DOCTORAL STUDIES: IMPLEMENTATION AND PERFORMANCE OF EDUCATION AND RESEARCH PROGRAM AT THE FACULTY OF CONSTRUCTION MANAGEMENT IN BELGRADE

S. PETROVIC [1], S. KOPRIVICA [2], A. TERZIC[3]
[1] Faculty of Construction Management, University "Union Nikola Tesla", Cara Dusana 62-64, Belgrade, Serbia
[2] Faculty of Construction Management, Belgrade, Serbia
[3] Institute for Material Testing, Belgrade, Serbia
e-mail: spetrovic@fgm.edu.rs

EXTENDED ABSTRACT

The preparations and later implementations of the Bologna process at universities in Serbia started at the beginning of the last decade. Apparently, this process was the most slowly developed in the field of doctoral education. Possible reasons for this could be concerned with the low interest of civil engineering students for pursuing the PhD studies from the practical standpoint as well as changes in the evaluation systems and requirements addressed to academic staff supposed to carry out the curriculum and mentorship. In addition, better relations and cooperation between faculties and scientific and R&D institutes must be established dealing with PhD courses. However, doctoral studies in Serbia are on their way to define integrative framework comprising research and education. The Faculty of Construction Management is one of the two civil engineering faculties in Belgrade which has been accredited for PhD program by Serbian Ministry of Education and Science. In order to provide students with the state-of-the-art knowledge and various research topics, several prominent professors who are leading experts in their fields are engaged from universities in USA and UK. Distance problem considering that students and professors live in the different states has been overcome by the use of the latest ICT approaches. The aim of this paper is to present the conceptual and organizational aspects of the doctoral studies at The Faculty of Construction Management with implementation of new teaching and learning technologies based on IP and up-to-date software tools. Special efforts have been made to include the best PhD students in scientific and R&D projects supported by Serbian Ministry of Science and Technological Development. There is considerable interest to participate in European FP6 and FP7 programs as well as in bilateral cooperation with universities in neighbor countries. Young researchers have been stimulated to publish investigation results under the leadership of their mentors. For the sake of illustration, PhD course topics in structural engineering are presented with the emphasis on curriculum, implementation of new technologies in teaching and learning, and inclusion of PhD students in scientific and R&D projects.

KEY WORDS

Civil engineering, Doctoral studies, Education and research, New teaching and learning technologies.

1. INTRODUCTION

The functioning and development of national and regional socio-economic systems depend on the increasing level of general education, professional expertise and usability of skills and knowledge. Therefore, it is not surprising that the European Union has chosen the development of knowledge society as its way to progress. The education process has become more complex and longer, and the need for continuous acquisition of new knowledge and skills has been more expressed. In this context, doctoral studies, especially regarding the strong research component, are recognized as a crucial factor in generating and improving the creative society and the innovative economy [2].

In order to complement the existing information on various experiences in implementation of Bologna process in PhD programs, this paper gives an illustration and analysis of education and research program at the Faculty of Construction Management in Belgrade. At the beginning we highlight the substantial changes that implementation of the Bologna process has brought to the European PhD education and then continue with the brief overview of reforms in Serbian higher education. In the main part of our study, we present PhD course topics in structural engineering as the example of doctoral studies program at the Faculty of Construction Management (FCM) in Belgrade and analyze to which extent this program overcomes certain problems and succeeds in providing the high-quality education and research conditions.

2. PhD STUDIES IN EUROPEAN CONTEXT

The doctoral studies were not directly involved in the Bologna Process until the Conference of European Ministers of Education in Berlin in 2003. This form of higher education was for the first time incorporated as a third level of study at the conference. The exclusively research-based character of PhD courses has been changed by including the teaching component and consequently making these studies more strongly linked to the previous two higher education levels (Bachelor and Master). The old definition of doctoral studies as a generator of new, original knowledge has been relativized in the sense that PhD level should be an open system where knowledge is generated and transmitted at the same time [4]. Also, contemporary doctoral studies have become more oriented to multidisciplinary fields so the possibilities to implement gained experiences and knowledge are now wider and more varied. Having this in mind and the fact that soft-skill workshops and trainings are more often included in PhD programs, it becomes more common that doctors of sciences have not been employed only at universities and laboratories but also as advisors, experts, project leaders and managers in large firms and corporations, as well as in political and economical institutions.

