Systems.

SUMMARY OF STRENGTHS AND AREAS FOR IMPROVEMENT

Strengths

• The balance between theoretical and practical studies is ensured by the sufficient workload of practical training carried out in enterprises and close cooperation with them, incl. field trips, review lectures delivered by representatives from the sector.

• The total of 4+3 development teams involving the students and teaching staff have been established and the research and development capacity of the college is improving, as are the number of research articles.

• Close and continuous cooperation is carried out with enterprises in the development of the study programme, as the graduates help resolve the acute need for automation and IT specialists.

• There is a strong on-spot support system at Virumaa College: the Study Director, the Office of Academic Affairs, incl. Education Technology Officer, the Development Division, IT Helpdesk.

• Tartu College has successfully exploited the scheme of immediate contacts between the students, teaching staff and the management and this has proved to be a very efficient way of excluding the development of bureaucratic walls inside the College.

Areas for improvement and planned development activities

• The joint working group does not meet and does not work systematically due to other employment and work pressures. The plan is to draw up an annual action plan for the development teams.

• In order to increase the share of teaching staff with a PhD in research in the field of IT and improve the research capacity, the classroom instruction workload of the teaching staff has been reduced, lecturers have been referred to master's and doctoral studies and development teams have been established at Virumaa College. At the same time, most members of the teaching staff at Tartu College have obtained PhD degrees.

• In order to provide a wider choice for students to achieve the expected learning outcomes of the study programme and ensure the provision of broad-based higher education, the list of elective courses should be extended by considering the recommendations of the programme advisory board, internship hosts and alumni.

4.8.2. LEARNING, TEACHING AND ASSESSMENT

TRAINING MOTIVATED STUDENTS

To find and train motivated students, close cooperation is carried out with general education schools. The study programme is actively introduced at meetings with school students and through social media. Both Tartu and Virumaa Colleges have long-term cooperation with schools in the region, and school students are offered both elective courses and courses within the framework of the national curriculum. Virumaa College has a particularly close cooperation with Kohtla-Järve Gymnasium, which offers the study module Digital Systems, including a total of 13 different IT courses. Tartu College has multiannual cooperation with Tartu Kristjan Jaak Peterson Gymnasium, the students of which are offered the elective course Sustainable Technologies in the framework of the Technology module. Training days are also organised for the young people in the region (e.g Nõo Gymnasium and Võru Gymnasium), where students can participate in three different workshops in one day. The representatives of the study programme participate also in major education and career fairs (e.g., Intellektika). As a result of this long-term and systematic cooperation, 5-10 students from these schools have commenced studies in the main specialty of Cyber-Physical Systems every academic year. The total of 65% of the applicants to Virumaa College come from the schools in their local area. The same is valid in the case of Tartu College. Most of the students originate from South Estonia. For the residents of the county of Ida-Virumaa, as one of the largest industrial areas, this is a regionally important opportunity, which is used not only by upper secondary school students but also by other people working in the area.

In order to assess the readiness and motivation of a candidate, an interview is conducted with each candidate. All members of the contracted staff teaching speciality courses are involved in conducting the interviews which provide, among other things, a good opportunity for getting acquainted with each other. The assessment of the student candidate is based on specific criteria. The candidate is assessed in four different categories and each interviewer's average score in every category is used to add up the candidate's final score for the interview.

The choice of specialisation of students who have already commenced studies is supported by the course Introduction to Telematics and Smart Systems Studies, where the concepts and definitions, areas of application and current state of the field are introduced, tours and meetings with the top specialists in the field are organised.

ASSESSMENT OF STUDENTS

The academic staff assesses students in adherence with the TalTech Academic Policies. Where non-graded (pass/fail) assessment is applied on a course, formative assessment, where a student sets goals for themselves and assesses their progress, is also used (e.g., on the courses NTR0520 Technical Training I, RAE0570 Prototyping, EVK0020 Data Science and Machine Learning). Summative assessment is used at the end of a course. In their feedback, academic staff has pointed out that holistic assessment is applied in the learning process, where formative assessment is used in seminars; practical training and performance evaluation tests, homework tests to motivate independent work, reports, etc. are also used. The results of all the tests and tasks form a part of the final grade for the course. Student feedback shows that they prefer continuous assessment.

