

## **External PhD Candidates: drivers of innovation**

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### **INTRODUCTION**

Many institutes for higher education maintain good contacts with business and governmental organisations. It is from these contacts that professors regularly recruit talented candidates for a PhD project. These so-called 'external PhD candidates' remain stationed elsewhere, and they are granted (part-time) leave for a PhD programme from their company or do their research unpaid and in their own time.

The added value of external PhD programmes can be significant. Knowledge and insights developed by PhD candidates can be applied in practice immediately – which is in line with the 'Europe 2020' goals – in this case, implementing the knowledge triangle. In addition, the university facilitates lifelong learning pathways of the PhD candidates.

However, what sounds appealing in theory is not so easy in practice. Not only is the time available for research a problem for external candidates, but they spend a relatively large amount of time learning to do research (searching for literature, formulating research questions, selecting research methods etcetera). It is sometimes years since they last attended university, which means that they possess a great deal of practical experience, but need to be trained as a scientific researcher. Furthermore, former research shows that implementing innovations generated by PhD projects is not a matter of course. Moreover, the competencies needed for a future career in industry and competences needed in a PhD project do not always correspond. [1]

For this reason, a series of interviews are held with supervisors, external PhD candidates and companies in order to recognise the specific needs of each party and be able to (co-)design a tailor-made PhD programme. In this paper, the results of the interviews with the external PhD candidates are discussed.

- What is the background of the PhD candidates who were interviewed? What is their motivation for starting a PhD project at a technical university?
- What problems do they encounter at the start of the PhD project, during the following years, and towards the end of the PhD project?

I will discuss doctoral education from the perspective of the knowledge triangle - the interplay between research, education and innovation (chapter 1). In chapter 2, the needs analysis of external PhD candidates will be discussed, and six cases will be analysed accordingly. Finally, the conclusion describes how these pathways can be made more efficient and more effective.

## 1. THE KNOWLEDGE TRIANGLE

Corporations and governmental organisations that have promising candidates for a PhD programme should be able to work together with universities. This is something that strengthens the cooperation between the university and industry or government, and this interaction increases the potential for innovation. It is one way to implement the knowledge triangle.

The knowledge triangle was introduced by the Lisbon Agenda at the dawn of this century in order to enhance Europe's competitiveness. As shown in Figure 1, the knowledge triangle links together Research, Education and Innovation, with special platforms and processes on its three sides. It replaces the traditional "one-way" flow of information, from research to education and from educators to students, with a "both ways" circular motion between the three corners of the triangle.

