ESTONIAN QUALITY AGENCY
FOR HIGHER AND VOCATIONAL EDUCATION

Assessment Report

Informatics and Information Technology

Mathematics and Statistics

PhD studies

Tallinn University

Tallinn University of Technology

University of Tartu

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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 Groups (SPG) of Informatics and Information Technology and Mathematics and Statistics at the level of doctoral studies in three universities: University of Tartu, Tallinn University and Tallinn University of Technology.

The team was asked to assess the conformity of the study programmes belonging to the study programme groups 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:

Ernst W. Mayr (chair)	Professor Emeritus, Department of Informatics, TUM, Munich (Germany)
Juha Kalevi Kinnunen	Professor, Head of the Department, Mathematics, Aalto University (Finland)
Dick H.J. Epema	Professor of Computer Science, Delft University of Technology (The Netherlands)
Sasu Tarkoma	Professor, Head of Department, Department of Computer Science, University of Helsinki (Finland)
Tõnu Pekk	Commercial Association Tuleva, Founder, CEO, Head of the Task Force for Research and Higher Education 2016-2017 (Estonia)
Josip Maric	PhD Student, University Of Montpellier (France)

The assessment process was coordinated by (EKKA).

After the preparation phase, the work of the assessment team in Estonia started on March 12 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 upon the overall questions and areas to discuss with each group at the three institutions which 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 finalized.

During the following days, meetings were held with the representatives of the University of Tartu, Tallinn University and Tallinn University of Technology. 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 March 16, the team held an all-day meeting, during which both the structure of the final report was agreed upon 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 members of the assessment team summarize their general findings, conclusions and recommendations which are relevant across all SPGs assessed by the team. 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 may be achieved. In formulating its recommendations, however, the assessment team did not evaluate the financial feasibility associated with their implementation.

General findings and recommendations

- PhD programmes and doctoral research are relevant for basically all areas of scientific research and also technological development. This definitely holds true for such rapidly developing areas like IT, but also for mathematical areas like statistics (and thus mathematics as the required base), when one considers the ongoing developments in data analysis and related fields.
- The assessment team got the impression that the value of a PhD thesis in computer science is not as highly regarded in the Estonian society as it could be and should be, and that therefore, the SPGs may not be attracting the best talents. The value of a PhD programme in general lies in the research results obtained by the PhD students, in the execution of the jobs held by alumni in industry, government and science, and in the early access to new knowledge obtained in other countries through participation in the scientific process (internships abroad, conference participation, etc.). The universities may put more effort into possibly jointly advertising these benefits, preferably in a quantified way and with explicit examples of these benefits.
- The assessment team appreciates the current internationalization efforts of the three universities. Still, especially because for a very small country connections with the outside world are extremely important, the team

recommends to push for more such efforts in all areas: attracting (and trying to retain) foreign PhD students and staff members to Estonia, and facilitating travel abroad for different purposes and durations (conference visits, collaborations, sabbaticals, internships, summer schools, etc.). The universities may also more explicitly undertake comparisons of their own achievements and goals with foreign universities at different levels in Europe and elsewhere.

- Overall, the assessment team finds the doctoral programmes well designed and thought through. However, it doubts whether the course programme is too heavy. Both skill-related and discipline-related courses deserve a place in the programme, but it is recommended to explore some reduction of this number, and to make it more personalized. Only if otherwise promising PhD candidates lack certain knowledge to start their research, can the programme go up to one year of course work.
- Industry connections and the attendance to (more) applied research topics are of great importance. On the one hand, this is based on the fact that numerous new scientific questions arise from innovative applications in industry, usually coming up in a relatively short time frame, and on the other hand established scientific methods need to be adapted to, and in quite many cases generalized to or even reinvented for new application areas. Clearly, to maintain their significance, the PhD programmes need to pay attention to these ever faster developments.
- The size of the PhD programmes (in terms of number of PhD students) appears comprehensible, given all the influencing factors mentioned elsewhere in this report. However, and in particular in the IT as well as the (Data) Statistics area, measures have to be taken and maintained to ensure proper scientific advancement within the country [e.g., state-of-the-art research courses in areas like Machine Learning or Data Analysis].
- Currently, all four PhD programmes evaluated in this report (Mathematics and Mathematical Statistics at UT being counted as one) have decent numbers of PhD students, especially given the adverse demographics in Estonia. Still, given that the assessment team thinks there is enough supervision capacity, given the recent improvement in payment of PhD candidates, and with hopefully a lower dropout rate and better promotion of the value of the PhD programme in computer science, the universities should be able to increase the number of PhD candidates.

1. Assessment report of Informatics and Information Technology SPG at Tallinn University of Technology

1.1. Introduction

The formation of Tallinn University of Technology (TUT) 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 TUT 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. TUT 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 PhD students benefit from studying at TUT 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 Informatics and Information Technology study programme group consists of one doctoral study programme – Information and Communication Technology, which is the third largest PhD study programme group in TUT by number of doctoral students. The Information and Communication Technology study programme is managed by the School of Information Technologies. The nominal period of studies is 4 years (240 ECs).

In the academic year 2016/2017, there were 644 doctoral students in TUT, of which 115 studied within the Information and Communication Technology study programme group. TUT accounts for 55% of all doctoral students in that study programme group in Estonian universities.

During the last 5 years the number of PhD students studying in the Informatics and Information Technology program has been decreasing from 154 in 2012 to 115 in 2016/2017 (more recent figures are not available).

In 2015/2016 the number of international students was 27, representing 23% of the cohort. The number of doctoral students working at the university at the same time as studying is high – approximately 45%. The average percentage of students registering for doctoral studies after completing their master's degree at TUT is also high, exceeding 50%.

(Please note that the following tables only include data until 2015/16.)

THE NUMBER OF PHD STUDENTS

Curriculum	2011/12		2012/13		2013/14		2014/15		2015/16	
	Total	working at TUT	Total	working at TUT	Total	working at TUT	Total	working at TUT	Total	working at TUT
Information and Communication Technology	154	59	146	56	145	53	135	49	115	52
TUT	794		782		762		737		644	

THE NUMBER OF INTERNATIONAL PHD STUDENTS

Curriculum	2011/12	2012/13	2013/14	2014/15	2015/16
Information and Communication Technology	12	12	25	24	27
TUT	**55**	**62**	**93**	**107**	**112**

THE NUMBER OF ADMITTED PHD STUDENTS

Curriculum	2011/12		2012/13		2013/14		2014/15		2015/16	
	Total	Directly from TUT MSc	Total	Directly from TUT MSc	Total	Directly from TUT MSc	Total	Directly from TUT MSc	Total	Directly from TUT MSc
Information and Communication Technology	22	12	21	15	25	10	21	16	11	8
TUT	**128**		**122**		**117**		**112**		**71**	

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	Total	on one's own will	Total	on one's own will	Total	on one's own will	Total	on one's own will
Information and Communication Technology	12	3	16	4	22	6	20	4	20	4
TUT	**78**	**33**	**75**	**32**	**91**	**44**	**76**	**24**	**97**	**33**

THE NUMBER OF DEFENDED PHD THESES

Curriculum	2011/12		2012/13		2013/14		2014/15		2015/16	
	Total	within 6 years	Total	within 6 years	Total	within 6 years	Total	within 6 years	Total	within 6 years
Information and Communication Technology	13	10	9	6	6	3	12	9	11	6
TUT	**67**	**49**	**54**	**32**	**57**	**39**	**62**	**41**	**75**	**53**

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

Information and Communication 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 labor 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 Tallinn University of Technology has a versatile PhD program with an emphasis on industry relevance. The PhD program consists of 1 full year (60 ECs) of course work and three years (180 ECs) of research. The University has established processes that govern the different aspects of the PhD studies and research, as well as graduation. The University leadership is proactive in developing the curriculum, and the PhD study program is being reformed in 2018. The self-evaluation report contains a detailed action plan for improvements. The PhD study program has extensive collaboration with industry and society, and the industry value of the PhD graduates is widely recognized.

