A Comparative Study of the Engineering Soft Skills Required by Moroccan Job Market

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Abstract

This paper aims at comparing the soft skills required by Moroccan employers to those developed in engineering schools in order to improve engineers' employability. On the one hand, soft skills needed for the job market integration are defined using a mixed method belonging to sequential exploratory design. On the other hand, educational curricula are examined to determine if they meet the workplace requirements. This study is strengthened by including findings collected by interviewing professionals about the level of soft skills development among newly graduated engineers.

Keywords: soft skills, engineering schools, engineers, employability

1. Introduction

This paper is an extended version of work originally reposted in IEEE ICOA 2019 (International Conference on Optimization and Applications) (Chaibate, Hadek, Ajana, Bakkali, & Faraj, 2019). We are making this version in order to present in detail the approach and results of our previous work. We have also added new findings to make the study more useful and beneficial to other researchers.

In the context of strong competitiveness, companies are facing different challenges related to the Fourth Industrial Revolution (Industry 4.0) where companies use digitization and new technologies to meet different socio-economic challenges. As a result, engineering schools must devote considerable efforts to improve students' employability skills and bridge the gap between educational programs and job market requirements (Schuster, Groß, Vossen, Richert, & Jeschke, 2016; Wall, 2010). Engineers are expected to manage projects and make decisions in different contexts therefore they must develop soft skills in addition to technical skills in order to integrate easily into this changing professional world (Rao, 2014).

This work aims at describing the soft skills required by Moroccan job market using a mixed research method. We conducted a comparative study of the soft skills needed for easy professional integration and those developed at engineering school. This paper is structured as follows: research methodology is presented in section 2. Qualitative content analysis is summarized in section 3. Quantitative content analysis is sufficiently described in section 4. Soft skills that are developed at Moroccan engineering schools are presented in section 5.

2. Research Methodology

In this study we adopted a sequential exploratory design belonging to mixed research methods where qualitative and quantitative approaches are combined to achieve specific results (Fetters, Curry, & Creswell, 2013; Cabrera, 2011). In this paper qualitative content analysis is used to answer the research question, what are the soft skills required in engineering education? By studying a set of standards and syllabus published by engineering accreditation bodies in some developed countries. Quantitative content analysis is used to answer the following research question: Do the soft skills described by the qualitative content analysis reflect Moroccan job market requirements? Quantitative data are engineering job ads collected form Moroccan job websites. Research methodology is presented in table 1.

Table 1. Research methodology

	Qualitative content analysis	Quantitative content analysis
Research question	What are the soft skills required in engineering education?	Do the soft skills described by the qualitative content analysis reflect Moroccan job market requirements?
Sources of collected data	Standards and syllabus of engineering accreditation bodies	Engineering job ads collected form Moroccan job websites
Research instrument	Content analysis grid	Content analysis grid
Data analysis	Deep reading of accreditation documents to highlight soft skills widely required in engineering education	After identifying the job market requirements by deeply analyzing the content of job ads. Collected data are analyzed using SPSS (Statistical Package for Social Sciences)

Content analysis is research techniques used to understand a phenomenon and answer a specific research question. This method can be applied in management, marketing, health and the social sciences for studying documents and communication artifacts. One of its wide applications is systemic analysis of media contents. Its diffusion is justified by the fact that it is (Riff, Lacy, & Fico, 2014; Krippendorff, 2018):

- Systematic: it means that research results are extracted according to scientific reasoning
- Reproducible: it means that obtained results can be applied to study any similar phenomenon
- Reliable: refers to the fact that the research's results can be obtained by any other researcher who has analyzed the same data using the same tools and methods.

3. How Important are Soft Skills for Improving Engineers' Employability?

In engineering schools, students are expected to develop two types of skills

- Technical skills refer to the practical knowledge and the ability to work with methods and tools related to the exercise of a specific activity. They are several skills related to engineering practice such as design, simulation, and software expertise.