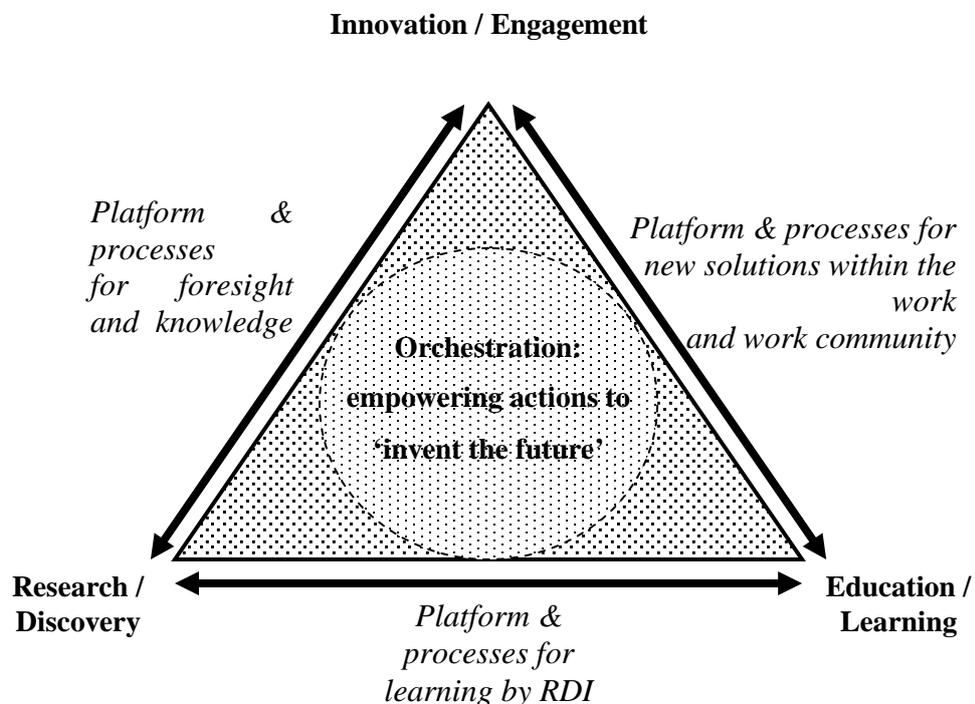


Figure 1 The Knowledge Triangle [2]

The concept of external PhDs covers all corners of the knowledge triangle. First of all, these PhD students are lifelong learners, educated to be scientific researchers. Doctoral education for external PhD students is therefore a form of continuing engineering education. Moreover, external PhD students can be involved in ordinary education; for example, by giving guest lectures. Furthermore, internships or thesis projects of regular Bachelor or Master students could be easily and meaningfully integrated into the external PhD trajectories because of the long-term in-depth relationship between industry and university. Secondly, the learning process of PhD students is strongly linked to research. The aim of the PhD study is contributing to science, therefore delivering new knowledge. At the same time, external PhD candidates are incorporating the third corner of the triangle in ensuring economic or societal innovation.

So the external PhD concept offers tremendous opportunities for education, research and innovation, provided that these processes are well designed. The next chapter describes how external PhD projects are currently organised.

## **2. NEEDS ANALYSES OF EXTERNAL PHD CANDIDATES**

### **2.1 Method**

Six external PhD students are interviewed for approximately 1,5 hours per person. The semi-structured interviews are conducted using an interview template with seven blocks of questions. Each interview starts with general questions about motivation, background and subject of the PhD study. The second block contains questions concerning the start of the PhD programme: how did it come about that you have started a PhD programme? Another question was: is there something formerly arranged at the start of your PhD? This is followed by blocks of questions about the problems they encounter during the first year, during the next phase, and the final phase of the PhD project. Finally, there are questions relating to external partners: what kind of support do you get from your company? There are also questions about the future: what do you want to do with the end result, both in terms of career development and the implementation of the results? The interviews are recorded and transcribed. All transcripts are then analysed using the seven blocks of questions. I will focus in this paper on the background of these candidates and on the problems they encounter during the various phases of the PhD project.

### **2.2 Background of external PhD students**

Delft University of Technology (TUD) is currently working on registration of all PhD candidates in an online programme called DMA. This is relatively convenient for internal PhD candidates who have a contract of employment with the university, such as PhD candidates who are working on (inter)nationally funded projects. They automatically become members of the graduate school of the faculty where they are appointed.

Registration of external PhD candidates is less simple. These projects often start on an informal basis. There are, for example, currently around 175 internal PhD candidates at the faculty of Technology, Policy and Management (TPM), one of the 8 faculties of TUD, and around 50 PhD students at TPM are registered as 'external'. It is expected, however, that the actual number of external PhD students is much higher.

Table 1 shows the background of these external PhD candidates and their motivation to start a PhD project.

	<b>Background (study)</b>	<b>Background (work)</b>	<b>Motivation</b>
1	Information science, MBA	Self-employed (formerly employed at energy company)	Value for the enterprise Personal development
2	Mechanical engineering, TWAIO: process technology in chemical engineering, executive MBA	Self-employed (formerly employed at (a different) energy company)	Academic career
3	MTS, HTS	Teacher at a university of applied sciences	Achievement of highest level on this topic
4	Electrical engineering (alumnus TUD)	Teacher at (a different) university of applied sciences	Interest in the topic
5	Civil engineering (alumnus TUD)	Staff/policy-making position at a water supply company	Expert training, possibly to find (new) job
6	School for business administration and economics (in Dutch: HEAO), Master's in Information management, register accountant	Registered accountant at Dutch Tax and Customs Administration, and trainer at a university	Tax Administration has opted for ICT research of TUD Own motivation: more freedom and appreciation, higher level of teaching