The PhD research is becoming increasingly project oriented, with PhD students working in research teams and groups. PhD student admission is supervisor driven, and the allocation decisions are made based on supervisor performance. The University has a common salary structure for all doctoral students, and is actively developing the PhD student salary instruments in order to support full time PhD studies. Student feedback is gathered through annual PhD progress reviews (attestations) and doctoral seminars, via a study information system for course feedback, Student Education Quality Working

Groups run by the Student Union, and through PhD program management committee meetings. The PhD study program is addressing the high number of dropouts through active supervision and monitoring, and by offering special training to supervisors. The annual intake of PhD students is on average about 20 over the last five years, and the number of graduations around 10. One fourth of the current PhD students are international.

Strengths

- The university has a common salary structure for the doctoral students equivalent to the average Estonian salary. The efforts in developing the salary system are commendable.

- The university is adopting a project based working mode that is generally seen as a good direction. However, it is instrumental to ensure good alignment between the project activities and the PhD research work.

- The new industry PhD program is a very necessary instrument for further supporting collaboration with companies. It is recommended to continue this development and consider formalizing relevant aspects of the collaborations, thus better defining the PhD study program interface towards the industry.

Areas of improvement and recommendations

- The university has introduced a system for the allocation of PhD positions to supervisors based on supervisor performance, with a limit on the number of PhD students per supervisor. This measure should be followed through, other teaching and administrative tasks of the supervisors should be taken into account.

- It is recommended to continue the harmonization of the processes and practices of the PhD study programs. For example, it would be beneficial to increase coordination in advertising open PhD positions and have a joint evaluation process for the applicants.

- The University is recommended to continue the commendable internationalization efforts.

- The University is recommended to place special emphasis in the further development of feedback mechanisms pertaining to PhD students, the industry, and alumni.

- Special attention should be paid to the efficiency of the PhD study programme in terms of the amount of course work necessary for graduation (see the corresponding item in "General findings and recommendations".

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

- Information and Communications Technology (ICT) PhD programme intake has been halved in the last few years as a result of significant changes in admissions procedures. As stated in the SER, "Readiness of the supervisor and the supervisor's department to create a position for the PhD student at the department and guarantee a salary is a prerequisite for participation in the competition...".

- ICT considers 1100 EUR net income as a minimum that needs to be guaranteed for a new PhD position. The state-funded stipend top-up comes from research funds and hence every prospective PhD student tends to be allocated to one of the grant-funded research projects.

- An alternative option for creating a new PhD position is a company-sponsored "industrial PhD", where the university signs an agreement with the PhD student's employer. Such instrument seems to be very new and the committee became aware of only 1 such PhD position created so far.

- ICT has over the past few years significantly changed the faculty and brought in experienced staff from outside universities. The PhD students have now the support of teaching staff and supervisors with wide international connections and skills.

- University-wide requirement limits the number of PhD students per supervisor to five (although, during the interviews, we identified supervisors who have more than five students). While this should ensure a good availability of supervision, there are still other conflicting assignments that limit the availability of supervisors' time for their students.

- ICT has very good dedicated facilities for students for working, experiments, and for socializing.

- There are twinning and other arrangements in place that provide for students' and staff international mobility. In addition, students can easily apply for additional mobility grants. There seems to be no uniform requirement to do so, however.
- The staff feels significant changes in research funding and hence is looking to senior management and the state to provide clearer prospective on how to maintain the good assets while the research funding is stagnating.

Strengths

- The clear commitment to provision of sufficient income to PhD students is very commendable. Student feedback states very clearly that working on a job is not really possible during PhD studies if one wants to complete in time.
- The commitment to increase the share of international staff is also very good and should be continued on every level.

Areas of improvement and recommendations

- While there is a number of very good supervisors in ICT, the quality is still very variable. Best practices should be shared regularly, non-performing supervisors should be identified not only based on graduation results but also on student feedback, and further training should be provided.
- Some management initiatives, e.g. the industrial PhD concept, have not been sufficiently disseminated among the stakeholders of the PhD programme. More support to supervisors should be provided here, like centralized contracting, sorting out IP issues etc.

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; organization 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 analyzed and such analyses serve as a basis for planning quality improvement activities.

Comments

Teaching practices and learning outcomes, which are in accordance with international standards, are implemented to assure the quality and relevance of the doctoral studies. An adequate amount of compulsory and elective studies ensures general competencies, transferable skills and the process of completing the PhD degree.

Objectives and learning outcomes of the PhD programme are clearly defined. The studies are designed to support the PhD student to achieve the learning objectives. Modules in specialization areas guarantee the individual development. The learning assessment is transparent, objective and supports the individual development of the PhD student.

Each PhD student compiles an individual study and research plan that supports achievement of the objectives and learning outcomes of the doctoral studies. The plan is accepted by the supervisor and prior knowledge is taken into account. Student feedback is collected in the study information system, annual progress reviews and informal discussions. PhD students are requested to annually present a written progress report, give a presentation and have a personal interview with the head of the study program and the review committee after the second year of studies. Challenges and possible problems are detected and discussed. The committee prepares a written feedback and approves the claimed credits.

The PhD students feel that their feedback is taken in to account. In general, they seem to be satisfied with the curriculum, teaching, supervision and workload. Overall, the curriculum seems to be adequate and flexible. Moreover, the PhD students are encouraged to attend in international summer and winter schools as well as international conferences and networking events. However, connections to industrial and other stake holders in the society could be strengthened.

Strengths

- PhD students and faculty are satisfied and enthusiastic.
- PhD students are members of research groups. Many PhD students have two or more supervisors. The studies support research and individual development.
- Annual progress reviews are performed in a systematic way.

Areas of improvement and recommendations

- Effective measures to reduce the dropout rate need to be taken. Study times are relatively long in international comparison.

- Quality ensuring mechanisms for supervisors have been implemented, but processes for sharing good practices among supervisors could (and should) be developed further
- More international comparison, collaboration, exchange and faculty would make the PhD programme more attractive.
- The new industrial PhD profile is promising, but feedback from alumni, industry and other stake holders could be implemented more in teaching and learning. Interdisciplinary collaboration is an opportunity for the future.

