

## The Overview Literature Review on Competence-Based Education in The Industrial Engineering Using PRISMA 2020

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**Abstract**— Structured methods for the methodical re-alignment of professional education programs are needed for the comprehensive integration of the human workforce in digital and sustainable manufacturing and logistics systems. It is believed that investing in engineering education is essential to the advancement of both industry and society. Future engineers, though, will need more than simply a solid foundation in technology. The focus on competence orientation is often neglected, particularly in the field of Industrial Engineering (IE), and empirically proven success criteria that support the holistic reorientation of engineering education are usually studied. The authors of this work perform a thorough literature review on engineering education, focusing on competence-based engineering education within the field of IE. Additionally, the writers offer beneficial implications for the competence-based for Industrial Engineering students and lectures writings.

*Index Terms*— *BoK, Curriculum, Industrial Engineering, Overview*

### I. INTRODUCTION

Maintaining innovation and, by extension, the long-term competitiveness of the entire economy, is critical to Indonesian society's sustained prosperity. One of the key success elements for professionalization programs can be considered to be the comprehensive integration of individuals into the so-called "factory of the future" and the related retraining or further certifications of the workforce. Thus, it is believed that investing in engineering education is essential for the future.

Recent studies demonstrate a significant increase in the shortage of skilled workers in

manufacturing enterprises over the next few years, highlighting a substantial demand for qualified engineers in smart and sustainable operations management as the primary area of application for industrial engineering and management professionals. Engineering education for IEs has evolved and expanded continuously since the middle of the 18th century, like these disciplinary advancements. The advancements of the Industrial Revolution are comparable to the ongoing professionalization initiatives. Thus, we can anticipate a paradigm change in the working world in the future, particularly for engineers.

The term "Engineering Education 5.0" refers to the implications that the technological advancements based on the further development of Industry 5.0 concepts and models will have for engineering education. These advancements will permanently alter work processes, replace traditional occupational fields, and generate new occupational fields. To do this, (future) IE specialists will require training beyond just a solid grounding in science and technology. The pandemic and the rapidly advancing implementation of Industry 4.0/Industry 5.0 concepts have sparked transformative educational processes that call for not only a redesign of teaching and learning methodologies but also a redesign of learning content and competencies taught, particularly in engineering education for tomorrow's IE professionals. The problem today facing educational institutions is to properly integrate the aforementioned trends and requirements into IE engineering education to ensure future generations' well-being, the workability of engineers, and the comprehension of their roles.

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This paper, therefore, pursues the following central research questions

1. What challenges is the IE discipline currently facing and what are the implications for engineering education of IEs?
2. Which competencies are perceived as necessary concerning the engineering education of IEs?

To determine the current state of research on competencies and teaching strategies in engineering education in the context of the fifth industrial revolution, the paper will conduct a systematic literature review (SLR), there are 46 literature studies. Based on the findings, it will conclude the knowledge triangle, which consists of business, science, and education. The format of the paper is as follows: The research design and, thus, the methodology of this work. Result and discussion overview of the descriptive findings and the content analysis that led to the identification of two categories. Review of the findings and their significance for researchers and practitioners. The important claims in the paper's conclusion.

## II. MATERIALS AND METHODS SYSTEMATIC LITERATURE REVIEW

Using the SLR method makes it possible to compile an extensive overview of the best literature available on a certain subject. The most acceptable systematic strategy for an open, understandable, and comprehensive analysis of the body of literature was to adopt the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) standard. The implementation of PRISMA 2020 has promise for numerous parties. Readers can evaluate the suitability of the procedures and, consequently, the reliability of the results, with the help of comprehensive reporting. The synthesis process facilitates the assessment of the findings' relevance for IE practitioners. Describe the degree of confidence in the body of evidence supporting an outcome and the implications of findings to assist managers, policymakers, and other

decision-makers in developing suitable practice or policy recommendations.

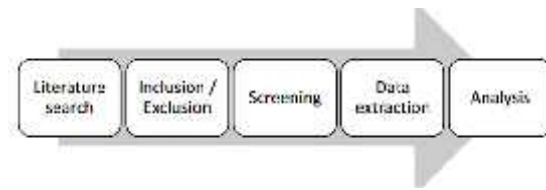


Figure 1. PRISMA Process (1)

## III. RESEARCH METHODOLOGY

The PRISMA method follows a systematic approach. This is shown in Figure 2 and will be described in more detail below (1).