The inclusion of doctoral studies as a third cycle in the Bologna process has created new opportunities but has also opened a number of questions for which there are no simple answers. They are as follows: 1) considerable diversity in the organization and structure of individual programs caused by rapid changes in the global labor market, 2) implementation of new, innovative mentoring methods and multiple mentorships due to the increasing multidisciplinary nature of PhD studies, 3) internationalization through the development of joint doctoral programs, 4) mobility of the researchers etc. With regard to civil engineering education, some of these issues were studied in the third project of the EUCEET (European Civil Engineering Education and Training) Thematic Network started in 2006 on the basis of a 3-year grant.

3. DOCTORAL STUDIES IN SERBIA

Reforms and harmonization process in the field of higher education in Serbia started with two significant events: 1) signing of the Bologna Declaration in September 2003 and 2) adoption of the new Law on Higher Education in September 2005. Comparison of the structure of higher education under the old and the new law is given in Figure 1. We can see the reduction of the nominal time required for completion of doctoral studies from 11-12 to 8 years.

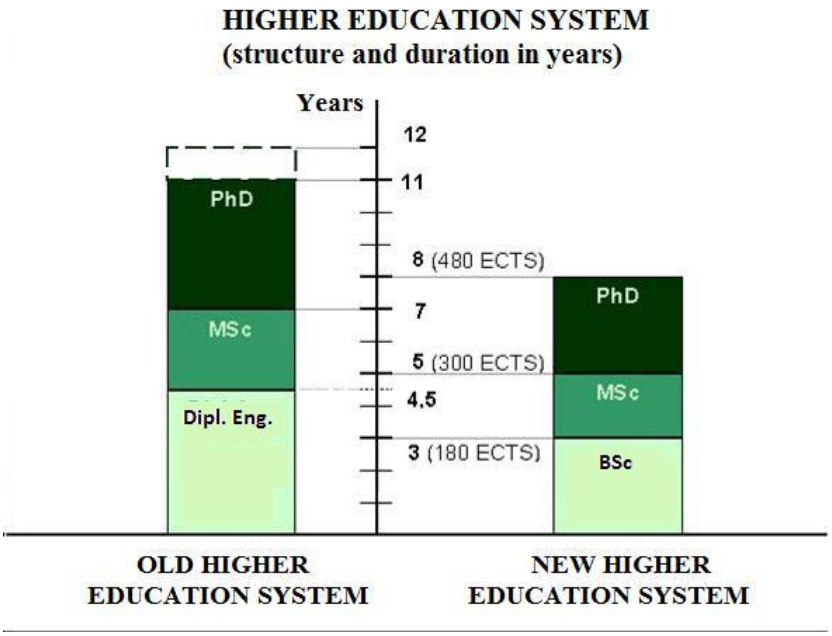

Figure 1: Comparison of nominal time required for completion of doctoral studies under the old and the new Law on Higher Education [4]

The period of transition for Masters of Science and postgraduate students under the old law to defend their doctoral dissertation was extended to 2016 according to the Amendments of new Law on Higher Education in June 2010.

The first implementation of new program of doctoral studies in Serbia started in 2006. This process was difficult and with a lot of starting uncertainties due to the fact that doctoral studies were sparsely covered by Serbian Law on Higher Education [6] and one can only find few clauses related to this issue:

- Credit hour requirements for PhD level corresponds to 180 ECTS (European Credit Transfer System) and the requirement for the admission of applicants is that they have previously realized at least 300 ECTS at lower education levels (Bachelor and Master);
- The doctoral dissertation is the final part of the study program at the doctoral studies implying that research and teaching process, mentorship, as well as PhD thesis submission and defense procedures should be regulated by General Act of higher education institution;
- Ranking conditions for acceptance of candidates on PhD programs are prescribed by General Act of higher education institution.