Soft skills refer to a set of interpersonal intrapersonal skills enabling employers to improve their relationships and work performance. They include, for instance communication, autonomy, initiative, problem-solving skills, time management, team working, and the skill to act while respecting social and professional values (Vijayalakshmi, 2016). These skills cover several important aspects that define the operational engineer when performing his work including:

- Personal skills: they are personal abilities enabling engineers to achieve the targeted results successfully and easily such as organization, efficiency, autonomy, decision-making, mobility, and problem resolution skills.
- Interpersonal skills: these skills define how the engineer interacts with his or her work group, namely Communication skills (languages, negotiation), and team-working skills.
- Managerial skills: refer to the skills of an engineer as a project manager including time management, stress management, and team management skills.
- Innovation and entrepreneurship skills: engineers must be innovative and create the best work opportunities by developing entrepreneurship skills in order to achieve competitive job opportunities.
- Ethical and professional skills: engineers must be faithful to their professional commitment and their social responsibility while exercising their profession.
- Technology skills: refer to the ability to use and keep up with emerging technologies in engineering practice

Unlike technical skills, soft skills are not easily developed and evaluated. This is because they are not specifically associated with a specific activity, but occur in a variety of situations. This means that soft skills can be developed if

students are faced with real situations enabling them to mobilize their knowledge in order to accomplish specific objectives (González-Morales, De Antonio, & García, 2011). The recruitment of engineers no longer depends only on technical skills but also on the level of development of soft skills because employers need engineers who are able to adapt quickly in their competitive work environment. Table 2 presents some works that have studied the importance of soft skills in improving engineers' employability.

Table 2. Importance of soft skills in improving engineers' employability

Studies	Results
(MS Rao, 2014)	-Soft skills improve engineering and management students' employability -Educational institutions must continuously identify the soft skills needed by the job market -According to companies (India), the students who succeed in their work are those who have a strong personality, better attitude, and good behavior -In order to ensure a better development of soft skills, students, faculty, employers, and director of educational institutions must collaborate with each other.
(Nilsson, 2010)	-Engineering graduates must be aware of the importance of soft skills and devote considerable effort to improve their employability -Engineering Education programs must focus less on technical knowledge and stress on developing soft skills required for student employability
(Zaharim, Yusoff, Omar, Mohamed, & Muhamad, 2009)	-Engineers' employability skills that most of the employers in Asia require are problem-solving skills, communication skills, and interpersonal skills. These skills can be more important than even technical skills
(Blom, & Saeki, 2011)	The authors carried out a survey addressed to Indian employers, they achieved the following results: -Employers are not satisfied with the qualification level of the newly graduated engineers -Soft skills are very important for the employability of engineering graduates -Educational curricula must focus more on high level thinking skills including engineering problem solving skills (Bloom's taxonomy) than just focus on basic thinking skills, such as remembering and understanding
(Saad, Robani, Jano, & Majid, 2013)	-When recruiting engineering graduates, employers give equal importance to soft skills and hard skills -Universities must accompany their graduates as they integrate into the professional world by evaluating their employers' satisfaction with the level of skills development -Universities must continuously collaborate with the job market in order to ensure that their graduates meet employers requirements

According to the studies presented in table 2, the importance of these skills can be summarized as follows:

- Students with the most developed managerial skills are those most likely to have competitive jobs.
- In addition to technical skills soft skills enable students to survive and succeed in the professional context.
- Students are better paid if they possess soft skills.
- The more developed engineers' soft skills are, the more satisfied they are with their job.

4. Qualitative Content Analysis

Engineering schools must devote considerable efforts to discover and integrate the international dimension of skills into their learning strategies in order to promote graduates who are operational in national and international competitive work environments. For this reason, a qualitative content analysis was carried out in our previous work (Chaibate, & Bakkali, 2017) in order to determine the soft skills required in engineering education. For this purpose,

we have studied the standards and syllabus published by engineering accreditation bodies in some developed countries. Table 3 presents the engineering soft skills identified from our previous study Chaibate, & Bakkali, 2017).

