

**Assessment Report**  
**Engineering, manufacturing and  
technology**

PhD studies

University of Tartu

Estonian University of Life Sciences

Tallinn University of Technology

2017

## Contents

INTRODUCTION .....	3
GENERAL FINDINGS AND RECOMMENDATIONS .....	5
1. ASSESSMENT REPORT OF SPG AT THE UNIVERSITY OF TARTU .....	16
1.1. INTRODUCTION .....	16
1.2. STRENGTHS AND AREAS FOR IMPROVEMENT OF STUDY PROGRAMMES BY ASSESSMENT AREAS .....	18
1.2.1. ENGINEERING AND TECHNOLOGY.....	18
2. ASSESSMENT REPORT OF SPG AT ESTONIAN UNIVERSITY OF LIFE SCIENCES .....	27
2.1. INTRODUCTION .....	27
2.2. STRENGTHS AND AREAS FOR IMPROVEMENT OF STUDY PROGRAMMES BY ASSESSMENT AREAS .....	29
2.2.1. ENGINEERING SCIENCES .....	29
3. ASSESSMENT REPORT OF SPG AT TALLINN UNIVERSITY OF TECHNOLOGY .....	40
3.1. INTRODUCTION .....	40
3.2. GENERAL FINDINGS AND RECOMMENDATIONS AT STUDY PROGRAMME GROUP LEVEL .....	42
3.3. STRENGTHS AND AREAS FOR IMPROVEMENT OF STUDY PROGRAMMES BY ASSESSMENT AREAS .....	44
3.3.1. CHEMICAL AND MATERIALS TECHNOLOGY.....	44
3.3.2. MECHANICAL ENGINEERING.....	52
3.3.3. POWER ENGINEERING AND GEOTECHNOLOGY .....	60

## Introduction

Quality assessment of a study programme group involves the assessment of the conformity of study programmes and the studies and development activities that take place on their basis to legislation, national and international standards and developmental directions with the purpose of providing recommendations to improve the quality of studies.

The goal of quality assessment of a study programme group is supporting the internal evaluation and self-development of the institution of higher education. Quality assessment of study programme groups is not followed by sanctions: expert assessments should be considered recommendations.

Quality assessment of a study programme group takes place at least once every 7 years based on the regulation approved by EKKA Quality Assessment Council for Higher Education *Quality Assessment of Study Programme Groups at the Level of Doctoral Studies.*

The aim of the assessment team was the evaluation of the Study Programme Group (SPG) of Engineering, Manufacturing and Technology at the level of doctoral studies in three universities: University of Tartu, Estonian University of Life Sciences and Tallinn University of Technology.

The team was asked to assess the conformity of the study programmes belonging to the study programme group and the instruction provided on the basis thereof to legislation and to national and international standards and/or recommendations, including the assessment of the level of the corresponding theoretical and practical instruction, the research and pedagogical qualification of the teaching staff and research staff, and the sufficiency of resources for the provision of instruction.

The following persons formed the assessment team:

<b>Mark G Richardson (chairman)</b>	Professor Emeritus; University College Dublin; Ireland
<b>Simo-Pekka Hannula</b>	Professor; Aalto University; Finland
<b>Klaus Hellgardt</b>	Professor; Imperial College London; UK
<b>Marios Kassinopoulos</b>	Professor; Cyprus University of Technology; Cyprus
<b>Pille Meier</b>	Project manager; Estonian Forest and Wood Industries Association; Estonia
<b>Henrik Persson</b>	PhD student; Lund University; Sweden
<b>Jan-Eric Ståhl</b>	Professor; Lund University; Sweden

The assessment process was coordinated by Hillar Bauman (EKKA).

After the preparation phase, the work of the assessment team in Estonia started on Monday, 16 October 2017, with an introduction to the Higher Education System as well as the assessment procedure by EKKA, the Estonian Quality Assurance organization for higher and vocational education. The members of the team agreed the overall questions and areas to discuss with each group at the three institutions, who were part of the assessment process. The distribution of tasks between the members of the assessment team was organized and the detailed schedule of the site visits agreed.

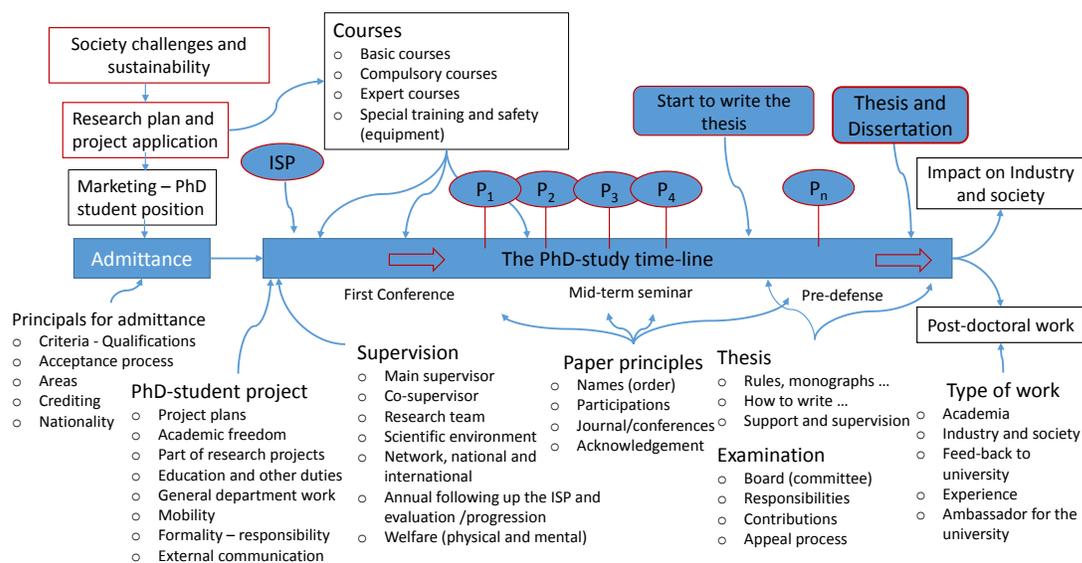
During the following days, meetings were held with the representatives of the University of Tartu (Tuesday 17 October), Estonian University of Life Sciences (Wednesday 18 October) and Tallinn University of Technology (Thursday 19 and Friday 20 October). In all cases, the schedule for discussion on site for each of the various study programmes only allowed for short time slots to be available for team members to exchange information, discuss conclusions and implications for further questions.

On Saturday, October 21, the team held an all-day meeting, during which both the structure of the final report was agreed and findings of team meetings were compiled in a first draft of the assessment report. This work was executed in a cooperative way and the members of the team intensively discussed their individual views on the relevant topics.

In the following two sections, the assessment team summarize their general findings, conclusions and recommendations which are relevant across the whole SPG. In so doing, the team provides an external and objective perspective on the programmes and the contexts within which they are delivered. Ultimately, the intention is to provide constructive comment and critique which may form the basis upon which improvements in the quality of the programmes can be achieved. In formulating its recommendations, however, the assessment team has not evaluated in-depth the financial feasibility associated with their implementation.

## General findings and recommendations

The findings are based on a comprehensive briefing on the Estonian higher education system, detailed documentation on the institutional and research evaluations concluded for the three universities to date, self-evaluation reports, together with verbal and written evidence gathered during the site visits. The Assessment Team conducted its work by evaluating all aspects of the educational journey of a Ph.D. student from the supervisor’s initial formation of a research question through to the impact of the student’s research. The various stages, illustrated in Figure 1, were comprehensively examined in dialogue with all stakeholders, including university management, programme management, academic staff, students and alumni. It would have been desirable to hear also views from a wider number of employers, even though representatives of that group are difficult to identify in respect of Ph.D. studies in Estonia – an issue discussed later in the report.



**FIGURE 1. THE STAGES OF THE PHD STUDENT EXPERIENCE EXAMINED BY THE ASSESSMENT TEAM.**

The Assessment Team noted the high quality of infrastructure in place to support Ph.D. studies, the laudable use of European Union development funds in inter-institutional doctoral schools and the use of competitive funding schemes at national and institutional level to encourage excellence. However, the Assessment Team also found eight aspects which may prevent Ph.D. studies in Estonia flourishing in a manner that optimises their value to the student, supervisor, institution, society and the Estonian economy.

These systematic constraints are:

- The **overall level of funding for R&D** in Estonia and the systematic negative consequences of the high fraction of state funding for R&D proportioned to competitively awarded funding, compared to baseline funding;
- The level of state funding allocated per **student stipend**, compared to the cost of living;
- The untapped potential of Ph.D. studies due to the **insufficient value placed on highly qualified researchers** by Estonian society and industry;
- The **slow pace of internationalisation** of the Ph.D. student experience;
- **Potential threat to sustainability of doctoral schools** when European start-up funding ends;
- **Unforeseen consequences of staff career development initiatives** during the transition to a tenure track system;
- Potential loss of the best qualified applicants due to a **lack of transparency in recruitment practice**;
- Loss of opportunity to use doctoral studies as a training ground for developing an excellent **health and safety culture** in Estonian industry.

The Assessment Team has identified these eight areas where targeted action could assist in harnessing the full potential of Ph.D. studies, for the benefit of the student, university and society.

### **Overall level of funding for R&D**

State financing of higher education is conducted by the Ministry of Education and Research, whose responsibilities include development of the rules for state financing of education; distribution of the resulting budgeted funds; and the preparation and implementation of national research development programmes. Public universities and state professional HEI's receive operational support from the state budget for providing higher education in approved study fields through baseline funding (at least 80%) and competitively awarded performance funding (up to 20%). Performance indicators of relevance to doctoral studies include:

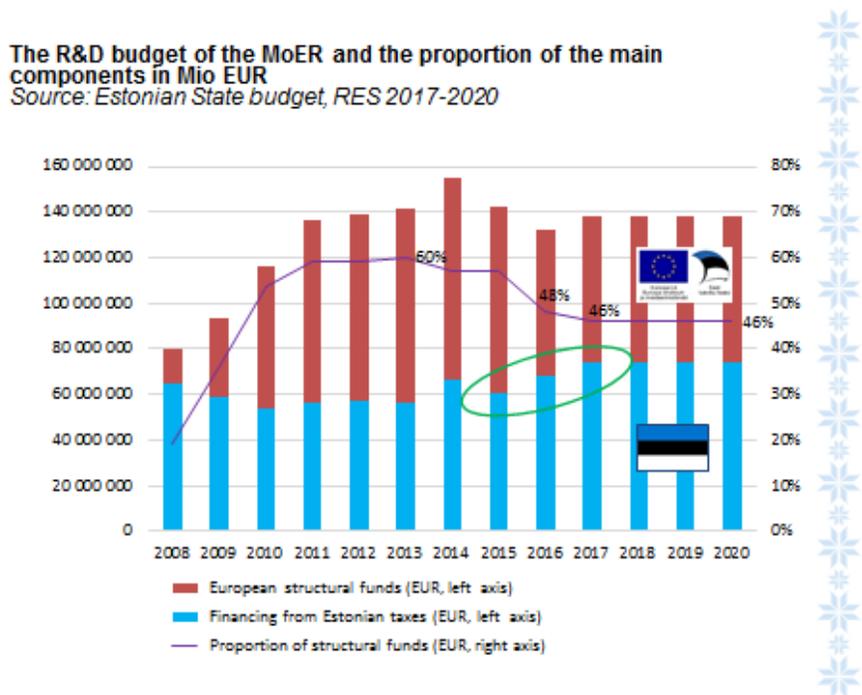
- Share of students graduating within nominal time (four years with possible one-year extension), 35%
- Share of students participating in short time mobility, 10%
- Share of enrolled foreign students, 10%

The Organisation of Research and Development Act provides, *inter alia*, for the further development of scientific and technological creation as a component of the Estonian economy. The main instruments of financing Estonian R&D activities, currently at a level of €136 million per annum, is as follows:

- Baseline funding for R&D institutions, €17.6 million per annum;
- Research grants in a public competition on conditions and procedure of the Estonian Research Council. The Council awards research grants to individual researchers and research groups, currently from a combined fund of €39.3 million per annum with the majority (typically about 75%) going to research groups;

- Nationally-funded R&D programmes and annual running costs of R&D infrastructure, currently €16.4 million per annum;
- European-funded R&D programmes including centres of excellence, doctoral schools, mobility programmes etc., currently €62.6 million per annum.

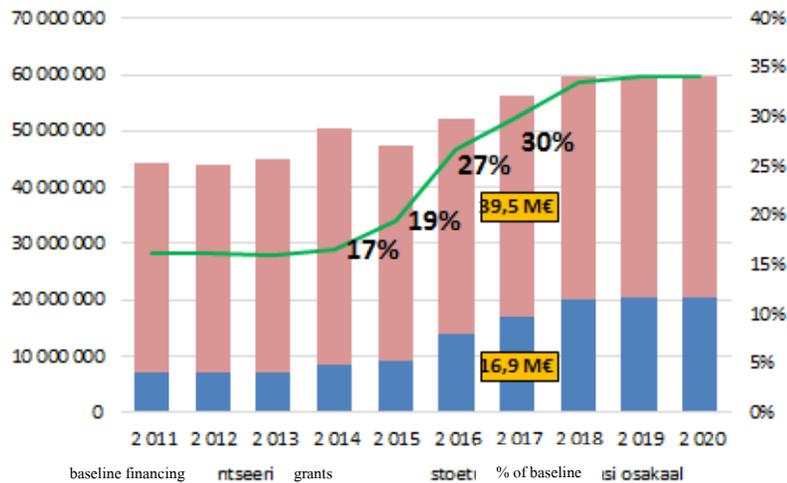
The funding per annum from state finances (currently €73 million per annum) has progressively increased in recent years, such that the proportion of the total from EU Structural Funds now represents less than 50%, as illustrated in Figure 2.



**FIGURE 2. R&D BUDGET OF THE MINISTRY OF EDUCATION AND RESEARCH**

The Estonian competitiveness strategy “Estonia 2020”, prepared in accordance with the “Europe 2020” strategy, includes an objective of raising the level of investment in R&D to 3% of GDP by 2020. Excluding European structural funds, the overall level of state funding for R&D in universities, at €73 million per annum is less than 1% of GDP. A step change in funding from Estonian taxes would be required after EU structural funding ends. However, of greater immediate concern to university management is the proportionate distribution of baseline funding and competitively won research grants, as illustrated in Figure 3.

### Baseline financing and research grants and their proportions



**FIGURE 3. BASELINE FINANCING AND RESEARCH GRANTS: HISTORICAL AND PROJECTED PROPORTIONS (MOER DATA, APRIL 2017)**

University management cannot plan on more than 30% of state R&D funding being predictable year-on-year based on KPI's within their control. Approximately 70% is dependent on competitive funding. This mitigates against strategic planning which would commit long term funding to initiatives that would (a) increase capacity for Ph.D. research supervision through staff career development programmes, (b) attract more and better local and international Ph.D. students.

The Assessment Team believes that universities need a more stable financial basis on which to plan support for the development of human capital and infrastructure that underpin quality Ph.D. studies. Accordingly, **the following recommendations are made:**

- **The portion of investment in R&D through the public university sector should be targeted at a level of 1% of GDP by 2020 through ringfencing one third of R&D funding envisaged in the "Estonia 2020" competitiveness strategy;**
- **The proportion of baseline and competitively awarded funding for R&D in universities needs to shift closer to 60%-40%, rather than the current 30%-70%, with oversight by the Estonian Research Council to ensure satisfactory impact against agreed development outcomes.**

### **Student stipend**

Full-time study in Estonian language is free of charge for students in the six public universities and eight state professional higher education institutions. A state stipend of €422 per month is paid to registered Ph.D. students during their nominal term for completion. The value of the stipend has not increased for a decade (during the global economic recession) and the current (September 2017) average salary in Estonia, at €1224 per month, is almost a multiple of three times the state stipend for Ph.D. students. Many stakeholders informed the Assessment Team that the current level of stipend is significantly below the living wage in Estonia today.