Systematic attention is paid to the prevention of academic fraud, i.e., each teaching staff member informs students of the consequences of violation of good academic practice. Student feedback (spring 2020) showed that the majority of them (80% of the students surveyed) have not encountered academic fraud, but if this has occurred, the teaching staff has reacted immediately. The detected cases of academic fraud (approximately 1-2%) (submitting another person's writing under one's own name, cheating) are discussed with the programme directors and management of the colleges. Teaching staff has completed the training on the plagiarism detection system Ouriginal and use it on their Moodle courses to check written assignments. All graduation theses are checked for plagiarism before granting permission for defence. Based on the feedback given by students in SIS, it can be concluded that the teaching staff monitors very strictly to detect cheating and often the assignments are designed in such a way that cheating would be virtually pointless.

PERSONAL APPROACH, PRACTICAL TRAINING

Studies take place in small groups, which allows for a more personalised approach and provides an opportunity to apply active learning methods (brainstorming, problem-based learning, project-based learning) on (speciality) courses, where students develop their teamwork, time planning skills, creativity, initiative and where they can apply their knowledge in practice. The study programme includes 50% project-based or teamwork courses. Students can share their previous work or professional experience and take on different roles such as a student, teacher, assessor, developer, project manager and entrepreneur. There is also an opportunity to participate in larger projects and teaching staff can provide multi-phased feedback on the project. The personal approach is also supported by e-courses (6 of which have been awarded the e-course quality label), which are available for all compulsory courses and where it is possible to give students personal feedback and students can monitor their progress in studies. In the professional higher education study programme, great attention is paid to both practical training and internship.

In order to achieve the learning outcomes of practical training, the learning process is combined with real-world assignments in companies, by conducting practical training by the example of work processes and equipment used in enterprises:

• The project carried out in the Data Analysis course is completed as teamwork. Students gain research and teamwork experience, acquire real-world data processing, analysis, visualization skills and also presentation skills upon defending their projects. In the Technical Training I course, in the data analysis module, students gain practical experience of modern data processing and visualization technologies used in real life.

• Together with students, the technologies used in the programming of network and mobile devices are explored, and students conduct projects in teams using various modern web technologies. In the field of IoT, teams are given the same assignment, which is solved using different technologies.

• In the Computer Networks Design course, a project assignment related to IoT is carried out (e.g., Smart House), which allows the application of different knowledge and skills, e.g., security, administration, within one project.

• In the CAE Systems Modelling course, a major joint project is completed (3D city model, college model, industrial robot model), which can be used in other projects in the future. The projects completed on the Multimedia course participate in the international festival "Laterna Magica".

• In 50% of the speciality courses, students' independent work is required as part of the course: a project must be completed (usually in a team), which is often related to problems encountered by the students themselves (e.g., simpler building automation and cyber security solutions).

• Students are supported in gaining practical experience through encouraging them to participate in various events and recognising their good results. The students of the study programme have successfully participated at the Negavatt Energy Saving Competition, Enginaator engineering competition and AHHAA Robot Battle.

Internships are planned considering that before the internship, the student must have acquired the necessary competencies in certain courses, which enable achieving the learning outcomes of the internship.

• For example, before the taking the Technical Training I course, a student must have passed the courses NTR0290 Telecommunication, NTR0450 Engineering Informatics, RAM0620 Programming. During the internship, professional knowledge and skills are applied in a real work situation and thus, through work experience, theoretical and practical learning are combined, which consolidates and complements the knowledge gained.

• In addition, internships provide an opportunity to obtain material for writing course projects, research, or graduation theses.

• As a rule, a student finds the host organisation by themselves, but the programme director and an internship coordinator can provide assistance. Finding an internship host provides a student experience in job searching.

• Internship can be done also in the form of teamwork at the college solving practical assignments with the aim of consolidating the acquired theoretical knowledge, for example, in the NTR0520 Technical Training I course.

• The colleges have close relations with the companies in the region (e.g., the largest of them in Virumaa are Energia AS and Viru Keemia Grupp AS, etc.), where students are welcome to do their internship and who are willing to employ students upon graduation. Virumaa College organises seminars for internship

supervisors at host organisations, who participate in the defence of internships. Cooperation and internships in companies can lead to innovations in the production process that find real use: e.g., a student at Tartu College, in cooperation with his supervisor designed an automated manufacturing process (of disposable mops) for the company Vikan Eesti. The part of the production line completed in cooperation with the factory specialists is currently in use. At Tartu College, internships are carried out also in the College labs in the framework of various development projects, e.g., drone applications and environmental modelling. Students are generally satisfied with the content of internships, a solution is found as quickly as possible when a problem emerges, and the internship experience is analysed with a view to the future. In their feedback on internships, students assess both general work experience and as well as coping with various challenges (complex assignments, nature of work).