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 organizations, 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 is involved in conducting doctoral studies, participating in doctoral thesis defense 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 qualification requirements for the teaching staff of the doctoral study programme are set in the "Academic Career Management" document, the performance is evaluated at least once every 5 years, based, among others, on the following main criteria: participation in research, development and/or creative activity at the level of and to an extent sufficient to conduct doctoral studies in the curriculum group and to supervise doctoral theses. As mentioned before, academic staff obtain the right to supervise PhD students by completing a special competition of supervisors organized annually at the University level according to the special "Procedure for the selection of doctoral thesis topics opened for admission to doctoral studies". The actual number of PhD students per supervisor appears adequate in general, however, there are a few exceptionally high spikes that should be taken care of.
Staff teaching performance is taken into account by the fact that, after passing a course, PhD students can give a feedback on the teaching staff involved in a course using the study information system. In the PhD study

programme, this feedback has already been used to change supervisors and research topics of some PhD students.
Support for teaching staff mobility is available in general, e.g. by means of mobility grants from the IT Academy and Doctoral School. While local supervisor trainings to develop supervisor competences and share best practices have been organized and used, other directions seem underdeveloped, like stays abroad. It is true that participation in international research networks, conferences, workshops and trainings is supported in principle. However, it appeared that some of the staff did or could not use these opportunities (e.g., during their sabbaticals), for different reasons, probably mostly based on the financial situation.
Staff members are in general satisfied (some though not necessarily happy) with their workload. The legal requirement of having at least a PhD degree is satisfied, and the majority of staff works at full load. The average living age of the involved teaching staff is 57 years (as taken from the SER). While this poses great challenges and opportunities at the same time (concerning retirements and new recruitments), it appears strange to the assessment team that, in the list of lecturers supplied by the university (file "APPENDIX 2_List of Lecturers_IAQD.xlsx"), Profs./LRS Kotta, Draheim, Raik are not contained, but were present (and welcome) at the interview session.
In addition, some of the interview partners expressed their desire to have more time available for (PhD) students and for research, about their perception that the salary level is too low, and, while basically satisfied with the present state, a fundamental worry about the future developments (in spite of the feeling by some that quite some "vibrant" development is going on within the Programme).

Strengths

- Supervisors participate in international research networks and projects. Research results are published in peer-reviewed journals and proceedings.

- Lectures and courses by foreign professors as well as summer and winter schools are regularly organized.

Areas of improvement and recommendations

- The handling of student feedback and the quality/efficiency of supervision demands continuous monitoring and systematization.

- Measures for improving supervisory skills should be installed and/or improved. As a case in point, there are courses for disseminating best practices of supervising, but sharing them peer-to-peer is still only informal.

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[1].
- ✓ 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 structural approaches regarding the regulation of details of the PhD programme at TUT are considered positively by the PhD candidates. This especially concerns the implementation of measures to ensure the quality of the programme through the extra-matriculation of the doctoral candidates who did not fulfil the criteria after the 2nd year of their PhD studies. This leads to a decreased number of PhD candidates, but, on the other hand, ensures quality of PhD candidates and better management of the state funding and their allocation to new PhD projects.

PhD candidates seem to be pleased with the admission procedure, which they find transparent enough. They also consider the level of organizational support to be sufficient, even though a pressing progress evaluation is implemented after the 2nd year of their PhD studies. They find the general work ambiance at the HEI stimulating and encouraging, with good support regarding the resources, which enables them possibilities to develop international visibility (through summer schools, conference, etc.). Teaching workload seems to be handled and clarified through contract details, with no specific remarks from the PhD candidates on this issue.

However, on the question of gender-related mechanisms, some notions were noted from the PhD candidates where they would be favorable for measures to ensure gender-balance and increase the number of female PhD candidates in ICT related disciplines. It is hard to generalize this notion, but since TUT is a leading HEI with a high number of PhD candidates in Informatics and Information Technology on a state level, implementation of gender-related measures would probably not harm the PhD programme quality and could lead to a positive PR through media or discussions with policy-makers.

Strengths

- Academic career opportunities at the HEI (75% of PhD candidates remain within the institution).

[1] In the context of this document, 'research and development institutions' denote both research institutions and research-intensive companies.

- Deliberate structural policies for quality assurance of the PhD projects and PhD candidates (rigorous annual progress evaluation after the 2nd year of PhD projects and ex-matriculation of inadequate candidates) have reduced the number of students who are unlikely to complete their degree, and have thus improved the quality of the student body.
- Clear PhD candidate status at the HEI and departmental level, with deliberate support to obtain competitive funding throughout their PhD projects.
- Stimulating work environment, infrastructure and institutional support for PhD candidates' research and teaching possibilities.
- Flexible individual curriculum development and administrative support regarding the verification of external courses (from other HEIs within the country, or MOOCs).
- Clear teaching workload for each PhD candidate through deliberate and specific contract details.
- Encouraging work environment to foster international collaboration and mobility of the PhD candidates.

Areas of improvement and recommendations

- The assessment team recommends the implementation of institutional policies for ensuring gender balance and inclusion of women in the admission/application process, which can serve in discussion and argumentation with policy-makers (see for instance UN Women Strategic Plan 2018–2021[2]).
- More transparency in the project funding allocations is recommended, based on the relevant criteria of supervisors' academic output (like high impact factor publications).
- Develop formalized career roadmaps and make the information available for the PhD candidates from the early stages of their PhD projects.
- Consider/propose development of models for tax reductions for industry stakeholders who hire PhD candidates (argument for discussions with policy-makers), as a possible measure to popularize industrial PhD programs (observe the best practices from other European countries, e.g. France[3]).

[2] More info : http://www.unwomen.org/en/digital-library/publications/2017/8/un-women-strategic-plan-2018-2021
[3] More info (in French) : http://www.anrt.asso.fr/fr/faq-7782

2. Assessment report of Informatics and Information Technology SPG at Tallinn University

2.1. Introduction

Tallinn University is the third largest public university in Estonia, focusing primarily on the fields of humanities and social and natural sciences. They have about 7500 students and over 800 employees.

The University is a merger of several higher education and science institutions (e.g. Tallinn Pedagogical University, Academy Nord, Estonian Institute of Humanities, Institute of History of Estonian Academy of Sciences, Academic Library of Estonia) into a single institution, which resulted in the founding of TU as a public university on 18 March 2005.

In 2015, a significant structural and management reform took place whereby 26 existing units were merged into just nine: 6 academic units – Baltic Film, Media, Arts and Communication School; School of Digital Technologies (DT); School of Educational Sciences; School of Governance, Law and Society; School of Humanities; School of Natural Sciences and Health; 2 regional colleges (in Haapsalu and Rakvere) and the library. In addition, 5 centers of excellence, 9 research centers and 15 support units were formed.

The vision of the University is to play a leading role in promoting and developing intelligent lifestyle in Estonia, thus contributing to Estonian sustainability and to self-actualization of individuals.

The objective of TLU for 2015–2020 is to consolidate activities into five main focus fields: educational innovation; digital and media culture; cultural competences; healthy and sustainable lifestyle; society and open governance. The main responsibility for developing a focus field lies with the academic unit (school), whereas the School of Digital Technologies supports all the rest with digital technologies and analytics.

According to the university development plan for 2015-20, TLU wants to promote itself as a leader in promoting digital literacy, studying the impacts of human-computer interaction. TU intends to contribute to the development of innovative solutions for the information society and implementation of digital and media culture in different spheres of life. The University is developing a systematic approach to applying digital environments and digital means in teaching and working.

The Informatics and Information Technology study programme group consists of one doctoral study programme – Information Society Technologies. Information Society Technologies study programme is managed by the School of Digital Technologies. The nominal period of studies is 4 years (240 ECs).

In academic year 2016/2017 there were 363 doctoral students in TLU, of which 32 studied at the Informatics and Information Technology study

programme group. The first graduate from the programme was in 2016/2017 academic year. TLU accounts for 17 % of all doctoral students in that study programme group in Estonian universities.

During the last 5 years the number of PhD students studying on the Information Society Technologies programme has been growing from 15 in 2012 to 32 in 2016. In 2015/2016 the 53% of the students were international students studying on the Information Society Technologies program.