It is evident that Law on Higher Education left the higher education institutions to individually define plenty of issues such as application requirements, curricula, additional trainings and workshops, dissertation structure and defense procedure etc. Accreditation of doctoral studies has brought more clarity and order to this area.

Serbia has 8 state and 11 private universities. PhD programs in civil engineering have been accredited at 4 of them: 1) Faculty of Civil Engineering - University of Belgrade, 2) Faculty of Civil Engineering and Architecture - University of Nis, 3) Faculty of Technical Sciences in Novi Sad and Faculty of Civil Engineering in Subotica - University of Novi Sad, and 4) Faculty of Construction Management - University “Union Nikola Tesla”.

Strategy of Scientific and Technological Development in Serbia for period 2010-2015 was adopted in July 2010 [7]. Seven research priorities, including civil engineering, have been established with the emphasis on:

- Improvement of research infrastructure,
- Creation of Serbian Scientific Center,
- Stimulation of young researchers and PhD students to participate in R&D projects financed by the budget,
- Optimal usage of experimental facilities through mandatory cooperation of relevant institutes and faculties.

4. DOCTORAL STUDIES AT THE FACULTY OF CONSTRUCTION MANAGEMENT IN BELGRADE

The Faculty of Construction Management (FCM) was accredited as a scientific and research institution by the Serbian Ministry of Science and Technological Development in January 2007, while accreditation of study programs for three levels of higher education (undergraduate, Master and Doctoral) was realized in May 2009. Civil and construction engineering requirements for the PhD degree relate to academic regulations (program standards, thesis requirements, credit hour requirements) and procedural elaborations (selection of mentor, forming a committee, review of study program, qualifying examination concerned with PhD theoretical basis, PhD thesis submission and defense).

Doctoral studies comprise two programs: 1) structural engineering and 2) management of sustainable development in construction. Considering the limited scope of this paper, the authors will focus on the structural engineering program, particularly to the education and research program in the area of vibration serviceability.

The key points of structural engineering PhD program defined by FCM are:

- Development of the exceptional expertise in the major area,
- Providing the background and adjunct knowledge required to practice or teach this specialty at the highest professional level and to conduct significant research in this field,
- Providing significant and original contribution to engineering knowledge.

The authors have made the list of most relevant aspects of the program in order to give the systematic presentation and analysis.

4.1 Model of studies

Serbian Law on Higher Education [6] prescribes the model of PhD studies based on the Bologna principles (structured program which comprises individual research and coursework). This model is established at all universities and higher education institutions in Serbia.

Doctoral studies at FCM last three years, although they can be extended to at most six years in the case of experimental research. The total number of ECTS attached to doctoral studies in structural engineering is 180, where 105 ETCS are realized through 4 obligatory and 4 elective courses examinations, 15 ETCS for qualifying examination of theoretical basis of doctoral dissertation, 40 ETCS assigned to two study research works towards PhD thesis and 20 ECTS by completing and successful defense of PhD thesis [1].

4.2 Admission

The main requirements for application to structural engineering PhD program are at least 300 ECTS gained at both BSc and MSc levels in the related field as well as high grades and proven research ability. These criteria are used in order to rank and select applicants [1].

4.3 Curriculum

Doctoral study program in structural engineering consists of 3 phases: 1) coursework intended to improve the student's knowledge in the field of interest and to provide tools for individual research (first 3 semesters), 2) theoretical foundations of PhD thesis - initial research which comprises review of the relevant literature, classification and comparison of existing approaches and solutions for the chosen problem (1 semester), and 3) research work, submission and defense of PhD dissertation (2 semesters). Curriculum example for structural engineering PhD program at FCM is presented in Table 1.

