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Systematic Literature Review of Skills in Management Engineering

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Abstract**—** *This paper presents a comprehensive systematic literature review of scientific research on skills and competencies in Management Engineering (ME). Although ME is often associated with Engineering Management (EM), the two fields differ significantly. ME is an engineering branch focusing on engineering methodologies. In contrast, EM employs a more general management approach, applicable across all engineering disciplines. In this research, using the PRISMA methodology, a systematic literature review was conducted on 23 articles published between 2010 and 2025 in the Scopus database. Eighteen of the studies (78.2%) focus on educational aspects, while only five focus on the professional roles and tasks of management engineers. The main conclusions of this study are: a) ME is closely linked to an interdisciplinary perspective, having strong ties with Industrial and Construction Engineering. This leads to a wide range of professional careers in different sectors, including manufacturing and telecommunications, as well as healthcare and human resources. b) The cultivation of both hard and soft skills is recommended, emphasizing not only problem-solving but also sustainable development and a more holistic/systemic perspective. c) The need for cooperation between Higher Education and the labor market is highlighted, alongside the promotion of integrated work-based learning, internships, and lifelong learning. The results of this study can be used by academic staff, engineering students, HR personnel, and career counselors interested in ME skills and bridging the gap between education and the labor market.*

Keywords**—***Competecy; Management Engineering; PRISMA; Skills; Systematic review.*

I. INTRODUCTION

Management Engineering (ME) is the branch of constructing and analyzing mathematical models of real-world systems in order to make well-reasoned and reasoned management decisions [1]. According to Google Scholar, the term "Management Engineering" (ME) was first used in the title of a book in the early 20th century [2] and then referred to in the 1920s [3]. The ME is a distinct scientific field of engineering that shares similarities and differences with "Industrial Engineering" and "Engineering Management" [4], [5]. It is also sometimes used as a synonym for operations research, systems engineering, or management science [1].

[5] emphasize that ME is a convergence of engineering and management disciplines and falls within the broader field of industrial engineering. [4] also consider management engineering (ME) as a modern form of industrial engineering that integrates information technology (IT) into management. In particular, they point out [4], the extensive adoption of a range of technological skills and analytical methodologies already used by industrial engineers in the manufacturing and processing industries. These methodologies find application in management engineering (ME) in a multitude of other sectors, beyond industry, in both the public and private sectors. In addition, ME, especially in North America, has been defined as industrial engineering for healthcare [1], [6], [7]. This view emerged in the mid-20th century, when Lillian Moller Gilbreth—also known as the pioneer of Industrial Engineering [8]—proposed the application of ME in nursing. In the healthcare sector, IT is considered to be able to contribute to high-value services by reducing costs, enhancing productivity and efficiency, and improving information systems and facilities [6].

In contrast, Engineering Management (EM) uses a different and more expansive management approach. It includes engineers and other technical professionals who need to develop management skills as part of their roles, as engineering managers [9]. EM as a professional discipline encompasses the knowledge, skills, and general management responsibilities of engineers at supervisor/manager level. These tasks include applying engineering principles as well as organizing and guiding people and projects [10].

Despite the extensive use of the terms 'skills' and 'competences' in recent years, there is still some conceptual confusion about the use of these terms, which have traditionally been associated with education, and have now gained wider acceptance with a focus on professional roles [11].

A systematic literature review [12] is defined as a comprehensive review of existing publications, using clear and systematic methods to collect and synthesize studies aimed at answering a clearly formulated question. Systematic literature review as a methodology has been used in a wide range of studies on skills and competences, including employability skills [13] and transversal competencies for university graduates [14].

In reviewing the existing literature, we found the absence of a systematic literature review focusing on skills and competencies in Management Engineering (ME). Also, there is limited literature on scientific research in engineering education, with a focus on engineering skills in relation to the labor market.

The aim of the thesis is to identify a set of skills and competences, based on existing studies. The research questions (RQ1–RQ3) focus on the distinction between educational research and occupational research regarding the professional roles of management engineers.