The Assessment Team welcomes state-financed support for Ph.D. studies through fee concession and stipend. However unforeseen aspects have arisen from a combination of the laudable concept of guaranteed state support for Ph.D. studies and the level of stipend declining progressively to well below the living wage. It seems that expectations have been raised that Ph.D. studies at public universities should be free of charge and equally free of responsibility – free of the responsibility to contribute daily to the shared learning experience within an active cohort of doctoral research scholars. Another aspect is that potential supervisors of full-time Ph.D. students are now mandated to provide a sustainable stream of finance for student stipend top-up funding from competitively-won grants as a precondition for allocation of each new Ph.D. student to them. Several unsatisfactory consequences have resulted:

- A culture has grown up of 'hobby Ph.D. students' (a term used to describe the phenomenon to the Assessment Team). This describes a situation whereby it is deemed acceptable for a Ph.D. student to be in full-time employment outside the university for economic reasons, even if the time available for research is restricted to weekends. These individuals neither benefit from the research training aspect of doctoral studies nor do they contribute to the life of the university community;
- Those in full-time doctoral studies are sometimes tasked with significant teaching responsibilities as part of their financial top-up package. Their workload can become excessive and out of balance with that of a full-time research student with consequent impact on timely completion of studies;
- The research question that forms the core of a student's Ph.D. study may become inextricable from deliverables associated with the research grant that partially supports their income. This then deprives them of freedom to devote time and research resources to independent exploration of speculative research hypotheses as part of the wider research quest;
- The relatively low level of the value of the stipend, compared to a living wage, is seen as a measure of the low value attaching to doctoral studies by Estonian society, with consequent problems in attracting and retaining the best students;
- Career development of academic staff may be hindered by the 'catch-22' situation whereby they cannot get on the ladder of winning research funding until they have a record of principal supervision of research

students but they need to win funding before they are allocated principal supervision of doctoral students.

The low level of state stipend, at €422 per month is at the heart of these systematic difficulties. It is understood that the value of the stipend will be increased by approximately 50% in 2018 but many stakeholders indicated this will be insufficient. The Assessment Team learned that at least one university has already set a requirement for funding to be in place for payment of €1100 per month as a baseline before approving admission of a student to Ph.D. studies. There are currently *circa* 2600 registered Ph.D. students (*circa* 300 in engineering) and if most of these are within the qualifying period for a state stipend the funding required currently amounts to €13 million per annum. This is a significant sum as a proportion of current state investment in support of R&D at the universities. Therefore, in conjunction with the Assessment Team's recommendation that annual state investment in university R&D be raised to at least 1% of GDP, **it is recommended that a portion of increased R&D investment be ringfenced to bring the level of the state funded Ph.D. student stipend to a baseline figure of €1100 per month as soon as possible**, replicating the baseline figure already in place (albeit currently through matched top-up funding) in at least one of the state universities.

### **Insufficient value placed on highly qualified researchers by society**

The Estonian Research Council fosters basic and applied R&D, supports researchers, encourages international co-operation and co-ordinates the implementation of national and international training, educational and research programmes. National programmes currently include those which support government's priorities for R&D and innovation, building on the third Estonian Research and Development and Innovation (RDI) strategy "Estonian Research and Development and Innovation Strategy 2014-2020: Knowledge-based Estonia". The strategy envisages an Estonian society that is innovative, understands the need for research and development, and values highly qualified research staff. It targets the number of new doctorate graduates in an academic year at 300 by 2020 (up from 175 in 2010).

However, it is clear that the completion rate and impact of doctoral studies has not been sufficient to make changes to the structure of the economy or to fulfil the needs of society. The number of registered Ph.D. students in Estonia was 2635 in 2016/17, indicating a decline at a rate of approximately 15% over each of the previous five years. The corresponding number of these registered to engineering studies is 294, representing an average 20% rate of decline over the same period. The number of engineering graduates per year has fluctuated in the range of 25 to 41 in the same period, demonstrating that the average period required to complete a Ph.D. greatly exceeds the 4 years anticipated. The nominal length of doctoral studies is 3 to 4 years (180-240 ECTS credits). Although doctoral programmes in the 'Engineering, Manufacturing and Technology' SPG are 240 ECTS credits, in practice few students complete their

Ph.D. in the nominal period and a culture of '4+2 years' is increasingly being accepted as a basis for the funded period.

These statistics demonstrate a disconnect between industry and the perceived relevance of Ph.D. studies, research and doctoral graduates to the Estonian economy and society. The Assessment Team did not meet any employers characterised as 'Ph.D. graduate employers' and discussions with alumni did not reveal any particular use of their training and education in workplaces other than in universities. This separation of research from the economy and society, through universities limiting their research ambition to that fundable from state funds, has perpetuated the lack of status attaching to doctoral studies, compared to many other European Union countries. The number and quality of doctoral students is currently self-limited by the universities through several factors including:

- Restricting the number of admission opportunities per year to the number of state-funded positions allocated to a university that are also supportable through supplementary support from a research group's grant funding;
- Failure to communicate with industry the importance of doctoral studies to the economy and society, despite the potential created by successive and supportive national strategy documents.

The first factor is a result of over-reliance on state funding for research rather than a combination of public and private investment in R&D. The second factor is influenced by the lack of sustained engagement by university research groups with industry and *vice versa*. The number and quality of students admitted to doctoral studies, especially in engineering, requires an enhancement of the value placed on highly qualified researchers by society and a greater awareness of the benefits of doctoral graduates by industry. To this end the Assessment Team **recommends that university-industry interaction be enhanced through the establishment of Industry Advisory Boards by engineering departments together with the widespread piloting of Industrial Doctorates, based on the Danish model, by public universities** with such Ph.D. students spending approximately half of their time in the university and half in the industrial company.

### **Slow pace of internationalisation**

Following a peer review of the Estonian research and innovation system by the European Research Area Committee in 2012 and recognising that one of the most important barriers to the development of the Estonian economy and society is the limited human capital, the recommendations in the Estonian Research and Development and Innovation Strategy 2014-2020 include the need for a migration policy that supports the study and employment of specialists that are required for the state and the economy. Public support for such a policy requires leadership and the universities can play a significant role in this regard, given the competitive international environment in which they already operate.

The Assessment Team applaud the clear support offered to doctoral students for periods of study abroad through mobility grants but the internationalisation of the student experience also depends on the number of international students and staff that they interact with on a daily basis on their home campus in Estonia. To improve the international competitiveness of graduates, the Assessment Team **recommend that university management:**

- **Conduct a review of barriers to internationalisation of the doctoral student experience, leading to:**
- **An action plan of proactive measures to promote an inclusive study environment for doctoral students that will:**
- **Harness the integration of diverse cultures and varied prior graduate educational experience as an every-day part of a challenging and thought-provoking collegiate Ph.D. study environment.**

### **Sustainability of doctoral schools**

The Assessment Team were impressed by the high number of doctoral schools in Estonia. These schools *inter alia* promote interdisciplinary research projects of doctoral candidates, co-operation between the private and public sectors and facilitate the mobility of doctoral candidates. Of great significance is the fact that they promote co-operation between universities, with significant benefits to Estonian higher education and the quality of Ph.D. student experience through the focusing of scarce resources into selected centres of excellence and doctoral schools.

Co-operation between universities is as important for provision of adequate resources as competition between universities is for raising standards. However the Assessment Team has concerns about the sustainability of doctoral schools due to a change in the funding model. In the period of 2014-2020 Estonian universities manage 13 doctoral schools of which almost half are of direct relevance to engineering Ph.D. studies. Doctoral schools are project-based, funded from the European Regional Development Fund and the Ministry of Education and Research ASTRA programme. They are financed as part of the institutional contract between the state and the university which leads the school. The University of Tartu leads 8 schools, Tallinn University of Technology leads 3 and University of Tallinn leads 2. The funding model differs from that which applied in the period 2009-2014, when doctoral schools in Estonia were co-owned by universities with a common budget. The change in funding model has discouraged co-operation between universities due to budgetary concerns. Universities are now more reluctant to contribute to common initiatives like winter or summer schools. The Assessment Team were informed that the organizational changes in the arrangement of doctoral schools in Estonia have been problematic.

Mindful of the need to encourage co-operation between universities and between universities and industry, the Assessment Team is anxious to see the concept of doctoral schools flourish in Estonia. Therefore **it is recommended that a review of the funding model be undertaken to ascertain the optimal model for ensuring sustainability of the doctoral school network**, especially when European Regional Development Fund support ends.

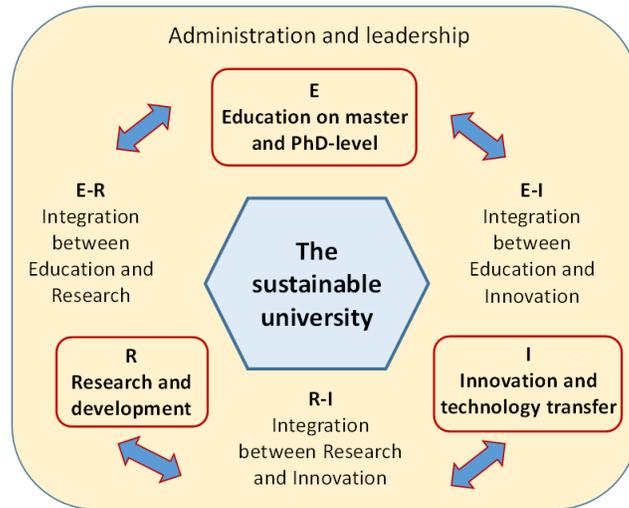
### **Unforeseen consequences of staff career development initiatives**

The main mission of a university is education. Doctoral study research sits in that context. It is recognised however that other pressures regarding research output exist which inevitably impact on doctoral studies. For example university management must be mindful of expectations, under the “Estonian Research and Development and Innovation Strategy 2014-2020: Knowledge-based Estonia” that academic staff members of a university will contribute to meeting targets that include:

- Raising from 7.5% (2008) to 11% (2020) the share of Estonian research publications among the 10% most-cited research articles in the world;
- Raising from 87% of EU average (2012) to 100% of EU average (2020) the volume of contracts won per resident in the EU Horizon 2020 research and development framework programme;
- Raising from 1.31% (2010) to 3% (2020) the share of internationally coordinated research in state-financed R&D.

Responding to these expectations, some universities are in the process of developing a tenure track approach to the recruitment and career development of academic staff. The Assessment Team supports this approach but cautions against any moves that would create a division between ‘teachers’ and ‘researchers’ in a university. The workload of each academic should involve regular integration of education, research and innovation, as illustrated in Figure 4.

To ensure ever-improving supervision of doctoral students in tandem with the intensification of research expertise in universities, the Assessment Team **recommends that doctoral studies in universities be conducted under the supervision of academic staff with workloads that integrate education, research and innovation without the ability for complete ‘buy-out’ of time devoted to any one of these aspects of workload.** Recruitment and promotion policies should reflect ability and performance under all aspects.



**FIGURE 4. THE INTEGRATED ASPECTS OF AN ACADEMIC'S WORKLOAD.**

### **Lack of transparency in recruitment practice**

The access requirement for doctoral studies is a master's degree or a corresponding qualification. Given the limited number of admission opportunities that are approved each year, due to budgetary restrictions, it would be expected that the Ph.D. student cohort would represent the top achievers from a range of national and international master's degree programmes. In practice, this is not the case, with decreasing interest in Ph.D. studies nationally; lack of relative attractiveness in the competitive international market; and the fact that state-funded Ph.D. positions are made official in May each year, long after the highest quality national and international students have accepted places in industry or academic studies elsewhere. Thus, the Assessment Team noted a very high percentage of Ph.D. students continuing their studies in the same university as their undergraduate and master's degree. Many supervisors only recruit Ph.D. students through discussion with talented students during their master's degree studies, in the belief that this represents their only pool of quality applicants. This has become a self-fulfilling prophecy.

To improve the quality of doctoral studies through recruitment of the best qualified students, the Assessment Team **recommend that each funded Ph.D. opportunity be marketed internationally in a timely manner with associated mandatory and desirable criteria specific to the research project. Candidates should be assessed by a departmental doctoral studies committee against the published criteria and places offered in a transparent manner with feedback available if requested to disappointed applicants. This recommendation is contingent on the state approving Ph.D. positions officially by January of each year to coincide with international recruitment cycles in the northern hemisphere.**

### **Health and Safety culture**

There is a special responsibility on universities to promote the highest standards in all aspects of their operations so that students may gain lifelong attributes that promote a highly professional culture in their workplaces after graduation. A special responsibility arises for nurturing in Ph.D. students a strong health and safety culture when they conduct research in laboratories. While the Assessment Team noted strong awareness of safety procedures among supervisors and students working in laboratories, the opportunity to develop a strong safety culture was not being used to full effect. To enhance Ph.D. graduate attributes in respect of a safety culture the Assessment Team **recommend that greater use be made of formal assessment of skills and knowledge after safety briefings and the use of activity risk assessment, with associated sign-off.**

# 1. Assessment report of SPG at the University of Tartu

## 1.1. Introduction

In 2017, the University of Tartu celebrated the 385th anniversary of its founding. The University of Tartu that was established in 1632 as Academia Gustaviana has been reborn a number of times throughout its history.

According to the University of Tartu Act adopted on 16 February 1995, the University of Tartu is the national university of the Republic of Estonia. Its mission is to advance science and culture, provide the possibilities for the acquisition of higher education based on the development of science and technology on the three levels of higher education in the field of humanities, social, medical and natural sciences and to provide public services based on teaching, research and other creative activities. The infrastructure for research in the city of Tartu has been greatly strengthened by investment in both UT and EMÜ. This includes targeted investment in national centres of excellence which, by an agreement between EMÜ with TTÜ, do not duplicate resources in other Estonian institutions, thus adding to the national capacity for specialist facilities for doctoral studies. Under the structural reform, initiated in 2014, the nine faculties and five colleges of UT were consolidated into four fields (Faculties).

The curriculum group Engineering, Manufacturing and Technology comprises one doctoral programme - Engineering and Technology (80615). The programme is managed by the Institute of Technology at the Faculty of Science and Technology. The programme has four specialties – Engineering of Bioactive Compounds, Biomedical Engineering, Physical IT Engineering, Environmental Engineering. The nominal period of studies is 4 years (240 ECTS).

In academic year 2016/2017 the number of doctoral students at the University of Tartu in the study programme group 'Engineering, Manufacturing and Technology' represented approximately 25% of all doctoral students in Estonian universities in that study programme group.

During the last 5 years the number of PhD students studying at the programme has been stable, between 50 and 55 students. In 2015/2016 seven of them (13%) were foreign students. The number of those working at the university at the same time as studying has been fluctuating between 23-69%.