• Internship is defended at a public meeting involving all the students and academic staff of the study programme. The representatives of companies and both main specialities are involved as members of the defence committee of graduation theses.

INTERNATIONAL COOPERATION

Students have an opportunity to study single courses or modules in other Estonian and foreign universities. Before a student goes to study abroad, the courses the student is going to take are agreed upon in advance, so that they would be in line with the learning outcomes of the study programme. All information about the possibilities and requirements are published on the website. The organisation of studies facilitates students' participation in international mobility: the teaching staff encourage students to participate in international mobility. TalTech has signed agreements with foreign universities, educational institutions and companies (e.g., ERASMUS agreement concluded with Mid-Sweden University; Angel Kanchev University of Ruse; Jon von Neumann University; University of Picardie Jules Verne for IT students' exchange) and students are encouraged to study and do their internship abroad, during which the students are fully supported.

To foster the exchange of students and academic staff, Tartu College has launched cooperation with Lappeenranta-Lahti University of Technology LUT, Oxford University (UK) and ITMO University, St. Petersburg (Russia). Tartu College has also signed cooperation agreements (for exchanging students and academic staff under ERASMUS+ programme) with several foreign universities (Michigan State University (USA), Seinäjoki University of Applied Sciences (Finland) and Sumy State University (Ukraine). The students of Tartu College have recently studied a semester in foreign universities in the Netherlands, Finland and Croatia. Academic exchange activities have long-term traditions at Tartu College and strongly supported by the leadership of Tartu College by encouraging students and academic staff to exploit the very attractive offers provided by our university.

Virumaa College received financial support for teaching staff mobility between Virumaa College and Kazakh National Research Technical University named after K. I. Satpayev in the framework of the Erasmus+ICM 2018 project and a positive decision was received on Erasmus+ICM 2019 project regarding the proposed cooperation with Polotsk State University. Cooperation with Polotsk State University has also taken place in the framework of the development cooperation project "New technologies, including ICT application in the development of study programmes in Belarus" from 01.09.2018.

In the frames of Erasmus agreement with Hungarian university, the Vice Dean for Scientific Affairs of the Faculty of Engineering and Computer Science of JNU (Field of teaching: Software engineering, Visual programming, Matlab, C++, C#) held a series of lectures for the students of the Telematics and Smart Systems at Virumaa College in September 2019.

As an example of fruitful cooperation an internship for Virumaa College group consisting of five students was arranged at University of Picardie Jules Verne (2 of Mechanical Engineering and 3 of Telematics and smart systems specialties). Such kind of interdisciplinary teamwork for students is very useful to get professional and social experience in international environment.

Besides the above-mentioned four agreements, the students studying Telematics and Smart Systems at the TalTech Virumaa College and Tartu College can apply for exchange studies by Erasmus Agreements of School of Information Technology of TalTech if there are places available. For example, a student of Virumaa College was an exchange student at Vaasa University of Applied Sciences (VAMK, Finland). The Information Technology programme at VAMK has a lot of commonalities with Telematics and Smart Systems programme. Second- and third-year students studying Telematics would have no problem at selecting suitable courses at VAMK.

SUPPORT SERVICES FOR STUDENTS, MONITORING PROGRESS

Student counselling takes place on various levels. For example, at Virumaa College a personal mentor has been appointed for each freshman to whom students can turn to with their concerns. In case of questions concerning a course or the study programme, the students can first contact the teaching staff or the programme director. Matters concerning the organisation of studies can be addressed to the Office of Academic Affairs in Virumaa College and to Study Manager in Tartu College. The counselling system is introduced to students at the very beginning of studies in the course titled Organization of Studies. A student can complete studies by using the standard study plan or complete the study programme by an individual study plan, e.g., by using APEL. To diversify learning opportunities for people working, students of Virumaa College can choose a suitable form of study (daytime or session studies), which can be changed during studies.