Table 1: Curriculum example for structural engineering PhD program at FCM.

N°	Course description	Course status	Semester	ECTS
1	Methodology of scientific and research work	obligatory	1	5
2	Selected topics in mathematics	obligatory	1	10
3	Selected topics in computational mechanics	elective	1	15
4	Selected topics in management and ICT in civil engineering	elective	1	15
5	Selected topics in concrete structures	elective	2	15
6	Total quality system control in civil engineering	elective	2	15
7	Selected topics in geotechnical engineering	elective	2	15
8	Selected topics in international projects management	elective	2	15
9	Selected topics in theory of structures	obligatory	3	15
10	Selected topics in earthquake engineering	obligatory	3	15
11	Selected topics in fracture mechanics	elective	3	15
12	Selected topics in civil eng. companies management	elective	3	15
13	Theoretical foundations of doctoral dissertation	obligatory	4	15
14	Study research work I - PhD	obligatory	5	30
15	Study research work II - PhD	obligatory	6	10
16	Doctoral dissertation (submission and defense)	obligatory	6	20

Coursework in the first phase consists of 4 obligatory and 4 additional elective courses, out of the offered list. The list of elective courses covers most important and fundamental fields of civil engineering and PhD candidate selects them in consultation with mentor and relevant professors. Usually, the student is required to complete satisfactorily examination of the theoretical basis of the selected course topics and to give a seminar on the topic suggested by student and approved by professor. Total numbers of active teaching classes per year during doctoral studies are given in Table 2. These classes comprise lectures, exercises, individual research work and other teaching activities.

Table 2: Total number of active teaching classes for structural engineering program at FCM.

N^o	Study year	Total number of active teaching classes
1	First	630
2	Second	600
3	Third	600
4	Total	1830

Better correlation between courses and research work was requested by PhD students, according to the survey on the quality of doctoral studies in Serbia, carried out by The Association of PhD Students and Young Researchers of Serbia [3]. Transferable skills trainings are not included in structural engineering PhD program at FCM. This problem is partially solved at the PhD program in vibration serviceability by the mentor who recommends the literature on these topics (e.g. “Your PhD companion” by S. Marshall and N. Green etc.).

4.4 Mentorship

Mentors are selected among professors working at FCM or scientists and researchers employed at R&D institutes who have published minimum 5 papers in international journals from SCI list in the relevant field in the last 10 years [1]. Except the mentioned formal requirement, FCM policy implies that mentors should be experts in the concerned scientific field with great experience in both teaching and research areas. Thus, several professors who are leading experts in the areas of interest are engaged from universities in USA and UK. If a PhD project is multidisciplinary, it is a practice that two mentors are assigned for mentorship (competent in different scientific disciplines).

Students choose research areas and corresponding mentor shortly after they enter the PhD program in structural engineering at FCM. Structural engineering PhD program covers several research topics such as vibration serviceability, earthquake engineering, geotechnical engineering, and computational mechanics. We shall pay particular attention to vibration serviceability PhD studies in the following sections.

Mentor assigned to the field of vibration serviceability is a prominent professor at the Department of Civil & Structural Engineering of Sheffield University. The key operating concept proposed by the professor is multitasking work. Students are advised to review the relevant literature and master necessary software and information management tools simultaneously with course attendance in the first year of studies. This model of student engagement in initial research related to PhD thesis at the very beginning of the studies leads to the publication of approximately two scientific papers and involvement of students in scientific projects in the second year of studies. Monitoring and evaluation of students work is accomplished through reports that students are required to regularly submit every month.