Table 3. Engineering soft skills required in engineering education

Engineering soft skills identified from the literature			
-Organization, rigour and efficiency	-Adaptability, Initiative and reactivity	-Autonomy and engineering decision making	-Mobility
-Engineering problem solving skills (analyze, synthesis)	-Communication (French English, negotiation)	-Writing skills	-Team working
-Engineering project management skills	-Team management	-Stress management	-Time management
-Professional responsibility in engineering practice	-Ethical and social responsibility in engineering practice	-Engineering innovation skills	-Entrepreneurship skills
-Using technology in engineering practice	-Keeping up with engineering technology		

5. Quantitative Content Analysis

5.1. Quantitative Data Collection

In order to answer our research question and determine the importance given by Moroccan job market to the soft skills previously identified from the qualitative content analysis, we have conducted a quantitative content analysis of job offers collected from different engineering fields. A job ad is an official announcement about a job opening created by the employer to alert job seekers with the required skills to apply for the offer. Job ads can be found in different sources including websites, print media, magazines, and newspapers. Today websites are the best solution to attract a wide choice of job seekers unlike newspapers which give a limited geographic reach.

In Morocco we find different job boards which publish job offers posted by companies, recruitment agencies and temporary employment agencies. Moreover, engineering job websites can be non-structured such as www.avito.ma, where the research process is difficult in contrast to the semi-structured websites which facilitate job finding (Khaouja, Rahhal, Elouali, Mezzour, Kassou, & Carley, 2018; Makdoun, Mezzour, Carley, & Kassou, 2018). In this study we have chosen to use three semi-structured comprehensive and complementary job sites in order to easily eliminate duplicates because the same job ad can be found in websites. Data were collected from September to December 2018 and the following job websites: emploi.ma, rekrute.com, and neuvoo.co.ma. Quantitative content analysis was conducted according to the steps described in figure 1. These steps will be sufficiently defined in the following sections.