From these six cases the diversity of the group external PhD students becomes clear. A provisional distribution based on their work looks like this:

1. (Single) Employee from a (large) company or public organisation (on his or her own initiative)
2. (Group of) Employees at the initiative of the private company or public organisation. The company wants to conduct specific PhD-research with the university through a number of their employees
3. Self-employed (owners of a small company)
4. Teacher at a university of applied sciences
5. Not employed (at TUD or) elsewhere (not in this corpus, but PhD students who are retired, unemployed, or not searching for a paid job, for instance, the wife of an expat.

All interviews are held face-to-face. Although not all of the external candidates live in the western part of the Netherlands, they regularly attend the university, or they even have a workplace for 1-2 days a week. The group of external PhD students working at a distance, for example, in Asia, is a category that has been omitted from the research completely.

The motivation to become a PhD holder varies significantly. All PhD students showed an interest in the topic and an effort to change something essential in the current situation by their research. However, their ultimate goal varies: from an academic career to innovation in the (own) private company or public organisation. In the case of the two teachers of two different universities of applied sciences, it was less clear what they want to do with the PhD, either for their own career or with the results of their research. It might be self-evident that they use it in their education, but it could

also be that too little attention is paid to the career perspectives of teachers at universities for applied sciences with a PhD.

Once we have progressed a little further with the registration of external PhD's, we could send a questionnaire to a larger group of external PhD students. Then we would be able to eliminate this division and among other things reveal the largest group.

### **2.3 Needs of external PhD students**

A large part of the interview was designed to create an inventory of the problems that external PhD candidates encounter or what they miss in the process (up to now). The time spent by the respondents on their PhD varies: 1 year (2 x), 1.5 years, 4.5 years and 5 and 6 years respectively. None of these candidates has graduated already.

Many comments related to the start-up phase. The first set of problems can be described as administrative problems. Most PhD candidates were given a hospitality declaration, some of them also acquired a workplace ('flexible work place') at the university. Respondents complained that registration, obtaining an e-mail address, a library card and access to the university's computer network was not properly organised. They also had trouble getting their workplace established for the PhD study. External PhD students suddenly had 3 workstations: at the university, at their employer and at home. Literature, for example, can be consulted at the university campus on paper only, so that meant dragging back and forth the literature, or finding it elsewhere.

Finding relevant literature and archiving is an issue that almost everyone labelled as problematic in the start-up phase. As a consequence, all PhD students were asking for a library course and also for a course to become acquainted with a programme such as Endnote. Endnote is a reference management software package, used to manage bibliographies and references, but no one has really used this programme so far. The best and fastest way of obtaining literature, according to the respondents, is to ask your supervisor for literature as a starting point.

If I analyse these statements further, however, the essence of the problem does not lie in information literacy. The core problem is the fact that external PhD candidates start from a practical question or problem and they want to solve that problem. In terms of the Knowledge Triangle, they start from an innovation question, not from a research question. As a result, they have no idea what a theoretical framework is and its place and function in a dissertation. They do not know which theories are relevant to their question, and what makes their problem/issue scientifically interesting. Therefore, they are unable to formulate a scientifically interesting research question on their own.

In addition, a problem that nearly everyone mentioned was 'methodology'. What is a good approach? How can I find a scientific justification for the cases that I already use in my work? Again, if I analyse this further, knowledge of qualitative or quantitative research methods can be a problem, but the starting point regarding methodology is more important in this phase. As many employees work in projects or in consultancy, they expect a similar schematic approach. They are searching for differences with a consultancy approach, since that is their frame of reference. Furthermore, they are amazed at what is involved in scientific methodology, especially if they are confronted with, for example, philosophy of science. This applies less for PhD candidates who work on a more technical subject.

A clear problem is also the English language. The language of practice is often (not always) the mother tongue, but the language of science is English. The reading ability is usually not a problem, but speaking and writing skills pose a problem for the external PhD students.