THE NUMBER OF PHD STUDENTS

Curriculum	2011/12		2012/13		2013/14		2014/15		2015/16	
	Total	working at TUT	Total	working at TUT	Total	working at TUT	Total	working at TUT	Total	working at TUT
Information Society Technologies	15	1	19	4	27	7	26	5	32	5
TLU	377		370		378		386		363	

THE PROPORTION OF INTERNATIONAL PHD STUDENTS

Curriculum	2011/12	2012/13	2013/14	2014/15	2015/16
Information Society Technologies	6,7%	21,1%	14,8%	57,7%	53,1%
TLU	6,6%	8,1%	10,9%	12,4%	13,2%

THE NUMBER OF ADMITTED PHD STUDENTS

Curriculum	2011/12		2012/13		2013/14		2014/15		2015/16	
	Total	Directly from TLU	Total	Directly from TLU	Total	Directly from TLU	Total	Directly from TLU	Total	Directly from TLU
Information Society Technologies	4	0	6	0	9	0	4	0	7	1
TLU	**46**	**8**	**44**	**6**	**46**	**11**	**42**	**16**	**50**	**9**

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	Total	on one's own will	Total	on one's own will	Total	on one's own will	Total	on one's own will
Information Society Technologies	1	0	2	2	1	1	5	4	2	1
TLU	**32**	**13**	**31**	**12**	**23**	**11**	**23**	**12**	**53**	**23**

THE NUMBER OF DEFENDED PHD THESES

Curriculum	2011/12		2012/13		2013/14		2014/15		2015/16	
	Total	within 6 years	Total	within 6 years	Total	within 6 years	Total	within 6 years	Total	within 6 years
Information Society Technologies	-	-	-	-	0	0	0	0	0	0
TLU	**12**	**9**	**23**	**13**	**16**	**5**	**25**	**8**	**19**	**6**

2.2. General findings and recommendations at study programme group level

The University of Tallinn has an interdisciplinary PhD program focusing on the two research areas of Digital Learning Ecosystems and Human-Computer Interaction, thus nicely complementing the other ICT PhD programs in Estonia. The School of Digital Technologies, which is responsible for the program, has a horizontal role in the university for supporting the take-up of digital technologies in all sectors of society.

- Teaching, learning and supervision practices are on a good level. PhD students and faculty seem to be satisfied and enthusiastic.
- The facilities are modern, and the School of Digital Technologies has modern tools that even several private companies line up to use.
- The "pre-admission school" introduced in 2016, which provides feedback and advice for potential PhD applicants, is a valuable addition to the PhD program supporting student recruitment. The pre-admission school helps in ensuring that the PhD student research plans are aligned with the research topics and projects on the institutional level.
- Based on the recommendations of the 2014 evaluation, most PhD students now have two supervisors. This is a commendable development.
- The development of structural approaches/processes for quality assurance in the PhD programme is encouraged.
- The internationalization activities such as staff and student mobility, and international marketing of the PhD program, should be strengthened. Long-term outgoing mobility of the PhD candidates can be supported, for example, with the development of joint supervisions or mobility programs.

2.3. Strengths and areas for improvement of study programmes by assessment areas

Information Society Technologies

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 study program is fairly recent, it was only started in 2010 and the graduation of the second PhD student took only place just before the visit of the Assessment Team. The program is still in growth mode. The curriculum has been significantly revised after a major structural reform in 2015 with a consolidation of the whole university into a much smaller number of units, and the effects of the change are now becoming evident. The PhD program has a full year (60 ECs) with general and subject-based courses, and three years (180 ECs) of research.

The PhD study program has incorporated innovative new features, such as a pre-admission school in which interested potential PhD students can present their research proposals and get feedback. The PhD study program has feedback mechanisms for students including regular meetings, feedback surveys, the management committee, and the annual PhD student assessment (attestation). Best practices pertaining to doctoral education are shared among supervisors within the study program and also at the university level across study programs. The self-evaluation report includes a clear and thorough action plan for improving the study program. The University is supporting PhD student mobility. The number of international students is high.

Strengths

- Having two well-defined research areas gives a good sense of direction to the research topics in the PhD program.
- The aims of aligning PhD topics with research projects and supporting PhD student integration with research projects are commendable.
- The research colloquium is commendable.

Areas of improvement and recommendations

- It is recommended to continue the development of the quality monitoring and assurance processes pertaining to the PhD program.
- The connections with industry and the government can be strengthened in order to tailor the research topics relevant for them.
- It is recommended to continue and strengthen the efforts to integrate PhD students with the research groups.

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

- ICT studies at TLU combine well existing resources of the university - digital media studies and learning systems research with the aim of developing a systematic approach to applying digital environments and digital means in teaching and working.

- Despite a small number of students, several courses have been specially designed for PhD level studies and students seem to be generally happy with the quality of the courses.

- ICT has only 2-3 new state-funded PhD positions every year. However, the management has decided to accept a larger number of new students and finance the required minimum stipend from faculty budget. The additional financing comes from the general administration part of research funding. Greater number of students is believed to lead to economies of scale.

- However, having a larger number of students can lead to a situation in which there are no funds left to pay for the top-up of the official state support. Therefore, only very few students are able to sustain on the state support minimum and most of PhD students work elsewhere.

Strengths

- ICT has made very good use of limited resources so far. However, finances need to be made sustainable to maintain quality and motivation of both students and staff.

Areas of improvement and recommendations

- The assessment team understands that the University considers a base salary as a necessary condition for students to be able to concentrate full time on their studies and completion of PhD. The use of research funding for even minimum level financing provided to students is not sustainable. The management plans to shift School research fund resources from new funded positions to existing students in order to alleviate the sustainability issue.

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; organization 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 analyzed and such analyses serve as a basis for planning quality improvement activities.

Comments

Teaching practices and learning outcomes, which are in accordance with international standards, are implemented to assure the quality and relevance of the doctoral studies. An adequate amount of compulsory and elective studies support the process to ensure general competencies, transferable skills and to complete the PhD degree.

Teaching activities consist of courses targeted to PhD students, a weekly research seminar and workshops. The learning assessment is transparent, objective and supports the individual development of the doctoral candidate. Student feedback is collected in the annual reviews, feedback surveys and informal discussions. PhD students feel that their suggestions are taken in to account. In general, PhD students seem to be satisfied with the curriculum, teaching, supervision and workload.

Each PhD student designs an individual study and research plan that supports achievement of the objectives and learning outcomes. The plan is accepted by the supervisor. Annual progress reviews are conducted in a systematic way. PhD students give short presentations and they receive immediate feedback. Challenges and possible problems are detected and discussed. The committee prepares a written feedback and approves the claimed credits.

Overall, the curriculum seems to be adequate and flexible. Moreover, PhD students are encouraged to attend international summer and winter school as well as international conferences and networking events. However, connections to industrial and business-related activities could be supported more.

Strengths

- Flexibility and the broad scope of studies support the individual development and take into account diversity of the PhD students.
- The programme provides a unique combination of competences in information, society and technology.
- Annual progress reviews for PhD students have been implemented.

Areas of improvement and recommendations

- Study times are relatively long in international comparison.
- More international comparison, collaboration, mobility, study material and faculty would make the doctoral programme even stronger and more attractive.

- The requirements of industry and other stake holders in the society, concerning new technologies in particular, should be taken into account more in the studies.