As the classes are small, each teaching staff member both at Tartu and Virumaa College can personally monitor students' progress and shall inform the mentor, programme director and study director/manager thereof. Students' progress can be assessed based on the results at the end of the quarter. The mentor, programme director or employee of the Office of Academic Affairs contacts a student, if necessary, to find out the reasons for their inadequate academic performance or for being absent. From the autumn of 2020, students of Virumaa College are offered on-site psychological counselling in Russian (80% of the students are Russian-speaking). All students can get psychological counselling in Estonian in the main building of Tallinn University of Technology.

The dropout rate in the study programme is approximately 41%. In daytime studies, the main reason for discontinuing studies is wrong choice of specialization. In session studies, the main reason for discontinuing studies is inability to combine work, family life and studies, since the share of independent work in learning is very high. Other family-related reasons (changes in the place of work and residence) also play an important role. To reduce the dropout rate, interviews are held with the student candidates to find out the candidate's motivation and readiness, whether the candidate has got acquainted with the study programme and courses and has carefully considered their study and career path. To reduce the dropout rate, pre-sessional courses, one-to-one counselling, consultations are offered to students. Before exmatriculation, the programme director contacts the student, offers assistance and notifies the college's study director/manager of the result.

SUMMARY OF STRENGTHS AND AREAS FOR IMPROVEMENT

Strengths

• Teaching and support systems are student-centred (small classes). Mentors for freshmen at Virumaa College. Efficient support system at Tartu College – all needed information reaches almost immediately the teaching staff or the students via the Director of Studies.

• At Virumaa College, the flexible form of study (block mode studies) provides an opportunity to study close to home and reconcile studies, work and family life.

• Strong cooperation with regional schools with the aim of educating the next generation.

• Application of active learning methods in studies.

• Taking into account the feedback of employers and alumni; their involvement in teaching contributes to the achievement of the learning outcomes.

• The alumni of the predecessors of the study programme are competitive in the labour market and satisfied with the acquired competencies.

• Involvement of students in development teams for internship. Beginning in the 1st year, students can start internship activities in their areas of interest in order to raise interest in the profession.

• In Tartu the students of Tartu college are an essential part of the large Tartu Students' body. They are able to exploit all the advantages offered to the students of Tartu University and Estonian University of Life Sciences.

• Tartu college students are free to take elective courses from Tartu University and Estonian University of Life Sciences. And of course, the students of both colleges are encouraged to take on-line classes from Tallinn.

Areas for improvement and planned development activities

• High dropout rate at Virumaa College. The following improvement activities are carried out to decrease dropout: each freshman has a personal mentor; an interview is held with the candidates to find out the candidate's motivation to study and future plans; on the course Introduction to Telematics and Smart Systems Studies students are familiarised with the demand for professionals.

• Students' moderate motivation to study is a matter of concern. The following improvement activities are carried out: the top-level executives of companies are invited to talk about the company's goals, need for labour force and career opportunities. Students are involved in the work of development teams to raise their interest in the profession and are encouraged to participate in competitions.

• In order to involve the students of session study (workload of class attendance 25%) in development activities, there is a plan to make the courses more project-based; the course Speciality Project is under development.

4.8.3. DEVELOPMENT, COOPERATION AND INTERNATIONALISATION OF TEACHING STAFF

MEMBERS OF TEACHING STAFF

At Virumaa College, studies in the main speciality of Telematics Software is conducted by 10 full-time and 4 part-time (junior) lecturers, from among whom 2 lecturers hold a PhD and 2 are pursuing a PhD, 1 has been awarded Master of Science in Engineering, 5 are pursuing a master's degree and others have acquired a higher education equivalent to a master's degree. The average age is 45 years and the average length of service is 11 years. All lecturers undergo professional in-service training 1-2 times a year. In addition, most of the lecturers have completed the trainings "Teaching and learning at a higher education institution" and "Internship supervisor training', lecturers have participated in the training "Contemporary science teaching approaches at a higher education institution", "Content and language integrated learning", various team trainings, etc. Eight speciality lecturers supervise professional higher education graduation theses every year. Six lecturers conduct studies in master's programmes. During the last three academic years, the scores given by students to lecturers in the study information system have been in the range from 3.66 to 4.88 out of 5.00.