Another problem is the contact with other PhD candidates. Where are other PhD students located, what are they working on and how can I contact those people? A Facebook page has already been suggested as a solution to the problem. Also, (full or half-day) events for PhD students have been useful according to the respondents. The opportunity to discuss your topic with internal PhD students or scientists from the department was especially useful, because they were much more familiar with the scientific approach, and much more aware of the 'school of thought' of the group or faculty. In order to be able to understand your supervisor you need to become familiar with the body of knowledge of the faculty; for instance, system engineering shaped the experience of the PhD candidates.

After the first year, in the next phase, in which, among other things, the data collection and analysis takes place, it is difficult to free up time. That is especially the case for the two respondents with their own private company. It is no problem to obtain data, but it takes time to collect and analyse the data. In those phases, it is difficult to keep going. Another problem mentioned by a PhD student who wants to finish his PhD study with a series of articles, is that it is not so easy to publish articles in reputable journals.

The time issue also plays a role when writing the thesis in the final phase. In the writing phase it is good if you can set aside a number of days in a row. Whether that is possible depends on the situation at work and at home.

All respondents have chosen a topic that in their words is 'hot' at the moment, for instance energy transition, measures against botnets, or maintenance management. As it is taking longer than they thought to finish a PhD, the research could be outdated for practical use. That is not an issue for these candidates, though, because they implement the findings immediately in their work, but some of these PhD candidates do think in terms of time-to-market. They characterise the trajectory as inefficient, but very enriching. "A PhD study is a way of life", said one of the respondents, "and no one told me!"

### **3. CONCLUSION**

In this paper I have looked at a special group of PhD students, namely external PhD students. They are 'external' from the university in the sense that they are not employed at the university, but somewhere else. From the perspective of the knowledge triangle, this is an interesting group since they are able to implement the findings from their PhD study in practice immediately. The ambition to increase Europe's competitiveness by innovating faster based on sound research could become a reality. An important condition, however, is that these external PhD projects run smoothly. I have therefore studied the problems that these PhD students encounter from the start of their PhD study to the end. Some of these problems can be solved easily. Administrative problems and IT-related problems, for instance, can be solved by a proper intake process and by appointing someone who is responsible for organising an effective infrastructure. External PhD students could be up and running much faster.

But this study revealed other problems that are less easy to solve, since they arise from differences in the domain of practice and the domain of research. External PhD students are working in a company (domain of practice), often for many years and are motivated by solving a practical problem. They want to make a difference in practice through their research, which is another starting point that differs from an internal PhD student who carries out a subsidised project, of which the proposal was written by a scientist. The translation of a practical problem into a scientifically interesting research question is an issue for most external PhD students. They use their own reference scheme to solve this issue, but that approach falls short. Some supervisors also speak a language different to what the external PhD students are used to. In terms of the Model-Activity-Utility (MAU) framework, universities and companies operate on the basis of different models, carrying out different activities. What is more, the incongruity regarding the production of satisfactory results poses problems for external PhD students and universities.[3]

An external PhD study is a learning process for all parties involved. Doctoral education can bridge the gap between innovation and research. However, the common 'sink or swim' method that puts the external PhD student to the test with hardly any guidance (not in this corpus) at first, is not effective and, for the external PhD students that prove to be swimmers, not efficient. As for all continuing engineering education programmes, tailor-made solutions are important [4]. That is not to say that there should be a different programme created for everyone; a few library courses and an English language course, however, are probably not sufficient.

Doctoral education could be delivered in many different ways. What has proved to be successful is an event for internal and external PhD students within the department in which important themes ('body of knowledge') are presented; there are also (Friday morning) meetings for the permanent staff and PhD students of a research programme, where PhD students also present and discuss their work. Those solutions work, but not for everyone. Some external PhD students live far away, are unable to attend on Fridays, or cannot make the transfer to their own topic or that transfer takes (too) long. It is therefore important to discuss the progress of scientific thinking and to determine the requirements for offline and online (collaborative) facilitation. Innovative forms of professionalization as peer groups, online communities, living labs can also be included. 'Keeping the candle burning, and filling in all the missing puzzle pieces in a way that suits the external PhD student' is the challenge.

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