

UNIVERSITY POLITEHNICA OF BUCHAREST

EXTERNAL EVALUATOR REPORT

DOCTORAL FIELD

Engineering and Management

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I. Introduction

This report summarizes the findings from the external evaluation of Doctoral Field of Engineering and Management at the School of Engineering - University POLITEHNICA of Bucharest (UPB). First, some background information is given as context, then the resources and methods used to prepare this report is listed. Next, an analysis of the performance indicators is given, followed by a SWOT analysis and recommendations. Finally conclusions are made.

General Background: UPB, through the efforts of professors and students, has consolidated its academic status and prestige in 200 years, being the most prestigious school of engineers in Romania. The mission assumed by UPB is conceived as an intersection of education, through professional training, scientific research, through the production of knowledge, and innovation, as the main objectives of the society and economy based on knowledge. The production of knowledge, mainly through scientific research, transmission through education and training, dissemination through information technologies, the use of technological innovation, the cultural dimension are the elements that define the uniqueness of the university.

The process of Teaching, Learning and Evaluation

UPB is a provider of continuing education, postgraduate or professional qualification programs, addressing various topics. Many of these are carried out as part of human resources training projects funded by the Structural Funds. Within UPB, special attention is paid to the process of modernization of teaching technologies and their orientation towards the needs and particularities of students.

The personal development of students is emphasized by the university, by designing student-centered learning methods and environments, with less emphasis on the simple transmission of information. In the teaching activity, the students are trained through questions in the classroom, demonstrative experiments, the teaching process being oriented according to their pace and way of learning. The teacher-student relationship is based on partnership, each party having responsibilities for students' academic results, and learning outcomes are explained and discussed with them, emphasizing their importance for their development. At the beginning of each course, the course objectives, requirements and evaluation form are announced. By involving students in research activities and projects, they are stimulated to discover and create knowledge.

Human resources

The university management and the faculty management aim at achieving an optimal ratio between the number of tenured teachers and the number of enrolled students, harmonization achieved by establishing the number of schooling, the policy of filling vacancies and the training strategy of the teaching staff. In the last four years, the university has managed to maintain a ratio comparable to that of similar universities in the country and the EU between the number of enrolled students and the number of tenured teachers. The teacher evaluation process comprises three components: self-evaluation, peer evaluation and evaluation by students, based on forms approved by the UPB Senate.

Financial Resources

University POLITEHNICA of Bucharest grants scholarships to university students in accordance with the legislative regulations in force and on the basis of its own Regulations. Scholarships are awarded from budget allocations and from own resources. Scholarship regulations are discussed with students, approved by a Senate decision and periodically reviewed.

Organizational Framework

The doctoral study programs were carried out in accordance with the provisions of the Code of Doctoral University Studies. In 2012, 13 doctoral schools were established in UPB, generally grouped in the fields of doctoral studies and integrated into the faculties: Electrical, Energy, Automatic and Computer Engineering, Electronics, Telecommunications and Information Technology, Mechanical and Mechatronics Engineering, Technological Systems Engineering and Management, Biotechnical Systems Engineering, Transportation, Aerospace Engineering, Materials Science and Engineering, Applied Chemistry and Materials Science, Applied Sciences, Entrepreneurship, Business Engineering and Management.

Background Doctoral School of Industrial Engineering and Robotics: The Doctoral School of Industrial Engineering and Robotics was established by Decision of the UPB Senate from May 2012. In September 2019, with the change of the name of the faculty, the IMST Doctoral School was named the Doctoral School of Industrial and Robotic Engineering.

At the Doctoral School of Industrial Engineering and Robotics, doctoral scientific supervisors and doctoral students work in the doctoral fields of Industrial Engineering (II), Mechanical Engineering (IM), Engineering and Management (IMg), these being three of the 16 doctoral fields at UPB.

Doctoral field of Engineering and Management (IMg):

The doctoral field of Engineering and Management (IMg) is managed within IOSUD UPB by the Doctoral School of Industrial Engineering and Robotic (SD IIR) - from the academic year 2018/2019.

Mission: The mission of the doctoral field “Engineering and Management” - IMg, from the IIR Doctoral School, as part of the mission of the IIR Doctoral School, is, in essence, to contribute in finding solutions of theoretical and/ or applied problems generated by processes/ products/

integrated systems/ technologies, both current and future ones, specific to the IMg doctoral field, with results as new knowledge, inventions, publications, physical components, equipment, educational / industrial software applications, etc.

