# Industrial Engineering Education in the Philippines: Issues and Concerns

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**Abstract**

Industrial engineering is a branch of engineering which mainly focuses on the design, improvement, and installation of integrated systems of men, materials, equipment, and energy. The purpose of this study was to provide an overview of industrial engineering education in the Philippines. 91 schools that offered industrial engineering program were assessed through its website and 10 universities that provide a graduate school in industrial engineering were analyzed. The result indicated that the industrial engineering program in the Philippines had only one doctoral program. This condition was found as a new opportunity to offer a new doctoral program in industrial engineering. The opening of PhD in Industrial Engineering program by Mapúa University will provide more opportunities to prospective students and can contribute to the advancement of industrial engineering education in the Philippines

**Keywords**:
Industrial Engineering; Mapúa University; Doctoral Program; Engineering Education.

## 1. Introduction

Institute of Industrial and Systems Engineering (IISE) is considered as the world's largest professional society dedicated solely to support industrial engineering education. IISE defines industrial engineering as a field that is concerned with the design, improvement, and installation of integrated systems of men, materials, equipment, and energy (Zandin, 2001). It draws upon specialized knowledge and skill in the mathematical, physical, and social sciences together with the principles and methods of engineering analysis and design to specify, predict, and evaluate the results to be obtained from such systems. (Zandin, 2001).

The industrial engineering programs outside the United States have largely adopted the practice and curriculum from the US (Zandin, 2001). In the Philippines, the Commission of Higher Education (CHED) through CHED Memorandum Order (CMO) No. 96 Series of 2017, specifies the Policies, Standards and Guidelines for the Bachelor of Science in Industrial Engineering program. This CMO specifies the core competencies expected of Bachelor of Science in Industrial Engineering graduates regardless of the type of higher education institutions they graduate from. To further enhance the industrial engineering practice, the Philippine Institute of Industrial Engineers (PIIE) is a professional society devoted to serving the needs of industrial and systems engineering professionals and institutions.

Despite the advancement of industrial engineering in the world, there is a limited study related to the assessment of industrial engineering education. Kádárová et al., (2014) described the industrial engineering education in Slovakia particularly describing the history, study & research activities, and graduate profiles. Similarly, Palma et al., (2012) also analyzed industrial engineering in Peru. Finally,

Brahimi et al., (2013) also studied the cooperative training on the performance of the industrial engineering students and study the role of the co-op training in enhancing the achievement of student learning outcomes. A further study is required particularly to compare industrial engineering education in different countries.

The purpose of this study was to provide an overview of industrial engineering education in the Philippines. Bachelor, master, and doctoral programs were assessed and briefly compared. This study contributes to the development of industrial engineering education around the world particularly in terms of providing an overview of the program in the Philippines.

## 2. Methods

The website of each university was used to identify the industrial engineering programs being offered at the undergraduate and graduate levels. Table 1 shows the sample list of institutions that offer the industrial engineering program in the Philippines. An overview of the programs was also discussed and briefly compared.

**Table 1. Sample list of institutions that offer the industrial engineering program in the Philippines**

| No | Institution | Website |
|---|---|---|
| 1 | Cebu Institute of Technology University | https://www.cit.edu/v6/colleges/engineering-and-architecture/mechanical-engineering/ |
| 2 | De La Salle University | https://www.dlsu.edu.ph/colleges/gcoe/academic-departments/industrial-engineering/ |
| 3 | Lyceum of the Philippines University - Batangas | https://lpubatangas.edu.ph/engineering/ |
| 4 | Mapúa University | http://ie-emg.mapua.edu.ph/ |
| 5 | Polytechnic University of the Philippines | https://www.pup.edu.ph/ce/BSIE |
| 6 | Rizal Technological University | https://www.rtu.edu.ph/?page_id=726 |
| 7 | Saint Louis University | http://www.slu.edu.ph/academics/schools/engineering-and-architecture/courses/ |
| 8 | Technological Institute of the Philippines | https://tip.edu.ph/Industrial_Engineering_QC_Branch |
| 9 | University of San Carlos | http://usc.edu.ph/academic/department/20 |
| 10 | University of the Philippines – Diliman | http://ieor.coe.upd.edu.ph/home |

## 3.0 Results

### *3.1 Program assessment*

Table 2 shows the number of institutions that offer industrial engineering program in the Philippines. Based on Table 2, there were 91 institutions offered bachelor of science in industrial engineering, 5 institutions offered master of science in industrial engineering, 7 institutions offered master of engineering in industrial engineering, 1 institution offered master of engineering education on industrial engineering, 1 institution offered master program in industrial engineering and management, and only 1 institution offered doctoral program in industrial engineering. Table 3 shows the institutions that offer the graduate school in industrial engineering. Basically, there were only 10 schools that provide a graduate level programs in industrial engineering. This condition was found similar to Slovakia (Kádárová et al., 2014) and Peru (Palma et al., 2012). A new doctoral program would be very beneficial for the advancement of industrial engineering in the Philippines.