4.5 Implementation of new technologies in teaching and learning

E-learning, primarily referring to computer and network based transfer of skills and knowledge, becomes increasingly popular and utilized at all levels of higher education in Serbia. The Government National Counsel for Higher Education determined 12 standards for a study program that must be fulfilled for accreditation. The last one deals with distance learning. Considering the differences between distance learning and e-learning there is an opinion that 12^{th} standard should be rewritten and put in the broader context. More information about this topic can be found in [5].

Negotiations on the procurement and implementation of Blackboard platform, consisted of Learn, Content and Community modules, started at FCM in March 2011 and finalization of the process is planned in October 2011, before the beginning of the upcoming school year. The platform will speed up and facilitate administrative work and remarkably improve the quality of teaching, consequently opening the way to distance learning opportunities and better cooperation with other faculties and R&D institutions.

Considering the fact that mentor in the field of vibration serviceability is the professor from Department of Civil & Structural Engineering of Sheffield University, and research students live in Serbia, there is a considerable experience in utilization of ICT for the collaboration and teaching purposes. For the sake of illustration, there are few examples:

a) Consultations are organized via Skype. One of the features offered by Skype is that one calling party can see the PC screen of the other and this is especially favorable if screen is pen-sensitive. Thus, professor can highlight the part of the text, make the sketch or directly view and put comments on the student's work. Also, Skype offers other possibilities like conference calls (if there are more than two interlocutors) or sending files by transferring them into the chat window.
b) Sharing of documents is done by Dropbox software. Sending files by e-mail may cause several problems. Firstly, sending large files (>10 MB) is difficult and time consuming. Secondly, mail can get lost or be placed in the spam folder. Even if everything went well and you have received the mail, you have to save the file and sometimes there is a problem later to find the folder where the file is placed. With installation of Dropbox software, Dropbox folder is created on your computer. Files that are stored in this folder can be accessed from your account at Dropbox website. It is more important that you can send an invitation to collaborators to share a folder created in your Dropbox. Every document that you save in this shared folder is automatically saved in Dropbox folder of the person you are sharing folder with. There is no possibility that file can be lost and everything is stored at one place. Free Dropbox account has 2GB space.
c) Management of courses is realized by using the wiki and Blackboard course sites. Students can access the course site only if the professor previously shared the link of the site with them. This is a very simple way to present the program and aims of the course, provide students with course material, and post notifications. Also, one page of the site can be designed for discussion so students can review the history of asked questions, ask the new ones or answer the questions posted by other students. Wiki sites are additionally used for monitoring student's work at PhD program in vibration serviceability. Every PhD student has a page where he/she writes about project and posts research results thus creating a research record.

d) Lectures and tutorials are recorded by CamStudio. This software doesn't provide top quality sound and image, but it is free of charge and suitable for the recording of specific topics explanations.

4.6 Inclusion of PhD students in scientific and R&D projects

Participation of doctoral students in scientific and R&D projects is important and beneficial in several ways as follows: 1) research towards PhD dissertation is usually part of the project, 2) work on the project is paid as well as conference fees and presentation of the results, 3) measuring equipment and components can be bought using project budget for this purpose, 4) mobility of researchers, 5) students have an opportunity to upgrade communication and organization skills, 6) results of the R&D project contribute to the development of national and regional economy. PhD students at doctoral studies in vibration serviceability were included in the scientific project TR36023 supported by Serbian Ministry of Education and Science from the beginning of 2011. The project entitled "New Trends of Construction Design and Management of Buildings" investigates the ways in which the physics and management of problems can be integrated into a unified approach. The first benefits for PhD students will comprise scientific visits to experimental facilities at the University of Sheffield. Total number of the researchers at the project is 11 and cooperation is mainly realized by wiki sites and Asembla web application. Mentor and project leader are responsible to give reports on activities and results of PhD students included in the project at the end of every year.

In addition, it is also necessary for PhD students to become familiar with appropriate software tools for modeling and dynamic analyses (e.g. Ansys).