Following are the research questions that will be answered in this paper:

Research Questions

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- RQ1: "How many of the studies are educational, which countries do they originate from, what areas do they focus on, and which learning methodologies do they examine?"
- RQ2: "How many of the studies focus on the labor market, which countries do they originate from, and which professional sectors do they examine?"
- RQ3: "Which skills are studied in educational research and which skills are highlighted as important in research on the professional roles of management engineers?"

The paper is structured as follows: the methodology is described in the next section. Then the results are presented, based on the research questions. Subsequently, there is a discussion of the results, and finally, the conclusion is provided.

II. Methodology

We follow the Preferred Reporting Items for Systematic Reviews (PRISMA) methodology [15, 16] to conduct this study; the PRISMA statement includes a 27-item checklist and a four-phase flowchart (Fig. 1). It consists of methodological practices for identifying, selecting, evaluating, and synthesizing studies. The data was retrieved from the Scopus database on June 15, 2025.

The following inclusion/exclusion criteria were set: a) The title, abstracts, or keywords should contain the terms "management engineer*" and "skill* or competenc*". b) document type: only articles and conferences. c) Source types: only Journals or Conference Proceedings. d) Languages: only English language publications; e) Time frame for research implementation: 2010-2025; and f) included without limitation, both quantitative and qualitative research; g) results not referring to specific skills or competencies or referring to other topics or other professions and not to management engineers (or ME) are not included.

We have selected only peer-reviewed papers published in the last 15 years, in order to map the latest trends in the literature and the future of the research field.

Query: (TITLE-ABS-KEY("Management Engineer*" AND Skill* OR competenc*) AND (LIMIT-TO (DOCTYPE,"cp") OR LIMIT-TO (DOCTYPE,"ar")) AND (LIMIT-TO (SRCTYPE,"j") OR LIMIT-TO (SRCTYPE,"p")) AND PUBYEAR > 2009) AND (LIMIT-TO (LANGUAGE,"English"))

The inclusion/exclusion criteria were strictly applied to peer-reviewed papers published between 2010 and 2025. Data were extracted from a total of 60 publications. In the first phase of the PRISMA methodology, the existence of duplicate records was examined: no duplicate record was found. Subsequently, titles and abstracts were examined to determine if the papers satisfied the aforementioned inclusion criteria. After reviewing titles and summaries, 31 papers were excluded as they did not treat ME as a separate discipline. It was observed that did not refer to ME as a separate branch or profession. Most of these publications used the phrase "management, engineering" which is a clearly different term from the term "ME". Additionally, four papers were not available for download. By removing these papers, the papers to be studied were limited to 25 papers, which were studied thoroughly. After full-text screening of 25 assignments and excluding two non-relevant documents, 23 papers were ultimately included in the systematic literature review (Fig. 1).

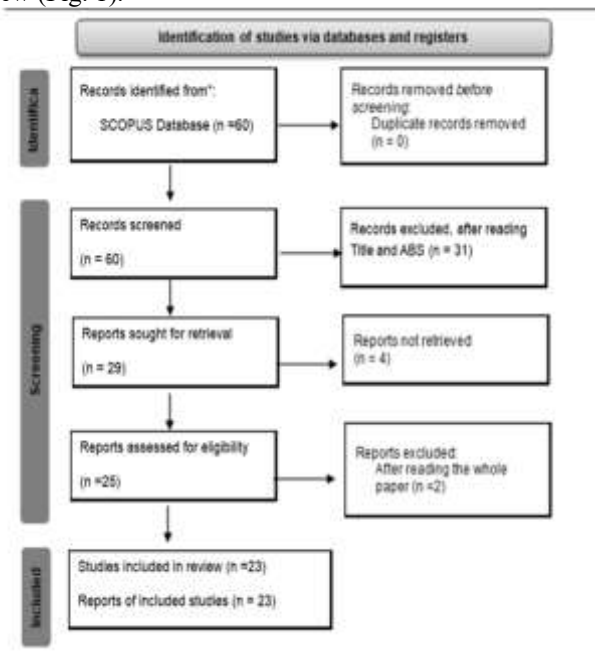

Fig. 1. PRISMA Flowchart

III. Results

- RQ1: "How many of the studies are educational, which countries do they originate from, what areas do they focus on, and which learning methodologies do they examine?"