### A. Literature search and inclusion and exclusion criteria

This study focuses on literature that has already been published by professors and students in the PGRI Adi Buana Surabaya Program Study Industrial Technology at the University PGRI Adi Buana Surabaya Program. The total amount of published works is 89, with 11 IE lectures contributing to the total throughout the 2019–2024 time frame. From these few literary works, humata.ai eventually quotes them and performs categorization. The results of this classification were then manually entered onto paper, which became a reset group or reset topic. This is important to understand because the curriculum's results are aligned with previously published analyses.

### B. Literature search and inclusion and exclusion criteria

Following the inclusion and exclusion criteria, all relevant papers were downloaded as full texts from the respective online sources for the subsequent analysis. Before the content analysis, all 26 identified papers were analyzed descriptively to provide an overview of the current state of research. The content analysis was generated based on guidelines of qualitative social research using qualitative content analysis using inductive thematic categorization of the literature examined (2).

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**IV. DISCUSSION AND IMPLICATIONS**

Our study sought to openly provide a well-organized summary of the most recent research on "Engineering Education 5.0," with an emphasis on competence-based learning in the field of IE. The findings of this study suggest additional efforts to professionalize engineering education, which in turn helps to further characterize engineering education in the field of IE. The competency discourse's research trends can be determined by carefully carrying out the SLR. Additionally, two categories within didactical planning—the macro level and the meso level, respectively—as well as their theme clusters can be identified. Considering the first study question, which examines the clusters within the macro level category, it is possible to identify the following issues and suggest some improvements for IE engineering education. The papers together draw attention to the necessity of coordinating learning outcomes, professional requirements, and educational objectives. To overcome these obstacles, academic staff, and students can utilize a teaching and learning center and train-the-teacher approaches.

On the other hand, it is acknowledged that sustainability factors, soft skills, and transversal skills receive insufficient emphasis. The majority of the examined IE curricula lack courses and initiatives that help students build their transdisciplinary and interpersonal skills, instead emphasizing just technical knowledge. Other efforts include going above and beyond the traditional curriculum, creating a mentorship program that pairs grads with current students, and issuing badges through the university job center.

2. Ambition and Production Strategy
3. Material and Technology Development
4. Ergonomics, Health, and Workplace Safety
5. Education and Training
6. Psychology and Adversity



**Figure 3.** Six BoK mostly used in research IE Adi Buana Surabaya

The last 10 years' effects of artificial intelligence, with an emphasis on supply chain management, robots, quality assurance, predictive maintenance, and operational optimization. Machine learning algorithms provide predictive maintenance, which reduces downtime and maximizes resource allocation. Operational optimization improves decision-making, resource usage, and overall efficiency. It is accomplished by AI's real-time data analysis. Artificial Intelligence (AI) in robotics improves production capacities and advances image recognition and machine learning in quality control processes to guarantee better quality. Artificial intelligence (AI) improves inventories, expedites routes, forecasts demand, and promotes resilience in supply chain management. The revolutionary



**Figure 2.** Themes mapping using humata.ai

Based on the analysis of several previously completed documents, several major topics have emerged, Summary of Key Aspects from the Documents in help with humata.ai.

1. Evaluation of Quality and Production Efficiency

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synergy between human-machine collaboration is exemplified by collaborative robots and AI-driven workforce empowerment. The piece ends with a review of the last ten years' advancements, highlighting the continuous growth of AI in industrial engineering and promising more intelligent, flexible, powerful (3).

### V. LIMITATION

The study conducted a review of the scientific literature from 2018 to 2023 for IE lectures at the University Adi Buana, the date of data extraction from the IE Department Adi Buana database. A limitation of this research is that during the period of the screening, selection, analysis, and development of the framework, further research on competence-based engineering education may have been performed and published. The current rapid development of research in this area is a limit to the results of this review.

In summary, these documents cover many important aspects of quality control, production efficiency, technological advancement, workplace safety and health, education, and psychological well-being. Work Design & Measurement, Operations Research & Analysis, Engineering Economic Analysis, Facilities Engineering & Energy Management, Quality & Reliability Engineering, Ergonomics & Human Factors, Operations Engineering & Management, Supply Chain Management, Engineering Management, Safety, Information Engineering, Design and Manufacturing Engineering, Product Design & Development, System Design & Engineering are the fourteen bodies of knowledge that are based on Industrial System Engineering (4). All of the BoK has already been completed at IE Universitas PGRI Adi Buana Surabaya; nevertheless, if the 14th BoK is examined more closely, the majority of the research that is done is six Bok.

