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SOFT SKILLS EDUCATION FOR ENGINEERING STUDENTS: A SYSTEMATIC REVIEW AND RECOMMENDATIONS FOR FURTHER RESEARCH

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Abstract. In a more comprehensive working environment and an increasingly competitive labor market, technical skills alone are insufficient for the career success of engineering professionals. Therefore, engineering curricula have integrated soft skills alongside professional knowledge and skills to enhance the competitiveness and employability of engineering graduates. Despite the global attention given to research on soft skills education for engineering students, this field remains underexplored in Vietnam. The aim of this article is to systematically review soft skills education for engineering students, thereby proposing further research directions on soft skills education for engineering students in Vietnam. This study utilizes the systematic bibliographic review to identify, evaluate, and synthesize all scientific literature related to soft skills education for engineering students that meets eligibility criteria to answer a research question: What are the main research directions on soft skills education for engineering students? Three main research directions on soft skills education for engineering students were categorized based on scientific documents, including (1) soft skills for engineering students; (2) forms and teaching methods of soft skills education for engineering students; and (3) assessing soft skills of engineering students. We also discuss the limitations and recommendations for further research in detail.

Keywords: Soft skills, engineering student, soft skills education, soft skills education for Engineer students.

1. Introduction

The term “soft skills” originally appeared in a 1968 US Army document titled “Regulation No. 350-100-1: Training Systems Engineering (Course Design)”. This regulation focuses on training soldiers to perform important responsibilities in the modern military [1]. According to Cinque (2016), “Soft skills” are referred to differently in some European countries as key competencies, cross-cutting competencies, key skills, core skills, life skills, key skills, transferable, cross-competence, generic competencies, essential competencies, cross-cutting competencies, or generic [2]. Thus, although “soft skills” are diverse in terminology, in terms of connotation, they all refer to skills that help improve job performance.

The World Economic Forum's Future of Jobs 2025 report, released on January 7, 2025, forecasts that by 2030, 170 million jobs are expected to be created and 92 million jobs displaced, resulting in a structural labor market shift of 22% of the 1.2 billion formal jobs in the dataset under study. This is equivalent to a net employment increase of 7%, or 78 million jobs. The rapid adoption of digital tools, remote working solutions, and advanced technologies such as machine learning and generative AI in the workplace requires workers to prepare soft skills to adapt to the new employment landscape [3].

In the current competitive employment market, businesses are progressively employing individuals who have both extensive job skills and robust non-technical competencies [4]. Soft skills assist students in adjusting to changing technologies and workplace dynamics, promoting flexibility and agility [4]. Many studies have explored the importance of soft skills in the workplace. The Stanford Institute for International Studies and the Carnegie Mellon Foundation conducted a study with Fortune 500 CEOs, which revealed that communication skills account for 75% of long-term job success, while technical knowledge accounts for only 25% [5]. Watts and Watts (2009) also noted that hard skills contribute only 15% to a person's success, while soft skills account for 85% [6]. The above findings on the importance of soft skills in the workplace and employability have underscored the importance of teaching and highlighting soft skills throughout the education process [7] and a greater emphasis on soft skills development in higher education curricula [8].

The fourth industrial revolution and deep international integration have elevated the demands on high-quality human resources trained in higher education institutions. To succeed in their careers, students must get training in both technical skills and soft skills to fulfill employer expectations, as soft skills are equally indicative of job success as traditional qualifications (hard skills) [9]. In order to enable engineering students to fulfill the soft skills requirements of employers after graduation, higher education institutions of technical and engineering in Vietnam have also integrated soft skills education into their training programs. However, there are still significant gaps in the research and best practices on soft skills education for engineering students in Vietnam. Therefore, we conducted a systematic literature review on soft skills education for engineering students to explore pedagogical strategies in the technological context for enhancing these skills from both theoretical and best practices perspectives. This study will address the following questions:

1) What are the main research directions on soft skills education for engineering students?

2) What are the recommendations for further research on soft skills education for engineering students, based on these main research directions?

The next section presents the answers to these questions in more detail.

2. Content

2.1. Research method

This study combined the systematic bibliographic review (SBR) related to soft skills education for engineering students and the narrative review approach to identify the main research directions of this topic. We limited the search to articles, conference proceedings, books, and projects featuring theoretical, review, experimental, or descriptive studies and utilized only freely available online publications published from 2007 to 2025. We conducted the search using tools like Google search engines and Google Scholar. The literature review has been conducted using the following keywords: soft skills, 21st-century skills, generic skills, core skills, non-technical skills, soft skills education, soft skills education for engineering students, teaching soft skills, and assessing soft skills.