A significant proportion of the studies, namely eighteen (18) out of a total of twenty-three (78.2%), focus on educational issues (Table 1). The educational research primarily originate from Italy (the most productive country with 7 papers) and Spain, with additional contributions from South Africa, Israel, the Netherlands, Saudi Arabia, Poland, and the USA.

Initially (Table 1), we highlight the study by [5] that presents the new perspective offered by ME as an integration of engineering and management knowledge.

A total of ten selected studies describe methodologies that promote the integration of engineering theory with its practical application (Table 2). The applied methodologies and related studies (in parentheses) are: project-based learning [30, 34, 25, 36], active learning [25], work-integrated learning [23], experiential learning [21, 26, 36], learning activities with Virtual Reality [22], training in product design [28] and open learning in design [26].

Four studies (Table 1) assess the prospects of an ME-related course or program, including: collaborative curriculum in ME construction [31], sustainable education [33], course and fieldwork in biomedical engineering education [36], and sustainability in the engineering curriculum [27]. Additionally, one study examines the impact of an internship program on students' academic performance [37].

Other fields of application of the education-focused documents include: Self-efficacy in engineering students' innovation [29], the role of multiple intelligences [32], and the

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competencies of future Waste Management Engineers [35].

Only six of the educational studies have been conducted on ME students; five studies are from Italy [21, 25, 28, 34, 37], and the sixth is from Spain [32]. In a much larger number of researches, ME is associated with other fields, such as Industrial and Management Engineering [22, 24, 27, 30]. Three papers examine Construction Management Engineering students [26, 29, 31]. There are also studies for Operations ME students [23] and Quality ME students [27]. In addition, the importance of ME skills for biomedical engineering [36] and for waste management program students [35] is recognized.