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 organizations, 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 is involved in conducting doctoral studies, participating in doctoral thesis defense 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

While, at the beginning of this PhD programme in 2010, the number of potential supervisors and teachers was somewhat on the lower side, this has been rectified by now. According to the SER (page 23 bottom), and thus supplementing the information given in the SER earlier (page 8, table 3, row 2), there are currently 36 PhD students, supervised by 19 faculty and teachers. It must be noted that the SER in Appendix 2 lists 10 persons only and thus appears to be incomplete. Otherwise, the legal requirements for the academic standing of the supervisors are satisfied. In this respect, the assessment team also finds very laudable the procedure to have prospective supervisors go through first a phase as co-supervisors, enabling them to gain a lot of experience for the job.

ICT has been able to recruit both local and international faculty. This is very important as international faculty brings in best practices from other universities and is an important factor in recruiting good students.

The supervisors recognize that many students work elsewhere and the PhD degree might not be their first priority, and are thus often less stringent on requirements to finish on time.

Strengths

- There are several good quality supervisors and informal work practices such as co-supervision, advisor roles for more junior staff, and sharing of notes. In general, good practices are shared quickly. In the panel interview, PhD candidates expressed their satisfaction with the level of collaboration, interaction and support.

Areas of improvement and recommendations

- Processes pertaining to quality assurance mechanisms, uniform practices and sharing of good practices among the supervisors could be documented and implemented more systematically.
- The development of teacher and researcher mobility is recommended, for example having a process for research sabbaticals.

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[4].
✓ 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 assessment team finds that the PhD candidates are satisfied with the general organization of the PhD programme at the TLU. This is particularly seen in the elements such as the Pre-admission school that PhD candidates find encouraging to meet and discuss research proposals with their possible supervisors.

Moreover, PhD candidates express their satisfaction with the level of collaboration and find no specific issues regarding the relationship with their supervisors. Feedback from the PhD candidates seems to be integrated on the institutional level through informal meetings and PhD candidates'

[4] In the context of this document, 'research and development institutions' denote both research institutions and research-intensive companies.

remarks/complaints expressly resolved. It is encouraging that the TLU is aiming to implement a more structural feedback mechanism in the upcoming years.

PhD candidates also indicate that the annual progress evaluation is transparent where the emphasis is given to the relationship with their respective supervisors. Some comments stream from the TLU's international candidates where they expressed that the international candidates might be seem as disadvantaged in information availability about the teaching possibilities at the TLU. However, it remains debatable whether this is a general state of matters or it remains a single opinion.

What appears to be some sort of troubling issue, even though the HEI is seen as supportive and integrative environment for PhD candidates, is the technical difficulties encountered in relevant information availability about the thesis defense process at TLU. This issue could be attributed to a low number of PhD graduates in the previous period so some segments of thesis defense probably remained loosely formalized. However, it seems that informal communication between the PhD candidates and the support through their personal networks biases this institutional issue.

Strengths

- Informal feedback system ensured through a close collaboration of the supervisors, PhD candidates, and the heads of the department
- Relevance of the curriculum/courses for the PhD programme, and the possibility to integrate external courses into individual study plans
- Availability of resources/funds to enhance international visibility and mobility (conferences, summer schools, events, seminars, …)
- Supportive environment for international PhD candidates, and encouraging policies to achieve gender balance at the HEI

Areas of improvement and recommendations

- Introduce and clarify career roadmaps for the PhD candidates from the early start of their PhD projects.
- Ensure information availability regarding the teaching possibilities at the HEI for the international PhD candidates.
- Clarify the procedures and the obligations concerning the thesis defense for the IST programme.
- Encourage closer collaboration with the industry stakeholders who hire PhD candidates (establish closer networks with the industry stakeholders through PhD projects).

3. Assessment report of Informatics and Information Technology SPG at the University of Tartu

3.1. 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.

Under the structural reform, initiated in 2014, the nine faculties and five colleges of the University of Tartu were consolidated into four fields (Faculties).

The curriculum group Informatics and Information Technology comprises one doctoral programme – Computer Science (2670; 80333). The programme is managed by the Institute of Computer Science at the Faculty of Science and Technology. The nominal period of studies is 4 years (240 ECs).

In academic year 2017/2018 the number of doctoral students at the University of Tartu in the study programme group 'Informatics and Information Technology' represented approximately 30 % 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 slightly growing, from 42 to 59 students. In 2016/2017 24 of them (40%) were foreign students. The number of those working at the university at the same time as studying has been fluctuating between 43-51%.

THE NUMBER OF PHD STUDENTS

Curriculum	2012/13		2013/14		2014/15		2015/16		2016/17	
	Total	working at UT	Total	working at UT	Total	working at UT	Total	working at UT	Total	working at UT
Computer Science	42	18	45	19	53	27	58	21	59	19
UT Total	1504	502	1457	493	1401	487	1348	380	1258	362

THE NUMBER OF INTERNATIONAL PHD STUDENTS

Curriculum	2012/13	2013/14	2014/15	2015/16	2016/17
Computer Science	11	13	19	22	24
UT Total	122	129	139	143	158

THE NUMBER OF ADMITTED PHD STUDENTS

Curriculum	2012/13		2013/14		2014/15		2015/16		2016/17	
	Total	Directly from UT MSc	Total	Directly from UT MSc	Total	Directly from UT MSc	Total	Directly from UT MSc	Total	Directly from UT MSc
Computer Science	10	8	10	8	12	7	12	6	14	7
UT Total	190	151	179	153	168	137	171	139	177	133

THE NUMBER OF PHD STUDENTS DISRUPTING THEIR STUDIES

Curriculum	2012/13		2013/14		2014/15		2015/16		2016/17	
	Total	on ones own will	Total	on ones own will	Total	on ones own will	Total	on ones own will	Total	on ones own will
Computer Science	7	4	3	1	3	1	10	3	7	3
UT Total	148	55	128	42	154	40	171	48	146	48

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	Total	within 6 years	Total	within 6 years	Total	within 6 years
Computer Science	3	1	2	2	5	3	3	3	8	6
UT Total	114	57	117	62	107	45	120	75	138	65

3.2. Strengths and areas for improvement of study programmes by assessment areas

Informatics

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 of Tartu has a well-documented and clear structure and processes for their doctoral program in Computer Science. The four-year program (240 ECs) consists of one full year (60 ECs) of courses, with discipline-oriented courses and seminars (36 ECs), courses on transferable skills (12 ECs), and optional courses (12 ECs), and with three years (180 ECs) of research. The thesis can be both article-based (with a requirement of at least three published papers), or it can be a monograph. The doctoral curriculum is regularly updated to reflect the state of the art in research topics and methods. As benchmarks, the university has identified several key reference universities, among them Aalto University in Finland and Chalmers University of Technology in Sweden.

Over the last six years, the university has stepped up its efforts in collaborating with industry in doctoral education and in increasing the industry component of the PhD program, allowing doctoral students to acquire and develop skills that are important in industry. The University is actively developing the financial support possibilities for the PhD students in order to support full time research work and reduce the dropout rate. The University is actively gathering feedback regarding the PhD programs and PhD student progress. The funded PhD student positions are allocated based on supervisor efficiency and quality, and evaluation of the PhD applicants. The annual number of new PhD students has grown to 12, and the annual number of graduations to 5. The percentage of foreign PhD students in the program has increased to 51%.

Strengths

- The curriculum of the PhD program is typically updated every one or two years allowing the introduction of timely topics, such as data science and quantum computing.

- The industry component in the PhD program is important in connecting the academic environment to the industry environment, in ensuring the industry relevance of the PhD research, and in securing financial

support for the work. The industry PhD program is a new instrument, so it is early to assess its efficacy.

- The measures supporting centralized doctoral program admission and other functions are commendable.

- The university-wide feedback collection system is seen to be a very necessary instrument.