Following the initial screening, we reviewed 2.060 articles, scrutinizing their titles, abstracts, and keywords to confirm their relevance to the paper's topic. We scrutinized 350 articles that aligned with the research scope, examining their introduction, literature review, methodology, findings and discussion, and conclusion to determine their inclusion or exclusion in the extended list. We excluded studies that contained some of the search keywords but did not directly relate to the research content. All criteria for the systematic bibliographic review on soft skills education for engineering students include the engineering field, engineering students, their soft skills, technical curriculum development, teaching strategies for these skills, and their evaluation. Finally, 20 scientific documents that met all criteria for the systematic literature review on soft skills education for engineering students were selected.

Three major research directions on soft skills education for engineering students are categorized based on 20 scientific documents, including (1) soft skills for engineering students; (2) forms and teaching methods of soft skills education for engineering students; and (3) assessing soft skills for engineering students. Table 1 describes the three major research directions on soft skills education for engineering students in further detail.

Table 1. Research directions on soft skills education for engineering students

Authors	Soft skills for engineering students	Forms and teaching methods of soft skills education for engineering students	Assessing the soft skills of engineering students
Lohmann et al. (2006)	x		
Renuga & Ezhilan (2014)	x		
Cimatti (2016)	x		
Fernández-Sanz et al. (2017)	x		
De Campos et al. (2020)	x		
Barakat & Shekh-Abed (2023)	X		
Naha (2024)	x		
Ferreira et al. (2024)	x		
Kumar & Hsian (2007)		x	
Da Silva (2007)		x	
Renuga & Ezhilan (2014)		x	
Idrus (2018)		x	
Deep et al. (2019)		x	
Korolyova et al. (2021)		x	
Caeiro-Rodriguez et al. (2021)		x	
Almeida and Morais (2023)		x	
Zhang (2012)			x
García et al. (2016)			x
Gopi Krishna et al. (2019)			x
Monahan & Callaghan (2024)			x

2.2. Research directions on soft skills education for engineering students

2.2.1. Soft skills for engineering students

The rapid development of science, engineering, and technology places new demands on the quality of human resources trained in higher education institutions. Employers are looking for graduates who not only have technical expertise in their field but also demonstrate soft skills in work and interaction with others. According to Naha (2024), technical and management careers increasingly recognize these skills as critical to success, requiring professionals to collaborate with diverse groups, communicate complex ideas, and solve problems creatively [8]. To increase the competitiveness of enterprises, each needs to build good, effective teams and a collaborative working atmosphere. Therefore, when recruiting new graduates for technical professions, enterprises often consider their soft skills more than their hard skills [10].

Study on defining, developing and assessing global competence in engineers, Lohmann et al. (2006) stated that the development of student competences is becoming more and more important in engineering curriculum. Professional skills, frequently referred to as "soft skills," are among the many new competencies that engineers today require. Global competence, or the capacity to operate intelligently and live comfortably in a transnational engineering environment and global society, is one of the emerging abilities for engineering graduates [11] .

Renuga and Ezhilan (2014) classified twenty-five soft skills for engineering students into three broad categories [12]: (i) communication skills (8 skills), (ii) professional skills (8 skills), and (iii) soft skills for employability (9 skills). Listening, reading, professional speaking, professional writing, seminar presentations, group discussions, interviewing, and job readiness are all examples of communication skills. Professional skills include self-management, language proficiency, goal-setting (professional objectives), time management, interpersonal skills, critical thinking, persistence, and a positive outlook. Honesty/integrity, problem-solving skills, leadership and team-building skills, willingness to learn, assertiveness, adaptability, change management, diversity management, and professional ethics are among the soft skills for employability.

A systematic review of 58 articles and 9 periodicals on engineering education out of a total of 2638 articles on Humanities and Engineering Education found that the six most important soft skill groups for engineers' employability are problem solving and critical thinking, communication, teamwork, ethical perspective, emotional intelligence, and creative thinking [7]. This study not only illustrates the relationship between technical education, the labor market, and social requirements, but also aids technical higher education institutions and engineering students in identifying the soft skills they should develop during their training to strengthen the connection between these three factors.