Objectives: The objectives of the doctoral field “Engineering and Management”, IMg, from the IIR Doctoral School, which derive from its mission, are considered to be, mainly, the following:

- attracting high-performance graduates of master's studies, in the field of Engineering and Management or related fields to the doctoral studies in the field of IMg;
- supporting the PhD habilitation system, for the affiliation of new doctoral supervisors in the field of IMg;
 - attracting current and perspective topics from the university and / or industrial environment in the doctoral issues of the IMg field, respectively, within the scientific doctoral areas;
 - creation of projects in dealing with issues of the IMg field and with the involvement of human and laboratory resources from the IIR Doctoral School, in partnerships with research institutes and / or industrial companies, as well as with complementary financial resources;
 - contribute to both the developments into solving theoretical and / or applied problems, and the publication of scientific papers in journals or books at national / international level, WOS / ISI, BDI, patents and other complex products.

Curricula: The Engineering and Management” (IMg) doctoral field curricula contains two specialized subjects - focused on the doctoral theme - and three subjects that develop general skills with a transversal character “Ethics”, “Research methodology and scientific authorship” and “Project management”. Examples of curricula within the doctoral field "Engineering and Management" from the IIR Doctoral School, are presented later.

Currently, there are 6 PhD supervisors in the Doctoral Field of Engineering and Management but it is expected that this will increase to 7 in the near future. Number of PhD students enrolled increased from 11 (2018-2019) to 54 (2010-2021) since establishment. This significant growth is common to Engineering and management programs in the United States too, indicating a fast growing program due to multidisciplinary industry, education and research needs. Since the IMg doctoral field was established only three years ago, there are no doctoral theses in the field of Engineering and Management defended yet, but this will be rapidly changing as three doctoral students will be defending their theses very soon, with others to follow.

II. Methods Used

This report is based on the information supplied by ARACIS, IMg Self-Study report by the Doctoral Field of Engineering & Management and several Zoom meetings/discussions with program administrators, faculty advisors and doctoral students. On site visit was not possible due to the COVID virus pandemic (see References section for resources used).

III. Analysis of Performance Indicators

Quality Assurance measures in meeting standards on the level of Engineering Management Doctoral Field.

Evaluation Criteria for doctoral programs grouped under parts A, B and C and their multiple sections are listed in Annex 4. The following conclusions are based on the Engineering and Management Doctoral Field's self-assessment report and the Zoom meetings/discussions listed in References. To avoid repetitions, only assessment results and sections thought to be significant are discussed in some detail.

Criterion A.1. The administrative, managerial institutional structures and the financial resources.

Eighteen criteria listed under A.1 were met except A.1.3.2 (proportion of students benefitting from all sources of funding).

Criteria no. A.1.3.2. is: The proportion of doctoral students existing at the time of the evaluation who benefit for at least six months from sources of funding other than government funding, through scholarships granted by individuals or legal entities or are financially supported by research or institutional development / human resources grants, is no less than 20%.

According to this criteria, 20% x 54 total number of students (about 11 doctoral students) should have benefited from at least 6 months of other funding sources. In this case, a total of seven doctoral students from the Engineering and Management field benefitted for at least six months from additional funding from their employing organizations (scholarships, funding from different projects, using the facilities and equipment of the company etc.) for working on their PhD theses. Therefore, this criterion is *partially met*.

This seems to be due to the relatively recent establishment of the PhD in Engineering and Management within IOSUD UPB (2018). However, it is estimated that PhD students in the field of IMg. will benefit from additional sources of funding through the new POCU projects in the next period.

Some of the performance indicators thought critical (by the author of this report) to the functioning and success of the IMg doctoral field are mentioned below in detail.

The topics of the doctoral study programs are established through direct discussions and consultations with the members of the Doctoral School Council (A1.1). The doctoral student proposes the topic together with the doctoral advisor. The Doctoral School Council analyzes it and together with the advisor, finalizes the topic that is included in a study contract. The advanced training program and the structure of the associated scientific research program are proposed by the doctoral student and are approved by the Doctoral School Council.

All doctoral theses are verified using the Turnitin computer platform; following the verification, a report is made regarding the degree and indices of similarity, thus performing the anti-plagiarism verification (A.1.2.2.). Using the platform allows to identify non-original content. The similarity report is mandatory for the thesis to be accepted for public support. All doctoral supervisors have access to the platform and all doctoral students are informed about the results.

In the doctoral field Engineering and Management, currently there are at least 7 research grants in progress or obtained by the doctoral supervisors.