Areas of improvement and recommendations

- The university is recommended to continue the advertising and marketing of the PhD program nationally and internationally in order to recruit top talent. Specific strategic partnerships can be valuable in supporting student recruitment and mobility.

- Further analysis of the coursework required for the PhD degree is expected to provide insights for faster completion of the required courses and improved relevance of the courses for the degree.

- The competitive allocation of PhD student positions to the supervisors is commendable. However, there is a risk that some supervisors will become marginalized and unable to have PhD 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. ✓ 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

The programme receives a large share of state-funded PhD positions from those allocated to UT – the report states that "10/12 out of a total 161 new positions created annually" are allocated to Computer Science. The annual

number depends on internal competition within the Faculty of Science and Technology, and the actual numbers of allocated positions depend on past performance of PhD supervisors, the novelty of the proposed projects, and the quality of the proposed PhD students.

Computer Science is one of the few institutes in the entire UT that is expanding its intake of PhDs, having increased it from 3-5 annually to the current levels. That creates certain friction within the Faculty as Computer Science has an ever-increasing need for resources and does not have similar options for cost-savings through consolidation of activities as other departments might have.

Computer Science has decided to top up the state stipends with internal funds to guarantee a net income of PhD candidates of at least 1000 EUR per month. This, together with additional money from participation in research projects, teaching and further scholarships, should allow students to study full-time if they desire (the PhD student dropout rate is high for ICT in Estonia, and at Tartu the rate is around 50%). The funds for the top-up are expected to come from research grants Computer Science receives. These funds are also expected to cover most of the international mobility expenses, e.g., participation in conferences etc...

There is a sufficient number of full-time qualified staff available for supervision of PhD students, many of them international and with degrees from other universities. This ensures inflow and adoption of international best practices, and enhances international mobility of PhD students. Computer Science has proper facilities for staff and students to conduct their studies. As the CS department is growing, it is expected to move to new and larger premises in 2020.

Strengths

- The university/Computer Science has well understood the need for a secure income for PhD students and has committed itself to augment state stipends in order to enable students to study full-time. This allows students to complete their degree on-time and increases satisfaction with the studies.

- CS stands out with its commitment to bring in international faculty, even though in the field of Information Technology this requires a lot of resources.

Areas of improvement and recommendations

- There seems to be no clear agreement on the value of a PhD degree to a student, prospective employer, or to society as a whole. This might be one of the reasons why it is hard to get sufficient funding for the PhD studies.
- The university is recommended to continue its efforts in maintaining and improving the PhD student compensation.

- The relationship with companies is somewhat affected by the fear of losing good PhD students before they complete their degrees. On the other hand, companies are an important source not only of funding, but also of emerging innovative practices in information technology, and hence, the potential costs of engaging them more should be weighed against the benefits, and different ways of interaction should be tried.

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; organization 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 analyzed and such analyses serve as a basis for planning quality improvement activities.

Comments

Teaching practices and learning outcomes, which are in accordance with international standards, have been implemented to assure the quality and relevance of the doctoral studies. An adequate amount of compulsory and elective studies support the process to ensure general competences and transferable skills and to complete the PhD degree. Personalized study plans are compiled for each PhD student in collaboration with the supervisors and prior learning is taken into account. This supports the achievement of the learning objectives of the doctoral studies.

Teaching activities consist of lectures, tutorials, practice sessions, labs, homework assignments and mini-projects. The learning assessment is transparent, objective and supports the individual development. Regular meetings of research groups with PhD students are arranged to ensure the progress of the studies. Student feedback is collected mainly in informal discussions, but more systematic processes could be implemented. Some courses have been criticized and measures have been taken to improve the

student satisfaction. In general, PhD students seem to be satisfied with the curriculum, teaching, supervision and workload.

Overall, the curriculum is adequate and flexible. Moreover, PhD students are encouraged to attend international summer and winter schools, conferences and networking events. However, participation in industrial and business-related activities could be encouraged and supported even more.

Strengths

- PhD students and faculty appear to be satisfied.
- Teachers are highly qualified researchers.
- Teaching and learning is research oriented.

Areas of improvement and recommendations

- Processes to share best practices, to take student feedback into account, and to discuss innovations for improving the execution of the PhD program could be implemented in a more systematic way.
- Study times are long in international comparison.
- More international and interdisciplinary collaboration would be an opportunity to strengthen the program.
- Needs of industry and society could be tied more closely to the studies.

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 organizations, 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 is involved in conducting doctoral studies, participating in doctoral thesis defense 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

According to Table 1 in Annex B of the SER, there are currently 30 teachers and supervisors involved in the PhD programme. They all satisfy the legal requirements concerning their academic degree, as well as their research records and publication activity. Quality of teaching and supervision skills are continually evaluated, further development of staff teaching skills is supported by the university.

There is a wide network of international collaborations, within which ICS takes part, providing numerous international contacts. Also, more than half of the professors and researchers originally come from abroad, supporting internationalization efforts even more.

Strengths

- International background of teaching staff
- Good research and publication records

Areas of improvement and recommendations

- The workload concerning teaching and supervision is generally deemed high and distributed unevenly; this should be corrected
- Additional training for the teaching staff's supervisory skills should be set up

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[5].

[5] In the context of this document, 'research and development institutions' denote both research institutions and research-intensive companies.

✓	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 assessment team discussed the topics related to the PhD programme in Computer Science with a lively and diverse group of PhD candidates, who showed openness and engagement to provide their perceptions on various questions. In particular, the high proportion (51%) of international candidates is impressive.

PhD candidates expressed that "the admission process is transparent," that they are "generally pleased with their status at the university," and that they experience "the annual progress evaluation as a transparent and formal process," where priority is given to the relationship with the supervisors.

PhD candidates expressed that "the curriculum could benefit from PhD courses that are more specific for their research topics," but they also "receive good institutional support for the validation of external PhD courses." On the other hand, due to individual study plans, the level of the teaching workload can vary from one candidate to another. This issue might be effectively resolved with a definition of a minimum and maximum teaching workload in their contacts.

Overall, the group of PhD candidates was "extremely favorable about the inclusion of people from abroad in the program, and the support received from the university." There seem to be enough resources, and a stimulating environment to develop national and international collaborations. Lastly, uniform feedback mechanisms could be introduced or better executed to ensure easier integration of feedback from PhD candidates on the institutional level.

Strengths

- Close collaboration between the supervisors and the PhD candidates
- Clear and transparent annual progress evaluation of the PhD candidates
- Clear PhD candidate status at the institutional level (enabling multiple contracts, intentions to further enhance funding sources)
- Stimulating work environment which fosters existing and new PhD project collaborations on the national and international level (candidates in joint supervision projects)
- High proportion of international PhD candidates (51%), going along with the objectives set by the UT Strategic Plan for 2009–2015 to obtain at least 10% of foreign doctoral students in the PhD program
- Stimulating policy to enhance PhD candidates' international visibility (conferences, summer schools, projects, mobility, …)

Areas of improvement and recommendations

- Enhance PhD courses/curriculum development with more flexibility in the curriculum planning of individual PhD candidates (currently it is centralized and programme-based).
- Formalize the teaching workload/obligations of the PhD candidates. It appears variable, and a few PhD candidates expressed concerns that they have a higher teaching workload than others. This issue could possibly be clarified with the definition of a minimum teaching workload per candidate and indicated in the PhD contract.
- Provide more deliberate structural processes/mechanisms to ensure that PhD candidate feedback is taken into account at the institutional level (currently it is based on the study programme questionnaires, with expectations to implement a new information system/tool in the near future).
- Consider implementation of deliberate institutional policies with regard to ensuring gender balance and participation of women in the admission/application process, which can serve well in discussion and argumentation with policy-makers.
- Consider/propose the development of models for tax reductions for industry stakeholders who hire PhD candidates (argument for discussions with policy-makers), as a possible measure to popularize industrial PhD programs.