The findings in [8] on soft skills in engineering and management education for students in India further enrich the findings in [7] regarding the skills required by engineers. Naha (2024) in [8] believed that communication, teamwork, problem solving, leadership, and emotional intelligence are the soft skills for career success and the contribution of engineers and managers to organizational performance in the Indian employment context. However, many engineering and business students in India continue to struggle with specific topics.

Fernández-Sanz et al. (2017) examined the perspectives of 123 experts from 45 nations regarding a compilation of 10 soft skills deemed essential for engineering students and emerging professionals, which encompass responsibility, self-confidence, ethical awareness, communication skills as a receiver, communication skills as a sender, flexibility, teamwork, initiative, planning skills, and innovation/creativity. This study established the stability and worldwide relevance of this collection of 10 soft skills for engineering education [13].

According to Barakat and Shekh-Abed (2023) not only proposed the concept of soft skills and the types of soft skills that engineering students need to develop, but also highlighted the

benefits of soft skills for engineering students' studies and future careers [14]. The results of a survey of 92 engineering students at the University of Texas at Tyler on their perceptions and applications of soft skills showed that soft skills such as communication, teamwork, and empathy are essential for developing a collaborative culture that encourages higher-order thinking and relationship building. This finding provides a scientific basis for integrating soft skills into engineering curricula to develop soft skills for engineering students, thereby increasing their chances of success in both their learning and future careers.

Ferreira et al. (2024) conducted qualitative data collection from four different stakeholders, such as lecturers, second/third year students, alumni, and employers in two fields of mechanical engineering and biomedical engineering with three different higher education institutions [15]. The findings showed that all parties emphasized the importance of developing soft skills on par with technical skills, and proposed some soft skills such as leadership, teamwork, creative thinking, and critical thinking to help students adapt to new realities and interdisciplinary needs.

In brief, although there is no complete consensus on the types of soft skills for engineering students, the ones commonly mentioned in studies include lifelong learning skills, problem-solving skills, communication skills, time management skills, creative thinking skills, critical thinking skills, and collaboration skills.

2.2.2. Forms and teaching methods of soft skills education for engineering students

To develop soft skills for students, higher education institutions and educators not only identify which skills are important, necessary, or aligned with societal needs but also must choose and apply pedagogical methods to promote and develop them. An overview of studies on the forms and methods of soft skill development for engineering students reveals that integrating soft skills into engineering training programs and using teaching methods that promote active and experiential learning are common ways to develop them. These are considered the primary pedagogical strategies in developing soft skills for engineering students across various countries, higher education institutions, and majors.

Kumar and Hsian (2007) developed engineering leadership skills for undergraduate and graduate students by incorporating these skills into the course "Geotechnical Engineering in Professional Practice" and implementing it through a combination of the problem-based curriculum and service learning pedagogy at Southern Illinois University Carbondale [16]. During the course, students work on real-world projects that engineers normally do in the first two to three years of their employment. The course allows students to practice leadership and management skill, ethics, and interactions with consulting engineers and community members. The integration of problem-based learning curriculum and service learning pedagogy in engineering is considered "the most effective way to prepare engineers for the 21st century" [16].

By integrating a personal portfolio approach into the training program's courses, the Instituto Superior Técnico of the Technical University of Lisbon has developed soft skills for students of Information Systems and Computer Engineering [17]. Students of Information Systems and Computer Engineering can explore and develop a range of soft skills in six semesters, including collaborative learning, self-directed learning, citizenship, social skills, organizational skills, creativity, entrepreneurship, time management, international awareness, leadership, management, professional relationships, teamwork, and systems perspective, and reflection on practice. To acquire these skills, students must perform prescribed activities, reflect on them, and report on the implementation and results related to them in their personal portfolio. The results of activities, reflections, and reports kept in personal learning portfolios for 6 weeks are the most authentic evidence of the level of soft skills of students majoring in Information Systems and Computing Engineering.

In their study on strategies for cultivating soft skills in higher engineering courses, Almeida and Morais (2023) asserted that due to the scarcity of disciplines dedicated to soft skills

development, these competencies should also be integrated into subjects primarily aimed at enhancing hard skills [18].