TABLE I. Educational studies

	Paper	Object of study - Learning methodology (if indicated) / Skills studied or research outcome	Sample
1.	[21] / Italy	Computer-Aided Innovation Tools - Experiential Learning / Problem-Solving Skills, Creativity and Interdisciplinary Approach	Students of Mechanical Engineering and Postgraduate Studies
2.	[22] / Spain	Educational Tools for Graphic Engineering Students / Virtual Reality (VR) Learning Activities / Spatial Skills	Industrial ME students and students of other engineering disciplines
3.	[23] / South Africa	Work-Integrated Learning (WIL) in Engineering Education / Employability Skills, Workplace Experience Improves Communication and Employability Skills	Operations ME Students
4.	[24] / Israel	Systems Thinking Development between Engineers and Engineering Students, Learning Organization / Systems Thinking Skills	Engineers and students of Industry and ME.
5.	[25] / Italy	Nonlinear Mathematical Programming Model for Operations Research (OR), tool for engineering students - Project-Based Learning, Active Learning/Analytical Skills, Hard and Soft Skills, Teamwork	ME students (Bachelor) and Industrial Engineering students (Master).
6.	[26] / Netherlands	Open Design - Experiential Learning, Synthetic Education / management skills to solve real complex problems, solutions for interdisciplinary management systems	Construction ME students (Master's).
7.	[27] / China - Australia	Curriculum for Sustainability in Engineering/Sustainable Skills	Quality ME Students
8.	[28] / Italy	BrainWriting Method for Education/Creativity in Product Design, Innovation	Students of Mechanical Engineering and ME
9.	[29] / USA	First-year Engineering Students Innovation Self-efficacy Beliefs/innovation, cognitive skills, expectations to solve complex, global issues	Engineering students from a variety of disciplines, including ME construction.
10.	[30] / Spain	Implementation of project-based learning, ongoing university-industry collaboration / employability skills. Corporate-based projects impacted students' skills more positively than traditional projects.	Industrial Engineering students (Master's), Industrial ME students (bachelor's degree) and managers
11.	[5] / Italy	Proposed framework for IT/ Integration of technological-engineering and managerial knowledge in the current socio-technical scenario.	No Sample – Review of Study Programs
12.	[31] / Saudi Arabia	Co-op Program for University Career Transition for Construction Education ME (on paper the term Engineering Management is also used) / Both technical knowledge, general skills and attitudes. Employers view soft skills as fundamental to selection.	Construction Management Students and Employers
13.	[32] / Spain	Multiple intelligences to address the Sustainable Development Goals in ME/Both logical-mathematical intelligence and interpersonal, intrapersonal, linguistic and spatial intelligence.	ME Students
14.	[33] / Italy	Sustainable education / Vocational skills for sustainable development	ME Students
15.	[34] / Italy	Recommended tool for mapping students' design skills in order to optimize the composition of a team - Project-based design / Skill distribution, teamwork, learning skills	ME and Data Science Students (Master)
16.	[35] / Poland	Competences of Future Waste Management Engineers / Sustainable skills, ability to deal with ecological threats, saving and renewal of all relevant resources (natural and social)	Students of the waste management program
17.	[36] / Mexico - UK	Interdisciplinary knowledge and skills for a broader professional role in healthcare processes - Project-based learning, experiential learning/Healthcare ME professional skills, interdisciplinary training.	Biomedical Engineering Students
18.	[37] / Italy	Student Score and Internship Relationship - Internship / Skill development when internship replaces lectures and exams for undergraduates.	2,279 Industrial and ME Bachelor students and 2,560 Master of Science (MS) degree students

- RQ2: “How many of the studies focus on the labor market, which countries do they originate from, and which professional sectors do they examine?"

As illustrated in Table 2 only five studies focus on professional roles and tasks. They are focusing on telecommunications [25], mechanical engineering [26], healthcare [27], and the maritime sector [28]. It is important to note that the majority of surveys focusing on the ME's profession come from different countries compared to the surveys that focused on education. Research from Japan [26], China-USA [28], Morocco [27], and Iran-Lithuania [29] provides diverse global perspectives. Only one study comes from Spain [39] (in collaboration with Jordan, where Jordanian Telecommunications is being studied). In contrast, no research comes from Italy, the country with the most educational studies on the subject (7).

In particular, the following have been studied: the healthcare sector [42], the maritime sector [41], the materials/biocomposites sector [38], the telecommunications sector [39] and the human resources sector [40]. In addition, in educational studies, we have seen that ME is closely correlated with the Industrial and Construction perspective as well as with Operations and Quality.

TABLE 2. Studies Focusing on the Labour Market

	Paper	Object of study	Sample	Skills Recommended
1.	[38] / Japan	Mechanical properties of composite material by spray manufacturing method	Traffic data of experts – non-specialists	Technical skills. Relationship between operator competence and product quality
2.	[39] / Spain – Jordan	Correlation between Business Size and Competencies Required for Management Engineers in Jordan's Telecommunications Sector	Employers in small/medium - large enterprises	Different skills/abilities are required, e.g. problem-solving and strategic planning
3.	[40] / Iran – Lithuania	Sustainable human resource management. Assessment of job satisfaction. A framework is proposed to address the problem of evaluation in real applications	-	Human resources are a key asset in guiding organizations to maintain their competitive advantages
4.	[41] / China – USA	Maintenance work on marine power equipment. An optimization algorithm is proposed to extract a work-personnel schedule	-	Making decisions for scheduling personnel and tasks through an algorithm (for project managers). Multiple skills.
5.	[42] / Morocco	Professional characteristics and administrative efficiency for high-performance ME in the healthcare sector.	100 directors of psycho-pedagogical centers - health directors / Ile-de-France region	Continuing education. Integrating Administrative Engineering into Professional Features

RQ3: "Which skills are studied in educational research and which skills are highlighted as important in research on the professional roles of management engineers?"