### THE NUMBER OF PHD STUDENTS

Curriculum	2011/12		2012/13		2013/14		2014/15		2015/16	
	Total	working at UT								
Engineering and Technology	54	12	53	26	55	38	50	31	52	21
<b>UT Total</b>	1493	481	1504	502	1457	493	1401	487	1348	380

**THE NUMBER OF INTERNATIONAL PHD STUDENTS**

Curriculum	2011/12	2012/13	2013/14	2014/15	2015/16
Engineering & Technology, International	4	3	0	2	7
<b>Eng &amp; Tech Group</b>	54	53	55	50	52
<b>UT Total</b>	103	122	129	139	143

**THE NUMBER OF ADMITTED PHD STUDENTS**

Curriculum	2011/12		2012/13		2013/14		2014/15		2015/16	
	Total	Directly from UT MSc								
<b>Eng &amp; Tech Group</b>	10	7	8	6	10	10	8	5	7	2
<b>UT Total</b>	255	218	190	151	179	153	168	137	171	139

**THE NUMBER OF PHD STUDENTS DISRUPTING THEIR STUDIES**

Curriculum	2011/12		2012/13		2013/14		2014/15		2015/16	
	Total	on ones own will								
<b>Eng &amp; Tech Group</b>	4	1	6	2	6	3	4	0	4	2
<b>UT Total</b>	119	45	148	55	128	42	154	40	171	48

**THE NUMBER OF DEFENDED PHD THESES**

Curriculum	2011/12		2012/13		2013/14		2014/15		2015/16	
	Total	within 6 years								
<b>Eng &amp; Tech Group</b>	3	3	3	2	8	6	4	3	12	9
<b>UT Total</b>	95	68	114	57	117	62	107	45	120	75

## 1.2. Strengths and areas for improvement of study programmes by assessment areas

### 1.2.1. Engineering and Technology

#### Study programme

##### Standards

- ✓ The launch and development of the study programme are based on the Standard of Higher Education and other legislation, national strategies, university development plans, the effectiveness of research and development, various analyses (including labour market and feasibility analyses); striving for the best overall programme quality.
- ✓ Doctoral programmes contain at least 70% research, development or other creative work by doctoral students, making the results thereof public in international peer-reviewed research journals or in other ways that have international dimensions.
- ✓ Study programmes incorporate doctoral student participation in conferences and/or other professional activities, and are counted towards completion of the study programme.
- ✓ Doctoral programmes enable doctoral students to acquire leadership and teamwork skills, develop coaching and teaching skills as well as a proficiency in foreign languages at the level needed for successful participation in international working environments.
- ✓ Different components of a doctoral programme form a coherent whole supporting the personal development of each doctoral student.
- ✓ Study programme development takes into account feedback from doctoral students, supervisors, employers, alumni and other stakeholders.

##### Comments

The University has set clear general requirements for doctoral studies. In addition to professional skills development, doctoral students are also enabled to acquire general 'soft' skills, such as academic leadership, project management, philosophy of science and proficiency in foreign languages, as preparation for an academic career.

The University carries out regular self-evaluations, both of results and efficiency, and implements a feed-back system for monitoring possible deviations from the standards. It is also offering various opportunities to improve competence in teaching, communication and industry relations.

Nevertheless, there is always room for improvement. In particular special attention should be paid to the average length of doctoral studies and actions should be taken helping the students to manage their studies within nominal time. The inter-university doctoral schools are very positively viewed by both the staff and students and should be further developed.

### Strengths

- Clear general requirements and good practice of doctoral studies are outlined.
- Regular self-evaluation of results and efficiency.
- Feed-back system is implemented and used as a base of improvements.
- Support to build relations with industry and the labour market exists as well as help to improve skills in communication and popularization of science.
- Measures for adding competence in teaching are defined and utilised.

### Areas of improvement and recommendations

- In order to improve co-operation between the different universities participating in the doctoral schools, the funding needed for the joint activities from the partner universities should be in place on an equitable basis. The doctoral schools should also be given an opportunity to develop joint courses, which could be taken by students from the participating universities. Adding an e-learning component to the co-operation would eliminate duplication of scarce resources and ensure that special courses could have an ensured critical mass of enrolled students.
- The average time to complete doctoral studies is relatively long given that the thesis may be submitted for defence after three papers are produced. It is recommended that actions to shorten study times are taken. These should involve benchmarking the best practices within Estonian Universities, organisation of student funding, sharing of work at the research group level and making sure that the PhD project remains as a doctoral project the student is responsible for, not only a part of supervisors' scientific work.
- It is recommended that the coherency of the study programme is improved. Those modules which are rarely if ever offered in practice should be identified and removed from the published list offerings where appropriate. The content and outputs of colleagues' work within the same study programme should be systematically reviewed and the modules offered rationalised with duplicated material removed from the study programme.

## **Resources**

### Standards

- ✓ In conducting doctoral study programmes, an adequate number of teaching staff and researchers participate, who hold the appropriate qualifications required to carry out doctoral studies and supervise doctoral theses in a given study programme.
- ✓ Universities shall ensure that sufficient funds are available to conduct doctoral

<p>studies, to provide development activities associated with doctoral studies and research, and to support the professional development of teaching staff and researchers.</p> <ul style="list-style-type: none"><li>✓ Resources (teaching, learning and research environments; libraries; resources required for teaching, learning and research) support the achievement of objectives set out in study programmes as well as the actual teaching, learning and research at the level of doctoral studies. Resource development is sustainable.</li><li>✓ Trends in the numbers of current learners, admitted learners and graduates (by study programme) in doctoral studies under the study programme group during the last five years indicate sustainability.</li></ul>
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### Comments

Following some consolidation in the HE sector, the Estonian education system has stabilized with a number of state universities being the leading institutions in the country – the University of Tartu (UT) is one of them. Although the national R&D budget has been increasing (currently at approximately 0.7% of GDP), an increase to 1% of GDP has not quite been achieved, despite this being a political aspiration.

When first introduced in 2004, the state doctoral allowance grant amounted to some 80% of the average salary in Estonia. In 2017 this doctoral state allowance only covers approximately 37% of the average salary. Consequently, the official state scholarship is not sufficient to motivate students to study for a PhD and/or to continue these studies for 4+ years. This means that 35% of UT PhD students have resorted to full time employment.

The University of Tartu has developed a Global Engagement Strategy and is very successful in attracting (research) funding from the EU (approximately 30%) whilst most of competitive funding is gained from Estonian sources. UT has invested into international collaboration and centres of excellence. A restructured R&D office will utilise advanced machine learning algorithms to match skills with opportunities.

### Strengths

- The laboratories are well equipped with additional key core facilities – the proteomics core facility, the core facility for applied virology and the core facility for constructing scientific machines. These appear to provide easy access to sophisticated technologies, thereby enhancing collaboration and external visibility through services sold abroad.
- The Engineering and Technology doctoral studies research and learning environment is based in a Faculty whose annual budget is 70% research related and the research infrastructure is founded on Institutes which have a track record in fundamental scientific research.
- The continuity of financial support to maintain and develop the infrastructure that underpins high quality doctoral studies is assured through prudent financial management and discipline at all levels. UT is

well positioned in respect of the national funding model involving baseline and performance-based metrics; there is significant equity capital available; and the planned return on investment in research infrastructure from EU Structural Funds is being realised.

- The canteen space is pleasant and conducive to staff collegial engagement and interaction.

#### Areas of improvement and recommendations

- The Assessment Team found, based on a visit to the laboratories and interviews with staff/supervisors and students, that the safety culture in general could be improved. This will mainly require investment into additional training and reporting such as annual Health and Safety testing – e.g. online, the implementation of activity risk assessments (documentation), development of documented SOPs (standard operating procedures), clear policy regarding lone working and good laboratory practice (wearing of lab coats, goggles, gloves etc.).
- The funds available to support the stipend for each doctoral student are varied and thus lead to a complex financial support structure. This in turn means that there is no consensus regarding overall student stipend. It may be useful to consider a standard student stipend commensurate and competitive to the basic average salary in Estonia. Thereby addressing the status but also the completion rate of future PhD students.

### **Teaching, learning, research and/or creative activity**

#### Standards

- ✓ Uniform principles, based on best international practices and agreed upon at the university level, shall be followed while implementing doctoral programmes and assuring the quality of the doctoral studies (including supervision of doctoral theses).
- ✓ Doctoral studies support students' personal and social development, including creating an environment which will prepare them to successfully participate in international working environments at research and development institutions, as well as in the business and public sectors.
- ✓ Supervision of doctoral theses; modern methodology used in teaching and research; organisation of studies; and doctoral students' professional research, development and/or other creative activities all support achievement of the objectives and learning outcomes of doctoral studies.
- ✓ Assessment of outcomes of the learning, research and creative work done by doctoral students is relevant, transparent and objective, and supports the development of doctoral students.
- ✓ Doctoral students are asked for feedback regarding supervision on a regular basis and the results of these surveys are taken into account for quality improvement activities.
- ✓ Effectiveness of the doctoral studies is analysed and such analyses serve as a basis for planning quality improvement activities.

### Comments

Uniform principles defined in Estonian regulations are followed in the implementation of doctoral programmes to assure the quality of the doctoral studies. The course structure for doctoral studies is in place and selection of courses is recommended for particular studies. The assessment of outcomes of the learning, research and creative work done by doctoral students supports the development of doctoral students.

It is noted that doctoral studies are carried out in an environment which prepares students to successfully participate in international research and development tasks in academia and public-sector research centres. However while it seems that participation in industrial and business-related activities could be supported to a larger extent.

Modern methodologies are used in the supervision of doctoral theses and in teaching and research. Personalized study plans are made for each student, supporting achievement of the objectives and learning outcomes of doctoral studies. The assessment of learning outcomes, research and creative work done by doctoral students is relevant, transparent and objective, which supports the development of doctoral students.

Doctoral students are asked for feedback regarding supervision on regular basis. The effectiveness of the doctoral studies is analysed and the results of these surveys are taken into account when planning quality improvement activities.

In some cases PhD theses defended in Engineering and Technology are quite voluminous by international standards. This problem derives from the requirement to publish at least three academic papers, the length of which may be viewed differently by the supervisor (from the viewpoint of the research group and potentially multiple authors) and the student (from the viewpoint of publishing the research for which they are clearly the principal contributor).

### Strengths

- A patent application may be accepted in partial fulfilment of the submission requirements instead of one of the three papers.
- One semester period abroad is both recommended and well-supported to carry out research related to thesis.

### Areas of improvement and recommendations

- Although the selection of available modules appears to be large there are courses which are not often given or are not offered in English. These modules should be removed from the course offering. While this is being done it should be made certain that the course load is properly divided such that teaching and research go hand in hand. However, additional offering of courses useful for non-academic careers e.g., in industry is recommended to be considered.

- It is not always clear that the thesis is an independent research paper of the candidate as there is often multiple authors included from a large research group behind the paper. It is recommended that the thesis projects are designed in such a way that it is possible for the candidate to manage responsibility as a first author in at least three peer reviewed papers during the four-year time of the thesis project.

## Teaching staff

### Standards

- ✓ Teaching staff participate in research, development and/or creative activity at the level of and to the extent sufficient to conduct doctoral studies in the curriculum group and to supervise doctoral theses.
- ✓ Teaching staff develop their supervisory competences and share best practices with one other.
- ✓ Teaching staff collaborate in fields of teaching, research and creative work within the university and also with stakeholders outside the university (public sector organisations, enterprises, other research and development institutions).
- ✓ Teaching staff further their skills at foreign universities or other research institutions, participate in international research and creative projects, and present papers at high-level conferences.
- ✓ Qualified international and visiting teaching staff are involved in conducting doctoral studies, participating in doctoral thesis defence panels and/or reviewing doctoral theses.
- ✓ When assessing the work of teaching staff (including their evaluations), the effectiveness of their teaching as well as of their research, development and creative works is taken into account; including the effectiveness of their student supervision, development of their teaching and supervisory skills, and their international mobility.

### Comments

It is encouraging to note that, starting from 2018, those filling the position of a lecturer are required to hold a doctoral degree. However, it is also noted that the percentage of academic staff holding a PhD has been quite constant at 74%. It is encouraging that the fraction of international PhD students has been steadily increasing but the fraction of international staff seems to have peaked in 2013 at 8.8%. It is probably desirable to consider the latter and identify incentives etc. to continue to internationalize academic staff. There is clear evidence of improving external visibility of research staff as evidenced by the continuing increase of number of papers in international peer-reviewed journals, rising from 0.83 in 2008 to 1.29 in 2014. The Assessment Team note and commend the above-average performance of the Institute in regard to publication output (1.6 in 2016) and internationalization of staff (22%). It is a credit to the quality of the research carried out in the Institute and University that a number of staff belong to the 1% most cited scientists and have joint appointments with other international universities.

The development of a study plan for PhD students (4 years) in conjunction with the supervisor is on the whole very well organized and implemented. The individual portion in terms of course attendance is planned jointly by PhD student and supervisor.

Monitoring of progress involves consecutive assessments (attestations), which involve the supervisors but also colleagues (students' progress review council) and thus allow for additional feedback to be received.

In terms of publications an interesting conflict of interest was highlighted between the need of the PhD student to publish three papers in order to complete his/her studies and the desire of the supervisor to increase his/her international reputation and that of the Institution by publishing in high impact journals, thus requiring more data etc. before a significant piece of work can be released.

In this context the University will need to think carefully about the agreed requirement of three papers on the one hand and its desire to improve its international research ranking on the other.

### Strengths

- The Institute appears to be well organised and there is a close and collegiate relationship between all members of the Institute (professors, research associates and students). The workload appears to be evenly distributed.
- All supervisors have international experience.
- PhD students collaborate on a number of projects, which in turn allows them to participate in the submission of papers. This then reduces the individual burden of the requirement to publish three papers for their thesis.
- In the past, PhD feedback was gathered through surveys. In an era of over-surveying, UT is now using LinkedIn and Facebook updates to understand PhD students' progression and professional careers as well as concerns and issues.
- The introduction of academic mentors (academic staff not involved in the research) whose role is to aid students in the advancement of studies is applauded.

### Areas of improvement and recommendations

- As indicated during discussions between the Assessment Team and the academic staff it is clear that induction of new staff is through initial co-supervision of PhD students. This very much amounts to learning-on-the-job and the supervisory skills acquired will depend on the respective skills of the senior colleague involved. It is recommended that this is decoupled somewhat in the sense that all prospective supervisors are given

- comprehensive training regarding supervision (specialist courses rather than those provided to Master or PhD students).
- Continuing education in the field of teaching skills has been in effect since 2010. A measure/strategic indicator is: "Percentage of academic staff who participated actively in teaching-related development activities". However, no such data were presented in the self-assessment report. Although the development of teaching skills is supported by the centre for excellence in teaching and learning located in the lifelong learning centre, discussions with staff and students indicate that there is generally room for improvement regarding the provision of staff development. This could take the form of (compulsory) courses (e.g. active bystander training, unconscious bias training, 360-degree evaluation, pedagogy).
  - The conflict of interest in terms of quality of papers eluded to above should be considered by the University. It is clear that research performance indicators will be biased towards high impact papers and a balance needs to be sought with respect to PhD education and student deliverables. In light of the desire to increase the research ranking of the university it is recommended that quality and impact of papers should trump quantity and that therefore the strict interpretation of the pre-requisite for submission, three published papers, be reconsidered.

## Doctoral students

### Standards

- ✓ When admitting students to doctoral study, their suitability for successful completion of their studies is assessed on the basis of transparent criteria.
- ✓ Doctoral students plan their studies as well as research and development activities in collaboration with their supervisor(s), setting out specific objectives for each year and taking responsibility for achieving these objectives.
- ✓ Evaluation of doctoral students is transparent and impartial. Its purpose is to support development of the doctoral students, provide an opinion regarding the effectiveness of their work to date, and assess their capabilities to complete their studies on time and successfully defend their doctoral theses.
- ✓ Universities offer doctoral students counselling on completing their studies and planning their further careers.
- ✓ Doctoral students' extracurricular teaching, research and/or creative activities or other work-related activities at the university support successful completion of their doctoral studies.
- ✓ Doctoral students participate in international mobility programmes or take advantage of other opportunities for learning or research at foreign universities and/or research and development institutions<sup>1</sup>.
- ✓ Alumni are regularly asked for feedback on the quality of the doctoral study, and employers are asked for feedback on the preparation of the graduates.