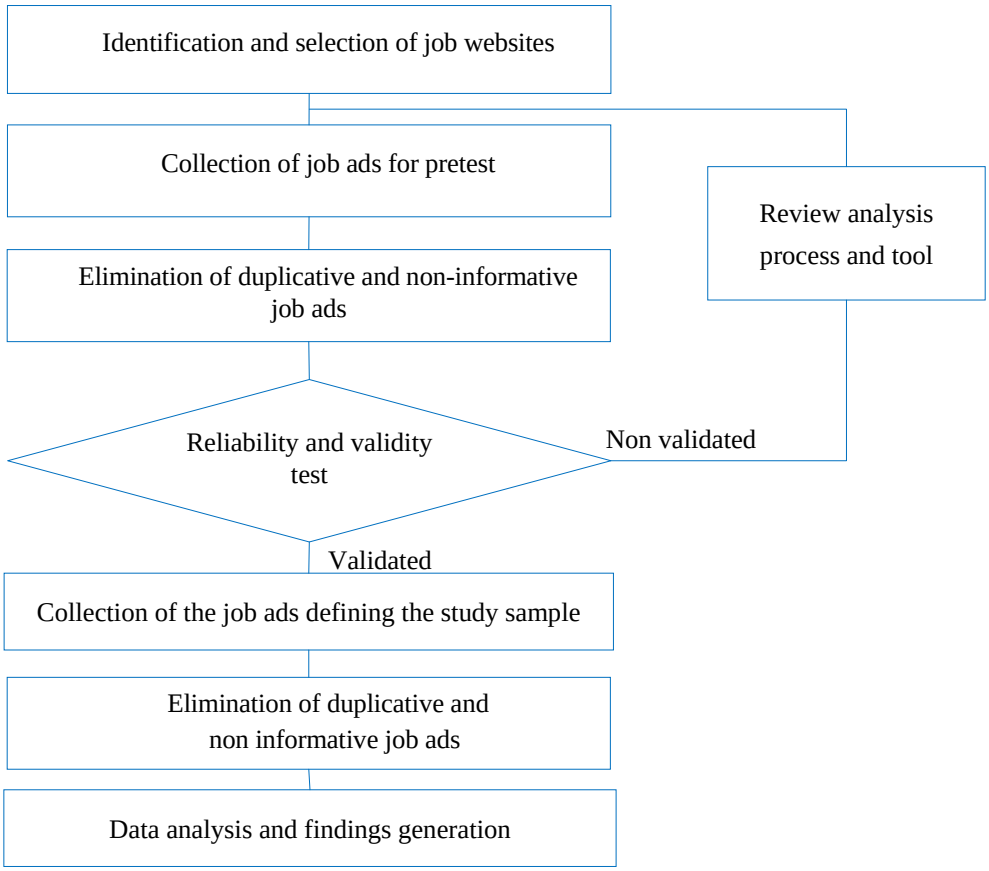

Figure 1. Quantitative content analysis steps

The analysis tool or instrument consists of an analysis grid composed of the soft skills defined from the qualitative approach. These identified skills are allocated to dichotomous variables that take two values 0 and 1:

- The variable takes 1 if the associated soft skill is contained in the job ad
- The variable takes 0 if the associated soft skill is not contained in the job ad

5.2 Reliability and Validity Test

Reliability refers to the consistency of a measure. It is defined by having the same results when measurements are applied to the same sample and under the same conditions (Riff, Lacy, & Fico, 2014; Krippendorff, 2018). In our study we have tested reliability using internal consistency which determines the extent to which items in the test evaluate the same construct, so they should be correlated with each other. This type of reliability can be calculated without reproducing the test or involving other researchers. Internal consistency is evaluated using Cronbach's alpha which is calculated using the formula (1). It ranges from 0 to 1 and it is maximized when test items are highly correlated which means that they evaluate the same construct.

$$\alpha = \frac{k}{k-1}\left(1 - \frac{\sum_{i=1}^{k} s_i^2}{s_T^2}\right) \quad (1)$$

Where:

- k is the number of items
- s_i^2 is the variance of the item i
- s_T^2 is the variance of the observed total test scores

Test reliability increases when alpha is closer to one. When Cronbach's alpha is above 0.5 reliability is considered acceptable so the study can be generalized to a larger sample (Nunnally, 1967; Briz-Ponce, Pereira, Carvalho, Juanes-Méndez, & García-Peñalvo, 2017).

When items in the test are assigned to dichotomous variables, in this case reliability is evaluated through the Kuder–Richardson Formula 20 (KR.20) which is calculated using the formula (2)

$$KR.20 = \frac{k}{k-1}\left(\frac{{s_T}^2 - \sum_{i=1}^{k} p_i(1-p_i)}{{s_T}^2}\right) \quad (2)$$

Where:

- k is the number of items
- sT ²is the variance of the total scores of the job ads
- p_i is the proportion of job ads mentioning the item (soft skill) i

In order to measure internal consistency (KR20), we have chosen randomly 30 job ads not belonging to the study sample. We have analyzed data using SPSS (Statistical Package for Social Sciences) which generates KR.20 automatically. SPSS result shows a value of 0.7 of the KR.20 coefficient. This value is acceptable to generalize the approach to the study sample.

Validity defines the extent to which the research instrument measures the expected phenomenon. It is evaluated by recourse to the expert judgment (Riff, Lacy, & Fico, 2014). In this study, we have tested the instrument and process validity by inviting a focus group of professionals in the labor market and academics in the engineering institution (professors, heads of departments, responsible for accreditation, researchers, and specialists of skills development in a multinational company). The focus group has extensively examined the adopted process and instruments in order to come up with guidelines and corrections that were taken into consideration during the approach implementation.

5.3 Data Analysis

After testing and validating the reliability and the validity of the test, 163 different engineering job ads were collected from the job websites mentioned above. These job ads were analyzed in order to identify the soft skills required by Moroccan job market. During the data collection process, a job ad is removed from the database if it is duplicative or not informative which means that it doesn't specify any soft skill. This quantitative content analysis enabled us to define which soft skills are highly required and which soft skills are lowly required.