4.7 Publishing of investigation results in SCI journals

Research related to doctoral dissertation and also investigations within the scientific projects should result in journal articles and conference papers. Formal requirement is that two papers have to be published or at least accepted for publication in scientific journals from SCI list before the approval of thesis defense [1].

The publishing of scientific papers is the indispensable part of doctoral program in vibration serviceability and its realization usually starts at the beginning of the second year of studies. For example, the student who entered structural engineering PhD program in school year 2009/2010 published the paper in EURODYN conference proceedings (held in Leuven from the 4^{th} to 6^{th} July 2011) and the abstract for another one was accepted for IMAC conference in USA in February 2012. One of the PhD program concepts is that all research results have to be published in high ranking journals or conference proceedings (4 or 5 papers during the studies) so the future PhD holders are not only advanced by the possession of doctoral degree but also by high-quality references and visibility in the world scientific community.

4.8 Structure of PhD dissertation

Doctoral dissertation is original research project with truthful and significant contributions to the scientific field. Commonly, PhD thesis is in the form of monograph but it may also be a collection of papers related to the relevant topic previously published by doctoral student in the high-ranking international journals.

Doctoral dissertation in vibration serviceability topics is a collection of scientific papers published in conference proceedings and journals from SCI list. Every scientific paper corresponds to one phase of research and represents a chapter in the future doctoral dissertation. It is important that some contents like theoretical explanations, illustrations, examples etc. are not repeated in different papers. Usually, first scientific paper is the review of literature relevant to the subject of the PhD thesis. The following papers are related to experimental research and observations and solutions that PhD candidate has made. This form of PhD thesis is favorable because the quality and originality of research results and scientific contributions were previously evaluated and validated by competent and usually quite demanding journal reviewers.

4.9 Mobility

Most of the student and staff mobility activities are realized through research projects and bilateral agreements. The Faculty of Construction Management established the bilateral cooperation with 4 foreign education and research institutions: 1) Rutherford Appleton Laboratory in Oxfordshire, 2) School of Mechanical and Materials Engineering of Washington State University in Pullman, 3) Florida International University in Miami and 4) Architectural Faculty of University “Crnorizac Hrabri” in Varna. Part of the mobility activities is also carried out through various international students' associations, Erasmus Mundus, and Tempus programs.

5. SUMMARY AND CONCUSIONS

A detailed analysis of doctoral studies in civil engineering from the stand point of education and research program implementation and performance at the Faculty of Construction Management in Belgrade is presented in this paper. Despite the fact that it is a relatively new education institution, the faculty is one of the few in Serbia that provides enough quality conditions for realization of PhD studies in civil engineering based on the Bologna principles.

Having in mind that higher education, which includes doctoral studies in Serbia, had gone through dramatic changes in the last years, it was necessary for authors to find all aspects where changes were the most evident. In addition, these criteria could be used to estimate and evaluate the implementation and performance of PhD programs in civil engineering. That is why authors’ contribution in this paper consists of the suggested list of the most relevant aspects for systematic presentation and analysis of doctoral studies at FCM. These criteria suggested by the authors are as follows: 1) model of studies, 2) admission, 3) curriculum, 4) mentorship, 5) implementation of new technologies in teaching and learning, 6) inclusion of PhD students in scientific and R&D projects, 7) publishing of investigation results in SCI journals, 8) structure of PhD dissertation, and 9) mobility.

Authors choose PhD studies in structural engineering at FCM to give curriculum in more details as an example. In particular, the paper addressed aspects such as: 1) mentorship, 2) implementation of new technologies in teaching and learning, 3) inclusion of PhD students in scientific and R&D projects, 4) publishing of investigation results in SCI journals, and 5) structure of PhD dissertation. These aspects are covered using very successful experiences and results in vibration serviceability PhD course at FCM. Authors feel that these topics are of the considerable interest for dissemination purposes and exchange of practical solutions in the fields of PhD education and research programs in civil engineering within EUCEET as well as in the cases of bilateral cooperation between universities and institutes worldwide.

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