Higher education institutions have been urged by industry professionals to develop competent graduates prepared to compete in the local and global job markets. Graduates, particularly in technical disciplines, are considered proficient in technical skills yet deficient in non-technical or soft skills necessary for the optimal application of their technical expertise. Idrus (2018) belived that it is essential to incorporate soft skills, including critical thinking, problem-solving, communication, teamwork, and leadership, into the teaching and learning process, particularly in engineering, to augment students' proficiency in non-technical abilities [19].

Deep et al. (2019) looked at how problem-based learning (PBL) and using e-learning tools like Schoology, Padlet, videos, and internet surfing in PBL classrooms affected the development of soft skills in Malaysian engineering students who are usually thought of as shy and quiet [20]. During the 12 weeks, 57 1st- and 2nd-year students from various engineering faculties participating in the Effective Communication course at Universiti Tun Hussein Onn Malaysia have to do some small group activities to practice soft skills, including language skills (reading, writing, English, presentations, and communication), group learning (cooperation, leadership, information gathering, multitasking skills, discussion, negotiation, and teamwork), conflict resolution skills, research skills, and mixed skills (consultation, passion for learning, independent learning, and general knowledge). Accorsing to Deep et al. (2019) PBL and the use of e-learning tools in PBL classrooms are effective instructional strategies for developing the soft skills of engineering students.

Korolyova et al. (2021) conducted a study on the development of soft skills for environmental engineering students by integrating these skills into the foreign language training program at Tambov State Technical University (Russia). Soft skills integrated into the English course for environmental engineering students include communication skills, teamwork skills, presentation skills, negotiation skills, leadership skills, time management skills, and interpersonal skills. When participating in this course, environmental engineering students must perform a variety of learning tasks. When performing learning tasks, students learn how to solve sustainable development problems and build different scenarios for the future. In addition, students learn how to negotiate, make arguments, manage time appropriately, and build effective communication with international partners when solving learning situations in English [21].

Caeiro-Rodriguez et al. (2021) surveyed 184 final-year engineering students from five countries, including Greece, Estonia, Denmark, Portugal, and Spain to determine which pedagogical methods were suitable for developing 44 selected soft skills for their future professional and personal lives after completing their studies. The students rated "Problem-based learning" as the most suitable educational method, followed by thinking-based learning, design thinking, and competency-based learning. Collaborative learning, gamification, and flipped classrooms were considered the least effective. Caeiro-Rodriguez et al. (2021) also looked at 22 best practices and found that almost half of them (10) were based on or focused on problem-based learning (PBL), which was often used with active learning (4) and teamwork (3). The other four used project-based learning. Furthermore, 9 of these best practices relied on some type of active learning approach [22]

In short, the forms and teaching methods of soft skills education for engineering students focus on two main approaches, including (1) integrating soft skills instruction into engineering curriculum, and (2) using teaching methods that promote active and experiential learning for engineering students. The aforementioned approaches provide engineering students with opportunities to practice various forms of soft skills throughout their learning process in the classroom and professional settings.

2.2.3. Assessing soft skills of engineering students

In addition to identifying the types of soft skills that engineering students need to develop and selecting appropriate pedagogical strategies to teach them, it is important to measure and evaluate students' soft skills levels and their attitudes toward learning them. The assessment of students' soft skills needs to be based on tools and data that ensure validity and reliability. Students' soft skills assessments may help higher education institutions develop appropriate strategies for enhancing students' soft skills or improving engineering curricula and instructional approaches.

Zhang (2012) designed a peer assessment scale to evaluate the soft skills of information technology students, as the assessment of these skills typically relies on arbitrary, non-standardized, or poorly structured peer assessment scales [23]. Zhang (2012) used a valid and reliable peer assessment scale to evaluate the eight soft skills of 24 information technology students, including being dependable and responsible; communicating with group members; cooperating with and supporting group members (sharing resources, ideas, encouragement, and constructive feedback); working through and constructively handling conflicts; being respectful of others' ideas and staying positive and open-minded; committing to a group goal; taking a leadership role; organizing the group; and helping it to function as a team. Zhang's (2012) study revealed that determining the success of soft skills education for information technology students requires the use of a peer assessment tool with tightly structured items while also ensuring validity and reliability.

García et al. (2016) asserted that evaluating generic competencies in a blended learning setting constitutes a significant difficulty in higher education [24]. García et al. (2016) created the Evalsoft system, which facilitates the monitoring and evaluation of generic abilities in a virtual professional setting. This program facilitates the effective management of student group projects and teacher oversight by incorporating several skill assessment options, including self-assessment, peer assessment, and teacher evaluation.