The teaching staff of the main speciality Cyber-Physical Systems at Tartu College consist of 7 academic staff members (6 of them with PhD degrees) and 2 engineers, supported by several other part-time instructors. The academic staff of the study programme is involved in various research and development projects inside and outside the college. Dr Merik Meriste has strong long-term international experience in this field. His experience and competence are of greatest value for the whole study programme. The scores given to the teaching staff of the speciality Cyber-Physical Systems in the feedback in SIS in the last five semesters have been in the range from 4.39 to 4.83 (maximum 5). In addition to the college's own academic staff, students in the speciality Cyber-Physical Systems are taught by teaching staff from Tallinn and Virumaa College. The instructors of several courses are outstanding specialists in their field, who are engaged in entrepreneurship and who pass on to students not only their subject knowledge but also the experience gained outside the university. Outside of the scheduled lectures, invited public lectures related to the speciality complement the programme. For example, at Tartu College Dr Johannes Heinsoo has given a lecture on quantum computing and MSc Viljo Allik on space technologies. Continuous self-improvement (e.g., on the online courses Elements of AI and Digital Wisdom) and the development of modern teaching tools form part of a teachers work and this has been set out also in the staff's job descriptions.

DEVELOPMENT OF TEACHING STAFF

The qualifications of the teaching staff comply with the Standard of Higher Education and Academic Career Management. The programme director is responsible for the annual assessment of the performance and feedback indicators of the study programme in SIS. The analysis of student feedback on the lowest and highest rated courses and student feedback on instructor forms a part of the self-evaluation of the study programme. Students give feedback twice a year; the most important information is reflected in the comments. The results of feedback are analysed at an annual appraisal interview. Two lecturers who have received low ratings in feedback have been referred to the course "Teaching and learning at a higher education institution", one lecturer has been attested for a term of two years (normally the teaching staff is attested in every 3-5 years) and two hourly paid lecturers have been dismissed. The results of and agreements made in an appraisal interview are recorded in the TalTech appraisal interviews system. Each year, the previous year's agreements are reviewed and evaluated. Job descriptions have been prepared for all employees. Since 2019, all employees at Virumaa College have a personal role and score card, where the employee's areas of responsibility, performance indicators, decision-making powers, competencies, and personal characteristics are listed. At an appraisal interview, a teaching staff member sets personal development goals.

The teaching staff at both colleges has set the following annual goals for self-development:
• obliged to supervise graduation theses, while ensuring that the number of graduation theses is not too big;

• recommended to write popular science articles; the staff who hold a PhD are recommended to write research articles;

• obliged to participate in at least one development project, preferably in cooperation with companies;

• obliged to participate in at least 1-2 professional in-service trainings;

• recommended (junior lecturers obliged) to complete the training 'Teaching and learning at a higher education institution;'

• recommended to participate in international mobility, including by giving lectures.

In order to improve themselves, the teaching staff have the opportunity to attend online didactics lectures in the Estonian Centre for Engineering Pedagogy, choose from among internal trainings or trainings provided in other universities. For example, at Virumaa College, all the lecturers have completed the internal training "Teaching and learning at a higher education institution", and most of them have completed the course "Digital Wisdom". A methodology lab has been established at Virumaa College. The colleges also support the self-development of employees in degree studies, e.g., employees studying for a master's or doctoral degree are allowed to work full-time and their studies and related research are considered as development activities. For example, five lecturers from Virumaa College have commenced studies in the master's programme Business Information Technology with an aim to pursue a PhD after that. Besides improving their qualifications, it enables them to increase the volume of research and development activities (incl. research publications).

Cooperation with companies, including training at employers' companies, plays an important role in self-improvement. A plan for training at companies has been prepared for the lecturers of Virumaa College (training for speciality course lecturers, every lecturer once in 5 years), which has been specified in the current Development Plan of Virumaa College. Due to lack of time, the training plan has not been fully implemented.

In the development of teaching staff, attention is paid on international cooperation and exchange of experiences: e.g. in April 2018, two teaching staff members from Tartu College and six lecturers from Virumaa College participated in an international week organised by Turku University of Applied Sciences. In November 2017, the lecturers of Tartu College visited the Seinäjoki University of Applied Sciences to get acquainted with the laboratories, and in September 2018, they delivered lectures in the field of their specialization in the framework of the international week. After secondments abroad, trainings and conferences, meetings and seminars are held to share the knowledge and experience gained at the training with colleagues in the college. Resulting from this cooperation and exchange of experiences, several new interdisciplinary cooperation projects have been launched, where the working groups of Tartu College participate jointly, e.g., the urban environment study eMOTIONAL Cities led by the University of Lisbon. Virumaa College has close cooperation with Polotsk State University in Belarus together with whom study materials have been prepared and applications for staff and student mobility under the ERASMUS programme have been prepared. A smart systems project is developed in cooperation with Polotsk State University, which will be financed by the Information Technology Foundation for Education HITSA on the Estonian side.