The skills and competencies studied in educational research include a wide range (both technical and social) such as: solving complex problems [25, 26, 29], teamwork [25, 34], innovation [28, 29], design skills [34], spatial skills [22], creativity [28] and communication skills [23].

A significant number of papers (five) focus on sustainable education and the need to enhance relevant skills in university programs [27, 30, 32, 33, 35].

Furthermore, a significant body of research has taken a comprehensive approach, recognizing the necessity of cultivating both soft and hard skills [25, 31]. [32] expand this view, incorporating the concept of multiple intelligence, which, according to the perceptions of ME students, requires reinforcement (both logical-mathematical intelligence and interpersonal, intrapersonal, linguistic and spatial intelligence).

In this context, some studies recognize the interdisciplinary dimension of ME [25, 26] and the need to cultivate relevant skills, such as systems thinking skills [24] and interdisciplinary skills [36]. [5] provide a comprehensive overview of this perspective, proposing an interdisciplinary conceptual basis for ME, integrating both technological engineering and managerial expertise into the present socio-technical context.

In the field of labor market studies, the focus is typically on technical skills [38]. However, the complexity of the subject matter and the need for a wide range of skills, including problem-solving and strategic planning, are recognized [39, 41]. Additionally, studies on human resource management skills [40] highlight the important role of human development and offer a broader perspective. Accordingly, the necessity of the skills and knowledge of the administrative engineer, as well as the professional characteristics of engineers, for the effective functioning of organizations is recognized [42].

IV. Discussion

Contrary to the prevailing belief in recent years that the terms "skills" and "competences" are simply a new trend in the debate on the role of education, in fact, both terms have been linked over time to prevailing educational, economic and social policies [11].

According to [4], ME is considered a field that integrates the analytical methodologies of industrial engineering with the knowledge of information technology found in software engineering and computer science. It also incorporates social and scientific knowledge about organizations and management systems. Management engineers have a wide range of job opportunities that span various economic sectors, beyond manufacturing. In addition to the industrial and manufacturing sectors, ME is also expanding into service-related industries such as healthcare, telecommunications, as well as government and military [5]. The wide range of sectors examined in studies focused on the labour market supports this approach.

All these job prospects demonstrate an interdisciplinary approach to ME, something that is already true for Industrial Engineering.

Although problem-solving is considered the core of the practice of engineering [43], in this paper we see the importance of both technical and social skills. A significant number of educational studies [25, 31, 32] and all studies focusing on the labor market [38, 39, 40, 41, 42] propose a variety of skills, both technical and social.

ME can provide skills and methods to manage complexity in various fields beyond industrial applications [44], such as successfully executing interdisciplinary projects in high-tech companies dealing with complex and dynamic systems projects [24]. The interdisciplinary dimension of ME [25, 26] and the cultivation of systems thinking skills [24] and interdisciplinary skills [36] provide an important perspective for training in ME. In addition, skills related to sustainable development provide a new perspective for ME students in a rapidly growing economic sector. Therefore, a multidisciplinary approach is proposed.

On the other hand, it is recognized that employers may require different skills and competencies, depending on the size of the company [39], e.g. more general skills such as problem-solving and strategic planning in small/medium-sized enterprises versus more technical skills and good training in large companies.

ME education proposes to provide rich learning

environments which will be closer to professional life and increase student motivation [30]. Project-based learning [25, 30, 34, 36], cooperative learning [31] and experiential learning [25, 26, 36] have a positive role in this process. Work experience is considered to be a fundamental aspect of the educational process and is present (directly or indirectly) in all the educational tasks under consideration. In particular, integrated learning at work and the need to develop employability skills [23, 30] as well as fieldwork [36] and internships [37]. Also, [39] highlight the importance of transitioning from higher education to the labor market.