4. Assessment report of Mathematics and Statistics SPG at the University of Tartu

4.1. Introduction

The curriculum group Mathematics and Statistics of the Institute of Mathematics and Statistics comprises two doctoral programs: Mathematics 80332 (8896212) and Mathematical Statistics 80331 (8896212). The programs are managed by the Institute of Mathematics and Statistics at the Faculty of Science and Technology. The nominal period of studies is 4 years (240 ECs). These are the only doctoral study programmes in the study programme group Mathematics and Statistics in Estonia.

During the last 5 years the number of PhD students studying at the doctoral program of Mathematics was between 15 and 23 doctoral students, in 2016/2017 three of them were foreign students. The number of those working at the university at the same time as studying has been between 1 and 6 students. During the same period the number of PhD students at the doctoral program of Mathematical Statistics was between 12 and 17 students (in 2012 – 2015 one of them was foreign student). The number of those working at the university at the same time as studying was between 3 and 6 doctoral students.

THE NUMBER OF PHD STUDENTS

	2012/13		2013/14		2014/15		2015/16		2016/17	
		working at		working at		working at		working at		working at
Curriculum	Total	UT	Total	UT	Total	UT	Total	UT	Total	UT
Mathematics	23	6	19	6	18	5	15	1	18	2
Mathematical Statistics	14	4	17	5	17	6	15	4	12	3
Group	**37**	**10**	**36**	**11**	**35**	**11**	**30**	**5**	**30**	**5**
UT Total	1504	502	1457	493	1401	487	1348	380	1258	362

THE NUMBER OF INTERNATIONAL PHD STUDENTS

Curriculum	2012/13	2013/14	2014/15	2015/16	2016/17
Mathematics	1	1	1	2	3
Mathematical Statistics	1	1	1	0	0
Group	**2**	**2**	**2**	**2**	**3**
UT Total	**122**	**129**	**139**	**143**	**158**

THE NUMBER OF ADMITTED PHD STUDENTS

Curriculum	2012/13 Total	2012/13 Directly from UT MSc	2013/14 Total	2013/14 Directly from UT MSc	2014/15 Total	2014/15 Directly from UT MSc	2015/16 Total	2015/16 Directly from UT MSc	2016/17 Total	2016/17 Directly from UT MSc
Mathematics	4	3	3	3	1	1	4	3	6	3
Mathematical Statistics	1	1	3	3	1	1	1	1	0	0
Group	**5**	**4**	**6**	**6**	**2**	**2**	**5**	**4**	**6**	**3**
UT Total	190	151	179	153	168	137	171	139	177	133

The number of PhD students disrupting their studies

Curriculum	2012/13 Total	2012/13 on ones own will	2013/14 Total	2013/14 on ones own will	2014/15 Total	2014/15 on ones own will	2015/16 Total	2015/16 on ones own will	2016/17 Total	2016/17 on ones own will
Mathematics	3	0	2	1	1	0	1	1	1	0
Mathematical Statistics	0	0	1	0	3	1	1	1	3	1
Group	**3**	**0**	**3**	**1**	**4**	**1**	**2**	**2**	**4**	**1**
UT Total	148	55	128	42	154	40	171	48	146	48

The number of defended PhD theses

Curriculum	2012/13 Total	2012/13 within 6 years	2013/14 Total	2013/14 within 6 years	2014/15 Total	2014/15 within 6 years	2015/16 Total	2015/16 within 6 years	2016/17 Total	2016/17 within 6 years
Mathematics	3	2	2	0	6	4	2	2	5	3
Mathematical Statistics	0	0	0	0	0	0	0	0	1	1
Group	**3**	**2**	**2**	**0**	**6**	**4**	**2**	**2**	**6**	**4**
UT Total	114	57	117	62	107	45	120	75	138	65

4.2. General findings and recommendations at study programme group level

Until 2017, there were two institutes (in Mathematics and Mathematical Statistics) each with its own curriculum group. Since 2017, there is only a single Institute of Mathematics and Statistics (ISM) with a single SPG group managing the two doctoral programmes Mathematics and Mathematical Statistics. These programmes have an important role nationally in their fields, since similar programmes are not offered elsewhere in Estonia. The doctoral programmes have high reputation and standards and the faculty consists of high-class researchers.

Overall, the general impression is that the doctoral programmes work well, but there is always room for improvement. The assessment team proposes that the two doctoral programmes should be consolidated and managed more efficiently. More systematic processes of annual progress reviews, sharing good practices among supervisors and quality assuring mechanisms could be established. A closer collaboration between mathematics and statistics is an opportunity for the future. More international comparison, collaboration, mobility, study material and faculty would make the doctoral programmes stronger and more attractive. The needs of industry and society should be taken into account more in the SPG.

The University of Tartu is actively developing the financial support possibilities for the PhD students in order to support full time research work and reduce the dropout rate. The study times and the annual credit point accumulation are low in international comparison. It is unclear how ISM is planning to implement planned university-wide top-up funding of the PhD students, but it would be important to ensure a possibility for the PhD students to work full time for their doctoral studies.

4.3. Strengths and areas for improvement of study programmes by assessment areas

Mathematics; Mathematical Statistics

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 of Tartu has a well-documented, clear structure and processes for the doctoral programmes Mathematics and Mathematical Statistics. The four-year programmes (240 ECs) consist of one full year (60 ECs) of courses, with specialty courses (36 ECs), university-wide elective courses in transferable skills (12 ECs), and optional courses (12 ECs), and with three years (180 ECs) of research. The category specialty courses of the PhD program Mathematical Statistics contains three mandatory courses (in total 18 ECs). The thesis can consist of a summarizing article based on three publications or of a monograph.

The University of Tartu is gathering feedback regarding the PhD programs and PhD student progress. Admission of the PhD students is based on applications for research projects proposed by supervisors, and on a ranking of candidates based on their research proposals and their previous grades. The annual total acceptance of new PhD students is from 2 to 6 students, and the annual number of graduations is from 2 to 5. The percentage of foreign PhD students in the two programmes together stands at less than 10%. According to the SER, each year several students disrupt their studies, Most of them complete their degree eventually, but it takes longer than the nominal time of four years. However, the dropout rate is high and the period of study is long.

Strengths:

- The change to a single curriculum group managing the two PhD programmes with more uniform regulations is commendable.
- The university-wide feedback collection system is a very good instrument.
- The PhD graduates have found employment related to their degree and specialty. The majority of the graduates, 80%, is working in the academic environment, and the remaining 20% is working in the banking or official statistics sector.

Areas of improvement and recommendations:

- During the assessment period, only one PhD student had a research visit abroad longer than 30 days. The development of the outgoing PhD student mobility is recommended for supporting longer term visits. According to the SER, two professors will retire in 2018-2019, and two

new professors will be elected through open international calls to replace them. The recruitment of one of the two professors has been completed. In order to support renewal and recruit the best talent worldwide, a wide search strategy for new professors is recommended.