Based on the level of soft skills requirements, obtained results were classified into four different categories:

• Category A: Contains the soft skills that are highly required by employers

• Category B: refers to the soft skills that are moderately required by the employers

• Category C: Consists of the soft skills that are lowly required by the professional world

• Category D: refers to the soft skills that are very lowly or rarely required by employers

5.3.1 Distribution of the Soft Skills in Category A

In figure 2 we find the soft skills that are highly required by the job market. Communication is the skill that is demanded by most of the employers (84%), because it enables engineers to deal with the company's environment including staff members, suppliers, and customers. 60% of the job ads require organization, rigour and efficiency. This justifies the importance of these skills in the achievement of work objectives. 52% of the job ads require engineers who are able to use technology in engineering practice. Moreover, adaptability, initiative, and reactivity skills are needed by 52% of the job offers. Educational institutions must dedicate great resources to the development of these soft skills in order to improve engineers' employability.

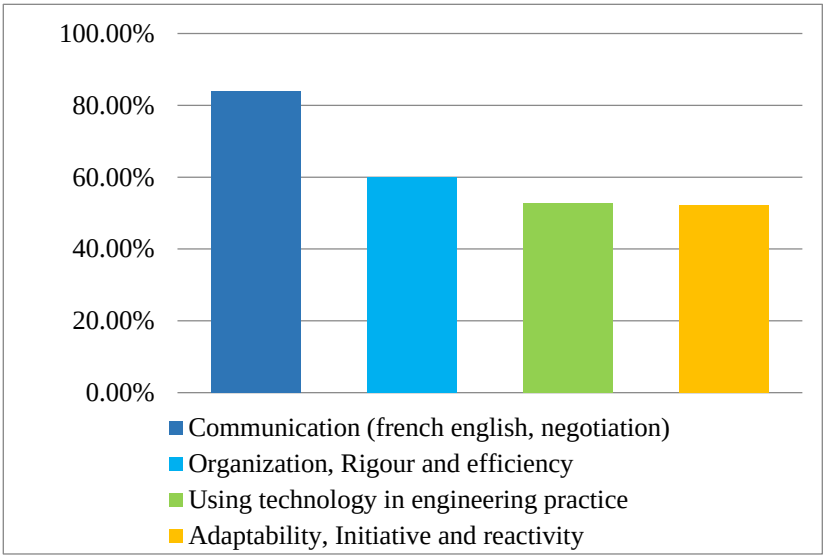

Figure 2. Distribution of the soft skills in category A

5.3.2 Distribution of the Soft Skills in Category B

While examining category B of the soft skills moderately required by Moroccan employers, as presented in figure 3, we can notice that professional responsibility (44.8%) is the most required soft skills. The latter refers to the ability to practice engineering by respecting work commitment and putting customer satisfaction before its own interests. Engineers must also develop the ability to work autonomously and make strong decision in different work situations (39.2%). They should also develop managerial skills including project management (38.6%), and team working (37.4%). Even if the ability to come up with innovative solutions (36.2%) and the capacity to define, analyze, and synthesize work problems (30%) are moderately required by Moroccan employers, they remain important to gain a competitive advantage in a very demanding market.