Criterion A.2 Research Infrastructure

All criteria under A.2. were met (see the self-study report for details).

Criterion A.3 Quality of Human Resources

All criteria under A.3. were met (see the self-study report for details).

A performance indicator thought critical (by the author of this report) to the functioning and success of the IMg doctoral filed is mentioned below in detail.

Instructors who support the subjects in the training program based on advanced university studies related to the field of IMg, have the quality of doctoral supervisor and/or are professor / CS I or associate professor / CS II with proven expertise in the field of subjects taught or other specialists in the field which meet the standards set by the UPB (A.3.1.3).

Criterion B.1 The number, quality and diversity of the candidates

All criteria under B.1. were met (see the self-study report for details).

A performance indicator thought critical (by the author of this report) to the functioning and success of the IMg doctoral filed is mentioned below in detail.

For the doctoral field Engineering and Management (which was founded in UPB since 2018), no case of dropout / abandonment of doctoral students was registered within the two Doctoral Schools 3 years after admission (0% percentage), (B.1.2.1).

Criterion B.2 The content of doctoral university study programs

All criteria under B.2. were met (see the self-study report for details).

A performance indicator thought critical (by the author of this report) to the functioning and success of the IMg doctoral filed is mentioned below in detail.

Students benefit from the counseling/guidance of functional guidance commissions, as follows (B. 2.1.4) : - On the occasion of supporting the papers; - In meetings scheduled in the period between the presentations of two papers; - For writing articles; - In some projects (for example, in the POCU project “BeAntreprenor” 29 doctoral students and 9 post-doctoral researchers benefited from several complementary courses: Ethics in research and copyright, Valorization of research results, Equal opportunities, coaching).

Total number of PhD students enrolled in Engineering and Management: 54 - No. of doctoral supervisors (B.2.1.5).

Criterion B.3 The results of doctoral studies and their evaluation process

All criteria under B.3. were met (see the self-study report for details).

Criterion C.1 Quality Management

All criteria under C.1. were met (see the self-study report for details).

Criterion C.2 Transparency of information and accessibility to learning resources

All criteria under C.2. were met (see the self-study report for details).

A performance indicator thought critical (by the author of this report) to the functioning and success of the IMg doctoral filed is mentioned below in detail.

In the UPB Campus, using the existing network, based on the IP, all students have access to several relevant academic platforms. Access can also be done remotely via the Mobile Access option (C2.2.1.).

Criterion C.3 Degree of internationalization

All criteria under C.3. were met (see the self-study report for details).

Some of the performance indicators thought critical (by the author of this report) to the functioning and success of the IMg doctoral filed are mentioned below in detail.

POCU Project - Scholarships for entrepreneurial education among doctoral students and postdoctoral researchers (Be Entrepreneur!), No. MySMIS 124539, no. contract 51680 / 09.07.2019 2. POCU Project - Development of entrepreneurial skills of doctoral and postdoctoral students - key to career success (A-success), ID 125125, based on the financing contract no. 51 675 / 07.09.2019. 3. Engineer in Europe 2019, contract no. FSS / 2019; 4. Engineer in Europe 2020, contract no. 457GP / 08/06/2020. (C3.1.1)

In Annex C.3.1.1.b. 19 examples of doctoral students are presented (35% x 54 doctoral students in the field of IMg = 19 doctoral students) who benefited in the period of self evaluation (2016-2020) from internships or participation in international scientific conferences

PhD students benefited from guest lectures from leading experts (C.3.2.1).

IOSUD-UPB participated in the period 2016-2020 in numerous educational fairs to attract international doctoral students.(C.3.1.3)

Overall, Quality Assurance measures in meeting standards on the level of Engineering Management Doctoral Field.

CONCLUSION FOR A, B, C: The criteria A, B, and C are met

IV. SWOT Analysis and Recommendations

The doctoral program of Engineering and Management (IMg) at UPB has many strengths and opportunities. Some of the *strengths* are:

-IMg is a relatively new doctoral program that started in 2018. Within three years it has experienced fast growth reaching 54 students. There are six faculty advisors for these students, with another addition coming soon. Program focuses on ethics, scientific internship, and project management. All the essentials of a good engineering and management program are covered.

-Students seem to be mostly working professionals or have significant engineering experience. They seem to have high positions in their organizations. They bring industrial experience and potential resources for the program.

-There are several research centers that provide resources and support for doctoral students in their research and publishing. Students can work together and have co-advisors from other doctoral programs. Center for advanced technologies and Manufacturing labs provide resources for students in conducting research and encourage students to get patents.