- According to the PhD students, the requirement of having three published papers in the nominal time of four years is a challenge, in particular, taking into account long publication cycles in the relevant fields. More flexible forms of a PhD thesis could be implemented without lowering the quality. For example, it is possible to defend PhD with a monograph dissertation having published a scientific article in an internationally recognized journal and having additional research results corresponding to two journal articles. According to the PhD student feedback in the SER, the annual study credit point accumulation is only 22 ECs in a year, which is a very low number. It should be ensured that the credit point accumulation is in accordance with the workload of the PhD students.
- PhD studies have been interrupted in 4 cases out of 11 students (36%). The university is recommended to continue its efforts in improving the PhD student compensation in order to support full-time PhD research and studies.

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

ISM is a merger of two institutes, and the main resources – teaching staff and supervisors - seem to be still split according to the previous departments. This is also reflected in the fact that the PhD students are admitted to two separate doctoral programmes in Mathematics and Mathematical Statistics.

While the faculty recognizes the need to pay students top-up through part-time or full employment in order to allow them full-time studies, ISM is currently able to employ only 5 out of 30 current PhD students.

ISM has a sufficient amount of qualified faculty. Supervisors have often worked with the prospective PhD students already during their master level studies. Such collaboration, often referred to as academic curiosity during the interviews, seems to be one main factor motivating students to continue to PhD studies.

While not in the report, from the interviews the assessment team understood that the current main research grant of ISM allows participation of the PhD students in one EU-conference attendance annually. If students are not members in research teams, or for additional travel, they have to apply for individual grants outside ISM. An important support used to come from the Estonian Doctoral School in Mathematics and Statistics (funded by EU structural funds); however, as we learned from the interviews, the EU support for this initiative has expired.

ISM has made attempts to identify potential for applied science projects with Estonian companies but no such contracts have been signed in the past five years. The assessment team has been told that consultation assignments with companies have been concluded by staff and students directly on an individual basis. PhD students who work full-time outside the university do not have agreements between their employers and ISM covering such relations.

Strengths

- Availability of qualified supervisors who nurture the prospective students, often from the very early years of their bachelor studies on, is a great strength in attracting PhD students with true passion for science.

Areas of improvement and recommendations

- Due to the small number of students, many required courses are only available every second or third year, thus making study planning difficult.
- Financial pressure forces most students to work outside the university, mostly in fields not directly linked to their PhD thesis. The University has told the assessment team that central development funds will be used to finance the basic salary requirement after UT makes it compulsory.

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; organization 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 analyzed and such analyses serve as a basis for planning quality improvement activities.

Comments

Teaching practices and learning outcomes, which are in accordance with international standards, have been implemented to assure the quality and relevance of doctoral studies. An adequate amount of compulsory and elective studies support the process of ensuring general competencies and transferable skills and to complete the PhD degree.

Objectives and learning outcomes of the PhD programmes are clearly defined. The studies are designed to support a PhD student to achieve the learning objectives. Teaching methods are relatively traditional, including lectures and seminars. The learning assessment is transparent, objective and supports the individual development of the doctoral candidate.

Each PhD student works according to an individual study and research plan that supports achievement of the objectives. The selection of courses and the exact contents of the studies depend on prior knowledge and competencies of the PhD students. Every year, the progress review report and detailed plan of the studies and research for the next year are updated in the plan.

Student feedback is collected primarily in informal discussions. PhD students feel that their feedback is taken into account. In general, PhD students are satisfied with the curriculum, teaching, supervision and workload. However, the annual study credit point accumulation is very low, possibly an indication that the study credits are not in accordance with the actual workload of the PhD students. This may also delay the doctoral studies and, in the worst case, be one reason for a relatively high level of dropouts.

Overall, the two curricula are adequate and flexible. Moreover, PhD students are encouraged to attend international summer and winter schools as well as conferences and networking events. However, connections to industrial and business-related activities could be encouraged and supported more.

Strengths

- Teaching and learning is research oriented and supports the process of completing the PhD degree.
- PhD students and faculty are satisfied with the teaching, learning and supervision practices.

Areas of improvement and recommendations

- The annual study credit point accumulation is very low, and the study time is relatively long in international comparison.
- The needs of industry and society should be taken into account more in the studies. This applies, in particular, to the PhD programme in mathematical statistics.

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 organizations, 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 is involved in conducting doctoral studies, participating in doctoral thesis defense 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

These comments concern both the PhD programme in Mathematics and the one in Mathematical Statistics (i.e., sections B1 and B2 in the UT MS SER; the listings of the respective pedagogical staff (Annex 2 A and B, resp.) naturally overlap considerably, but not completely).

Starting 2018, all lecturers are required to have a PhD, as has been the case for all supervisors of doctoral theses already for some time. All these requirements (legal and otherwise) appear to be satisfied. Teaching and supervision skills are continually being monitored within the professional review procedures of the university, further development of the staff's teaching skills is supported by the Lifelong Learning Center. Cooperation with other research groups (both nationally and internationally), from which doctoral students can greatly benefit, is in place in a number of cases.

Several professors are up for or close to retirement. Due to the budgetary constraints, the University will try to find some of the replacements in house among the researchers with excellent research and publication records.

Strengths

- Workload regarding teaching and supervision appears to be well distributed.
- Staff members are by and large quite satisfied with the situation and the general prospects, even though a number of problematic issues (financial development, size of programme) are seen.
- Opportunities for career development are available and being used.

Areas of improvement and recommendations

- Training for teaching (and supervising) skills should be improved and intensified.

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[6].
✓ 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 assessment team finds that the PhD candidates are provided with relevant information and support in the admission process. The PhD candidates, however, expressed their concern on the overall duration of the PhD projects/theses, which could be attributed to the low funding opportunities, and which results in candidates searching for day-jobs outside of academia. These other sources of income may not be directly related to their PhD projects, which could also influence individual cases of the PhD

[6] In the context of this document, 'research and development institutions' denote both research institutions and research-intensive companies.

candidates leaving academia for several years, meaning extension of the overall thesis duration.

The PhD candidates expressed supportive and collaborative relationships with their supervisors. Some remarks noted in our discussion are linked to the availability of the PhD courses/curriculum design. The PhD candidates find it hard to follow certain courses related to their PhD projects since they are available only every few years. However, this fact is rather an effect of the institutional approach in course organization where the HEI provides certain courses only every few years to ensure the necessary quota. A final outcome is that this may also influence the overall thesis duration, and it does not allow flexibility in adjusting the PhD curriculum to individual needs and PhD project relevance.

The PhD candidates find the annual progress evaluation as appropriate for their overall PhD programme objectives and expressed no critical remarks on this matter. Some future perspectives could envisage development of PhD tracks with applied research tracks that could add to the value of PhD candidates in the industrial sectors, and possibly lead to development of industrial PhD programs.

Strengths

- Close collaboration and supportive relationships between the supervisors and the PhD candidates.
- Transparent annual progress evaluation.
- Stimulating programme ambiance to develop international visibility and boost international cooperation of PhD candidates (conferences, seminars, …).

Areas of improvement and recommendations

- Improvements could be made on the status of the PhD candidates at the HEI level and the clarification of their respective funding possibilities (majority of interviewed PhD candidates rely on the governmental funding with a minimum of 660 EUR, which results in their search of external funding sources).
- Enhance institutional support and availability of information for career planning and roadmaps.
- Improve the support of international PhD students concerning teaching and supervising/mentoring.
- Develop possible applied research tracks to ensure visibility of the PhD candidates towards the non-academic stakeholders. Currently, preference is given to the development of theoretical research tracks.
- Ensure availability of up-to-date information regarding the PhD courses/curriculum and enable flexibility in the adoption to specific PhD projects.