**Table 1.** Literature reviews as part of IE Studies

Source	Paper Title from IE Adi Buana Database (2018-2023)
1	Optimal Control Policy for Human-Machine System by Integrating Online Feedback and Adaptive Control (1)
2	Implementing Online Feedback Control and Adaptive Control (2)
3	Analysis of Human-Machine System for Industrial Applications (3)
4	Design for Longevity and Design for 3D Concept, Application, and Perspectives (4)
5	The Willingness to Pay for Education Facilities: Evidence from the State of Education in East Indonesia (5)
6	Reorganizing Shift in Five-Day (5E) Shift System (6)
7	Safety and Health Management Implementation (7)
8	Research on the Effectiveness of Risk Reduction in COVID-19: A Case Study of a Retail Store in East Indonesia (8)
9	Thailand's Production and Automation Development: A Global Impact of COVID-19 on Manufacturing in Thailand (9)
10	Optimizing Company Performance Through Internal Coordination Training: A Practical Science Approach (10)
11	Managerial Leadership in the Era of Industry 4.0: A Study of the Effectiveness of Leadership in the Era of Industry 4.0 (11)
12	Optimization of Production Process of Paper Through the Technology of Control (12)
13	Model Perencanaan Teknologi dalam Pengembangan UMS (13)
14	Development of Controller for Product Quality Using Quality Function Deployment (14)
15	Kontribusi Manajemen Risiko dalam Meningkatkan Kualitas Produk (15)
16	Analisis Efisiensi dan Efektivitas Sistem Manajemen Mutu (16)
17	Perencanaan Sistem Produksi dan Logistik (17)
18	Apresiasi dan Pengembangan Kompetensi Manajerial (18)
19	Research Methodology in the Design of a Control System for a Manufacturing Process (19)
20	Implementation of Quality Control in the Production of Paper (20)
21	Implementation of Material Requirement Planning (MRP) in Controlling Performance for Glass Products in PT. XYZ (21)

22	Perencanaan Sistem Bahan Baku dan Logistik dalam Meningkatkan Efisiensi Produksi (22)
23	Perencanaan dan Implementasi Sistem Manajemen Mutu (23)
24	Optimalisasi Proses Produksi Berbasis Teknologi (24)
25	Implementasi Sistem Manajemen Mutu Berbasis Teknologi (25)
26	Implementasi Sistem Manajemen Mutu Berbasis Teknologi (26)
27	Implementasi Sistem Manajemen Mutu Berbasis Teknologi (27)
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37	Implementasi Sistem Manajemen Mutu Berbasis Teknologi (37)
38	Implementasi Sistem Manajemen Mutu Berbasis Teknologi (38)
39	Implementasi Sistem Manajemen Mutu Berbasis Teknologi (39)
40	Implementasi Sistem Manajemen Mutu Berbasis Teknologi (40)

### VI. DISCLOSURE STATEMENT

No potential conflict of interest was reported by the author(s).

### VII. CONCLUSION

Particularly the industry and the related engineering education must completely realign due to the primary forces of digitalization and sustainability (Industry 4.0) as well as human centeredness (Industry 5.0), a greater commitment to sustainable business management, and ultimately crises, global disruption, internationalization, and pandemics. This makes it clear that engineering education is still in need of further growth before it becomes sufficiently professionalized. One major challenge that needs

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to be addressed is the alignment of educational objectives, learning outcomes, and professional obligations. Innovative teaching and learning techniques, industry collaboration, and real-world applications must all be incorporated into the curriculum to meet this challenge. Challenge-based learning, the use of tools, simulations, and specialized software, life-cycle engineering, flipped classrooms and laboratories, and closer industry engagement are a few examples of these teaching and learning strategies. The latter can be accomplished using strategic partnerships and collaborations with nearby sectors, involving alumni to cultivate relationships and tackle real-world issues and challenges to establish environments that are favorable for learning.

More research should focus on identifying the competencies required for both professional and private competence development to successfully navigate both the professional and personal spheres of daily life. To do this, future research should focus on developing better methods for measuring competencies or undertake more thorough studies using mixed-method approaches to investigate the competencies required of IE experts. Future studies to further engineering education should start with the findings of this paper. An immersive adaptation of the professional education and training of (future) engineers is necessary, as was already noted in the introduction. The dynamic junction of AI and industrial engineering has undergone a dramatic metamorphosis that has propelled the industry into the era of Industry 4.0. In addition to completely redefining conventional manufacturing processes, this revolutionary integration of AI technology has ushered in a period of previously unheard-of efficiency, predictive power, and data-driven decision-making. Predictive maintenance has emerged as a crucial application of artificial intelligence, which has caused a seismic upheaval in the industrial sector. Machine learning algorithms anticipate equipment breakdowns by carefully analyzing data from sensors and machinery, which enables preventative maintenance interventions.

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