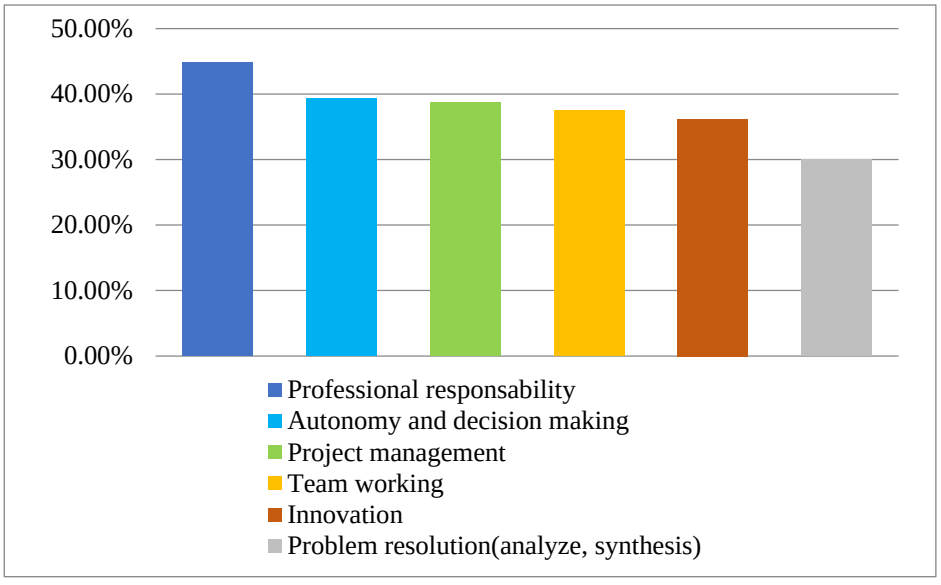

Figure 3. Distribution of the soft skills in category A

5.3.3 Distribution of Soft Skills in Category C

As presented in figure 4, the ability to write reports, standards, and any other documentation related to engineering practice is lowly required by employers (24.5%), this is not justified by the fact that this skill is not important, on the contrary that's because some companies often use the term communication to also identify the writing skills. For the same reason, Team management (16.5%), stress management (15.9%), and time management skills are in low

demand by the job market because they represent the skills necessary to manage a project which is a moderately required competency (see figure 3). Despite the importance of ethical and professional responsibility, Moroccan companies are not sufficiently aware of the importance of this dimension in engineering practice (12.2%). With the appearance of the offshoring sector as a promising field known by its potential to create local job opportunities in multinational groups, mobility is not often required by manufacturing companies (14.1%).

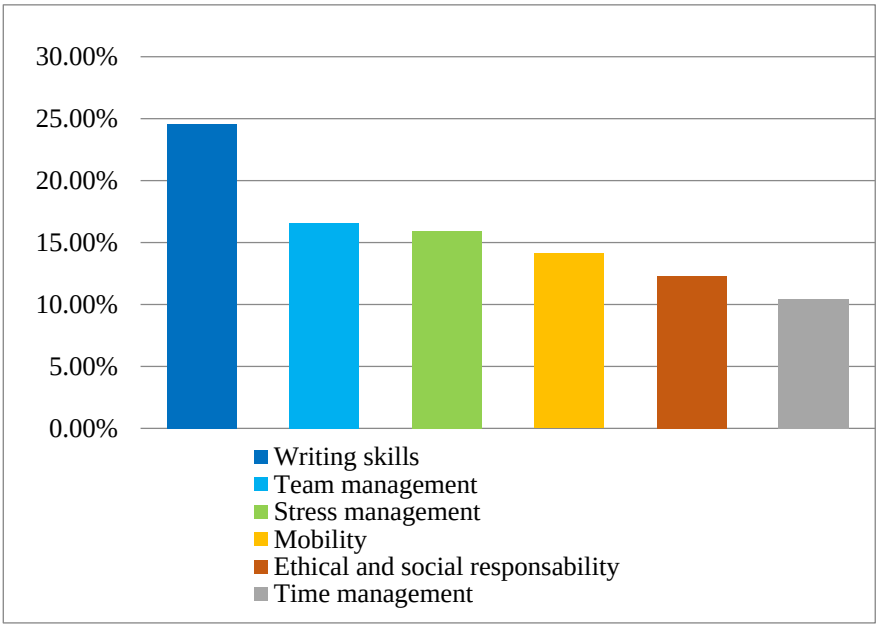

Figure 4. Distribution of the soft skills in category C

5.3.4 Distribution of the Soft Skills in Category D

As presented in figure 4, entrepreneurship is required only by 7.9% which means that this skill is not at all important from the point of view of the employer who is looking for a stable employee who is not looking for the best job offers. However, engineering schools must develop this kind of skills to enable their students to cup with the competitiveness challenges by creating their own work opportunities. The ability to keep up with new technology emerging towards the job market is very lowly required by the job market (6.7%). In order to avoid teaching obsolete technologies, schools must maintain a strong and ongoing relationship with the national and international job market to be up to date with technological development.