-Advisors are accessible and always available to assist students in their research as mentioned by doctoral students attending the meetings. The students were highly complementary of their doctoral advisors. Students are allowed to change advisors if needed.

-Students have computer accounts to access the library and scholar publication sites. Funds are available to assist students to go to conferences and for publishing. Licensed software are available with free access for students.

-Students are educated in writing proposals and publishing papers as one of the competencies.

-Doctoral school is flexible in allowing students to choose advisors/co-advisors from different domains, like mechanical, chemical, industrial and electrical engineering.

-FAIMA Business and Management journal established at the doctoral school provide a resource for students to publish and share their research activities.

-There are many multidisciplinary research topics and doctoral thesis titles such as:

- Strategies for Competitiveness in food industry,
- Modeling business processes to improve organizational behavior,
- Risk management in human resources; integrated system management,
- Innovative techniques in surgery,

Detection and management of drones, and
Simulation of business planning.

Research on these and similar topics lead to getting patents as an indicator of success. Patents and publications are expected to increase as number of students and advisors increase.

A *strength* and also an *opportunity* is the international cooperation for the IMG doctoral field. The doctoral program has been successfully seeking International co-operation in research, education and student exchange with Turkey, China, Egypt and Jordan to name a few and organizing scholarly conferences abroad (ICMIE 2021, International conference in IMg). These activities attract new students and carry the reputation of UPB IMg doctoral program internationally.

One can make some *recommendations* in terms of opportunities for improvement that may be seen as *weaknesses*:

-There are currently 54 students with only 6 advisors. Given the success of the students in getting patents and publishing, an average of 9 students per advisor seem to be a heavy load. Recommend increasing the number of doctoral advisors as an additional resource. Clearly, the program will continue to grow.

-Some students mentioned large classes (200) common to all doctoral programs. Such large classes limit students from working together and exchanging of ideas. Recommend breaking down such classes into smaller working groups that are led by the students themselves. Student groups can make proposals to the instructor on their topic of study and their expected outcomes. Each group can then make a presentation of their topic at the end of the semester. That way learning may be advanced.

The doctoral school seems to impose strict (mostly numerical) standards in the operation of doctoral fields. Some of this is understandable and desirable. However, there may be differences in the operation and management of each field. Some flexibility in each field establishing their own standards and criteria, especially in relevant qualitative measures may be helpful.

V. Conclusions and general recommendations

Internationally, Engineering and Management programs at graduate level are both popular and serve an essential need from industry, academia and applied research. The popularity seems to stem from the multidisciplinary nature of the curricula and research. Students, practicing engineering professionals and administrators of technical organizations with diverse backgrounds are attracted to the field of Engineering and Management as they all find themselves operating in a project management environment.

Overall, the Doctoral Field in Engineering and Management has a clear and well-defined mission statement, objectives and well thought out curricula, fulfilling a unique need for a multidisciplinary doctoral program addressing industry demands and meeting the expectations. The doctoral program has been fulfilling Quality Assurance measures in meeting standards of UPB. The doctoral theses are leading to patents, scholarly publications and research proposals.

Students have access to the library, software, multidisciplinary labs and financial resources. The doctoral program has been successfully seeking International co-operation in research, education and student exchange.

This is noteworthy for such a young program growing rapidly. Indications are there that the doctoral field in Engineering and Management is well managed with dedicated advisors going out of their way in advising students and being available any time. Doctoral students are highly complementary of their advisors. It seems to be an ideal environment where students advisors are working in harmony to make the program a continued success. As an external evaluator, I give my highest approval of the Doctoral field in Engineering and Management at UPB.

VI. References and resources:

UPB Engineering and Management Self-Assessment Report: Doctoral Field IMg. (2021)

ARACIS Code of Ethics Rules of Conduct (2017)

Annex 4: Critical Indicators related to doctoral study domains (2021)

15.6.2021 ZOOM meeting: 16:00 pm. Coordinated by Prof. Nicolae Ionescu and Prof. Dana Deselnicu

18.6.2021 ZOOM meeting: 17:00 pm. The online meeting of the committee of expert evaluators with professors holding the title of doctoral advisor.

18.6.2021 ZOOM meeting: 18:00 pm with doctoral students

24.6.2021 ZOOM meeting: 17:00 pm with members of the Doctoral Schools Councils

24.6.2021 ZOOM meeting: 18:00 pm with the directors of the research centers/laboratories.