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<sup>1</sup> In the context of this document, 'research and development institutions' denote both research institutions and research-intensive companies.

### Comments

When admitting students to doctoral study, their suitability for successful completion of their studies is assessed on the basis of transparent criteria.

### Strengths

- Transparent criteria for admitting doctoral students: Doctoral project and assessment of its feasibility (entrance examination) – 70% of the result; Average grade of the previous level of study - 30% of the result.
- Doctoral students take part in mobility programmes, spending at least one semester studying abroad.

### Areas of improvement and recommendations

- Although the criteria for admitting the students is transparent, the competition for the position is not clearly set. It is recommended that the rules for advertising the positions and the means of selection between the potential candidates are defined.
- It is recommended that the role of doctoral student in developing the thesis project as a responsible researcher be clarified in order to insure the clear visibility of the independent contribution role of the student in producing the results presented in the thesis as published papers.

## 2. Assessment report of SPG at Estonian University of Life Sciences

### 2.1. Introduction

The Estonian University of Life Sciences (EMÜ), one of six public universities, was registered as a public legal entity in 2003 and the current name dates from 2005. The university origins date back to the Tartu Veterinary School of 1848. EMÜ is the only university in Estonia providing higher education in agriculture, veterinary medicine and forestry. The main field of activity is research concerning bio-economy and the studies based on this research. The research focuses on serving the society and increasing its competitiveness by promoting innovation in all of the interdisciplinary fields related to rural life, the rural economy, sustainable use of primary resources and preservation of the environment. To this end the University promotes collaboration in six focal areas – agriculture, environment, forestry, food and health, engineering and technology and rural economy.

Today the University comprises five R&D institutes. Doctoral students in the study programme field of Engineering, Manufacturing and Technology are the responsibility of two institutes: the Institute of Technology (IT) and the Institute of Forestry and Rural Engineering (IFRE).

The transitional evaluation process in 2010 resulted in EMÜ being granted the right to conduct studies for an unspecified term at Prof HE, BSc and MSc levels. However at PhD level the right to conduct studies was initially limited to 3 years. The re-evaluation in 2013 again restricted the period to a further 3 years. The main problems identified at that time were:

- Very low graduation rate (50% supervisors with no graduates)
- Number of specialisations was too high
- Lack of competence by supervisors, as well as the defence committee
- Level of research output of some supervisors was not sufficient
- Low mobility of PhD students
- Not enough research projects

A re-evaluation took place in 2016, resulting in the right to conduct studies for an unspecified term. The programme was positively evaluated in all three sub-fields of evaluation: quality, resources and sustainability.

The current strategic aims are set out in the EMÜ Development Plan 2016-2025. The successful implementation of the plan is being monitored by 27 KPI's. Those relevant to the quality of doctoral studies are as follows:

- The number of publications per academic staff member per year (special account for publications in WoS and Scopus):  $\geq 1$  ;
- The number of international conferences in the responsibility area per five years:  $\geq 1$ ;
- The share of external staff among academic staff:  $\geq 10\%$ ;
- Number of young researchers supported:  $\geq 3$ ;
- Total earnings per one member of academic staff:  $\geq$  average of the three biggest universities in Estonia;

- Number of EU supported projects per focal area:  $\geq 1$ ;
- Earning-base revenue in R&D activities (three-year average): increase from the baseline of 25%;
- Number of interdisciplinary cooperation projects per focal area:  $\geq 1$ .

The study programme group 'Engineering, Manufacturing and Technology' comprises a doctoral programme in 'Engineering Sciences'. The nominal period of studies is 4 years (240 ECTS), although there is widespread use of a '4+2' year period to define the expectation in Estonian universities.

In academic year 2016/2017 there was a total of 217 doctoral students at EMÜ, across five study programme areas. The study programme group 'Engineering, Manufacturing and Technology' accounted for 31 doctoral students, representing 11% of all doctoral students in Estonian universities in that study programme group.

The number of students studying on the doctoral programme has been stable over the last five years, varying in a narrow band from 30 to 32.

In 2016/2017 the number of international students was 3, representing 10% of the cohort, but this was not typical, with only one international student registered on the programme in each of the preceding four years. The number of doctoral students working at the university at the same time as studying is very high – approximately 52% in 2016/2017 and has been as high as 76% in recent years. The average percentage of students registering for doctoral studies after completing their master's degree at EMÜ is also very high, regularly exceeding 55% and as high as 80% in 2015/2016.

### THE NUMBER OF PHD STUDENTS

Curriculum	2012/13		2013/14		2014/15		2015/16		2016/17	
	Total	working at EMÜ	Total	working at EMÜ	Total	working at EMÜ	Total	working at TTÜ	Total	working at EMÜ
Engineering Sciences	30	19	33	25	32	22	31	18	31	16

### THE NUMBER OF INTERNATIONAL PHD STUDENTS

Curriculum	2012/13	2013/14	2014/15	2015/16	2016/17
Engineering Sciences	1	1	1	1	3

### THE NUMBER OF ADMITTED PHD STUDENTS

Curriculum	2012/13		2013/14		2014/15		2015/16		2016/17	
	Total	Directly from EMÜ MSc								
Engineering Sciences	4	3	7	5	5	3	5	4	7	4

### THE NUMBER OF PHD STUDENTS DISRUPTING THEIR STUDIES

Curriculum	2012/13		2013/14		2014/15		2015/16		2016/17	
	Total	on one's own will	Total	on one's own will						
Engineering Sciences	4	2	3	1	4	0	6	2	Not yet available	Not yet available

### THE NUMBER OF DEFENDED PHD THESES

Curriculum	2012/13		2013/14		2014/15		2015/16		2016/17	
	Total	within 6 years	Total	within 6 years						
Engineering Sciences	3	2	1	1	2	2	5	4	Not yet available	Not yet available

## 2.2. Strengths and areas for improvement of study programmes by assessment areas

### 2.2.1. Engineering Sciences

#### Study programme

##### Standards

- ✓ The launch and development of the study programme are based on the Standard of Higher Education and other legislation, national strategies, university development plans, the effectiveness of research and development, various analyses (including labour market and feasibility analyses); striving for the best overall programme quality.
- ✓ Doctoral programmes contain at least 70% research, development or other creative work by doctoral students, making the results thereof public in international peer-reviewed research journals or in other ways that have international dimensions.
- ✓ Study programmes incorporate doctoral student participation in conferences and/or other professional activities, and are counted towards completion of the study programme.
- ✓ Doctoral programmes enable doctoral students to acquire leadership and teamwork skills, develop coaching and teaching skills as well as a proficiency in foreign languages at the level needed for successful participation in international working environments.
- ✓ Different components of a doctoral programme form a coherent whole supporting the personal development of each doctoral student.
- ✓ Study programme development takes into account feedback from doctoral students, supervisors, employers, alumni and other stakeholders.

### Comments

The curriculum in Engineering Science is delivered in close cooperation with other structural units within the University and two interdisciplinary doctoral schools. The doctoral studies programme consists of 240 ECTS, comprising a dissertation (180 ECTS), a basic module (20 ECTS), a speciality module (35-40 ECTS) and optional modules up to 5 ECTS. The volume of doctoral thesis thus constitutes 75% of the whole curriculum.

All students are required to complete an individual study plan, which takes account of both the deliverables of their research project and their personal development goals. Regarding personal development, the basic module and speciality module are used to familiarise students with research management, policy and funding; influence of research on economic and societal development; ethical, environmental and social issues; academic writing, publication and review; intellectual property and copyright. Although English language skills development is not credit bearing, in practice all doctoral students must demonstrate proficiency in verbal and written English to successfully complete their programme. Support from the Language Centre is available through optional modules.

Doctoral students participate in international conferences. International dissemination of doctoral student's research is also underpinned by the format of the doctoral thesis which may either be a collection of thematic research articles (usually three high-level publications); a monograph which contains references to the applicant's publications; or a monograph published under a scientific publisher outside the university. In the Engineering Sciences study programme the approach is to use a minimum of three publications. The Assessment Team noted that these publications often have multiple co-authors, including several students submitting from a supervisor's research group. The doctoral student is not always the principal author of the three publications used in their submitted thesis.

Some repetition of material is experienced in the basic module and speciality module by students who conducted their masters study at EMÜ and such matters are monitored by the curriculum leader. It may be noted that prior learning and working experience (RPL) can be considered towards completing the doctoral study programme. The focus of RPL is on general subjects, allowing a single pan-university RPL committee to assess applications and thus ensure equal treatment of doctoral students.

Feedback from doctoral students is collected both in the Studies Information System (ÖIS) and through student satisfaction surveys. ÖIS allows the doctoral students to give feedback on the general education courses and the lecturers every semester. External student satisfaction surveys, conducted at approximately three-year intervals, yielded positive feedback, especially in respect of administrative support for students.

### Strengths

- Doctoral students conduct their studies in a supportively ambitious atmosphere, underpinned by a combination of EMÜ's Development Plan 2016-2025 as a leader in KBBE R&D ('Knowledge-based bio-economy'); the value system of EMU's 'Green University Strategy' mind-set and the University's niche specialisation in the study of the management of rural life.
- Presentation of research findings at international conferences is now a mandatory aspect of the doctoral studies programme.
- A single pan-university Prior Learning and Working Experience (RPL) committee assesses applications for RPL to contribute to completing the doctoral study programme, thus ensuring equal treatment of doctoral students.
- The research focus on sustainability of natural resources is highly relevant to current national, international and societal priorities, underpinning likely success in strong international research impact.

### Areas of improvement and recommendations

- The use of multiple author papers to satisfy the minimum requirement for a doctoral thesis submitted as a collection of at least three high-level publications is less than satisfactory, unless the Ph.D. student is the primary research contributor and first author of each qualifying paper. Consideration should be given to introducing guidelines on the necessity for a paper to be under the principal authorship of the doctoral student before it qualifies as one of the three publications.

## **Resources**

### Standards

- ✓ In conducting doctoral study programmes, an adequate number of teaching staff and researchers participate, who hold the appropriate qualifications required to carry out doctoral studies and supervise doctoral theses in a given study programme.
- ✓ Universities shall ensure that sufficient funds are available to conduct doctoral studies, to provide development activities associated with doctoral studies and research, and to support the professional development of teaching staff and researchers.
- ✓ Resources (teaching, learning and research environments; libraries; resources required for teaching, learning and research) support the achievement of objectives set out in study programmes as well as the actual teaching, learning and research at the level of doctoral studies. Resource development is sustainable.
- ✓ Trends in the numbers of current learners, admitted learners and graduates (by study programme) in doctoral studies under the study programme group during the last five years indicate sustainability.

### Comments

Renovation of the buildings in the recent past has been done on a large-scale: lecture halls, auditoria and laboratories have been renovated and updated. This includes an investment of €3 million specifically relevant to Engineering Sciences in the last seven years.

The Institute of Technology (IT) and the Institute of Forestry and Rural Engineering (IFRE) participate in national Centres of Excellence and IT participates with TTÜ in the Estonian Research Infrastructure Roadmap project. This underpins the availability of substantial research funding in support of resources for doctoral studies. Although of high quality through national investment, accreditation of laboratories is not the norm.

Specific software is available in the computer labs and used in teaching. Free internet access is available in all study rooms and in the dormitories. The main international databases are available at the library.

Several mobility cost funding programmes, such as Erasmus+, Dora Plus, Kristjan Jaak Scholarship are actively used to support doctoral students in gaining international study experience.

Doctoral students working on funded projects are allowed receive a supplementary scholarship, in addition to the state allowance of €422 per month. Doctoral students whose research relates to a 'smart specialization' growth area (ICT, Health technologies and services, more effective use of resources) may receive 'smart specialization' scholarships (funded by the European Regional Development Fund) of €422 per month in addition to the state doctoral allowance scholarships for PhD students. However not all students in the EMÜ Engineering Sciences programmes would qualify and it was widely communicated to the Assessment Team that the state doctoral allowance (€422 per month) is inadequate, being below the living wage.

### Strengths

- The University has made provision for maintaining the quality of its research resources through a Depreciation Fund.
- Mobility cost funding programmes are actively used to support international study experiences by doctoral students.
- The sustainability of the doctoral research study programmes is underpinned by the relevance of doctoral graduates to the ever-emerging knowledge-based bio-economy.

### Areas of improvement and recommendations

- The research infrastructure has greatly benefitted from capital grants including EU structural funds but maintaining this infrastructure as state-of-the-art national facilities will rely on the Depreciation Fund being

supported in part by realistic overhead rates being factored into future research project proposals to external agencies.

- Despite the high quality of testing laboratories, few are accredited. Students should be exposed to greater visibility of the formal expectations of producing research test results under accredited laboratory conditions, even if the resources required to achieve and maintain accreditation cannot be justified by the university.

## Teaching, learning, research and/or creative activity

### Standards

- ✓ Uniform principles, based on best international practices and agreed upon at the university level, shall be followed while implementing doctoral programmes and assuring the quality of the doctoral studies (including supervision of doctoral theses).
- ✓ Doctoral studies support students' personal and social development, including creating an environment which will prepare them to successfully participate in international working environments at research and development institutions, as well as in the business and public sectors.
- ✓ Supervision of doctoral theses; modern methodology used in teaching and research; organisation of studies; and doctoral students' professional research, development and/or other creative activities all support achievement of the objectives and learning outcomes of doctoral studies.
- ✓ Assessment of outcomes of the learning, research and creative work done by doctoral students is relevant, transparent and objective, and supports the development of doctoral students.
- ✓ Doctoral students are asked for feedback regarding supervision on a regular basis and the results of these surveys are taken into account for quality improvement activities.
- ✓ Effectiveness of the doctoral studies is analysed and such analyses serve as a basis for planning quality improvement activities.

### Comments

Clear eligibility requirements for supervisors are implemented at the University. As the requirements ensure the quality of the supervision of PhD-candidates and in the graduate programme as a whole, the staff perceive them positively. Young researchers have the opportunity to become co-supervisors and thus increase their expertise and experience in order to later be able to meet set requirements. A change in the organization has been made where chair professors have been appointed, resulting in responsibility being concentrated and clarified. At present, the recruitment of the chair professors is ongoing, where 13 of 22 positions are now appointed. One of the reasons to this organizational change is strengthening cooperation between research fields (Chairs) and thus be better able to meet the multi-disciplinary challenges of society, both in research and in doctoral education.

The University management is developing and supporting the supervisors by exchange of experience, based on the principles set out in the document "Estonian Universities, Agreement on good practice regarding quality". There are also courses for supervisors; these are not mandatory but highly recommended by the faculty. Co-supervisors are frequently appointed from another University, including from universities outside Estonia. This, among other things, to broaden the perspectives and to better comply with international trends.

Supervision of PhD-candidates is done within a research group, which in its entirety is seen as a supervision team. During interview with the doctoral students, the cooperation with Tallinn University of Technology, through the graduate school framework appeared to be appreciated, as among other things it results in broadening of research perspectives. Overall, there is a positive opinion on national graduate schools. The majority of the doctoral students have an ambition to take up employment in the industry after graduation. This ambition also characterizes the graduate programme to some extent. It was revealed that some teachers and supervisors argued that it is equally important to solve problems in the industry as publishing in reputable journals.