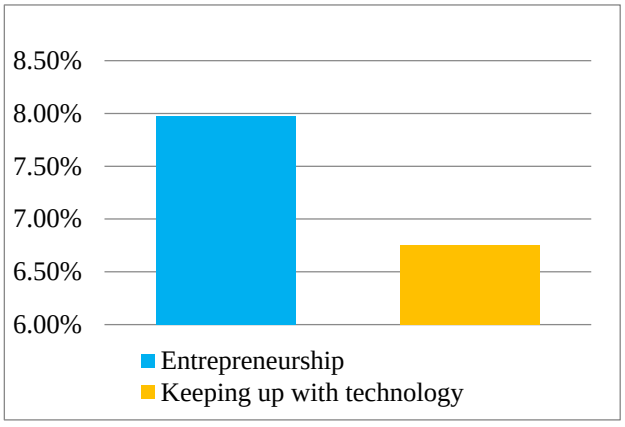

Figure 5. Distribution of the soft skills in category D

6. Soft Skills in Moroccan Engineering Education

6.1 Soft Skills Developed by Educational Curriculum

Engineering education in Morocco usually lasts for three years divided into six academic semesters organized as presented in figure 6 (CNPNCI, 2014).

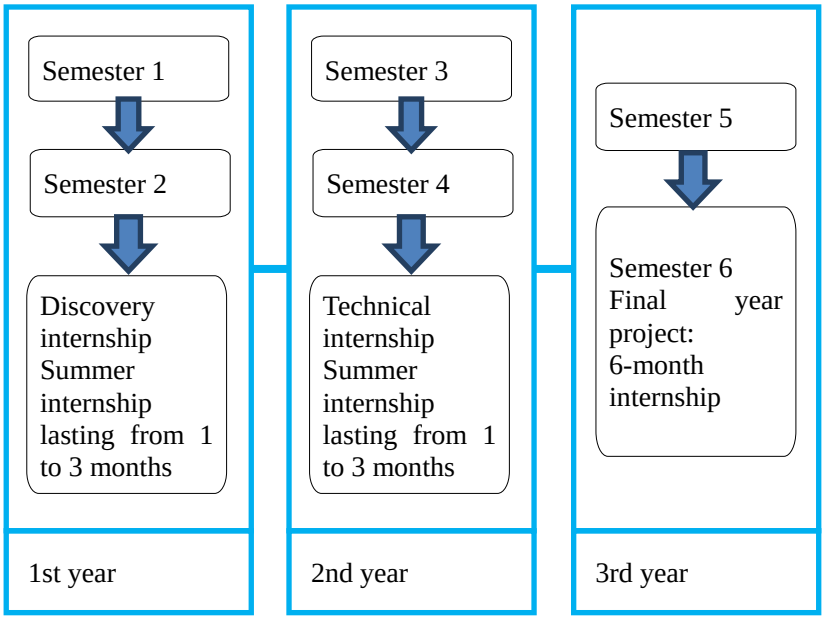

Figure 6. Structure of the three years of engineering education

Students must complete a one-month internship at the end of the first year where they will discover the professional world. Technical internship is a summer internship that responds to a problem within a company. It is carried out at the end of the second year and lasting from one to three months. Semester 6 is evaluated through a final year project lasting for six months and supervised by both a teacher from the school and a professional in the company. This project allows students to put into practice the skills developed during the three years of engineering training.