[52] also emphasize the importance of an interdisciplinary approach to ME education in an emergency management talent nurturing model for the prevention and control of major epidemics.

The use of technology for teaching purposes [21, 22] as well as learning tools and methodologies [25, 26, 28, 34] broaden the students' point of view and their skills.

Collaborative learning in the context of the learning factory (Lean School) to improve students' skills in lean manufacturing is also a proposal for engineering students in the field of ME [45]. Innovative teaching activities are also proposed [46] to combine three forms of learning (autonomous, collaborative and competitive) with the use of ICT.

In the present study, we observe the superiority of Italy and Spain in educational studies. Considering the important role of ME in emerging economies [47] and the overrepresentation of Mediterranean countries in our study, combined with the US focus on specific sectors, such as healthcare [1, 6, 7, 36, 42], we emphasize the critical role of geography when studying documents referenced in ME.

The field of ME is constantly changing [47]. ME faces a number of challenges [5], including complexity, digitalization, intellectual capital management, social networks, and technological entrepreneurship. The essential connection between the ME and the Industrial Organizations is also recognized, as well as the new challenges to be addressed [48, 49]. The correlation with Industrial Engineering is also strengthened by the existence of an increased percentage of female students in ME programs [37] compared to other engineering programs. This phenomenon is also typical in industrial engineering programs [53, 54].

In today's globalized environment, technological advancements have shaped a new reality that transcends linear structures or hierarchical models. ME needs to adapt to this changing environment and move away from the conventional model for problem-solving [50]. The rapidly changing global environment, characterized by instability and frequent changes, poses a significant challenge for engineering education. Being associated with the job market can provide valuable insights into educational studies. Continuing education and lifelong learning [30, 42, 45] as well as stronger university-industry collaboration [30, 37]. You also emphasize the need to align educational outcomes with labor market demands [11, 51] as it is increasingly expressed at institutional and state level (e.g. European Union).

Limitations

As with any study, there are some limitations to consider. In the present paper, the Scopus database was used for the systematic review of the literature and for the bibliometric analysis. Despite the recognized interdisciplinary nature of the Scopus database, an extensive examination of the relevant literature would be possible using other databases such as Web of Science or Google Scholar.

Both educational research and labor market research studies are characterized by distinct objectives and methodologies, which made it impossible to conduct a meta-analysis.

The present study focused exclusively on the literature published in English.

V. Conclusion

The present study uses a systematic literature review, following the PRISMA methodology [19, 20]. In addition, a bibliometric analysis works in a complementary way. In this review, we have included both educational studies and studies that have focused on the job market. Incorporating these results is a crucial step in the analysis of educational studies, as it allows for the synthesis of different findings to improve the overall understanding of the subject.

ME is a field that promotes an interdisciplinary approach. Despite the various conceptualizations of ME, it is a distinct discipline with a strong correlation with industrial engineering, management sciences and technology. It encompasses a wide range of professions across various economic sectors, ranging from telecommunications and sustainable development to human resources and healthcare.

The findings of the present study show that a broad and multifaceted set of skills is required, encompassing technical and social competences. This set also includes skills related to sustainable development, interdisciplinary knowledge and systems thinking.

Educational studies show a strong connection with experiential learning. Integrating the principles of integrated learning into the work is consistent with enhancing professional experience in any educational curriculum. From a pedagogical perspective, this approach entails the systematic integration of practical applications into teaching methodologies.

Incorporating modern technological resources that simulate the real world of work is a key strategy for enhancing the learning experience and educational content.

The findings of the present study may prove beneficial for academic staff, career counsellors, ME students and HR staff who are looking for a comprehensive approach to the existing literature on skills and competences in ME. This knowledge may prove useful in the context of teaching practice or in strengthening university-industry cooperation.

Finally, we observed different approaches to ME in different geographical areas. Further research in the literature focusing on the scientific field of MEs could provide more information about the autonomy of this discipline and the possible correlations with related scientific fields in engineering.

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