The update and use of individual study plans (ISP) works well. These plans are reviewed regularly by a Committee. Strict rules are implemented regarding how a doctoral thesis must be written. These rules mean that the candidate must have at least three published papers with one international indexed publication as first name author. Also publications from conferences can be used in the thesis, which may give the student experience in oral presentation of research results. In the day-to-day activities, the candidate usually works in a research group and gradually evolve the principles of teamwork. This form of teamwork enables ongoing feedback between supervisor and candidate.

### Strengths

- There is a good psychosocial work environment within the research groups where doctoral students are hosted, which facilitates good relations between doctoral students and supervisors.
- The Individual Study Plan works well and fulfils its purpose.
- Graduate schools and collaborations with other universities are viewed positively.
- Doctoral students are involved in research teams meeting each week, ensuring that these candidates are included in the daily work.
- Doctoral students are very satisfied with the doctoral courses.
- PhD-candidates and staff are very proud of their University.

### Areas of improvement and recommendations

- University management should urgently introduce the same financial support (stipend value) for all graduate students, although this might temporarily result in fewer doctoral students due to the strain on budget.
- Continue to be open for collaborations in research and graduate studies with other universities.
- Continue to build and develop the concept of graduate schools.
- Set the requirement that there must be at least assistance supervision in the student's immediate surroundings and stimulate further a possible co-supervisor appointed at another University, preferably internationally.
- Continue and strengthen the cooperation with the industry.

### **Teaching staff**

#### Standards

- ✓ Teaching staff participate in research, development and/or creative activity at the level of and to the extent sufficient to conduct doctoral studies in the curriculum group and to supervise doctoral theses.
- ✓ Teaching staff develop their supervisory competences and share best practices with one other.
- ✓ Teaching staff collaborate in fields of teaching, research and creative work within the university and also with stakeholders outside the university (public sector organisations, enterprises, other research and development institutions).
- ✓ Teaching staff further their skills at foreign universities or other research institutions, participate in international research and creative projects, and present papers at high-level conferences.
- ✓ Qualified international and visiting teaching staff are involved in conducting doctoral studies, participating in doctoral thesis defence panels and/or reviewing doctoral theses.
- ✓ When assessing the work of teaching staff (including their evaluations), the effectiveness of their teaching as well as of their research, development and creative works is taken into account; including the effectiveness of their student supervision, development of their teaching and supervisory skills, and their international mobility.

#### Comments

The requirements for supervisor are clearly defined. A doctoral student can be supervised by a person holding a doctoral degree or a qualification equivalent thereto and who meets the requirements set for the job description of a university professor, an assistant professor, a senior researcher or a leading research fellow. The number of academic staff holding a doctorate is currently 45%.

The right to supervise a doctoral student is granted on the basis of a supervisors' competition with the ranking list being submitted by the institutes. The Academic Board of the University Council considers the following criteria when approving a supervisor:

- Is the candidate a grant holder or a contractor of the ERC-supported institutional or personal research grants, grants or other research projects in the year of application, taking into account the duration and financial volume of the projects;
- The number of publications indexed by Thomson Reuters Web of Science in the past five years;
- The number of supervised doctoral theses defended in the past five years;
- The number of doctoral students being currently supervised;
- The justification of the chosen research topic;
- The existence of a potential doctoral student;
- The sustainability of the area of research.

The use of these stringent competition rules is being used to continually increase the quality of supervision capacity. The quality of supervision is reflected in the high percentage of doctoral students completing their studies in the commonly accepted nominal (4+2 year) period. Doctoral studies supervisors are highly skilled researchers. Researchers from the IT and IFRE institutes participated in 207 funded projects over the last 7 years, attracting an average of €3.3 million per annum. The supervisor was also the contractor in 67% of projects. During the period 12 patents and 2 utility models were registered in the field of engineering sciences and a further 5 applications are currently being processed.

The efficiency of doctoral studies is taken into consideration in allocating funding to institutes and supplementary benefits to successful supervisors. The funding scheme was introduced from 2014. The Institute receives financial support for each doctoral student in two phases. The first payment is calculated on the proportion of successfully completed doctoral studies in the past three years. The balance is transferred to the Institute after the successful defence. The efficiency of supervision is taken into account in a supplementary premium paid to the supervisor and co-supervisor (if they are employed at the University) from the Fund of the Vice-Rector of Studies. The effectiveness of supervision is also taken into account at academic staff professional reviews, which must by law be conducted at least once in every five years.

Formal courses and mentoring are used to develop the skills of novice supervisors through the course 'Higher education didactics' and the use of co-supervision.

### Strengths

- The volume of courses in the doctoral study programme taught by academic staff holding a doctoral level degree and active in R&D activities in the corresponding field (minimum 85% by Standard of Higher Education) is 96%.

- The quality of supervision is reflected in the high percentage of doctoral students completing their studies in the commonly accepted nominal (4+2 year) period.
- Formal development of supervisory skills in novice supervisors is provided through taught courses and the use of co-supervision.
- The effectiveness of supervision is taken into account at academic staff professional reviews and the efficiency of doctoral studies is taken into consideration in allocating funding to institutes and supplementary benefits to successful supervisors.
- An effective doctoral students' evaluation system is in place that provides constructive feedback to supervisors.

#### Areas of improvement and recommendations

- The proportion of academic staff holding a doctorate, at 45%, is below international norms for an institution with the ambition of EMÜ to be a significant international research centre. The benchmark criteria for recruitment need to be raised further or competition for staff posts needs to be increased by making posts in EMÜ more attractive to high quality internationally mobile academics.
- The challenge of supervising Ph.D. students who are also in employment requires supervisory skills in off-site supervision. Greater attention to this should be paid in respect of staff development.
- Staff engagement in mobility programmes needs to be increased by identifying the barriers to engagement and taking measures to reduce the impediments.
- Increasing collaboration with industry and other universities.
- Concentrating research through integrating loosely linked lines of research by reducing the number of research areas and increasing the number of researchers focusing on the specific line of research.

### **Doctoral students**

#### Standards

- ✓ When admitting students to doctoral study, their suitability for successful completion of their studies is assessed on the basis of transparent criteria.
- ✓ Doctoral students plan their studies as well as research and development activities in collaboration with their supervisor(s), setting out specific objectives for each year and taking responsibility for achieving these objectives.
- ✓ Evaluation of doctoral students is transparent and impartial. Its purpose is to support development of the doctoral students, provide an opinion regarding the effectiveness of their work to date, and assess their capabilities to complete their studies on time and successfully defend their doctoral theses.
- ✓ Universities offer doctoral students counselling on completing their studies and planning their further careers.

- ✓ Doctoral students' extracurricular teaching, research and/or creative activities or other work-related activities at the university support successful completion of their doctoral studies.
- ✓ Doctoral students participate in international mobility programmes or take advantage of other opportunities for learning or research at foreign universities and/or research and development institutions<sup>2</sup>.
- ✓ Alumni are regularly asked for feedback on the quality of the doctoral study, and employers are asked for feedback on the preparation of the graduates.

### Comments

Admission of candidates is on the basis of a master's degree (or equivalent) and assessment of specific compatibility with the research topic. The average annual proportion of doctoral students recruited immediately after completing their master's degree at EMÜ is very high (as high as 80% in 2015/2016), indicating that full use is not being made of international competition for raising the standard of admitted candidates.

The progress of the doctoral students is formally assessed by an Evaluation Committee annually at a public meeting, using a standardized evaluation report. Data collection for the research and at least 18 ECTS of general and/or field specific studies must be completed by the end of the first year of study. Data collection and analysis must be progressing and at least 36 ECTS of general and/or field specific studies must be completed by the end of the second year. The first scientific article must have been submitted for publishing and at least 54 ECTS of general and/or field specific studies must be completed by the end of the third year. Publishing and formalising the doctoral thesis itself are carried out during the fourth year. All aspects of the student experience are discussed: the number of published scientific articles, presentations at international scientific conferences, participation in international doctoral studies, internships taken, students' papers supervised and other relevant information. Students are supported throughout their studies by a multi-level counselling system.

Various components related to the individual's personal development contribute to earning credits for the speciality module, which is an integral part of the programme requirements.

EMÜ participates in six different inter-university doctoral schools and doctoral students in Engineering Sciences are involved in the activities of the Doctoral School of Energy and Geotechnology and the Doctoral School in Construction and Environmental Engineering.

The doctoral student experience measured by external student satisfaction surveys, conducted at approximately three-year intervals have indicated that the relationship between the student and supervisor met the expectations; the

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<sup>2</sup> In the context of this document, 'research and development institutions' denote both research institutions and research-intensive companies.

individual study plan was followed and adjusted according to the progress made; and the supervisor encouraged the student to work independently.

The efficiency of doctoral studies is taken into consideration in shaping the budget of the Institute.

#### Strengths

- The progress of the doctoral students is formally assessed by an Evaluation Committee annually at a public meeting, which promotes strong compliance with successful completion in the nominal study period (4+2 years).
- Students are supported throughout their studies by a multi-level counselling system.
- Doctoral students who are working as lecturers during their studies are given the possibility to take a semester off to encourage defence of their thesis within the nominal study period.

#### Areas of improvement and recommendations

- The culture of engaging in international mobility programmes during Ph.D. studies needs to be strengthened.
- A determined programme is required to increase the attractiveness of doctoral studies at EMÜ to international students. This should be preceded by a review of all aspects of the international student experience and must then address any and all barriers to promoting EMÜ as an attractive destination for high quality international doctoral students.

## 3. Assessment report of SPG at Tallinn University of Technology

### 3.1. Introduction

The formation of Tallinn University of Technology (TTÜ) can be traced back to 1918 when the Estonian Engineering Society opened an engineering school called 'Special Engineering.' Qualification of the university was granted to 'Tallinn University of Technology' in 1936. The status of a university, in public law, was granted in 1995 by the Universities Act. The role of TTÜ in the Estonian education and research landscape, as well as the institutional management structure, was defined in the 'Tallinn University of Technology Act', effective from 1 September 2014. TTÜ is recognized as a research university, providing research-based education at all cycles in the areas of natural and exact sciences, engineering, manufacturing and technology, social sciences and in related areas. The Ph.D. students benefit from studying at TTÜ as 'the leading engineering R&D institution in Estonia', building on two decades of transformation from a focus on the academic formation of engineers to a research-active institution, underpinned by a clear strategy. The strategic aims for 2020 include three main goals:

- Internationally outstanding university of engineering and technology, responding actively to the needs of the rapidly developing society.
- Being involved in tackling the challenges of the digital era.
- Contributing to knowledge and welfare in the society through cooperation between the university, enterprises and the public sector.

The study programme group 'Engineering, Manufacturing and Technology' comprises three doctoral programmes, all managed by the School of Engineering:

- Chemical and Materials Technology,
- Mechanical Engineering,
- Power Engineering and Geotechnology.

The nominal period of studies is 4 years (240 ECTS).

In academic year 2016/2017 there was a total of 644 doctoral students at TTÜ, across six study programme areas. The study programme group 'Engineering, Manufacturing and Technology' accounted for the highest number, 185 doctoral students. Significantly TTÜ accounts for 63% of all doctoral students in Estonian universities in that study programme group.

During the last 5 years the number of PhD students studying on each of the three doctoral programmes appeared to be stable over the first four years of the period but apparently dipped in 2016/2017. In practice, the drop was due to the termination of those on the register who had greatly exceeded the nominal period of 4 years study and greater insistence on secure funding before approval of the creation of a new place.

In 2015/2016 the number of international students was 35, representing 19% of the cohort. The number of doctoral students working at the university at the

same time as studying is high – approximately 40% in Chemical and Materials Technology; 33% in Mechanical Engineering; and 18% in Power Engineering and Geotechnology. The average percentage of students registering for doctoral studies after completing their master’s degree at TTÜ is high, exceeding 50%.

### THE NUMBER OF PHD STUDENTS

Curriculum	2011/12		2012/13		2013/14		2014/15		2015/16	
	Total	working at TTÜ								
Chemical and Materials Technology	71	28	75	32	70	28	69	28	57	23
Mechanical Engineering	94	30	92	28	91	33	83	27	69	25
Power Engineering and Geotechnology	74	11	81	13	76	12	74	14	59	13
<b>Group</b>	<b>239</b>	<b>69</b>	<b>248</b>	<b>73</b>	<b>237</b>	<b>73</b>	<b>226</b>	<b>69</b>	<b>185</b>	<b>61</b>

### THE NUMBER OF INTERNATIONAL PHD STUDENTS

Curriculum	2011/12	2012/13	2013/14	2014/15	2015/16
Chemical and Materials Technology	6	11	13	14	13
Mechanical Engineering	8	6	9	12	12
Power Engineering and Geotechnology	4	4	6	9	10
<b>Group</b>	<b>18</b>	<b>21</b>	<b>28</b>	<b>35</b>	<b>35</b>

### THE NUMBER OF ADMITTED PHD STUDENTS

Curriculum	2011/12		2012/13		2013/14		2014/15		2015/16	
	Total	Directly from TTÜ MSc								
Chemical and Materials Technology	16	15	15	11	9	7	10	9	4	4
Mechanical Engineering	19	14	15	10	13	10	12	7	8	4
Power Engineering and Geotechnology	21	16	12	10	12	9	8	4	4	2
<b>Group</b>	<b>56</b>	<b>45</b>	<b>42</b>	<b>31</b>	<b>34</b>	<b>26</b>	<b>30</b>	<b>20</b>	<b>16</b>	<b>10</b>

### THE NUMBER OF PHD STUDENTS DISRUPTING THEIR STUDIES

Curriculum	2011/12		2012/13		2013/14		2014/15		2015/16	
	Total	on one's own will								
Chemical and Materials Technology	7	4	5	3	6	0	6	2	7	2
Mechanical Engineering	7	1	7	5	8	1	11	3	14	6
Power Engineering and Geotechnology	10	3	5	4	8	5	8	2	13	2
<b>Group</b>	<b>24</b>	<b>8</b>	<b>17</b>	<b>12</b>	<b>22</b>	<b>6</b>	<b>25</b>	<b>7</b>	<b>34</b>	<b>10</b>

### THE NUMBER OF DEFENDED PHD THESES

Curriculum	2011/12		2012/13		2013/14		2014/15		2015/16	
	Total	within 6 years								
Chemical and Materials Technology	11	8	0	0	11	10	5	3	7	6
Mechanical Engineering	7	5	9	7	7	6	8	6	11	10
Power Engineering and Geotechnology	7	5	7	5	7	5	2	1	7	7
<b>Group</b>	<b>25</b>	<b>18</b>	<b>16</b>	<b>12</b>	<b>25</b>	<b>21</b>	<b>15</b>	<b>10</b>	<b>25</b>	<b>23</b>

## 3.2. General findings and recommendations at study programme group level

The current TTÜ strategic plan is clearly articulated and it is appropriate in its approach to supporting high quality doctoral studies. The main goals are international recognition, ability to respond to the society needs and be involved in the new challenges of the digital era. These contribute to a supportive environment for impactful research studies. TTÜ is a progressive university and the Assessment Team found an awareness among the University and programme leaders of the scale of the challenge in meeting their ambitious goals and a determination to meet these challenges.

The infrastructure for doctoral studies is very good and there is strong student satisfaction with the working atmosphere. Doctoral students are treated as colleagues in their research groups and this enhances their approach to their studies.

The annual attestation of all doctoral students is working effectively, ensuring timely feedback to students on their rate of progress and standard of work,

resulting in ever-increasing compliance with a study period that does not exceed 6 years (nominal period 4 years).