**Table 2. Number of institutions that offer industrial engineering programs in the Philippines**

| IE Programs | BS IE | MS IE | ME IE | MS Engineering Education IE | MS IEM | PhD IE |
|---|---|---|---|---|---|---|
| Number of Schools (N) | 91 | 5 | 7 | 1 | 1 | 1 |

**Table 3. Institutions that offer Bachelor, Master, and Doctoral Programs in Industrial Engineering**

| No | School | BS | MS/ME | PhD IE |
|---|---|---|---|---|
| 1 | Cebu Institute of Technology University | BS IE | ME IE | |
| 2 | De La Salle University | BS IE | MS IE & ME IE | PhD IE |
| 3 | Lyceum of the Philippines University- Batangas | BS IE | MS IE | |
| 4 | Mapúa University | BS IE | MS IE & MEP IE | |
| 5 | Polytechnic University of the Philippines | BS IE | MS IEM | |
| 6 | Rizal Technological University | BS IE | MS Engg Education in IE | |
| 7 | Saint Louis University | BS IE | ME IE | |
| 8 | Technological Institute of the Philippines | BS IE | ME IE | |
| 9 | University of San Carlos | BS IE | MS IE & ME IE | |
| 10 | University of the Philippines – Diliman | BS IE | MS IE & ME IE | |

Legend-
MS IE – Master of Science in Industrial Engineering
ME IE – Master of Engineering in Industrial Engineering
MS IEM – Master of Science in Industrial Engineering and Management

## 4.0 Discussion

### *4.1 Lack of Doctoral Degree Program in Industrial Engineering*

Doctoral education has often been viewed as a lower priority – given the need to attend first to the undergraduate level. But this approach underestimates the significant interdependence between these levels, as competent faculty members for the undergraduate level and a thriving and innovative research environment, to a large extent depend on the possibilities of high quality doctoral study (Park, 2007). This situation can be seen in the field of industrial engineering where 91 schools are currently offering the undergraduate degree program, and 10 schools for the Masteral level program. For the PhD program, only 1 school is currently offering the program (Table 4). Thus, there is a need to open a doctoral program that can contribute to the advancement of industrial engineering education as well as to the industrial engineering-related research and development in the country. In fact, this is not only a problem of Industrial Engineering but also by the other engineering programs in the Philippines as illustrated in Table 4. Although Chemical Engineering has the highest number of schools that offer the PhD program but this is still limited compared to the programs being offered by other countries.

**Table 4. Number of Schools Offering Selected Engineering Programs at Undergraduate and Graduate Levels, 2018**

| Program\Degree | BS | MS | PhD |
|---|---|---|---|
| Industrial Engineering | 91 | 10 | 1 |
| Civil Engineering | 213 | 26 | 2 |
| Electronics Engineering | 194 | 14 | 3 |
| Chemical Engineering | 34 | 11 | 4 |

Source: various websites

The lack of doctoral degree holders can be attributed to the same education system which produce barely a hundred new PhD graduates a year in the basic, applied and social sciences, technology, engineering and mathematics with the University of the Philippines accounting for more than 80% of the miniscule number (Saloma, 2016). This is very far from the PhD graduates of other countries as shown in Table 5. In 2015, United States produced the highest number of PhD graduates at 68,923. This is followed by China that produced 54,891 graduates and Russia, on a far third, with 29,632 graduates.

**Table 5. Top Ten Countries Producing PhD Graduates, 2015**

| Country | No. of graduates |
|---|---|
| United States | 68,923 |
| China | 54,891 |
| Russia | 29,632 |
| Germany | 29,218 |
| United Kingdom | 26,636 |
| India | 22,528 |
| Brazil | 18,625 |
| Japan | 15,714 |
| France | 13,774 |
| Korea | 13,077 |
| Philippines | ~ 100 |

Source : OECD, 2018

Aside from its importance in universities, doctoral degree holders can play a crucial role in the economic and social development of a country. However, the Philippines' Commission on Science Technology and Engineering reported the lack of science and technology and engineering doctoral degree holders which is one of the foremost reasons why the country is lagging behind in terms of science and technology development (COMSTE, 2010). The Philippines has very few doctoral degree holders as against its population with 1 doctoral holder for every 54,060 people (COMSTE, 2010). On the other hand, Japan has 1 doctoral holder per 11,621 people, in the USA there is 1 per 6,533, and Germany has 1 per 3,316 (COMSTE, 2010). Furthermore, the number of faculty members at state and private universities with doctoral degrees is only at 17% (Table 6). Most faculty members teaching in higher education have only a BS/BA degree, which lacks the necessary skills and experience in doing advanced research.