Krishna et al. (2019) conducted a study in which they investigated the acquisition of soft skills among 150 final year students studying five different engineering disciplines in India including mechanical engineering, civil engineering, electronics and communication engineering, computer science engineering, and electrical and electronics engineering [25]. Krishna et al. (2019) used ten questionnaires in the form of 5-point Likert scale based on the requirement of HR departments in companies for ten soft skills, including communication skills, problem solving skills, email management, interpersonal communication, technical skills, workplace skills, management skills, self-awareness skills, adaptability skills, and professional etiquette. The findings of this study demonstrate that integrating soft skills requirements from engineering firms into assessment criteria not only provides valuable information on soft skills but also assists engineering students in identifying areas for improvement to meet the requirements of employers.

Monahan and Callaghan (2024) used an authentic assessment method to gather evidence of the improvement in the soft skills of mechanical engineering students after they completed the employment experience module at Technological University Dublin (Ireland). They asked students to document evidence of their development of communication, teamwork, and self-management skills in a work journal. The evidence study, conducted on 39 students who successfully completed and passed the work experience module over a 4-year period from 2020 to 2024, revealed that the results of their work at the work experience site serve as authentic evidence of the development of soft skills among mechanical engineering students [26].

In short, studies on the soft skills assessment of engineering students show diversity in assessment forms and methods. However, a common feature of this diversity is the use of a competence-based assessment approach, such as peer assessment, self-assessment, authentic assessment, and the 5-point Likert scale, instead of traditional assessment methods like written or multiple-choice. The integration of soft skills assessment into the teaching process provides engineering students with opportunities to develop them throughout their learning process, life

experiences, and work experiences. Therefore, the findings of the literature review on soft skills assessment indicate that the soft skills assessment methods of engineering students being applied in higher education institutions around the world are suitable for formative assessment instead of focusing only on summative assessment.

3. Conclusions

The fourth industrial revolution and the rapid advancement of technology significantly impact job sectors, particularly engineering and technology. In addition to technical and technological skills, employers require engineering graduates to possess soft skills. The literature review on soft skills education for engineering students reveals that this topic has garnered the attention of numerous researchers worldwide. However, there remains a gap in research on this topic within the context of engineering education in Vietnam. This study looked at documents about soft skills education for engineering students and came up with three main research directions for soft skills education for engineering students, including (1) identifying soft skills for engineering students; (2) forms and teaching methods of soft skills education for engineering students; and (3) assessing soft skills for engineering students.

To meet the requirements of employers in the engineering field, engineering students need to be equipped with soft skills, including lifelong learning skills, problem-solving skills, communication skills, time management skills, creative thinking skills, critical thinking skills, and collaboration skills. Engineering students' soft skills are developed through integrating soft skills into the engineering curriculum and using teaching methods that promote active and experiential learning. Engineering students' soft skills are assessed using a variety of methods such as peer assessment, self-assessment, authentic assessment, and a 5-point Likert scale.

Although this study identifies three clear research directions on soft skills education for engineering students, there are still some limitations. This study focuses solely on identifying the soft skills of engineering students, without delving into specific soft skill types associated with each engineering field, such as information technology, mechanical engineering, construction, electricity, electronics, etc. This study has not investigated the development of soft skills education content for engineering students. In addition, this study has not explored the sustainability of the soft skills of engineering students under the impact of active and experiential pedagogical approaches.

Some recommendations for further research on soft skills education for engineering students in Vietnam are identified as follows:

- Exploring employers' requirements for soft skills needed for engineers in the context of engineering jobs in Vietnam.
- Exploring the soft skills level of engineering students from different types of universities in Vietnam, including public universities, private universities, and international universities.
- Comparative study of soft skills of engineering students among universities in Vietnam, including public universities, private universities, and international universities.
- Developing soft skills training programs based on the output approach or work-based learning approach for engineering students.
- Studying the impact of teaching methods that promote active and experiential learning (group teaching methods, problem-based learning, project-based learning, learning games, etc.) on the soft skills of engineering students.
- Studying methods and tools for assessing the soft skills of engineering students to ensure validity and reliability.
- Developing a soft skills scale for students of different engineering majors in Vietnam.

Studying the impact of information and communication technology on the development of soft skills for engineering students.

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