The University is mindful of its particular responsibilities in respect of engineering and technology being a key driver in meeting the needs of the developing Estonian economy and society. In this regard the University is taking active steps to be a synergistic partner through its promotion of the value of doctoral research to industry. The University is taking a lead in the attraction of high quality students by taking the unilateral step of introducing a common salary structure for all doctoral students, benchmarked to a living wage, which allows fair competition with industry and makes a declaration of the value of doctoral graduates to society and the economy. However all Estonian universities are still at a disadvantage in attracting high calibre doctoral students by the failure of industry to attach a high value to doctoral graduate attributes. It would be helpful if there was a forum to promote the exploitation of high quality doctoral studies outputs in both the academic and industrial world. The value of postgraduate education needs to be promoted better in the society and the industry in order to increase its status. It is important that the value of higher education at doctoral level is explained and disseminated in order to get a greater acceptance in the society. **The greater acceptance of the value of doctoral graduates to industry and society should be strengthened through the formation of an Industrial Advisory Board for the doctoral programmes.**

University-industry collaboration is high on the University's agenda. The recruitment of industrial Ph.D. students is a very positive practice as well as the participation of specialists from industry in the evaluation committees. **The University has an opportunity to take a lead on the greater participation of universities in Estonian industrial development through research including industrial Ph.D.'s.**

The value of the excellent initiative of inter-institutional doctoral schools is well understood and accepted but issues arise regarding the sustainability of the initiative. **A lead must be taken to ensure that the community building approach in TTÜ is harnessed by all partners to fully realise the synergistic impact of doctoral schools.**

The University is cognizant of the significance of internationalization in enhancing its profile. There has been an increase in the number of international doctoral students in recent years but the proportion is still relatively low. The proportion of international students exceeds national minimum benchmarks but **more needs to be done to attract international students through building a reputation as a 'go-to' destination for an excellent international doctoral student experience.**

Developments in the staffing profile are generally positive and a change to a tenure track system for staff is being rolled out. There is also competition among supervisors for acquiring doctoral students. Ultimately these measures are positive for doctoral studies because they encourage selection of the best supervisors but on the other hand they put obstacles to young staff in acquiring experience in doctoral supervision. The effect during the transition period may be

to grow an acceptance of fragmentation of academic staff roles into 'teachers' or 'researchers'. **Staff profile changes, especially during a transition period to a tenure track system, should be managed such that all academics take on teaching, research and administration to ensure deepening of the research-informed teacher culture.**

The doctoral studies programme consists of 240 ECTS, comprising a dissertation (180 ECTS), and 60 ECTS across basic, intermediate and advanced modules. **The true value of the distribution of the 60 ECTS across basic and intermediate modules is worthy of exploration. The role of doctoral schools in being the sole provider of advanced modules is also worthy of consideration.**

### 3.3. Strengths and areas for improvement of study programmes by assessment areas

#### 3.3.1. Chemical and Materials Technology

##### Study programme

###### Standards

- ✓ The launch and development of the study programme are based on the Standard of Higher Education and other legislation, national strategies, university development plans, the effectiveness of research and development, various analyses (including labour market and feasibility analyses); striving for the best overall programme quality.
- ✓ Doctoral programmes contain at least 70% research, development or other creative work by doctoral students, making the results thereof public in international peer-reviewed research journals or in other ways that have international dimensions.
- ✓ Study programmes incorporate doctoral student participation in conferences and/or other professional activities, and are counted towards completion of the study programme.
- ✓ Doctoral programmes enable doctoral students to acquire leadership and teamwork skills, develop coaching and teaching skills as well as a proficiency in foreign languages at the level needed for successful participation in international working environments.
- ✓ Different components of a doctoral programme form a coherent whole supporting the personal development of each doctoral student.
- ✓ Study programme development takes into account feedback from doctoral students, supervisors, employers, alumni and other stakeholders.

### Comments

The Assessment Team was very impressed by the proactive nature of the university in leading a number of innovations regarding curriculum development. The Vice Rector for Research of the university also engages actively with the state's Research Policy Committee, which in turn may influence the Ministry of Education & Research, thereby opening opportunities for the cascading of good practice. The Assessment Team applauds a number of key messages from the team leading the university as to the further improvement of education practice:

- Quality assessment should consider impact rather than e.g. H-indices.
  - This is a consideration that many other leading universities in Europe are turning to.
- Identify and define reference universities.
  - It is very sensible to aim for the right market in terms of ranking group.
- Create strategy and value portfolio and for these to permeate through to staff and students.
  - It is key that staff and student are properly informed and buy into significant changes.

The Assessment Team notes that the number of PhD students has decreased and that this has been due to appropriate progression procedures whereby those students for whom the education experience has not been a serious one have been removed from the register.

The Assessment Team applauds the university for taking the unilateral step of introducing a common salary structure for all doctoral students, equivalent to the average Estonian income. This serves two purposes: a) it gives PhD students a living wage, which allows them to concentrate on their studies and thus reduces the overall time spent in completing their studies and b) it gives a clear signal to society that PhD students are valued contributors. It is hoped that this initiative will permeate through the entire sector and will give the Ministry of Education food for thought regarding the realistic level of increase required above the current scholarship support of €422 per month.

The change to a tenure track system for staff is noted. This is a desirable move and gives transparency and internal mobility to current and future staff. It also makes the university more attractive to foreign applicants.

It is noted that changes have been introduced to the attestation and progression requirements for PhD students. A small committee will be implemented to determine the degree of completion of a PhD programme. An open discussion is underway regarding the relaxation of the strict regulation of the requirement of three papers per PhD. Considering the diversity of PhD activities this could, for example, be expanded to include the generation of a product or indeed a computer code. The Assessment Team supports these considerations.

The Assessment Team finally note the enthusiasm for industrial PhDs and believe that TTÜ is in a unique position to lead this type of curriculum development. The university is encouraged to take a proactive but inclusive (involvement of other universities) approach.

### Strengths

- The Ph.D. students benefit from studying at TTÜ as 'the leading engineering R&D institution in Estonia', building on two decades of transformation from a focus on the academic formation of engineers to a research-active institution, underpinned by a clear strategy. The University management team's research focus is outward and forward looking, with many new ideas and initiatives, which will permeate the rest of the sector.
- The Ph.D. students benefit from the TTÜ design department, whereby research results are used for product development, as for example in application of low temperature powder technology.
- Many key initiatives have already been, or in the process of being, implemented which will support high quality doctoral studies including the unilateral step to introduce a common salary structure; tenure track system for staff; stricter review of attestation and progression requirements; potential inclusion of product development or indeed a computer code as partially meeting pre-requisite conditions for submission; increased role for industrial PhDs.
- Restructuring into 5 department and 2 colleges has been successful.

### Areas of improvement and recommendations

- TTÜ are leading appropriately in parameters that enhance the doctoral studies research environment (tenure track staffing, living wage stipend etc.) and it would be helpful for the Estonian economy and society if this best practice was shared with other Estonian universities. Therefore an inclusive approach with partner universities in doctoral schools is hoped for by the Assessment Team, to benefit the entire Estonian education sector.
- It will be useful to tighten the criteria for admission to a PhD programme, in part to address the issue of self-selection, which currently appears to favour the appointment of TTÜ master's degree students.

## **Resources**

### Standards

- |   |   |
|---|---|
| ✓ | In conducting doctoral study programmes, an adequate number of teaching staff and researchers participate, who hold the appropriate qualifications required to carry out doctoral studies and supervise doctoral theses in a given study programme. |
|---|---|

- |   |
|---|
| <ul style="list-style-type: none"><li>✓ Universities shall ensure that sufficient funds are available to conduct doctoral studies, to provide development activities associated with doctoral studies and research, and to support the professional development of teaching staff and researchers.</li><li>✓ Resources (teaching, learning and research environments; libraries; resources required for teaching, learning and research) support the achievement of objectives set out in study programmes as well as the actual teaching, learning and research at the level of doctoral studies. Resource development is sustainable.</li><li>✓ Trends in the numbers of current learners, admitted learners and graduates (by study programme) in doctoral studies under the study programme group during the last five years indicate sustainability.</li></ul> |
|---|

### Comments

TTÜ has been improving its learning and teaching environment. Lecture rooms and laboratories have been renovated. Research apparatus are at a high quality level. In general, Health and Safety procedures are adhered to in the labs (lab coat, safety glasses etc.). The availability of textbooks in the library is very good and doctoral students have access to research articles through databases. Financial resources are mainly obtained by the research groups' research or company projects. The university tends to move towards company projects. There are no tuition fees for international PhD studies. International mobility of doctoral students is supported by research projects, and a number of international mobility funding schemes.

It is gratifying to note that there has been a gradual increase in the fraction of potentially qualified supervisors for PhD students (number of academics with PhD).

Since there has not been a surge in government support for PhD programmes, TTÜ has decided to reallocate and structure its funding in order to allocate competitive salaries to its PhD students. Whilst this has reduced the number of potential places to those that can be adequately funded, it helps to improve the attractiveness and visibility of PhD programmes in Estonia.

### Strengths

- The facilities are of a very high standard. Research laboratories are well laid out, clean and tidy. The lecture and seminar rooms are well-equipped and modernized. Access to publications is very good.
- All research laboratories in the Faculty of Chemical and Materials Technology have been renovated in recent years and investment in equipment exceeded €3 million.

### Areas of improvement and recommendations

- Whilst the safety culture at TTÜ is generally of a high standard, these could be improved further, e.g. a UV protection shroud should be available for the operation of high power solar simulator, when working with

potentially toxic gases, an appropriate gas detection system (alarm) should be installed.

- Along the same lines it would be good to improve on the use of Activity Risk Assessments as these are commonly found in industrial settings and would be more personal to student research plans as a supplement to generic safety exams and annual fire drills.
- It would be useful to develop a funding plan for maintenance, upgrading and replacement of equipment, especially aiming at the reduction of reliance on overheads from competitively-won national funding.
- We encourage TTÜ to further increase the fraction of qualified persons in the doctoral studies (teaching, supervising).
- We encourage TTÜ to pursue more company related projects in order to support the development of a thriving industrial PhD programme and also to reduce the dependency on e.g. EU project income.

### Teaching, learning, research and/or creative activity

#### Standards

- ✓ Uniform principles, based on best international practices and agreed upon at the university level, shall be followed while implementing doctoral programmes and assuring the quality of the doctoral studies (including supervision of doctoral theses).
- ✓ Doctoral studies support students' personal and social development, including creating an environment which will prepare them to successfully participate in international working environments at research and development institutions, as well as in the business and public sectors.
- ✓ Supervision of doctoral theses; modern methodology used in teaching and research; organisation of studies; and doctoral students' professional research, development and/or other creative activities all support achievement of the objectives and learning outcomes of doctoral studies.
- ✓ Assessment of outcomes of the learning, research and creative work done by doctoral students is relevant, transparent and objective, and supports the development of doctoral students.
- ✓ Doctoral students are asked for feedback regarding supervision on a regular basis and the results of these surveys are taken into account for quality improvement activities.
- ✓ Effectiveness of the doctoral studies is analysed and such analyses serve as a basis for planning quality improvement activities.

#### Comments

The quality of teaching and learning is regarded as the main priority of the university. Uniform principles agreed upon at the state level for doctoral studies in Estonian universities are followed in the unit. The study environment facilitates the preparation of students for work at different environments, including periods

of study abroad. The supervision of doctoral studies is effective and feed-back is collected from the students on a regular basis to support the improvement of the activities. As a result the number of students interrupting their studies or dropping out completely is relatively small. Effectiveness of the doctoral studies is analysed and such analyses serve as a basis for planning quality improvement activities. The attestation of doctoral students takes place regularly and the supervisors have to evaluate the completion of research cumulatively at the end of each academic year against the goals set for the year. The study information system is in place and functioning. Doctoral students teach and/or supervise bachelor and masters students and learn teaching and supervising skills. They are supported through a mandatory module in teaching practice.

### Strengths

- Quality of teaching and learning is the priority of the university.
- A more rigorous attestation procedure of doctoral students is expected to give clear feedback on the progress of students allowing early detection and response to possible problems earlier.

### Areas of improvement and recommendations

- Teaching is one of the tasks in a doctoral student's training experience. The doctoral students teach and/or supervise bachelor and masters students. It is not clear how the teaching load is divided among the doctoral students. It is recommended that clear rules are set on the expected teaching load of each doctoral student as part of their training whether credits are given or not and fixing of the maximum amount of teaching load of doctoral students in the study programmes.
- Modern teaching methods include lectures, exercises, literature surveys, presentations, web courses, team work etc., and the student should be exposed to all of these modes in appropriate proportions. As these methods appear in individual courses it is recommended that examples of individual study plans are analysed to find if there is a balance of different methods in the curricula.
- Industrial doctoral students form a synergistic bridge to industry and the programme should be further developed in this respect. It is recommended that the university invite representatives of industrial companies to discuss the development of industrial doctoral programme in engineering field.

## **Teaching staff**

### Standards

- |   |   |
|---|---|
| ✓ | Teaching staff participate in research, development and/or creative activity at the level of and to the extent sufficient to conduct doctoral studies in the curriculum group and to supervise doctoral theses. |
| ✓ | Teaching staff develop their supervisory competences and share best practices   |

<p>with one other.</p> <ul style="list-style-type: none"><li>✓ Teaching staff collaborate in fields of teaching, research and creative work within the university and also with stakeholders outside the university (public sector organisations, enterprises, other research and development institutions).</li><li>✓ Teaching staff further their skills at foreign universities or other research institutions, participate in international research and creative projects, and present papers at high-level conferences.</li><li>✓ Qualified international and visiting teaching staff are involved in conducting doctoral studies, participating in doctoral thesis defence panels and/or reviewing doctoral theses.</li><li>✓ When assessing the work of teaching staff (including their evaluations), the effectiveness of their teaching as well as of their research, development and creative works is taken into account; including the effectiveness of their student supervision, development of their teaching and supervisory skills, and their international mobility.</li></ul>
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### Comments

The qualification requirements of teaching staff are set in the personnel strategy of the university. The academic staff involved in the study programme are actively carrying out research to the extent sufficient to supervise doctoral theses. The work of teaching staff is regularly evaluated including the effectiveness of the student supervision, development of teaching and supervisory skills, and their international mobility. Teaching staff participate in research.

### Strengths

- Academic staff are highly qualified internationally recognized professionals.
- A competition model for allocating doctoral studies supervisor opportunity has been established.
- University supports the students and teaching staff for developing teaching skills.
- Graduate school for Functional Materials and Technologies showed good examples of activities.
- Feedback procedures are defined well.
- Integration of research and teaching in all aspects and for all personnel involved as supervisors to doctoral students.

### Areas of improvement and recommendations

- The number of doctoral students per supervisor is very high in some cases (should be limited to 5 according to the new rules). It is recommended that the new supervisor competition model is fully implemented.
- The share of international teaching staff is quite low; it is recommended that the university takes action to increase the number of international

staff members as this would help to attract high quality students from abroad and help the whole community in internationalization efforts.

- In the case of industrial doctoral students the question of supervisors available from industry is essential. As supervisors should also have Ph.D. level qualifications, the choice is probably quite limited. The university should identify the companies, where its alumni are working and extend systematically the co-operation with these companies.