**Table 6. Higher Education Faculty by Highest Degree Attained, AY 2018-19**

| Institutional Type | BA/BS | MA/MS | PhD | Grand Total |
|---|---|---|---|---|
| State/Local University | 25,463 | 20,919 | 12,631 | 59,013 |
| Private University | 36,935 | 30,282 | 9,956 | 77,173 |
| Grand Total | 62,398 | 51,201 | 22,587 | 136,186 |
| % to Total | 46% | 38% | 17% | 100% |

Source: Commission on Higher Education, 2018

*4.2 New Industrial Engineering PhD program at Mapúa University*

The doctorate program takes a number of different forms in different countries (Noble 1994). In the USA, for example, a doctorate program usually includes both taking advanced-level taught courses and undertaking academic research. In Europe and Australia, the doctorate program is typically based on research (Park, 2007). To accommodate the needs of increasingly diverse professions employing doctoral graduates, the form of the doctorate program has diversified. This led to differently structured doctorate degrees such as the emergence of the titles 'professional' doctorate, and 'practice-based' or 'practice-led' doctorate (UK Quality Code for Higher Education, 2015).

Mapua's new PhD IE program will be the second program to be offered in the Philippines. It is research-based which provides students with solid fundamental and theoretical knowledge, as well as substantial research experience for innovative system design and problem-solving in various research areas, including human factors and ergonomics, operations research and its applications, data analysis and modelling, supply chain management, and other relevant industrial engineering topics. Table 7 and Table 8 show the proposed full-time professors and proposed visiting professors respectively. In addition, Table 9 and 10 represent the detail of the courses that would be offered in the doctoral program.

**Table 7. Proposed full-time professors**

| | Faculty | Research Interest |
|---|---|---|
| 1 | Dr. Yogi Tri Prasetyo | Human Factors and Ergonomics |
| 2 | Dr. Michael Nayat Young | Operation Research and Financial Engineering |
| 3 | Dr. Larry Vea | Data Analytics and Applications |

**Table 8. Proposed Visiting Professors**

| | Faculty | Research Interest | Institution |
|---|---|---|---|
| 1 | Dr. Ping-Shun Chen | Operation Research, Systems Simulation, Healthcare Modelling, Network Planning | Chung Yuan Christian University, Taiwan |
| 2 | Dr. Chao-Lung Yang | Big Data Analytics and Applications, Numerical Computations, Data Mining | National Taiwan University of Science and Technology |
| 3 | Dr. Chiu-Hsiang Joe Lin | Human Factors, Occupational Biomechanics, Human-Computer Interaction, Virtual Reality | National Taiwan University of Science and Technology |
| 4 | Dr. John Francis T. Diaz | Financial Management, Managerial Economics, Corporate Finance, Business Ethics | Chung Yuan Christian University, Taiwan |
| 5 | Dr. Kristine V. Tuliao | Applied Multilevel Modelling, Cross-Cultural Management, Leadership and Communication | National Taiwan University of Science and Technology |
| 6 | Dr. Ferani E. Zulfia | Data Mining, Advance Optimization, Vehicle Routing Problem, Deep Learning | Pertamina University, Indonesia |

The program educational objectives are as follows:

1) Find new combinations or innovate existing knowledge to provide solutions to the needs of society in the form of new materials, devices, systems or processes.
2) Conduct independent research and investigations to generate new knowledge or innovate existing knowledge.

Program outcomes:

1. Demonstrate a comprehensive broad understanding of industrial engineering principles and apply advanced knowledge on the specific discipline.
2. Analyze, synthesize, create, and evaluate industrial engineering systems.
3. Communicate effectively technical knowledge, both orally and in writing, on complex engineering activities.
4. Contribute to the generation, dissemination, and preservation of engineering knowledge, methodologies, techniques, and processes.
5. Engage in life-long learning.
6. Conduct oneself within professional and ethical standards.