NOTICING AND RECOGNITION

The development of teaching staff members is recognised and recognition is governed by orders of the Directors of the Colleges and the acknowledgement procedure of Tallinn University of Technology; the best of them can apply for an activity grant for improving their teaching skills. They are recognised for positive student feedback, participation in projects, conferences, etc. Student feedback recorded in SIS is considered upon recognition.

Salaries are determined based on the person's contribution to teaching and the development of the speciality and service to society. Teaching staff members can choose in which in-service-training (in Estonia or abroad) and conferences they want to participate. Staff mobility and training costs are covered either from project funds or from the budget of the programme director or college.

In the spring of 2020, a survey was conducted, in which all teaching staff members conducting studies in the study programme participated. The majority (85%) of them are involved in the development of the study programme and the implementation of development projects. 54% of the staff members find that there are adequate financial resources to develop the study programme. Project writing skills must be developed. Teamwork skills need to be improved.

SUMMARY OF STRENGTHS AND AREAS FOR IMPROVEMENT

Strengths

• The average age of the teaching staff of the programme is 43.3 (in Virumaa) and 45 (in Tartu). Several lecturers of Virumaa College have graduated from the college and continued their studies in the master's or doctoral studies at Tallinn University of Technology. In recent 5 years 3 academic staff members of the programme from Tartu College have received PhD degrees (one from France).

• The colleges support the development of the teaching staff in all areas, incl. in-service-training, participation in conferences (abroad), etc.

• Teaching staff members conduct trainings in the field of their specialization and participate in international conferences and projects.

• Academic staff members contribute actively to service to society, they organise clubs, workshops, etc.

• Cooperation is carried out with companies, public sector institutions, and third sector organisations, which facilitates employees' self-development and helps them keep up with the topical subjects.

• Many students enrolled in block-mode studies work in speciality-related fields and internship defences allow teaching staff to stay informed of the development trends in companies.

Areas for improvement and planned improvement activities

• In order to increase the volume of research and development activities (research publications), the qualifications of the lecturers need to be improved.

• To increase the teaching staff's volume of training in companies, the plan is to reduce their classroom instruction workload.

• In order to improve teamwork skills, the plan is to create various forms of cooperation to enhance communication between academic staff members, e.g., participation in joint development projects, joint seminars, trips, brainstorming, etc.

Annexes

Annex 32. Study programme form of Telematics and Smart Systems

Annex 33. Descriptions of the key courses of Telematics and Smart Systems

Annex 34. A chart illustrating the interconnections between modules/courses of Telematics and Smart Systems

Annex 35. Teaching staff of Telematics and Smart Systems

ANNEXES

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Annex 12. Study programme form of Industrial Ecology

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Annex 14. A chart illustrating the interconnections between modules/courses of the Industrial Ecology

Annex 15. Teaching staff of Industrial Ecology

Annex 16. Study programme form of Industrial Engineering and Management

Annex 17. Descriptions of the key courses of Industrial Engineering and Management

Annex 18. A chart illustrating the interconnections between modules/courses of the Industrial Engineering and Management

Annex 19. Teaching staff of Industrial Engineering and Management

Annex 20. Study programme form of International Business Adminstration

Annex 21. Descriptions of the key courses of International Business Adminstration

Annex 22. A chart illustrating the interconnections between modules/courses of International Business Adminstration

Annex 23. Teaching staff of International Business Adminstration

Annex 24. Study programme form of IT Systems Administration

Annex 25. Descriptions of the key courses of IT Systems Administration

Annex 26. A chart illustrating the interconnections between modules/courses of IT Systems Administration

Annex 27. Teaching staff of IT Systems Administration

Annex 28. Study programme form of Product Development and Robotics

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Annex 30. A chart illustrating the interconnections between modules/courses of Product Development and Robotics

Annex 31. Teaching staff of Product Development and Robotics

Annex 32. Study programme form of Telematics and Smart Systems

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Annex 35. Teaching staff of Telematics and Smart Systems

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