## Doctoral students

### Standards

- ✓ When admitting students to doctoral study, their suitability for successful completion of their studies is assessed on the basis of transparent criteria.
- ✓ Doctoral students plan their studies as well as research and development activities in collaboration with their supervisor(s), setting out specific objectives for each year and taking responsibility for achieving these objectives.
- ✓ Evaluation of doctoral students is transparent and impartial. Its purpose is to support development of the doctoral students, provide an opinion regarding the effectiveness of their work to date, and assess their capabilities to complete their studies on time and successfully defend their doctoral theses.
- ✓ Universities offer doctoral students counselling on completing their studies and planning their further careers.
- ✓ Doctoral students' extracurricular teaching, research and/or creative activities or other work-related activities at the university support successful completion of their doctoral studies.
- ✓ Doctoral students participate in international mobility programmes or take advantage of other opportunities for learning or research at foreign universities and/or research and development institutions<sup>3</sup>.
- ✓ Alumni are regularly asked for feedback on the quality of the doctoral study, and employers are asked for feedback on the preparation of the graduates.

### Comments

The university has set priorities for doctoral studies in terms of quality, efficiency, long-term mobility, quality of supervision, and improvement of evaluation procedures.

However, the status and salary of PhD students are key issues that impact progression but, more importantly, affect the career choices of excellent undergraduate students, who would be interested in taking on such a challenge.

From an industrial perspective, it is clear that the economy can readily absorb PhD students. However the current average length of a PhD study programme is not commensurate with the needs of industry in terms of an industrial PhD. It is therefore difficult for industry to support such activities.

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<sup>3</sup> In the context of this document, 'research and development institutions' denote both research institutions and research-intensive companies.

### Strengths

- The Assessment Team was very impressed by the enthusiasm and openness of the PhD students. All had only positive comments regarding their educational experience.
- The drop-out rate has been reduced.
- There are numerous funding opportunities for students to gain international experiences (exchanges, conferences, workshops etc.)

### Areas of improvement and recommendations

- The Assessment Team were able to talk to PhD cohort representatives but noticed that formal representation at various committees within the study group and university is not well co-ordinated.
- It appears that IP is not owned by students – this should be incentivised in other ways.

## 3.3.2. Mechanical Engineering

### **Study programme**

#### Standards

- ✓ The launch and development of the study programme are based on the Standard of Higher Education and other legislation, national strategies, university development plans, the effectiveness of research and development, various analyses (including labour market and feasibility analyses); striving for the best overall programme quality.
- ✓ Doctoral programmes contain at least 70% research, development or other creative work by doctoral students, making the results thereof public in international peer-reviewed research journals or in other ways that have international dimensions.
- ✓ Study programmes incorporate doctoral student participation in conferences and/or other professional activities, and are counted towards completion of the study programme.
- ✓ Doctoral programmes enable doctoral students to acquire leadership and teamwork skills, develop coaching and teaching skills as well as a proficiency in foreign languages at the level needed for successful participation in international working environments.
- ✓ Different components of a doctoral programme form a coherent whole supporting the personal development of each doctoral student.
- ✓ Study programme development takes into account feedback from doctoral students, supervisors, employers, alumni and other stakeholders.

### Comments

A clear ISP (Individual Study Plan) is used to plan and monitor the student's progression throughout the education. A part of the ISP is setting a timeline for each publication to be done within the thesis. In order to achieve the best possible supervision for doctoral students, a ranking system is applied for evaluating the supervisors' ability, which also, to some extent, forms the basis for the allocation of new doctoral students.

The most important source of funding for doctoral students is external research projects. This relationship represents an uncertainty for doctoral students, which justifies increased base funding. The management of the Department in conjunction with the main supervisors largely govern the process of seeking new funding, and therefore have the greatest influence on the students' education. The project within the research studies are completely in focus during the education at the same time as the students are satisfied with the courses offered within the programme.

The students receive training in teamwork, "we are part of a research team", getting continuous supervision, often daily. A good activity is the weekly meetings that are held within the research group, as well as monthly meetings within the Department. This contributes to a sense of participation and affinity in a bigger team.

The doctoral students are encouraged to participate in conferences, in addition to other supports such as practicing oral presentations. It is stated that increased mobility between international universities is common, but it could increase even further. The doctoral students are participating in laboratory and practice teaching, as well as being trained to supervise master's students.

Graduate schools provide good conditions for keeping a long-term high standard of courses included in the graduate programme. Industrial PhD students are becoming increasingly important, providing favourable conditions for strengthening cooperation between TTÜ and industry. The industrial PhD students are also able to bring to industry new knowledge and innovations from the university. This co-operation with industry provides a good working environment in which to increase the acceptance of higher education research as a force in the development of small to medium sized enterprises (SME's). The supervisors are very much in favour of strengthening international cooperation and cooperation with the industry.

### Strengths

- Supervisors have a very clear responsibility for the students' overall development.
- A functioning quality assurance procedure through an obligatory attestation process.
- Maintenance and management of a positive atmosphere within the visited research groups, which is a prerequisite for further development of the business.

- The University has taken the responsibility for trying to create equal economic conditions for all admitted graduate students, which allows a financially more secure situation for the student during his/her education.

#### Areas of improvement and recommendations

- It is apparent at the interviews that there is a very strong focus on the supervisor. It is suggested, however, that the research group and the co-supervisor are given more responsibility in the supervision of the doctoral students. This to reduce the workload for the primary supervisor while increasing the redundancy in the tutorial. Furthermore, it is recommended to use the principle of having a complementary international co-supervisor for each PhD student. (An alternative might be to establish an international expert for each research group, who can help with general guidance and comments.)
- Emphasize the guidelines, "Estonian Universities, Agreement on good practice regarding quality", that already exist for the supervision of graduate students.
- Rules regarding admissions and prerequisites for industrial PhD students should be further investigated. Experience shows it is preferable for all doctoral students in one research field to have the same rules and requirements. This may mean the framework of the regular graduate programme must be adjusted to adapt to the specific conditions applicable to industrial PhD students.
- Due to the current economic conditions and that EU funding is expected to decrease in the coming years, it is proposed to increase the admission of industrial PhD students.
- Better conditions should be created for increased international mobility of doctoral students and other staff.

## Resources

### Standards

- ✓ In conducting doctoral study programmes, an adequate number of teaching staff and researchers participate, who hold the appropriate qualifications required to carry out doctoral studies and supervise doctoral theses in a given study programme.
- ✓ Universities shall ensure that sufficient funds are available to conduct doctoral studies and research, to provide development activities associated with doctoral studies and research, and to support the professional development of teaching staff and researchers.
- ✓ Resources (teaching, learning and research environments; libraries; resources required for teaching, learning and research) support the achievement of objectives set out in study programmes as well as the actual teaching, learning and research at the level of doctoral studies. Resource development is sustainable.
- ✓ Trends in the numbers of current learners, admitted learners and graduates (by study programme) in doctoral studies under the study programme group during

the last five years indicate sustainability.
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### Comments

There is evidence of a positive atmosphere in the Mechanical Engineering doctoral programme. The teachers and supervisors are well qualified for their positions, and the doctoral students are satisfied with the supervision they receive.

Both staff and PhD students are satisfied with the current state of the labs and equipment, and during the laboratory tours high-level equipment was shown. From the interviews with the students, it was pointed out that on certain specialized equipment, such as Scanning Electron Microscopy, the queue can be rather long and the equipment is only operated by dedicated personnel. Students who need the use of such equipment on a regular basis would benefit greatly from learning to operate it by themselves. In the student interviews it was stated that training in application writing would be appreciated, something that would be beneficial to the young researcher. Increased funding for mobility such as international conferences is also desired by the PhD-students.

According to the self-evaluation report, the number of admissions have decreased during the last five-year period (2012-2016). However, the University's new policy from 2016/2017 to guarantee the admitted doctoral students a realistic salary to live on (€1100 per month, including the state scholarship of €422 per month) might contribute to the lower number. However sustainability could be more likely with this new policy. The number of international students has increased during the last five years.

### Strengths

- Positive atmosphere among staff and PhD-students.
- Both staff and the doctoral students are satisfied with the state of the laboratories and the equipment. The research laboratories are being upgraded on a rolling basis using resources from R&D projects. Sustainability of investment source is assured to 2023 through support of over 20 companies in joint projects through IMECC competence centre. Greater access to facilities has been created by rationalisation of research groups.

### Areas of improvement and recommendations

- For the personal involvement, education, and later thesis defence, of the PhD-students, the analysis and usage of advanced equipment is important. The training on, for example, SEM could be used in the curriculum and crediting.
- Training in application writing would be an excellent addition to the PhD-studies, increasing the young researcher's ability to make an academic career.
- It is important that the projects in the doctoral education are carefully chosen so that these can be carried out with the internally or externally available equipment.

## Teaching, learning, research and/or creative activity

### Standards

- ✓ Uniform principles, based on best international practices and agreed upon at the university level, shall be followed while implementing doctoral programmes and assuring the quality of the doctoral studies (including supervision of doctoral theses).
- ✓ Doctoral studies support students' personal and social development, including creating an environment which will prepare them to successfully participate in international working environments at research and development institutions, as well as in the business and public sectors.
- ✓ Supervision of doctoral theses; modern methodology used in teaching and research; organisation of studies; and doctoral students' professional research, development and/or other creative activities all support achievement of the objectives and learning outcomes of doctoral studies.
- ✓ Assessment of outcomes of the learning, research and creative work done by doctoral students is relevant, transparent and objective, and supports the development of doctoral students.
- ✓ Doctoral students are asked for feedback regarding supervision on a regular basis and the results of these surveys are taken into account for quality improvement activities.
- ✓ Effectiveness of the doctoral studies is analysed and such analyses serve as a basis for planning quality improvement activities.

### Comments

The four year (nominal period) Mechanical Engineering doctoral programme of 240 ECTS consists of three taught modules, totaling 53 ECTS, and the graduation thesis of 187 ECTS. The taught modules build from General Studies (8 credits), to Basic Studies (15 credits) and Special Studies (30 credits). These modules include lectures taking account of the professional needs of the doctoral students together with support of independent study and research. As part of the Basic Studies module the students have the opportunity to teach and supervise BSc and MSc students. Although a certain amount of credits is awarded for these duties the effective load of teaching and supervision is not regulated yet.

Specific software is used for checking the doctoral thesis. In case of plagiarism the academic commission takes the appropriate decisions.

Recognition of Prior Learning and work experience is set out in the university regulations. No specific problems in this issue were noted.

Students provide feedback regarding their supervision and other relevant aspects through the Study Information System (OIS). Every year the students are globally assessed for the progress in their studies and research activities. Although this attestation system is much appreciated by students further improvements are planned by the university.

The Assessment Team did not find enough information on research organisation, such as research activities exhibition, research committees etc. nor on the monitoring and quality control management of the teaching and research of the doctoral programmes.

### Strengths

- Students and staff have the possibility and sufficient funding to participate in international mobility studies, seminars, conferences and other research activities.

### Areas of improvement and recommendations

- In order to increase the added value acquired by doctoral students during their participation in teaching and supervision process it is recommended that this process be clearly defined as regards workload and subjects of teaching/supervising. Teaching duties should directly relate to their thesis topic.
- It is recommended that visiting lecturers such as high tech industrial scientists be invited more often to contribute to the training of students.

## **Teaching staff**

### Standards

- ✓ Teaching staff participate in research, development and/or creative activity at the level of and to the extent sufficient to conduct doctoral studies in the curriculum group and to supervise doctoral theses.
- ✓ Teaching staff develop their supervisory competences and share best practices with one other.
- ✓ Teaching staff collaborate in fields of teaching, research and creative work within the university and also with stakeholders outside the university (public sector organisations, enterprises, other research and development institutions).
- ✓ Teaching staff further their skills at foreign universities or other research institutions, participate in international research and creative projects, and present papers at high-level conferences.
- ✓ Qualified international and visiting teaching staff are involved in conducting doctoral studies, participating in doctoral thesis defence panels and/or reviewing doctoral theses.
- ✓ When assessing the work of teaching staff (including their evaluations), the effectiveness of their teaching as well as of their research, development and creative works is taken into account; including the effectiveness of their student supervision, development of their teaching and supervisory skills, and their international mobility.

### Comments

TTÜ offers several courses for improving the pedagogical, didactic, language and supervision skills through the Staff Development and Mobility Centre and other programmes. This clearly supports the development of the staff.

The qualification of the academic staff complies with the qualification requirement of TTÜ 2011-2015. Supervisors are professional and internationally recognized researchers. They have the required level to supervise doctoral students.

The thesis topics of doctoral students are mainly taken from local or international projects of their supervisors. In this way the students may obtain additional financing grants. About 20% of the students are involved in EU and other international or company projects.

Although in the SER it mentioned that there is insufficient popularity in pursuing an academic career, during the interviews with students it is noted that almost all of them wanted to remain as teaching staff in the university after graduation and follow an academic career.

TTÜ organize regular feedback from doctoral students about teaching and supervision. Feedback from teaching is obtained through the OIS system and feedback about supervision is garnered from doctoral students during the attestation which takes place once a year.

#### Strengths

- The approval of doctoral thesis topics and thesis distribution is based competition between supervisors. The selected supervisors are high ranked academics and this ensures a high quality supervision.
- Novice staff acquire experience and supervising skills by co-supervising a thesis with experienced supervisors.
- Qualified teaching staff participate in doctoral thesis defence panels abroad. Similarly high quality international scientists participate in local doctoral thesis defense panels or give lectures to PhD mechanical students.

#### Areas of improvement and recommendations

- Although it is recommended by the university that the number of students per supervisor be limited to a maximum of 5, it was noted that in one case an academic had 10 students to supervise making available only 1 hour per week to each student. It is recommended that the university policy be applied by all academic staff.
- The numbers of supervisors and thesis topics from industry is currently very limited. It is recommended that the university organize a better collaboration with industry in general in order to attract more thesis topics and more industry-based scientists for supervision of the doctoral programme.
- The involvement of supervisors in teaching activities, research activities and administrative obligations does not always leave enough time to them for students' supervision. It is recommended that supervisors monitor time allocated to all tasks such that there is adequate space for high quality students' supervision.

## Doctoral students

### Standards

- ✓ When admitting students to doctoral study, their suitability for successful completion of their studies is assessed on the basis of transparent criteria.
- ✓ Doctoral students plan their studies as well as research and development activities in collaboration with their supervisor(s), setting out specific objectives for each year and taking responsibility for achieving these objectives.
- ✓ Evaluation of doctoral students is transparent and impartial. Its purpose is to support development of the doctoral students, provide an opinion regarding the effectiveness of their work to date, and assess their capabilities to complete their studies on time and successfully defend their doctoral theses.
- ✓ Universities offer doctoral students counselling on completing their studies and planning their further careers.
- ✓ Doctoral students' extracurricular teaching, research and/or creative activities or other work-related activities at the university support successful completion of their doctoral studies.
- ✓ Doctoral students participate in international mobility programmes or take advantage of other opportunities for learning or research at foreign universities and/or research and development institutions<sup>4</sup>.
- ✓ Alumni are regularly asked for feedback on the quality of the doctoral study, and employers are asked for feedback on the preparation of the graduates.

### Comments

The students are generally very satisfied with the courses in the graduate programme, which is also supported by evidence from the self-evaluation. Further, the students perceive the principle of graduate schools as very good and important for the quality of education, among others through collaboration in courses and resource exchanges with other universities. Collaboration in shared projects between universities is also important for the quality of the doctoral education.

The doctoral students perceive their treatment in postgraduate education as being good and are positive in their reaction to working in research groups, since the continuous guidance and supervision in their daily work is included. The doctoral students have positive perceptions of the cooperation with their supervisors, and that the annual attestation process works well for assuring the quality of the postgraduate education.

Some of the doctoral students consider that their scientific studies might be more efficient if it was possible to plan the daily time better. They also reflected that it would be positive for their education if they received more training on the advanced equipment, which is currently operated by specialist technical personnel. More than 50% of the PhD students want/have the ambitions to remain in academic careers after graduation.