**Table 9. List of Courses under the PhD IE program**

| Year/Term | Course Number | Course Name | Units |
|---|---|---|---|
| 1 / 1Q | IE311 | Psychological Foundations and Advanced Topics in Human Factors & Ergonomics | 3 |
| | IE312 | Advanced Topics in Math Modelling | 3 |
| 1 / 2Q | IE313 | Data Analysis and Modelling | 3 |
| | IE398 | Seminar on Research & Publication | 3 |
| 1 / 3Q | IE400X | Qualifying Exam | 3 |
| 1 / 4Q | IE400-1 | Dissertation 1 | 3 |
| 2 / 1Q | IE400-2 | Dissertation 2 | 12 |
| - | - | - | |
| 2 / 4Q | - | - | |
| 3 / 1Q | IE400-3 | Dissertation 3 | 12 |
| - | - | - | |
| 3 / 1Q | IE 400-3 | Dissertation 3 | 12 |
| - | - | - | |
| 3 / 4Q | - | - | |
| 4 / 1Q | IE400-4 | Dissertation 4 | 3 |

**Table 10. Course description**

| Course Number | Course Name | Course Description |
|---|---|---|
| IE311 | Psychological Foundations and Advanced Topics in Human Factors & Ergonomics (Bridger, 2009; Sanders & McCormick, 1993) | This is an advanced ergonomic course which covers: (1) Human information processing (2) Signal detection theory (3) Usability engineering and product design (4) Applied structural equation modelling in human factors and ergonomics (5) Human error and accident analysis (6) Technology acceptance model and theory of planned behavior (7) Applied Fitt's Law and Hick-Hyman Law (8) GOMS model and keystroke-level model (9) Applied anthropometry, work physiology, and biomechanical analysis (10) Human factors research methodology |
| IE312 | Advanced Topics in Math Modelling | This course will address a number of advanced topics in mathematical programming with particular emphasis on optimization problems with non-linear objective function and/or non-linear constraints. Topics will include duality theory, Lagrangian relaxation, and algorithmic methods for solving non-linear programs. The algorithmic methods covered will include descent methods, Newton's method, conjugate gradient methods, and penalty & barrier methods. |

| | | |
|---|---|---|
| IE313 | Data Analysis and Modelling | This course covers the methodologies steps of a prediction exercise, statistical probabilistic modelling, stochastic modelling, artificial intelligence methodologies for prediction of both continuous and discrete variables with applications in manufacturing and service industries. It also covers practical issues in predictive analytics and how to address them. |
| IE398 | Seminar on Research & Publication | This course involves discussions on the expectation of a doctoral research work and format of thesis manuscript and research article as well as workshops on preparation of research articles, review of grammar rules, procedures for paper submission, use of reference management, and use of Turnitin. |
| IE400X | Qualifying Exam | Qualifying examination on fundamentals of industrial engineering: human factors and ergonomics, mathematical programming, data analysis, and modelling |
| IE400-1 | Dissertation 1 | The course requires that the student chooses a dissertation adviser, form members of the examination committee, and presents research plan. |
| IE400-2 | Dissertation 2 | The course requires that the student publishes, as the first author, Paper No.1 in SCOPUS-indexed journal. The paper must be connected to the research plan of the student. |
| - | - | |
| - | - | |
| IE400-3 | Dissertation 3 | The course requires that the student publishes, as the first author, Paper No.2 in SCOPUS-indexed journal. The paper must be connected to the research plan of the student. |
| - | - | |
| IE 400-4 | Dissertation 4 | The course requires that the student submits the dissertation manuscript, presents his/her thesis before the examination committee, revises the manuscript, and submits the final manuscript. |

Graduation requirements:

1. Passing all course works, with GWA of 1.75 or better
2. Passing the doctoral qualifying examinations in Human Factors and Ergonomics, Operation Research, and Data Analysis and Modelling
3. Publication of 2 research papers in SCOPUS-indexed journals. The student must be the first author and the papers are connected to his/her research plan.
4. Successful oral presentation of the dissertation before the examination committee.
5. Submission of final dissertation manuscript.
6. Presentation in a colloquium or conference (for clearance for application for TOR and diploma).

## 5.0 Conclusion

Industrial engineering is a branch of engineering which mainly focuses on the design, improvement, and installation of integrated systems of men, materials, equipment, and energy. The purpose of this study was to provide an overview of the industrial engineering programs in the Philippines. 91 schools that offered industrial engineering program were assessed through its website and 10 universities that provide a graduate level programs in industrial engineering were analyzed. The result indicated that the industrial engineering program in the Philippines had only one doctoral program. The opening of PhD Industrial Engineering program by Mapúa University will provide more opportunities to prospective students and can contribute to the advancement of industrial engineering education in the Philippines.

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## Biographies

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