During the first five semesters engineers develop two kinds of skills including technical skills and soft skills. Technical skills are acquired through specific modules related to the engineering field. Technical modules cover 60 % to 80 % of the overall hours of the first five semesters. Soft skills are developed through managerial modules representing 10% to 20% of the overall hours of the first five semesters. These skills are also developed using Language and communication modules covering 10% to 20% of the overall hours of the first five semesters (Chaibate, Hadek, Ajana, Bakkali, & Faraj, 2019).

We have previously carried out a study aimed at identifying the soft skills developed through the management and communication modules. For this purpose, we have deeply studied the educational curriculum of a Moroccan school of engineering education (Chaibate, & Bakkali, 2017; Chaibate, Hadek, Ajana, Bakkali, & Faraj, 2019; CNPNCI, 2014; MENFP, 2017). Table 4 shows the results of this study.

Table 4. Distribution of management and communication modules

Soft skills developed by communication modules	Soft skills developed by management modules
-Communication and negotiation	-Efficiency
-Writing skills	-Initiative, autonomy
-The ability to communicate in French	-Engineering decision making
-The ability to communicate in English	-Team working
-Professional conduct	-Engineering project management (resources)

It can be seen that educational programs develop the soft skills that are highly required by employers. As a result, they are located close to the job market requirements (figure 2, figure 3). On the one hand, management modules aim at enabling students to build a set of skills including efficiency, initiative, autonomy, decision-making, team working and project management skills. On the other hand, communication modules are intended to develop communication skills such as negotiation, professional writing skills, languages (French, English), and professional conduct. In order to deal with the challenges related to the job market competitiveness, educational institutions must also identify and develop soft skills that are in low demand to improve students' employability.

6.2 Finding about Moroccan Engineers Soft Skills

In order to collect finding about Moroccan engineers soft skills, we interviewed professionals from nine companies operating in different fields in Morocco including consulting in advanced engineering, electricity production, after sales service, plastic injection (automotive industry), automotive cabling, portfolio management, heavy metal construction for industry, delivery of liquefied petroleum gas, and mining engineering. The interviewed professionals perform different functions within the targeted companies such as project leader, consulting engineer, technical executive engineer, specialist in customer support agreements, logistics engineer, methods manager, director of human resources, project manager, and human resources Manager. This study allowed us to come up with the following findings:

• 92% of the professionals interviewed consider that soft skills are strictly important in the professional insertion of Moroccan engineers

• Moroccan engineers' soft skills insufficiently developed when compared to the job market requirements which justifies the difficulties encountered while integrating into the labor market

• Professionals also revealed a set of weaknesses detected by welcoming newly graduated engineers. These deficiencies are related to the low level of development of some soft skills including communication, autonomy, decision-making, priority management, team working, stress management, self-confidence, and creativity. After reviewing educational programs (section 5.1), we found that engineering curricula are situated close to the employers requirements because they develop the soft skills that are in high demand. However, professionals' findings reveal that Moroccan engineers' soft skills are not sufficiently developed to improve their employability. This contradiction leads us to deeply examine the pedagogical methods adopted to develop this kind of skills in engineering schools.

7. Conclusion

Moroccan engineering schools must provide better training that enables engineers to meet workplace requirements. This paper aims at evaluating the importance of soft skills in Moroccan job market and engineering education. On the one hand, we have determined the soft skills needed by Moroccan employers using a mixed research method belonging to the sequential exploratory design. In this study we have identified the highly required soft skills such as communication, organization, using technology in engineering practice, and initiative. We have also identified soft skills that are very lowly required despite their importance in the literature including entrepreneurship skills and the ability to keep up with emerging technology. On the other hand, we have carried out a study to determine the soft skills covered by engineering educational curricula. Results show that learning programs are located close to the job market demand by containing most of the soft skills needed by employers. However, the findings collected by interviewing professionals operating in different fields reveal that the soft skills of Moroccan engineers are not sufficiently developed to reach the required level. As a result, considerable efforts must be devoted to deeply examine the pedagogical methods used to develop this kind of skills in order to answer the following question: do the strategies adopted contribute to the development of the needed soft skills and the monitoring of students' progress?

Conflict of Interest

The authors declare no conflict of interest.

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