It is clear there are good contacts and good relationships between graduate Ph.D.'s (former doctoral students of TTÜ) in the industry and the university.

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<sup>4</sup> In the context of this document, 'research and development institutions' denote both research institutions and research-intensive companies.

### Strengths

- The doctoral students are very positive about their research education and do not regret their choice of programme.
- A good psycho-social atmosphere exists in the research groups.

### Areas of improvement and recommendations

- Consideration should be given to compulsory international mobility of doctoral students for at least one month.
- The physical safety connected to the research equipment should be reviewed. Clear instructions should be proclaimed for each equipment, respectively, in order to avoid accidents.

## 3.3.3. Power Engineering and Geotechnology

### **Study programme**

#### Standards

- ✓ The launch and development of the study programme are based on the Standard of Higher Education and other legislation, national strategies, university development plans, the effectiveness of research and development, various analyses (including labour market and feasibility analyses); striving for the best overall programme quality.
- ✓ Doctoral programmes contain at least 70% research, development or other creative work by doctoral students, making the results thereof public in international peer-reviewed research journals or in other ways that have international dimensions.
- ✓ Study programmes incorporate doctoral student participation in conferences and/or other professional activities, and are counted towards completion of the study programme.
- ✓ Doctoral programmes enable doctoral students to acquire leadership and teamwork skills, develop coaching and teaching skills as well as a proficiency in foreign languages at the level needed for successful participation in international working environments.
- ✓ Different components of a doctoral programme form a coherent whole supporting the personal development of each doctoral student.
- ✓ Study programme development takes into account feedback from doctoral students, supervisors, employers, alumni and other stakeholders.

#### Comments

The Power Engineering and Geotechnology Doctoral Programme is a 4-year programme offered by the School of Engineering and belongs to the Department of Electrical Power Engineering and Mechatronics. The objectives and regulations set by the Strategic Plan for 2011-15 have been followed through to one with

clear and suitably ambitious objectives up to 2020. This doctoral programme satisfies Level 8 of the Estonian/European Qualifications Framework.

The aims of the programme are the preparation of leading specialists in the field of Power Engineering and Geotechnology for employment in the state institutions and national economy. This includes the preparation of teachers and scientists in universities and research institutions. In addition to that the programme aims to provide the graduates with transferable skills like leadership, management and teamwork that are important tools for employability.

The 4-year programme, besides the Graduation thesis (180 credits) includes General Studies module (12 credits), Basic Studies module (18 credits) and Special Studies module (30 credits) making a total of 240 credits. The General Studies programme includes optional courses, the Basic Studies consists of compulsory teaching practice and Doctoral seminars and the Special Studies requires individual learning of the students in the field of their thesis topic only.

As regards the learning outcomes of the curriculum they are written in a generic way and do not refer to the specific field of Electrical Power. It is noted, for example, that the same learning outcomes are used to describe the Mechanical Engineering programme curriculum.

The Assessment Team did not receive any information on Geotechnology doctoral studies, neither in the SER or on-site meetings and as a result this field is not commented on.

### Strengths

- The modules clearly support the achievement of the programme aims in a coherent way. They offer transversal studies, target teaching and supervision experience and encourage the self-learning by research.
- The study programme incorporates doctoral student participation in international conferences, publication of their study-research results with at least three scientific papers and gives possibilities for mobility through students' exchanges. All these are counted towards completion of their doctoral studies.
- The doctoral study programme is being updated. The target is to ensure a more broad-based programme and supports the interdisciplinary development.
- The study programme development takes into account the students, supervisors, alumni and other stakeholder's feedback.
- The Ph.D. students benefit from studying at TTÜ as 'the leading engineering R&D institution in Estonia', building on two decades of transformation from a focus on the academic formation of engineers to a research-active institution, underpinned by a clear strategy.
- The Ph.D. students researching Energy Systems benefit from the application of TTÜ research to the optimal operation and stability of the Estonian power grid, especially in respect of emerging issues as renewable energy from solar power is coupled to the grid.

### Areas of improvement and recommendations

- In order to further enhance the effectiveness of the doctoral programme of Power Engineering and Geotechnology it is recommended to revise the learning outcomes so that they are less generic and more discipline-specific to the required graduate attributes of the related programme.
- In order to help international students fully acquire the desired transversal skills it is recommended to offer in English all the modules of the general studies.
- It is recommended that a course on Project Management be included in the elective courses of the General Studies module.

### **Resources**

#### Standards

- ✓ In conducting doctoral study programmes, an adequate number of teaching staff and researchers participate, who hold the appropriate qualifications required to carry out doctoral studies and supervise doctoral theses in a given study programme.
- ✓ Universities shall ensure that sufficient funds are available to conduct doctoral studies, to provide development activities associated with doctoral studies and research, and to support the professional development of teaching staff and researchers.
- ✓ Resources (teaching, learning and research environments; libraries; resources required for teaching, learning and research) support the achievement of objectives set out in study programmes as well as the actual teaching, learning and research at the level of doctoral studies. Resource development is sustainable.
- ✓ Trends in the numbers of current learners, admitted learners and graduates (by study programme) in doctoral studies under the study programme group during the last five years indicate sustainability.

#### Comments

Regarding supervision resources, the age profile of the staff is such that a gap currently exists. This creates a less than ideal situation in ensuring an even spread of workload to accommodate one-to-one supervision. However the group dynamics are working well in research groups which act as a support to doctoral students. The Department is confident that the current cohort of doctoral students will yield promising talent as future staff members at professor and lecturer level and thus address the age gap.

The teaching and learning facilities are modern. Good library facilities include access to both textbooks and good quality journal databases. Doctoral students work in research laboratories that are well equipped, reflecting the success of their academic supervisors in winning funding to support their research.

The University has clear policies in place to ensure that sufficient funds are available to conduct doctoral studies. Approval of supervision is not granted unless the supervisor has ensured that adequate resources are in place for the full term of studies (for example through a funded research project). Furthermore from 2016/2017 doctoral students are guaranteed a realistic salary to live on (€1100 per month, including the state scholarship of €422 per month). In combination with the Universities policy starting 2016/2017 to guarantee the doctoral students a salary at the University the number of admissions has dropped. However it is felt that the higher remuneration package will increase the University's ability to compete with the industry, and thereby promote the sustainability of the programme. Also, the proportion of admitted international students has increased in recent years.

Staff and students are satisfied with the equipment in the laboratories and the facilities, but there is some concern at the lack of common software in the University such as Matlab, which could greatly benefit both the research and education at the University.

Sustainability is related to addressing the gap in the age profile of academic supervisors for doctoral students and a more stable funding base. The drop-out rate is relatively high. The number of students admitted per year has fallen in recent years but the overall critical mass of students has remained strong (*circa* 60) even when new restrictions caused the exit of those who had failed to complete having already considerably exceeded the nominal period of study. The number of international students has increased during the last five years. There is good evidence of industry-based doctoral students being a strong feature of future doctoral student cohorts. A combination is required of development of new academic staff who can succeed in competitive research funding calls and a wider spread of reliable funding sources (baseline from the state, competitive from the state, industry research projects and industry-based doctoral students).

### Strengths

- The research laboratories in the Faculty of Power Engineering are well equipped. Especially noteworthy are the Mechatronics Research Group's industrial robotics laboratory and the industry funded Power Grid Simulation Laboratory. The feedback from doctoral students on the adequacy of the resources is positive.
- The University ensures that sufficient funds are in place before approving each doctoral supervision and is investing matching funding to ensure that student stipends are guaranteed to be at realistic living wage level.
- No tuition study fees are required from international students.
- A variety of sources exist for financial support of international mobility.

### Areas of improvement and recommendations

- The gap in the age profile of the staff needs to be addressed such that the continuity of mentoring junior staff through co-supervision of doctoral students is assured when experienced staff retire.

- A funding plan for maintenance, upgrading and replacement of equipment is required that reduces dependence on overheads from competitively-won national funding and industry projects.
- Consider the introduction of agreed common software licences across a number of engineering programmes in the University, such as Matlab, as a great asset in both research and education. This would preferably be on a University-wide level.

## Teaching, learning, research and/or creative activity

### Standards

- ✓ Uniform principles, based on best international practices and agreed upon at the university level, shall be followed while implementing doctoral programmes and assuring the quality of the doctoral studies (including supervision of doctoral theses).
- ✓ Doctoral studies support students' personal and social development, including creating an environment which will prepare them to successfully participate in international working environments at research and development institutions, as well as in the business and public sectors.
- ✓ Supervision of doctoral theses; modern methodology used in teaching and research; organisation of studies; and doctoral students' professional research, development and/or other creative activities all support achievement of the objectives and learning outcomes of doctoral studies.
- ✓ Assessment of outcomes of the learning, research and creative work done by doctoral students is relevant, transparent and objective, and supports the development of doctoral students.
- ✓ Doctoral students are asked for feedback regarding supervision on a regular basis and the results of these surveys are taken into account for quality improvement activities.
- ✓ Effectiveness of the doctoral studies is analysed and such analyses serve as a basis for planning quality improvement activities.

### Comments

The principles for implementing doctoral programmes and assuring the quality of the doctoral studies are set out in the document "Estonian Universities, Agreement on good practice regarding quality". Implementation of this in the programme is evident. The individual needs of students are assessed and incorporated into their individual study plans. The yearly attestation process is overseen by a committee which actively encourages timely completion of studies. Compulsory courses in teaching practice ensure that graduates gain teaching and supervisory skills through interaction with bachelor's and master's degree programmes.

### Strengths

- The programme contributes to many of the general strengths outlined in Section 3.2.

### Areas of improvement and recommendations

- The teaching workload of doctoral students is not regulated and some students undertake heavy loads to financially support their studies. A balance between research and teaching needs to be determined which caps teaching hours.
- Training doctoral students in writing research proposals should be considered if post-doctoral opportunities are few while many students consider following a career path into academia.

## **Teaching staff**

### Standards

- ✓ Teaching staff participate in research, development and/or creative activity at the level of and to the extent sufficient to conduct doctoral studies in the curriculum group and to supervise doctoral theses.
- ✓ Teaching staff develop their supervisory competences and share best practices with one other.
- ✓ Teaching staff collaborate in fields of teaching, research and creative work within the university and also with stakeholders outside the university (public sector organisations, enterprises, other research and development institutions).
- ✓ Teaching staff further their skills at foreign universities or other research institutions, participate in international research and creative projects, and present papers at high-level conferences.
- ✓ Qualified international and visiting teaching staff are involved in conducting doctoral studies, participating in doctoral thesis defence panels and/or reviewing doctoral theses.
- ✓ When assessing the work of teaching staff (including their evaluations), the effectiveness of their teaching as well as of their research, development and creative works is taken into account; including the effectiveness of their student supervision, development of their teaching and supervisory skills, and their international mobility.

### Comments

The staff and supervisors at the Power Engineering programme are well qualified for their positions, however both staff and students express concern over the “missing generation” of experienced people in the ages of 40-50 in the staff. The university is looking to hire more professors in the future but it is difficult to find them. The supervisors have a manageable amount of Ph.D. students to supervise, and the students are satisfied with the amount of time their supervisor dedicates to them. One of the research groups also conduct weekly meetings within the group, which is highly recommended.

Both staff and students wish to see increased support for mobility, increasing the possibility for students to travel abroad for conferences, lab work, and studies. Younger staff expressed the desire to get training in application writing, to be able to succeed as a young researcher, something that would be excellent to

implement already in the Ph.D. studies. To be able to participate in the competition for supervisors, the supervisor must show funds guaranteeing the student a salary from the University as a junior researcher.

Information was not received about the Geotechnology programme from the on-site visit, lab tours and stakeholder interviews and as a result this field is not commented on.

### Strengths

- The quality of supervision is now assured through a ranking system which assigns competitively-won scholarships to the research projects of staff with the best records of publications, citations, and successful doctoral study supervision completions during the previous ten years.
- Mentorship of new staff in supervising Ph.D. students is commonplace through co-supervision.

### Areas of improvement and recommendations

- A structured staff recruitment plan is required which ensures a growth in the number of experienced doctoral student supervisors through recruitment of young staff with promising research trajectory, before loss of mentorship from experienced staff, soon to retire.
- Invite researchers and scientists from high quality universities abroad for short or long duration visits to collaborate in the supervision of doctoral students.

## **Doctoral students**

### Standards

- ✓ When admitting students to doctoral study, their suitability for successful completion of their studies is assessed on the basis of transparent criteria.
- ✓ Doctoral students plan their studies as well as research and development activities in collaboration with their supervisor(s), setting out specific objectives for each year and taking responsibility for achieving these objectives.
- ✓ Evaluation of doctoral students is transparent and impartial. Its purpose is to support development of the doctoral students, provide an opinion regarding the effectiveness of their work to date, and assess their capabilities to complete their studies on time and successfully defend their doctoral theses.
- ✓ Universities offer doctoral students counselling on completing their studies and planning their further careers.
- ✓ Doctoral students' extracurricular teaching, research and/or creative activities or other work-related activities at the university support successful completion of their doctoral studies.
- ✓ Doctoral students participate in international mobility programmes or take advantage of other opportunities for learning or research at foreign universities and/or research and development institutions<sup>5</sup>.
- ✓ Alumni are regularly asked for feedback on the quality of the doctoral study, and

<sup>5</sup> In the context of this document, 'research and development institutions' denote both research institutions and research-intensive companies.

employers are asked for feedback on the preparation of the graduates.
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### Comments

The admission requirements for the doctoral study programme are set out in the Admission Requirements regulations and students are admitted on a competitive basis.

In the Power Engineering and Geotechnology doctoral programme 71% graduated during the nominal period of studies in the most recent academic year. Some interesting quality indicators are set to increase the graduation efficiency by 2018 (by 35%) and 2020 (by 50%).

The number and quality of candidates applying for admission in the Power Engineering programme is not satisfactory due to competition from industry – master’s degree graduates easily find employment in industry and are not attracted into a doctoral programme with insufficient grants and an uncertain employment career after a further 4 to 5 years of study.

Some international students face problems adapting to doctoral studies in Estonia, due to issues with language (not all desired modules available in English), cultural differences and personal problems. This aspect of the student experience needs to be addressed.

### Strengths

- The doctoral studies programme supports international mobility of Ph.D. students. Funding for participation in international conferences is provided.
- The employment of doctoral studies graduates is very high. This shows that the PhD programme is successful and suitable for the local industry.
- Students in doctoral studies in collaboration with their supervisors prepare a study and research plan. This plan is flexible and gives the possibility to students to make modifications accordingly.

### Areas of improvement and recommendations

- The relevance of assigned teaching topics and the extent of teaching workload of doctoral students should be carefully monitored as part of their personal research and study plan.
- The SER states clearly that admission requirements are applied on a competitive basis. However during the interviews it was stated that some supervisors recruit students during their master’s level studies or even abroad and arrange with them their admission under their supervision. It is recommended that the admission requirements be applied for all students with transparency.
- The low interest for the doctoral programme among master’s degree graduates is mainly due to insufficient funding. For this reason it is

- recommended that the problem be faced at university level. It is suggested to solve the problem of funding according to the proposed plan and also to increase awareness among master's degree students and employers the relevant enhanced attributes that the Ph.D. programme graduates have compared to master's degree graduates.
- In order to facilitate the entrance and attraction of international students to the university it is recommended that the Doctoral Programme Director investigates any current impediments to a high quality international student experience and draws up an action plan to address any concerns. For example, the possibility of including prospective international doctoral students in summer schools connected with their proposed research group should be considered before they officially commence their doctoral studies programme.